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Leibniz-Institut für Meereswissenschaften
an der Universität Kiel

RV SONNE
Fahrtbericht / Cruise Report
SO 199 CHRISP

Christmas Island Seamount Province and the Investigator Ridge:
Age and Causes of Intraplate Volcanism
and Geodynamic Evolution of the south-eastern Indian Ocean

Merak/Indonesia - Singapore
02.08.2008 - 22.09.2008

Berichte aus dem Leibniz-Institut
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Christian-Albrechts-Universität zu Kiel

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SUMMARY

The research project SO199 CHRISP (CHRistmas Island Seamount Province and the Investigator Ridge: Age and Causes of Intraplate Volcanism and Geodynamic Evolution of the South-Eastern Indian Ocean) comprises petrological, volcanological, geochemical, geochronological, geophysical, and biological studies in the area of the northern Wharton Basin (South-East Indian Ocean). R/V SONNE cruise SO199 focused on the "Christmas Island Seamount Province", a huge (~1,800 x 600 km) submarine volcanic province of unknown origin, and on the Investigator Ridge, a ~1,800 km long N-S striking fault zone in the ocean crust of the Wharton Basin. The studies conducted on cruise SO199 include multi-beam mapping, sediment echo sounding, magnetic profiling, hard rock sampling, and biological sampling. The major targets of the cruise are (1) to map and sample seamounts in the northern Wharton Basin and the Investigator Ridge, (2) to record bathymetrical, sub-bottom profiling, and magnetic data in the northern Wharton and western Argo Basin, and (3) to sample meio- and macrofaunal key taxa. SO199 CHRISP aims to contribute towards a better understanding of the origin of intraplate volcanism and the „Indian Mantle Domain" as well as of geodynamic evolution and the diversity and the distributional patterns of the invertebrate communities in the south-east Indian Ocean.

The R/V SONNE cruise SO199 started in Merak/Indonesia on August 3rd, 2008 and ended in Singapore on September 21st, 2008. Complementing 5,694 nm of SIMRAD EM120 and Parasound profiling (including 2,787 nm of magnetic profiling) a total of 70 dredges, 13 TV grabs, and nine multi corers were carried out during SO199. Of these deployments, 63 recovered magmatic rocks, 39 volcaniclastics, 25 sedimentary rock, and 11 Mn-Fe oxides. Fifty deployments yielded macrofauna and 75 unlithified sediment for biological studies.

Dredging at the Investigator Ridge yielded a spectacular array of rock types representing a full cross section through the entire ocean crust into the upper mantle. At the seamounts, porphyric sheet and pillow lavas dominate, but various types of volcaniclastic rocks are also common. Minor lithologies include, among others, evolved lavas and sedimentary rocks. Mapping of ~1,300 km of the Investigator Ridge revealed a steep west-facing scarp along most of the fracture zone, suggesting recent reactivation related to the presently diffuse but developing new plate boundary between the eastern (Australian) and the western (Indian) parts of the Indo-Australian Plate. Faulted sediments and north-south oriented ravines and asymmetric tops of seamounts adjacent to the ridge imply left-lateral reactivation of older seafloor fractures, consistent with the regional tectonic picture in which Australia is continuing to move northwards whereas India has been stuck since the collision with Asia. The Christmas Island Seamount Province is marked by a broad variety of volcanic and tectonic (?) structures ranging from small, isolated volcanic cones to huge plateau-like structures. Uneroded volcanic cones on the guyot platforms as well as uneroded seamounts being higher than the guyots indicate revival of volcanic activity after subsidence of the guyots below sea level, being inconsistent with a stationary plume source below a moving plate. Moreover, the varying depths (~1,200 – 3,000 m) of the erosional platforms of the guyots, the variety of morphologies, and the occurrence of rocks formed in different environments indicate a complex, long-lasting tectonic and magmatic history of the Christmas Island Seamount Province.

Magnetic profiles east of the southern Investigator Ridge show anomalies indicating that this crust was formed in the Jurassic. Further magnetic profiles in the area of the south-eastern Wharton Basin and the Argo Basin have been placed in existing data gaps and will be used for a new interpretation of the seafloor spreading anomalies in this area.

Biological material was obtained successfully as macrofauna and as sediment samples containing meiofaunal organisms with the help of a geological chain bag dredge, sediment traps, a multicorer and a TV-grab. During the cruise, a total of 9,132 meiofaunal organisms were centrifuged out of about 60 kg of sediment and sorted to animal group. Foraminifera and Nematoda dominated the meiofauna, followed by Copepoda and at a lower abundance by Tardigrada, Kinorhyncha and Loricifera. Macrofaunal organisms were surprisingly rare on the dredged rocks. The benthos community was dominated by hexactinellid sponges and sedentary polychaetes. The rareness of animals in the samples despite the recorded species richness at some TVG stations is discussed.

ZUSAMMENFASSUNG

Das Forschungsprojekt SO199 CHRISP (CHRistmas Island Seamount Province and the Investigator Ridge: Age and Causes of Intraplate Volcanism and Geodynamic Evolution of the South-Eastern Indian Ocean) umfasst petrologische, vulkanologische, geochemische, geochronologische, geophysikalische und biologische Untersuchungen im nördlichen Whartonbecken (SE-Indik). Die FS SONNE-Expedition SO199 konzentrierte sich auf die „Christmas Island Seamount Provinz“, eine gewaltige, ca. 1.800 x 600 km große submarine Vulkanprovinz unbekannten Ursprungs und auf den Investigatorrücken, eine 1.800 km lange, N-S streichende Störungszone in der Ozeankruste des Whartonbeckens. Mit SO199 CHRISP soll zu einem besseren Verständnis des Ursprungs von Intraplattenvulkanismus, der „Indian Mantle Domain“ und der geodynamischen Entwicklung des südöstlichen Indik beigetragen werden sowie Diversität und Verteilungsmuster des Tiefseebenthos in diesem Gebiet untersucht werden.

Die FS SONNE-Expedition SO199 begann am 3. August 2008 in Merak (Indonesien) und endete am 21. September 2008 in Singapur. Insgesamt wurden während SO199 neben 5.694 nm Profilfahrten (SIMRAD EM120/Parasound), davon 2.787 nm mit Magnetometersensoren, 70 Dredgezüge, 13 TV-Greifereinsätze, und 9 Multicorereinsätze in einer durchschnittlichen Wassertiefe von 3.901 m durchgeführt. Dreiundsechzig dieser Geräte-einsätze erbrachten magmatische Gesteine, 41 Vulkaniklastika, 27 sedimentäre Gesteine und 13 Mn-Fe-Oxide. Für die Biologie erbrachten 50 Geräteeinsätze Makrofauna und 75 unverfestigte Sedimente.

Die Dredgezüge am Investigatorrücken erbrachten eine spektakuläre Vielfalt von Gesteinstypen, die einen kompletten Querschnitt durch die Ozeankruste bis in den oberen Mantel repräsentieren. An den Seamounts dominierten teilweise hochporphyrische Schicht- und Pillowlaven sowie verschiedene Vulkaniklastika. Untergeordnete Lithologien sind u.a. entwickelte Laven und sedimentäre Gesteine. Die Kartierung von etwa 1.300 km des Investigatorrückens zeigte, dass dieser durch einen sehr steilen Westhang gekennzeichnet ist. Dieses morphologische Merkmal könnte mit einer rezenten Reaktivierung der Störungszone erklärt werden, die wahrscheinlich mit der “diffusen”, sich neu entwickelnden Plattengrenze zwischen Indien und Australien zusammenhängt. Auch verfaltete Sedimente sowie N-S verlaufende Schluchten und asymetrische Tops von in der Nähe des Rückens gelegenen Seamounts deuten darauf hin, dass N-S-streichende Strukturen in der ozeanischen Lithosphäre als linkslaterale Störungen reaktiviert werden. Die Christmas Island Seamount Provinz ist durch eine große Vielfalt an vulkanischen und tektonischen (?) Strukturen gekennzeichnet, die von kleinen, isolierten Vulkankegeln bis zu riesigen Plateaus reichen. Die Existenz unerodierter Vulkankegel auf den Erosionsplattformen von Guyots sowie unerodierter Seamounts, die die Guyots überragen, zeigt, dass die vulkanische Aktivität nach Erosion und Absenkung der Guyots wieder aufflammte. Auch die stark variierende Tiefe der Erosionsplateaus der Guyots (ca. 1.200 – 3.000 m), die großen Unterschiede in der Morphologie der Vulkanbauten oder das Auftreten von Vulkaniten, die in unterschiedlichen Environments gebildet wurden, zeigen, dass die Christmas Island Seamount Provinz offenbar eine lange, sehr komplexe geologische Geschichte hat und nicht allein mit dem “klassischen” Modell eines ortsfesten Plume erklärt werden kann.

Mit Magnetikprofilen konnte auf der Ostseite des Investigatorrückens ein jurassisches Alter der Kruste nachgewiesen werden. Weitere Magnetikprofile im südöstlichen Whartonbecken und im Argobecken wurden gezielt in bestehende Datenlücken platziert und gehen in eine Neuinterpretation der dortigen magnetischen Seafloor-Spreading-Anomalien ein.

Biologisches Material (Makrofauna und Meiofauna aus Sedimentproben) konnte mit Hilfe von geologischen Dredgen, Sedimentfallen in geologischen Dredgen, einem Multicorer und einem TV-Greifer gesammelt werden. Bereits an Bord wurden 9.132 Meiofauna-Organismen aus insgesamt etwa 60 kg Sediment auszentrifugiert und nach Tiergruppen vorsortiert. Foraminifera und Nematoda dominierten die Meiofauna, gefolgt von den Copepoda und in etwas geringerer Häufigkeit von Tardigrada, Kinorhyncha und Loricifera. Makrofauna wurde insgesamt nur spärlich auf den geborgenen Steinen gefunden werden. Dominiert wurden Benthos-Organismen von hexactinelliden Schwämmen und sedentären Polychaeten. Gründe für die geringe Ausbeute der ansonsten nach TVG-Beobachtungen reichen Benthos-Fauna des Untersuchungsgebietes werden ausführlich diskutiert.

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The SO199 Shipboard Scientific Party.

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3. MAJOR OBJECTIVES AND BACKGROUND OF SO199 CHRISP

(R. Werner, F. Hauff, K. Hoernle, U. Barckhausen, C. Lüter, B. Neuhaus)

The research project SO199 CHRISP (CHRistmas Island Seamount Province and the Investigator Ridge: Age and Causes of Intraplate Volcanism and Geodynamic Evolution of the South-Eastern Indian Ocean) comprises investigations of volcanic and tectonic structures, magmatic rocks and marine organisms in the area of the northern Wharton and western Argo Basin (South-East Indian Ocean). The morphology of the northern Wharton Basin is dominated by the Investigator Ridge, a ~1,800 km long, N-S striking fracture zone and the „Christmas Island Seamount Province", a huge (~1,800 x 600 km) submarine volcanic province of unknown origin (Fig. 3.1.). The geological and geophysical studies carried out on R/V SONNE cruise SO199 focused on multi-beam mapping of the ocean floor, sediment echo sounding, magnetic profiling and hard rock sampling by dredge and TV-grab. The major targets of the cruise were (1) to map and sample seamounts of the Christmas Island Seamount Province and the Investigator Ridge and (2) to record bathymetrical, sub-bottom profiling, and magnetic data in the northern Wharton and western Argo Basin. Subsequent morphological, volcanological, petrological, geochemical, geochronological, and geophysical analyses aim to improve our understanding of:

(1) the origin of intraplate volcanism by reconstruction of the magma sources and the temporal and spatial evolution of volcanism forming the Christmas Island Seamount Province;
(2) the evolution of the "Indian Mantle Domain" (enriched geochemical signature of mid ocean ridge basalts in the Indian Ocean) by reconstructing the age and composition of the ocean crust in the northern Wharton Basin;
(3) internal deformation of oceanic plates by characterization of recent and ancient deformation of the Indo-Australian plate; and
(4) plate convergence in the southeastern Asian area by identification of ocean floor spreading anomalies.

The integration of these results with existing data should contribute towards a better understanding of the origin of intraplate volcanism and the „Indian Mantle Domain" as well as of geodynamic processes in the South-East Indian Ocean.

Furthermore the diversity and the distributional patterns of the invertebrate communities are investigated in the framework of SO199 CHRISP. With a focus on meio- and macrofaunal key taxa, the biological samples will provide insight into the biogeography of the respective groups. The biological data may be used to assess results of the geological part of the project and *vice versa*. Notably, the benthos biology of this region is largely unknown and by collecting and analyzing soft sediment samples as well as hard bottom dwelling organisms, we expect to get a representative overview of the species composition of the northern Wharton Basin.

3.1. CHRISTMAS ISLAND SEAMOUNT PROVINCE AND INVESTIAGTOR RIDGE

The "Christmas Island Seamount Province" (working name given by the SO199 CHRISP science team) is located between ~ 10°S and ~ 15°S and ~ 95°E and ~ 109°E (Fig. 3.1.) and covers ~1,000,000 square kilometers (approximately three times the area of Germany). This area is characterized by approximately 50 large, up to >5,000 m high seamounts (including Cocos/Keeling Atolls, Muirfield Seamount, Vening Meinesz Seamounts, and Christmas Island; Fig. 3.1.) and numerous smaller submarine volcanic and tectonic features. Up till now the origin and nature of this huge seamount province is largely unknown. The Christmas Island Seamount Province extends in E-W direction and therefore orthogonally to the NNE-direction of plate motion in the Wharton Basin, contradicting an origin by a "classical" fixed mantle plume (see chapter 3.2.). It is also unlikely that the existence and evolution of the Christmas Island Seamount Province is exclusively controlled by the faults and fracture zones in this area since most of these structures (e.g., Investigator Ridge) strike in N-S direction. Furthermore it is yet unclear to which extend the magmatism forming the Christmas Island Seamount Province is related to the internal deformation of the Indo-Australian plate and the possible incipient break-up of this plate (see chapter 3.4.).

Most informations and data from the volcanoes of the Christmas Island Seamount Province are obtained through studies of the islands, in particular Christmas Island (see also chapter

5.2.5.). Christmas Island is subject to strong uplift which is possibly related to a flexure of the Indo-Australian plate caused by bending of the plate off the Java trench (i.e. prior to subduction) (Woodroffe 1988). On Christmas Island two volcanic successions have been identified (Woodroffe 1988). The „lower series“, being deposited during or prior to Eocene, comprise of a lower unit (andesites to trachybasalts) and an upper unit (basalts to andesites and trachybasalts) (Trueman 1965). The „upper series“ consist of mafic limburgites (basanites) overlain by Late Oligocene and Miocene limestones (e.g., Trueman 1965, Woodroffe 1988). By contrast to Christmas Island the Cocos/Keeling Atolls, being located ~900 km to the west, subside (see also chapter 5.2.3.). Charles Darwin visited these islands in 1836 when he developed his well known theory of atoll formation (Darwin 1842) which has gained wide acceptance. He considered that the upgrowth of coral reefs continued long after the seamounts that supported them had subsided. The thickness of the corals underlying Cocos/Keeling Atolls is not known, but dredging of basaltic rocks in local waters suggest that it is in the order of 500 – 1,000 m (Pulu Keeling National Park Plan of Management, Darwin, 1999).

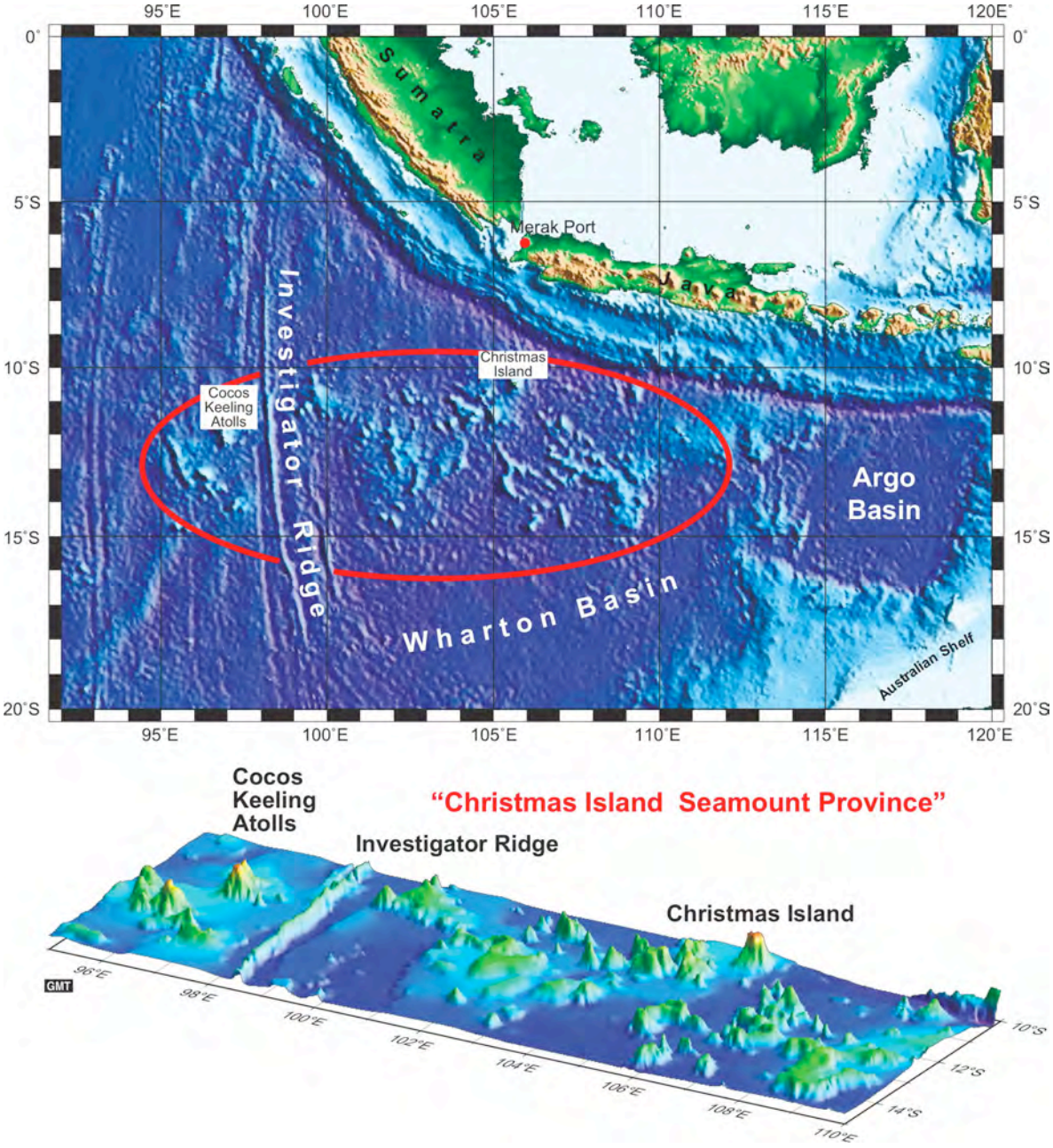

Fig. 3.1.: *Overview bathymetric map of the south-eastern Indian Ocean including the Christmas Island Seamount Province (marked by red circle) and the Investigator Ridge.*

To our knowledge only a few of the submarine structures of the Christmas Island Seamount province have been sampled so far. Dredging on the RV Argo (1 dredge according to Exon et al. 1993), RV Vityaz (Bezrukov and Andrushenko 1974), RV Franklin (Fallon et al. 1989) and RV Rig Seismic (Exon et al. 1993) yielded alkali basaltic and trachytic lavas as well as various volcaniclastic rocks from the base of Christmas Island and adjacent seamounts. However, many of these samples have not been analyzed or the data have not been published since these cruises mainly aimed exploration of mineral deposits. During DSDP Leg 22, three sites have been drilled into the ocean crust in the area of the Christmas Island Seamount Province. Site 211 is located to the northwest of Christmas Island and yielded amphibole-bearing basalts overlain by Campanian (?) sediments. K/Ar dating of doleritic sills which penetrated these sediments yielded an age of 71±2 Ma (McDougall 1974). Site 212 to the south and Site 213 to the west of Christmas Island yielded altered pillow basalts with Indian mid ocean ridge basalts (MORB) composition (Hekinian 1974). Taken together, prior to SO199 CHRISP the sample and data set of the Christmas Island Seamount Province was too poor to enable the reconstruction of the origin and evolution of this huge submarine volcanic province.

The Investigator Ridge is a ~1,800 km long, roughly N-S striking bathymetric high that extends from 18°S to ~2°S (Fig 3.1.), where it subducts beneath Sumatra. The ridge represents the most prominent of the numerous N-S to NNW-SSE striking faults in the ocean crust of the Wharton Basin and presumably formed prior to the plate tectonic reorganization of the circum-Indian area at 90 to 100 Ma. In general the Investigator Ridge is thought to represent a fracture zone along which younger ocean crust to the west is aligned against older crust to the east. Based on the proposed location of anomaly M33 (79 - 74 Ma) on both sides of the Investigator Ridge, ocean crust of similar age appears offset by ~900 km in a left lateral sense. Existing magnetic profiles are, however, scarce in this part of the Indian Ocean (see chapter 3.5.) and for a good stretch immediately east of the Investigator Ridge practically non-existent so that the true nature and offset in crustal age along this presumed fracture zone was largely unknown prior to SO199. Sushchevskaya et al. (2000) discuss the geochemistry from basalts dredged at one site at the southern Investigator Ridge and a second site on the ocean crust somewhat to the west. These samples have heterogenic compositions ranging from MORB to alkali basalts and show enriched lead isotope ratios. To our knowledge, further rock samples or detailed bathymetric data from the Investigator Ridge do not exist.

3.2. INTRAPLATE VOLCANISM AND THE “GREAT PLUME DEBATE”

Since the introduction of plate tectonics, intraplate volcanism has generally been attributed to fixed, deep-seated mantle plumes (e.g., Wilson 1963, Morgan 1971, Burke and Wilson 1976) or continental rifting (e.g., Weaver and Smith 1989). In response to increasing problems in explaining intraplate volcanism in many areas as, for example, in the southern Pacific or north-eastern Atlantic region, a global debate has developed on the origin of intraplate volcanism and the classical "plume” or “hotspot hypothesis" has been challenged and modified with respect to depth of origin, shape and fixity (“Great Plume Debate”, e.g., http://www.mantleplumes.org). In addition, it has been proposed that only a few plumes have deep-mantle sources, while most plumes originate within the upper mantle (Courtillot et al. 2003, Montelli et al. 2006). Recent progress in numerical modeling of thermomechanical plumes (e.g., Farnetani and Samuel 2005, Lin and van Keken 2006) propose that besides the classical vertical diapirs, plumes are likely to achieve more complex forms that lead to episodic or pulsating plume activity or could consist of collections or strings of discrete blobs rather than continuous plume conduits, as has also been suggested based on geochemical and geochronological studies of intraplate volcanism (e.g., Hoernle and Schmincke 1993a, b, Geldmacher and Hoernle 2000, Geldmacher et al. 2006a, Hoernle et al. 2004a, O’Conner et al. 2000). Furthermore, they can have irregular shapes with several plume heads or small plumelets connected with a larger plume at depth. Finally mantle convection models question the fixity of mantle plumes (Steinberger and O’Connell 1997, 1998, 2000, O’Neill et al. 2005) and are supported by field evidence for a paleolatitude drift of the Hawaiian hotspot (Tarduno et al. 2003). Thus it is likely that mantle plumes are not fixed relative to each other; a view independently suggested by plate circuit studies which require large amounts of motion between the Pacific and Indo-Atlantic hotspots (Cande et al. 1995, Raymond et al. 2000). Still

others question mantle plumes as exclusive source for (oceanic) intraplate volcanism or even contradict the existence of mantle plumes and relate intraplate magmatism to shallow processes, such as convection in the upper mantle (e.g., King and Anderson 1998, King and Ritsema 2000, Anderson 2000), melting of weak zones in the lithosphere (e.g., Smith 2003), magmatism at propagating fault zones (e.g., Anguita and Hernán 1975, 2000), and faulting or lower lithopsheric detachment allowing upwelling and decompression melting of fertile upper mantle (e.g., Smith and Lewis 1999, Anderson 1995, 2001, 2005, Foulger 2002, Hoernle et al. 2006). In recent years intraplate magmatism occurring diffuse over a large area within long time periods (several 10 mill. years) with low production rates (e.g., the Cenozoic intraplate province in the Southwest-Pacific) has been related to “diffuse alkaline magmatic provinces” (e.g., Smith 2004, Finn et al. 2004, 2005). Finn et al. (2005) attributed this magmatism to interaction between the upper mantle with metasomized subcontinental lithosphere along zones of crustal weakness. The “Great Plume Debate" is, however, largely based on theoretical models, since only a few intraplate volcanic provinces have been sampled sufficiently to enable critical tests for the various theoretical models mentioned above. The investigations of the enigmatic Christmas Island Seamount Province in the framework of SO199 CHRISP may therefore provide an important contribution to the “Great Plume Debate".

3.3. INDIAN MANTLE DOMAIN

Indian MORB clearly differ in their isotopic signatures from Atlantic or Pacific MORB (e.g., Dupré and Allégre 1983). Indian MORB may show significantly higher $^{87}Sr/^{86}Sr$ and lower $^{143}Nd/^{144}Nd$ and $^{176}Hf/^{177}Hf$-ratios and has higher $^{208}Pb/^{204}Pb$-ratios at given $^{206}Pb/^{204}Pb$ (e.g., Hofmann 2004). The origin and evolution of this so-called „Indian Mantle Domain“ is a question of considerable debate. The most popular explanation is contamination of the upper mantle beneath the Indian Ocean by sediments or enriched sub-continental mantle (e.g., Allègre and Turcotte 1985, Hart 1988). Based on a few data from the Ninetyeast- and Investigator Ridge, Sushchevskaya et al. (2000) postulate that the opening of the eastern part of the Indian Ocean was related to the formation of a „super plume“ which caused the Gondwana break-up. These authors explain the geochemical heterogeneity of the basement of the Indian Ocean by plume-induced melting of different parts of the lithosphere. Another possible origin of the „Indian Mantle Domain“ could be fragments of continental crust since the geochemical characteristics of this anomaly could also be explained by mixing of primitive mantle (MORB source) and continental crust (upper continental crust with a composition similar to the enriched mantle [EM] 2 endmember and lower crust with a composition similar to the EM 1 mantle endmember). Such crustal fragments could be either form enriched areas in the upper mantle by delamination of lower continental crust (Escrig et al. 2004) or get into the upper mantle as a consequence of the Gondwana break-up (Hanan et al. 2004) or could be situated within the oceanic lithosphere (Whitmarsh and Party 1998, Hoernle et al. 1991, Hoernle 1998). However, it is still unclear for how long the specific isotopic composition of the upper mantle beneath Indian Ocean exists is in existence and if and how, respectively, this composition has changed in the course of time. SO199 CHRISP will address these questions by the investigations of the Investigator Ridge since sampling along this Ridge will allow us to reconstruct the composition of parts of the upper Indian Mantle between ~50 Ma and >(?)130 Ma.

3.4. INTERNAL DEFORMATION OF OCEANIC PLATES

In the past years it has become evident, that oceanic plates do not generally behave rigid but instead can deform internally. This observation is of increasing scientific importance. For example, Steinberger et al. (2004) showed that the geometry of the Hawaii-Emperor seamount chain and other hotspot tracks could be explained by the combination of global plate movements, internal plate deformation, and movement of hotspots due to changes of global mantle currents.

The Wharton Basin has long been known to be the site of several of the largest strike-slip intraplate earthquakes ever recorded with the largest Earthquake (magnitude 7.8, June 18, 2000) occurring where the Christmas Island Seamount Province intersects the Investigator Ridge (Deplus 2001). Direct evidence of active deformation has been reported from the

northern Wharton Basin (Deplus et al. 1998). Swath-mapping during the DEFLO campaign with the R/V Marion Dufresne in 2000 produced evidence that some of the N-S trending fracture zones in the central Wharton Basin are still active. This activity may be related to differential spreading rates along the Central Indian Ridge and Southeast Indian Ridge (e.g., Gordon et al. 1990, DeMets et al. 1994), reflecting different boundary conditions for the Indo-Australian plate (Deplus 2001). The northward motion of India is resisted by the India-Asia collision, whereas Australia continues to move northward. Seismic and bathymetric data combined with suggestions for late Tertiary to Quaternary (?) volcanism suggest that the Christmas Island Seamount Province may be linked to active ongoing internal deformation of the Indo-Australian Plate, possibly even the break-up of the Indo-Australian plate.

3.5. PLATE CONVERGENCE IN THE SOUTHEASTERN ASIAN AREA

At its eastern boundary, the Indo-Australian plate subducts under the Eurasian plate along the Sunda Arc which stretches over more than 5,000 km from the Andaman Sea to the Banda Sea. Along this subduction zone, many different types of subduction regimes are being observed. The changes along arc are related to different types of overriding crust, changing convergence rates, an increasing amount of trench parallel slip components towards the northwest, and massive changes in the sediment load which the downgoing oceanic plate carries into the subduction zone. However, changes in slab geometry can also be the result of the subduction of oceanic crust of different ages and of different crustal thickness and temperature status resulting from volcanic events that overprinted parts of the oceanic lithosphere long after its formation. It is known that the oceanic crustal ages along the Sunda Arc range from Jurassic in the Banda Sea to Eocene offshore Sumatra. However, many details about the location of fracture zones and offsets along them as well as crustal ages especially in the eastern Wharton Basin remain unclear to date. In the Argo and Gascoyne basins, the identification of magnetic seafloor spreading anomalies is still under debate. The observation and identification of seafloor spreading anomalies is the most important method for defining the tectonic inventory of the oceanic plate along the Sunda Arc and at the same time provides information needed for the plate tectonic reconstruction of the opening of the Indian Ocean basin following the Gondwana break-up.

4. CRUISE NARRATIVE

(R. Werner, K. Hoernle)

The starting point of the SO199 cruise funded by the German Ministry of Education and Research (BMBF) was the port of Merak on Java, Indonesia (Fig. 4.1.). In the early afternoon of August 2nd, the SO199 scientific party boarded R/V SONNE. On Sunday August 3rd, R/V SONNE departed from Merak at 4:00 pm under nice weather conditions and headed for the northern end of the Investigator Ridge south of Sumatra, Indonesia. On the way out of the Sunda Straits, we passed Krakatoa Volcano in the late evening. With light enhancing binoculars, it was possible to see lava fountaining on Anak (child of) Krakatoa, the new volcanic cone growing in the center of the Krakatoa Crater formed during the catastrophic eruption of 1883.

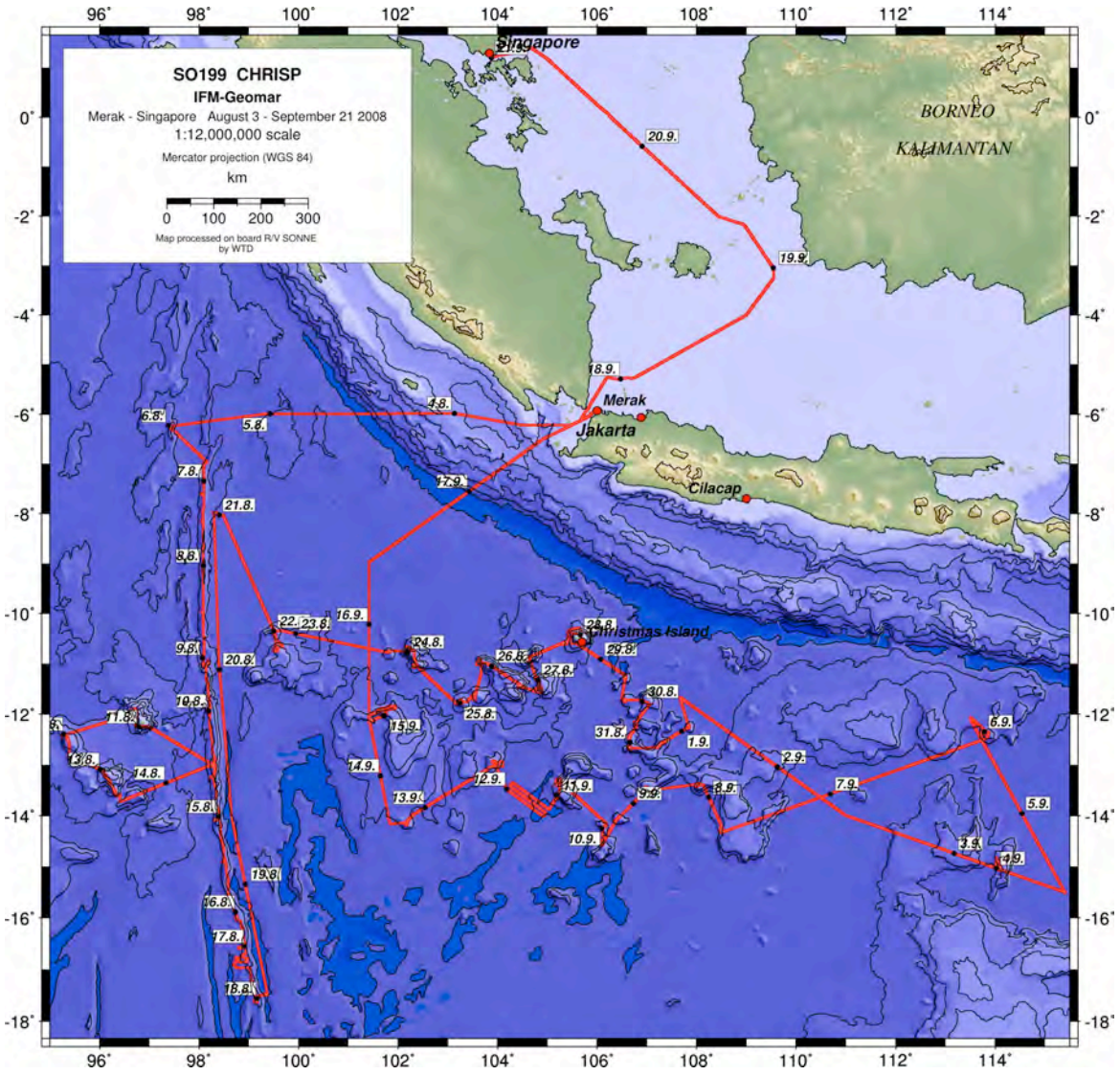

Fig. 4.1.: *Cruise track for SO199 (map processed onboard RV SONNE by WTD).*

The two days of transit to the working area were used by the scientists to accommodate on board, to unpack the equipment and to setup the labs. On August 5th R/V SONNE finally reached the northern end of the Investigator Ridge, just south of the Indonesian 200 mile exclusive economic zone, where the scientific work of SO199 started with the deployment of the CTD to receive a sound speed profile for calibration of the SIMRAD echo sounding system. Multi-beam mapping of the northernmost part of the Investigator Ridge revealed that the ridge is to flat to sample in this area. However, in the early morning of August 6th we mapped and sampled successfully a small, ~2 km high seamount to the west of the ridge.

Thereafter, we carried out winch and TV grab tests, followed by a 60 nm magnetic profile which led us back to the Investigator Ridge. This profile served to test the magnetometer and data recording systems, but also provides a first piece of the puzzle of plate tectonic age reconstructions that are part of this cruise's agenda.

From the evening of August 6th till August 10th, SO199 conducted systematic bathymetric mapping and dredge sampling of the Investigator Ridge between ~6 - 13°S (~800 km). Recovery of samples approximately every 100 km along the ridge (with eight out of nine dredge hauls being successful) has revealed a spectacular array of rock types representing a full cross section through the entire ocean crust into the upper mantle. Additionally two TV-grab stations were carried out for biological studies at the northern Investigator Ridge. One TV-grab on top of the ridge showed a diverse fauna of octocorals. Sampling by TV-grab, however, but failed due to technical problems.

Fig. 4.2.: *View of southern Cocos/Keeling Atoll, Australia.*

After finishing geological and biological work at the northern Investigator Ridge, the focus of SO193 shifted to the Cocos/Keeling Atolls and adjacent seamounts, i.e. the westernmost part of the Christmas Island Seamount Province. After completing a 90 nm long magnetic profile from the Investigator Ridge to the Cocos/Keeling Atolls, we mapped the southern and western flanks of these beautiful palm-lined islands (Fig. 4.2.) on the morning of August 11th. The islands form a crude oval (~10 - 15 km) with a lagoon in their midst. A dredge on a ridge protruding to the northwest of the islands brought a variety of volcanic samples (Figs. 4.3., 4.4.). A multi-corer and TV-grab station were used to sample sediments for biological studies from the deep sea plain west of the Cocos/Keeling Atolls. On August 12th a 60 nm magnetic profile led us to a group of huge seamounts to the southwest of the atolls. During the following two days five of these seamounts were partly mapped and successfully sampled, despite fairly rough seas. Murfield Seamount, the largest of the ones sampled, is so shallow that the top can be seen from the surface in clear water. All recovered samples are volcanic ranging from mafic olivine basalts to fairly evolved compositions.

Fig. 4.3.: *A full dredge arrives onboard.*

Fig. 4.4.: *Geologists and biologists evaluate and save rocks just obtained by dredging.*

After finishing a 110 nm long magnetic profile from the Murfield Seamount area back to the Investigator Ridge on August 14th, SO199 concentrated on systematic mapping and sampling of the southern part of the Investigator Ridge between 13° - 18°S. Similar to the northern part of the Ridge, dredging at 7 stations along the ridge recovered a large variety of rocks types from upper ocean crust (lavas), lower ocean crust (wide variety of mafic and felsic intrusive rocks and mafic cumulates) and the upper mantle (serpentinites). Two multi-corer station on the abyssal plain to the west and the east of the ridge, respectively, and one TV-grab on its eastern slope yielded sediment for biological studies (Fig. 4.5.), whereas 2 other TV-grabs in this area failed to return samples.

From the evening of August 18th on, two magnetic profiles were carried out over a four day period (Fig. 4.6.). The first profile, located approximately 20 - 40 km from to the eastern side of the Investigator Ridge, covered ~580 nm from the southern end of the Investigator Ridge at ~17°30' and extends all the way till 8°00'S into the area where ~80 Mill. year old magnetic anomalies are identified in the literature. After reaching the northern end of this profile on August 21st, the magnetic surveys were interrupted for a multicorer station. The second profile covered ~150 nm, running at a strike of ~160° towards the easternmost Vening Meinesz Seamounts.

Fig. 4.5. (to the left): *Seafloor sediments being scooped out of the TV-grab.*

Fig. 4.6. (to the right): *Setting the magnetometer out at night.*

On the early morning of August 22nd, RV SONNE reached the Vening Meinesz Seamounts. This seamount group extends over ~300 nm in E-W direction between the Investigator Ridge and Christmas Island. During the following week SO199 conducted extensive mapping and a total of 15 dredge hauls at 11 of Vening Meinesz Seamounts. The dredges recovered a surprisingly wide range of mafic and evolved lavas, various volcaniclastic rocks, and solidified sediments (mainly carbonates). A possible explanation for the great success of dredging at the Vening Meinesz Seamounts was provided by two TV-grab deployments. The pictures from the ocean floor showed mostly barren outcrops of volcanic successions and an almost complete lack of sediment. The TV-grab also revealed that some of the Vening Meinesz Seamounts seem to be diversity hotspots of benthic filter feeders. Unfortunately, the slopes of this fascinating habitat were too steep, to successfully deploy the TV grab and to get samples of this community on board RV SONNE. Additionally one multi corer yielded sediment samples of the deep sea plain between the seamounts.

After finishing work on the Vening Meinesz Seamounts on the early morning of August 28th, we sailed to Flying Fish Cove, the „capital" of Christmas Island (Fig. 4.7.), for a short port call. Subsequently we carried out a multi corer off Christmas Island as well as of parts of its submarine base and two dredge hauls which recovered lavas, lapilli tuffs, and carbonates.

Fig. 4.7.: *View of Flying Fish Cove, the capital of Christmas Island, from RV SONNE. To the left is the loading pier of a phosphate mine.*

After the last dredge haul off Christmas Island the magnetometer was deployed for a 70 nm long profile in southeastern direction. At the end of this profile, we reached a cluster of 12 seamounts which rise from > 5,000 m water depth up to 2,000 m below sea level. Altogether 10 dredge hauls at 8 of these seamounts yielded mainly porphyric sheet and pillow lava and a surprisingly wide range of volcaniclastic rocks.

A longer section of magnetic profiling began on September 1st. The first profile was run in southeastern direction over a distance of 547 nm from the Wharton Basin south of Christmas Island into the Argo Basin off northwestern Australia, crossing the Roo Rise on its way. On September 3rd we interrupted the magnetic profiling for sampling of a large seamount being located on the western margin of the Argo Basin. This seamount has a peculiar, N-S elongated edifice with a at least 25 km wide plateau forming its top area and steep flanks. The dredge hauls conducted at this seamount yielded vesicular lavas and lapilli tuffs (Fig. 4.8.), suggesting a rather volcanic than exclusively tectonic origin of this structure. At the end of the first magnetic profile a multi corer sampling sediments from the abyssal plain of the Argo Basin (Fig. 4.9.) marked the easternmost deployment of SO199. The magnetic surveys continued from this point in northwestern direction over a distance of 236 nm through the Argo Basin. At the end point of this profile, several seamounts are located at the edge of the Argo Basin, which morphologically resemble rather tilted crustal blocks than volcanoes. Two dredge hauls at one of these structures recovered dense lava fragments. In the area of the seamounts at the edge of the Argo Basin, we saw for the first time on this cruise several fishing vessels. A possible explanation for this may be that upwelling currents at the seamounts transport nutrients to upper water levels, providing food supply for plankton organisms, which in turn attract fish.

Fig. 4.8.: *Scientists study rock samples dredged from a seamount at the western margin of the Argo Basin.*

Fig. 4.9.: *Samples of the sediment surface from the Argo Basin, yielded by multi corer out of more than 5,700 m water depth.*

On September 6th SO199 started with a 328 nm long magnetic profile which led us back from the Argo Basin into the southern part of the Christmas Island Seamount Province. This area is characterized by an unusual seafloor morphology. It is dominated by large plateau-like structures with an uneven surface which extend over an area of up to ~20,000 km^2 and rise from ~5,500 m up to 1,500 – 2,000 m above the surrounding ocean floor. Our dredge hauls at the flanks of these features yielded mainly dense or slightly vesicular, feldspar-phyric lava fragments. Adjacent to these „plateaus“, the predicted bathymetry (based on satellite altimetry) reveals several isolated, up to 3,000 m high seamounts and ridges showing a wide range of different morphologies. Six of these volcanic structures have been partly mapped and successfully sampled by SO199 during the past week. The dredges recovered mainly various types of lavas and volcaniclastica. Additionally one multi corer and 3 TV-grabs have been conducted in this area. Whereas the multi corer yielded sediments the TV-grabs failed to return samples. On September 10th and 11th, sampling of the southern Christmas Island Seamount Province has been interrupted for three parallel magnetic profiles of 55 nm each and a spacing of 5.5 nm in order to define the boundary between crustal segments of different age belonging to the Argo Basin and the Wharton Basin, respectively.

On September 13th, R/V SONNE departed the southern part of the Christmas Island Seamount Province and proceeded northward. The last three days of the SO199 scientific program were dedicated to a 337 nm long magnetic profile running in northern direction parallel to the Investigator Ridge through the Wharton Basin at a distance of ~250 km to the ridge and for sampling of two seamounts in the center of the Christmas Island Seamount Province. Dredging at the flanks a more than 3,500 m high plateau-like structure measuring at least 40 km at its base yielded mainly almost aphyric lavas with thick manganese crusts. Approximately 15 nm west of this huge feature, SO199 discovered a small, ~500 m high, volcanic cone. Here, the last dredge haul of the cruise as been conducted. This dredge recovered highly vesicular, olivine und pyroxene phyric pillow lavas. Thereafter, a multi corer recovered surficial sediment for biological investigations from 5,000 m.

When approaching the Indonesian exclusive economic zone on September 16th at 4:00 pm ship’s time, the recovery of the magnetic sensors marked the end of the scientific work of SO199. On the same evening, we celebrated the successful end of the expedition with a nice party. The following, more than 1,000 nm long transit to Singapore led us again through the Sunda Straits, where we passed Merak, the starting point of our journey, and further through the Java Sea and the Southern Chinese Sea. The scientists spent the last days at sea packing and cleaning up the laboratories. On the morning of September 21st, SO199 ended at a berth of the old part of the port of Singapore (Fig. 4.10.).

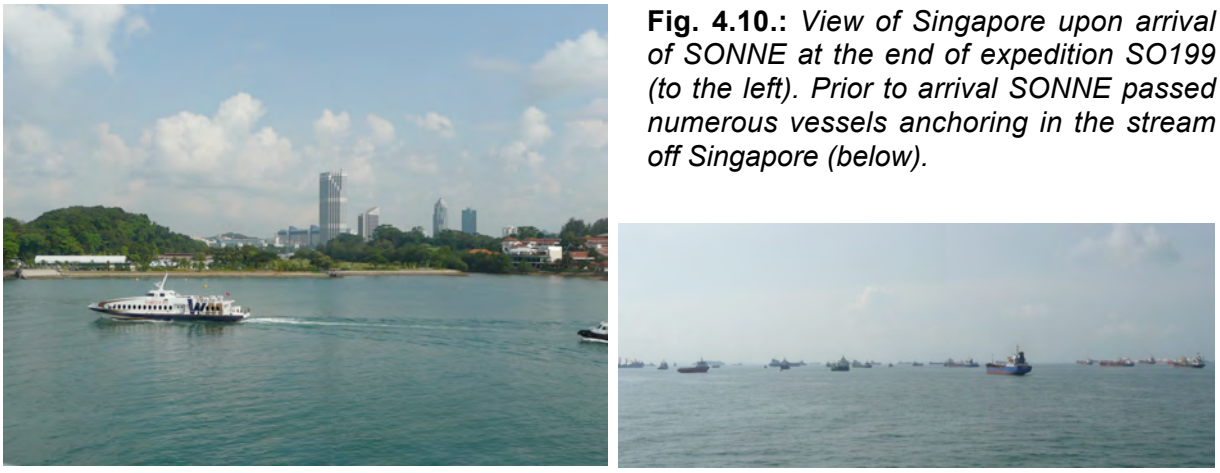

Fig. 4.10.: *View of Singapore upon arrival of SONNE at the end of expedition SO199 (to the left). Prior to arrival SONNE passed numerous vessels anchoring in the stream off Singapore (below).*

Complementing 5,694 nm of SIMRAD EM120 and Parasound profiling (including 2,787 nm of magnetic profiling) a total of 70 dredges, 13 TV grabs, and nine MUCs were carried out in an average water depth of 3,901 m during SO199. Of these deployments, 63 recovered magmatic rocks, 39 volcaniclastics, 25 sedimentary rock, and 11 Mn-Fe oxides. Fifty deployments yielded macrofauna and 75 unlithified sediment for biological studies.

5. BATHYMETRY AND ROCK SAMPLING

(F. Hauff, R. Werner, D. Maicher, K. Hoernle)

5.1. METHODS

5.1.1. Bathymetry

Data Acquisition

Since June 2001 the R/V SONNE is equipped with the SIMRAD EM120 multi-beam echo sounder (Kongsberg) for a continuous mapping of the seafloor. The SIMRAD EM120 echo sounder system consists of several units. A transmit and a receive transducer array is fixed in a mills cross below the keel of the vessel. A preamplifier unit contains the preamplifiers for the received signals. The transceiver unit contains the transmit and receive electronics and processors for beam-forming and control of all parameters with respect to gain, ping rate and transmit angles. It has serial interfaces for vessel motion sensors, such as roll, pitch and heave, external clock and vessel position. Furthermore the system contains a SUN-workstation as an operator station. The operator station processes the collected data, applying all corrections, displays the results and logs the data to internal or external disks. The EM120 system has an interface to a sound speed sensor, which is installed near by the transducers.

SIMRAD EM120 uses a frequency of about 12 KHz with a whole angular coverage sector of up to 150° (75° per port-/starboard side). If one ping is sent the transmitting signal is formed into 191 beams by the transducer unit through the hydrophones. The beam spacing can be defined in an equidistant or equiangular distance, or in a mix of both of them. The ping-rate depends on the water depth and the runtime of the signal through the water column. The variation of angular coverage sector and beam pointing angles was set automatically. This optimized the number of usable beams.

During the survey the transmit fan is split into individual sectors with independent active steering according to vessel roll, pitch and yaw. This forces all soundings on a line perpendicular to the survey line and enables a continuous sampling with a complete coverage. Pitch and roll movements within ±10 degrees are automatically compensated by the software. Thus, the SIMRAD EM120 system can map the seafloor with a swath width about up to six times the water depth. The geometric resolution depends on the water depth and the used angular coverage sector and is less than 10 m at depths of 2,000 - 3,000 m.

The accuracy of the depth data obtained from the system is usually critically dependent upon weather conditions and the use of a correct sound speed profile. During SO199 one sound profile has been recorded after reaching the working area, ensuring the use of the correct sound velocity on this cruise.

Data Processing

The collected data were processed onboard with the coverage software EM120. The post-processing was done on two other workstations by the accessory software Neptune. The Neptune software converted the raw data in 9 different files which contains informations about position, status, depth, sound velocity and other parameters and are stored in a SIMRAD own binary format.

The data cleaning procedure was accomplished by the Neptune software. The first step was to assign the correct navigational positions to the data without map projections. The second step was the depth corrections, for which a depth threshold was defined to eliminate erratic data points. In the third part of post-processing statistical corrections were applied. Therefore, a multitude of statistical functions are available in a so called BinStat window where the data are treated by calculating grid cells with an operator-chosen range in x and y direction. Each kind of treatment is stored as rule and has an undo option. For the calculation the three outermost beams (1-3 and 188-191) were not considered. Also a noise factor, filtering and a standard deviation were applied to the calculated grid. All this work was done by the system operators of R/V SONNE. After the post-processing the data have been exported in an ASCII x,y,z file format with header informations and it was transferred to another workstation where assembling, girding and contouring with the GMT software (Wessel and Smith 1995) took place.

All maps presented in this report are created by W. Borchert and A. Ehmer (RF Forschungsschiffahrt GmbH, scientific and technical department [WTD]) onboard R/V SONNE (except of Figs. 3.1., 5.33., and Appendix V).

5.1.2. Rock Sampling

Rock sampling on SO 199 was carried out using chain bag dredges and, at some stations using a TV guided grab. Chain bag dredges are similar to large buckets with a chain bag attached to their bottom and steel teeth at their openings, which are dragged along the ocean floor by the ship or the ship's winch. The TV-grab consists essentially of a set of steel jaws with a video camera in the center, which transmits pictures of the ocean floor. Suitable objects for sampling can be identified on a monitor and sampled from the ocean floor by closing the hydraulic jaws by remote control around the objects and then heave then on board.

Selection of Dredge Sites

Sites for detailed SIMRAD EM120 mapping and dredging were chosen on the basis of a number of existing datasets. These include:

1. Predicted bathymetry, derived from gravity data and ship depth soundings (Smith and Sandwell 1997), as well as GEBCOdata sets.
2. swath bathymetry data and maps, provided Geoscience Australia.
3. Published monographs and papers (see, for example, chapter 3.).

Shipboard Procedure

Once onboard, a selection of the rocks were cleaned and cut using a rock saw. They were then examined with a hand lens and microscope, and grouped according to their lithologies and degree of submarine weathering. The immediate aim was to determine whether material suitable for geochemistry and radiometric age dating had been recovered. Suitable samples have an unweathered and unaltered groundmass, empty vesicles, glassy rims (ideally), and any phenocrysts that are fresh. If suitable samples were present, the ship moved to the next station. If they were not, then the importance of obtaining samples from the station was weighted against the available time. However, a second dredge nearby was necessary only in a very few cases.

Fresh blocks of representative samples were then cut for thin section and microprobe preparation, geochemistry and further processes to remove manganese and alteration products and/or to extract glass (if applicable). Each of these sub-samples, together with any remaining bulk sample, was described, labeled, and finally sealed in either plastic bags or bubble wrap for transportation to IFM-GEOMAR or cooperating institutions.

Shore Based Analyses

Magmatic rocks sampled by the R/V SONNE from the ocean floor will be analyzed using a variety of different geochemical methods. The ages of whole rocks and minerals will be determined by $^{40}Ar/^{39}Ar$ laser dating. Major element geochemistry by X-ray fluorescence (XRF) and electron microprobe (EMP) will constrain magma chamber processes within the crust, and also yield information on the average depth of melting, temperature and source composition to a first approximation. Phenocryst assemblages and compositions will be used to quantify magma evolution, e.g. differentiation, accumulation and wall rock assimilation. Petrologic studies of the volcanic rocks will also help to constrain the conditions under which the melts formed (e.g., melting depths and temperatures). Further analytical effort will concentrate on methods that constrain deep seated mantle processes. For example, trace element data by inductively coupled plasma mass spectrometry (ICP-MS) will help to define the degree of mantle melting and help to characterize the chemical composition of the source. Long-lived radiogenic isotopic ratios by Thermal Ionization Mass Spectrometry (TIMS) and Multi-collector ICP-MS such as $^{87}Sr/^{86}Sr$, $^{143}Nd/^{144}Nd$, $^{206}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$, $^{208}Pb/^{204}Pb$, and $^{187}Hf/^{188}Hf$ are independent of the melting process and reflect the long term evolution of a source region and thus serve as tracers to identify mantle and recycled crust sources. Additionally, morphological studies and volcanological analyses of the dredged rocks will be used to constrain eruption processes, eruption environment and evolution of the volcanoes. Through integration of the various geochemical parameters, the morphological and volcanological data, and the age data the origin and evolution of the sampled structures can be reconstructed.

Non-magmatic rocks and Mn-Fe oxides yielded by dredging will be transferred to co-operating specialists for further shore based analyses.

5.2. SAMPLING REPORT AND PRELIMINARY RESULTS

This section gives background information and short summaries of the features sampled and/or mapped on SO199 and on the rocks obtained by dredging. Some preliminary conclusions based on the results of sampling and mapping on SO199 are summarized in chapter 5.2.8..

Only a few of the studied seamounts have been named by earlier surveys (e.g., Muirfield Seamount, Vening Meinesz Seamounts, Sherbakov Seamount). SO199 assigned informal working names (marked by quotation marks) to un-named seamounts and ridges. Refer to Appendix I and II for exact latitude, longitude, and depth of dredge sites and more detailed rock descriptions. Appendix V shows an overview map with all SO199 sampling sites. Distances between seamounts are given between the seamount tops and are approximate only; dimensions and heights are preliminary and are included only to give a rough idea of dimensions of morphological features.

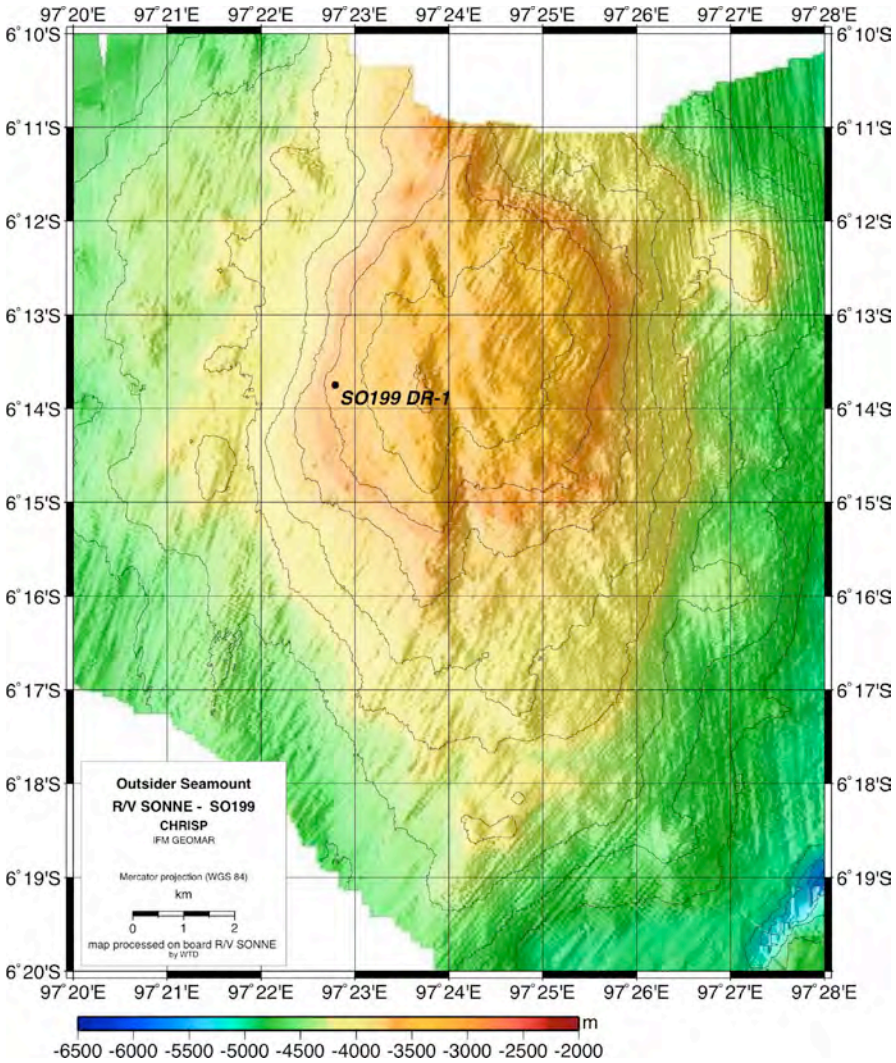

Fig. 5.1.: *Dredge site DR 1 at the upper western flank of "Outsider" Seamount.*

5.2.1. "Outsider" Seamount (DR 1)

„Outsider" Seamount is an isolated, oval shaped seamount with a north-south oriented long axis. It is located ~45 nm west of the Investigator Ridge at ~6°15'S and rises from depths of >5,000 m to ~3,300 or more than 2,300 m above the surrounding seafloor Fig. 5.1.). A linear

Fig. 5.2.: *Representative hard rocks yielded by dredging on the first part of SO199.*

north-south structure runs through the middle of the seamount, forming north-south oriented ravines in the middle of the northern and southern flanks, which are connected at the top of the seamount. The top of the seamount is asymmetric with the eastern portion of the top extending further to the north than the western portion, i.e. eastern half appears to be offset to the north relative to the western half of the top. A single dredge (DR 1) has been carried out along the western flank below the summit (Fig. 5.1.) and recovered a full dredge of glassy pillow and sheet flow lava. The aphyric lava has less than 1% open vesicles (<1 mm) and contains 20% fresh plagioclase microlites. The groundmass color varies between samples and

progresses from grey in the least altered to brownish grey and brown in the most altered rocks. Notably significant amounts of fresh glass are preserved in the 0.5 to 2 cm thick chilled margins of the lava fragments (Fig. 5.2.). Minor heterolithological debris flow material consisting of aphyric basalt, palagonite and manganese crusts was also recovered. A single piece of a rounded, highly altered tff was also found, but is probably not of *in situ* origin.

5.2.2. Investigator Ridge and Adjacent Features (DR 2 - DR 12 and DR 22 - 31)

SO199 for the first time fully mapped the Investigator Ridge over ~1,300 km between 6°S and 18°S and aimed to obtain hard rock samples at an approximately 60 nm interval. A second survey was carried out on a parallel stretch and obtained bathymetric and magnetic data of the seafloor immediately east of the Investigator Ridge. Multi-beam mapping revealed that the morphologically most pronounced areas of Investigator ridge generally vary in width between ~10 - 25 km, but between 16°30'S and 17°00'S the ridge and associated NE-SW trending sub-ridges extend the width to ≥ 35 km. The height of the Investigator Ridge above the surrounding seafloor varies from ~600 m in the north to ~2,800 m in the central part of the ridge (between 11°00'S and 11°30'S). In the north, the Investigator Fracture Zone is divided into two ridges by a valley with a steep west-facing scarp on the eastern ridge (Fig. 5.3.). Further south the higher eastern part of the ridge is separated from the lower western part by a steep westward-facing scarp. In the central and southern part of the Investigator Ridge, the valley is no longer very pronounced and the western side forms a lower plateau, compared to the higher, dominant eastern ridge. Along almost the entire mapped length of the Investigator Ridge, the eastern ridge is asymmetric with a steep west-facing scarp and a more gentle east-facing slope.

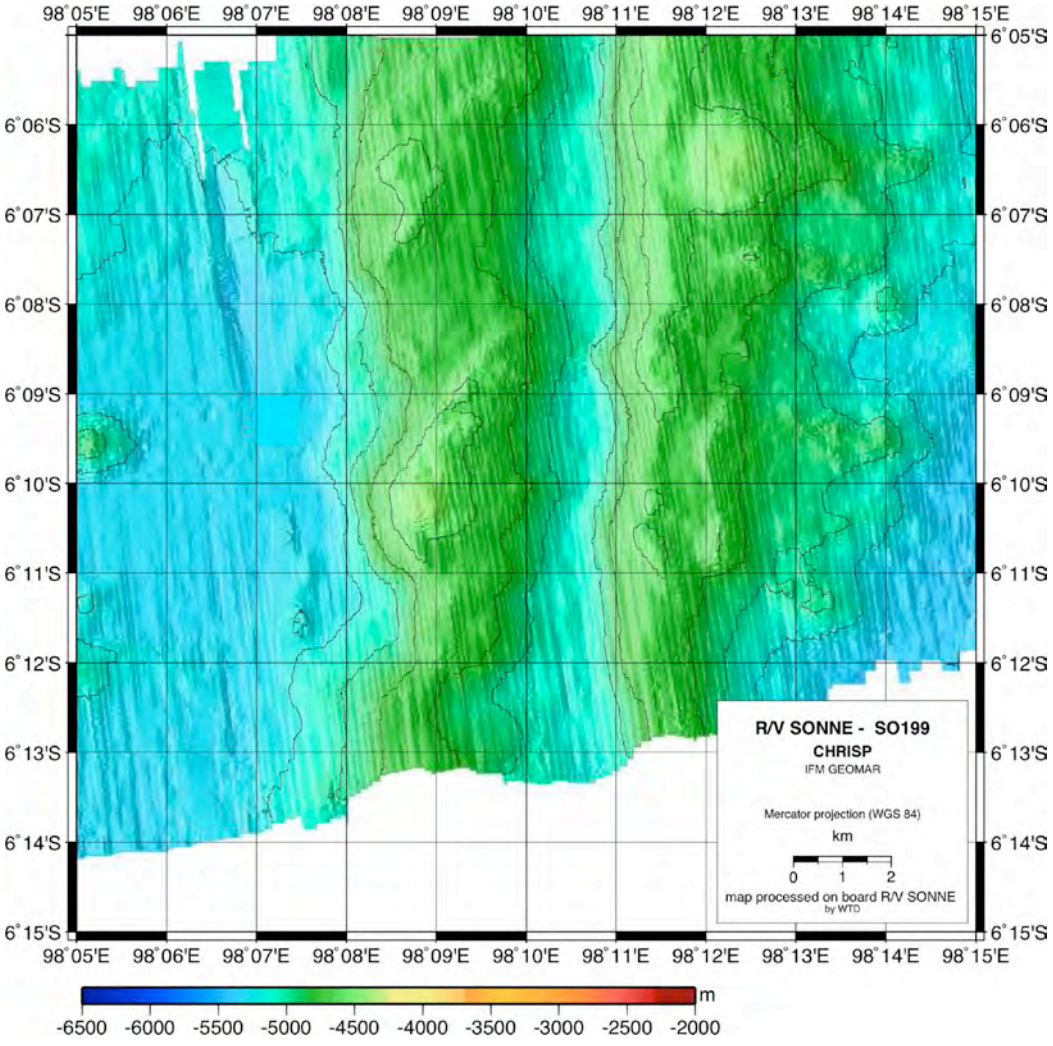

Fig. 5.3.: *Multi-beam bathymetry of the northernmost part of the Investigator Ridge.*

DR 2 and 3: Northern Investigator Ridge at 7°01´S and 7°20´S

The first dredge along the Investigator Ridge has been carried in its northern section. This part of the ridge is morphologically characterized by two N-S trending subparallel ridges that are separated by a small valley. DR 2 is located along the steep westward facing slope of the shallower Eastern ridge, just below the ridge crest between 4,602 and 4,135 m below sea level (b.s.l.) (Fig. 5.4.). A nearly full dredge was recovered containing plutonic to subvolcanic rocks together with porphyric to less phyric basalt fragments as well as pillow lava with partially fresh

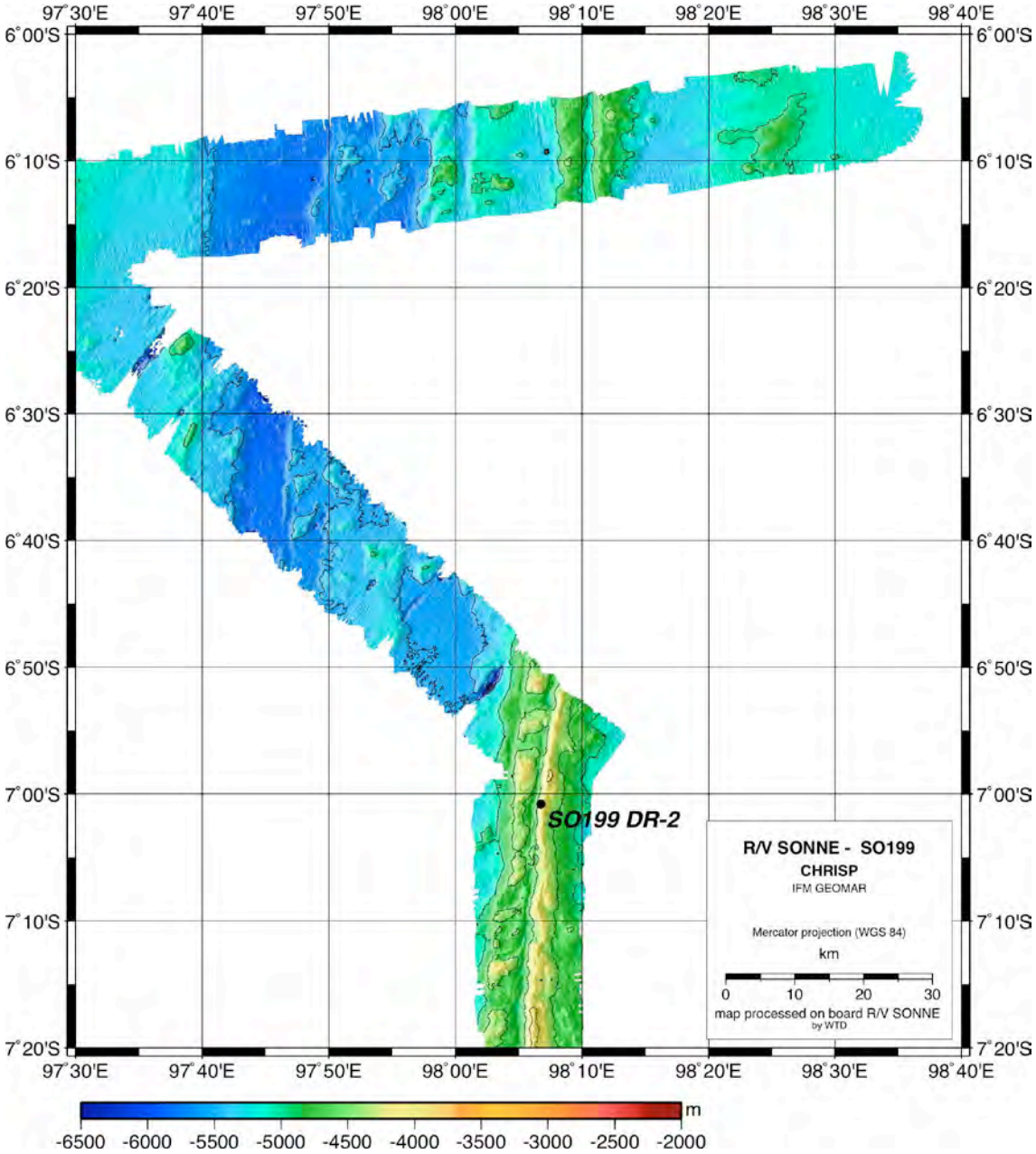

Fig. 5.4.: *Dredge site DR 2 at the northern Investigator Ridge.*

glassy margins. All rocks posses little to near absent Mn coating or encrustations (<2 mm in places) and are generally angular to subangular in shape. The supposed intrusive rocks have a fine crystalline groundmass with a patchy-mottled yellowish-grey to spotty red texture on a 1 to 5 mm scale. Feldspar needles (5%) up to 1 mm range from fresh to altered while abundant (10 - 20%), 0.5mm sized olivine often occur in small clusters and is altered to Fe-Oxhydroxide. Minor pyroxene (<1 - 5%) occurs as sub millimeter sized crystals. The feldspar-olivine porphyric basalts are non-vesicular and often possess a dark red, several centimeter wide alteration halo around a core with a medium grey groundmass. Notably the alteration halo is not always concentric and of uniform thickness. In addition the contact between oxidized and

non-oxidized groundmass often does not follow the shape of the sample margins. This may indicate that alteration occurred prior to deposition of the rock fragments in the dredged talus deposit. Thus the reddish oxidation may possibly reflect an earlier (high temperature?) alteration event. Identified phenocryst phases include 10% altered olivine up to 1 mm and 0.5 mm long feldspar laths that range from fresh to altered as well as minor pyroxene. The other basalt varieties in this dredge generally have lesser amounts of the above listed phenocryst phases (see Appendix II). Notably in sample DR 2-12 partially fresh olivine was identified during initial inspection. Finally several pillow basalt fragments with 1 cm thick chilled margins were also recovered. The glassy margins appear to contain fresh glass while the oxidized groundmass contains ~10% equal amounts of altered olivine (<1 mm) and ± fresh pyroxene up to 4 mm. A single hyaloclastite containing non-vesicular pillow fragments and glass probably originates as interstitial filling of pillow tubes. The heterolithological composition of the dredge indicates that a talus deposit was sampled consisting of intrusive and extrusive units. Overall these observations together with the asymmetric slope geometry across the ridge imply (recent?) tectonic reactivation of the fracture zone that lead to gravitational instabilities and accumulation of debris along the steep sided fault(?) plane. Whether the uplift of deeper crustal rock units is related to the presumed fault reactivation or connected to the earlier transform fault phase or fracture zone phase is unclear.

Dredge DR 3 was carried out about 14 nm south of DR 2 along the steeper western slope of the ridge. Due to a loose bolt at the end of the main cable the dredge and gear was lost after off bottom contact within the water column.

DR 5: Northern Investigator Ridge at 8°10´S

Dredge DR 5 is located at the steeper, westward facing slope of the ridge, immediately below its crest which also houses a local high, in 4,357 to 3,805 m water depth (Fig. 5.5.). In contrast to the DR 2 area, the second, morphologically less pronounced western ridge has almost diminished with only a few traces, manifested as relatively small ridges that are spaced approximately every 10 nm. The N-S striking valley between the main ridge and the small ridge like structures could be the surface expression of a presumed sinistral fault system along which the main part of the Investigator Ridge moves northward relative to the area West of it. DR 5 recovered few angular to subangular rocks that are mostly pillow lava fragments, some with chilled margins and rarely with altered glassy margins. A few heterolithological lapilli tuffs were also found. The majority of lava fragments are slightly pyroxene (2%) – feldspar (1%) phyric basalts with <1% carbonate filled vesicles. Both phenocryst phases are 1 - 2 mm in diameter and appear fresh in hand specimen. The groundmass is, however, strongly oxidized to reddish-brown, so that the overall condition of these rocks is considered medium to strongly altered. Other lava fragments are aphyric, non-vesicular and possess a dark grey, coarse grained groundmass, that has a dark green color when altered. A less abundant porhyric lava type contains 7% fresh feldspar phenocrysts (2 – 4 mm) and <1% open vesicles (0.1 - 0.3 mm). The completely oxidized groundmass of these lavas could either indicate an advanced stage of alteration or a more evolved composition. The freshest volcanic rock of DR 5 is represented by a vesicular lava with 3 - 4% vesicles (1 - 2mm) partially filled with calcite, but fresh dark grey groundmass that contains <1% altered olivine (DR5-1). In summary this dredge exclusively recovered mostly non-vesicular extrusive volcanics ranging from aphyric to slightly phyric with the exception of a few feldspar porhyric lava fragments and a single, relatively fresh, vesicular olivine phyric lava.

DR 6: Northern Investigator Ridge at 9°02´S

This sampling station lies on the steeper, westward facing slope of the ridge between 4,135 and 3,704 m b.s.l. (Fig. 5.5.). The area lies about 30 nm north of the southern termination of the morphologically continuous ridge crest from 7°50'S to 9°40'S. Similar to DR 5 local highs become as shallow as ~3,500 m b.s.l. and the secondary, smaller ridge like highs to the west are still present. Although the dredge only contained some rocks they posses a very heterolithological character and range from lavas, volcaniclastics, dikes (?), intrusives to serpentinites. The large variety of rocks indicates that at this location a cross section through oceanic crust assembled through tectonic processes along the Investigator Ridge. The first lithological group consists of fine crystalline, non-vesicular aphyric rocks with a light grey groundmass. In some of these rocks dark grey zones with diffuse contacts to the light grey

groundmass are observed. Therefore these samples (DR 6-1 through -5X) are tentatively interpreted to stem from a sheeted dike complex or at least from some sort of melt transfer zone within the ocean crust. More coarse grained varieties (DR 6-6) with microcrystalline feldspar and pyroxene are interpreted to either represent subvolcanic rocks or parts of massive lava flows (dolerites). The next lithological sub-group are holocrystalline rocks that resemble plutonics (DR 6-7 through -9). They occur as subangular to rounded clasts and

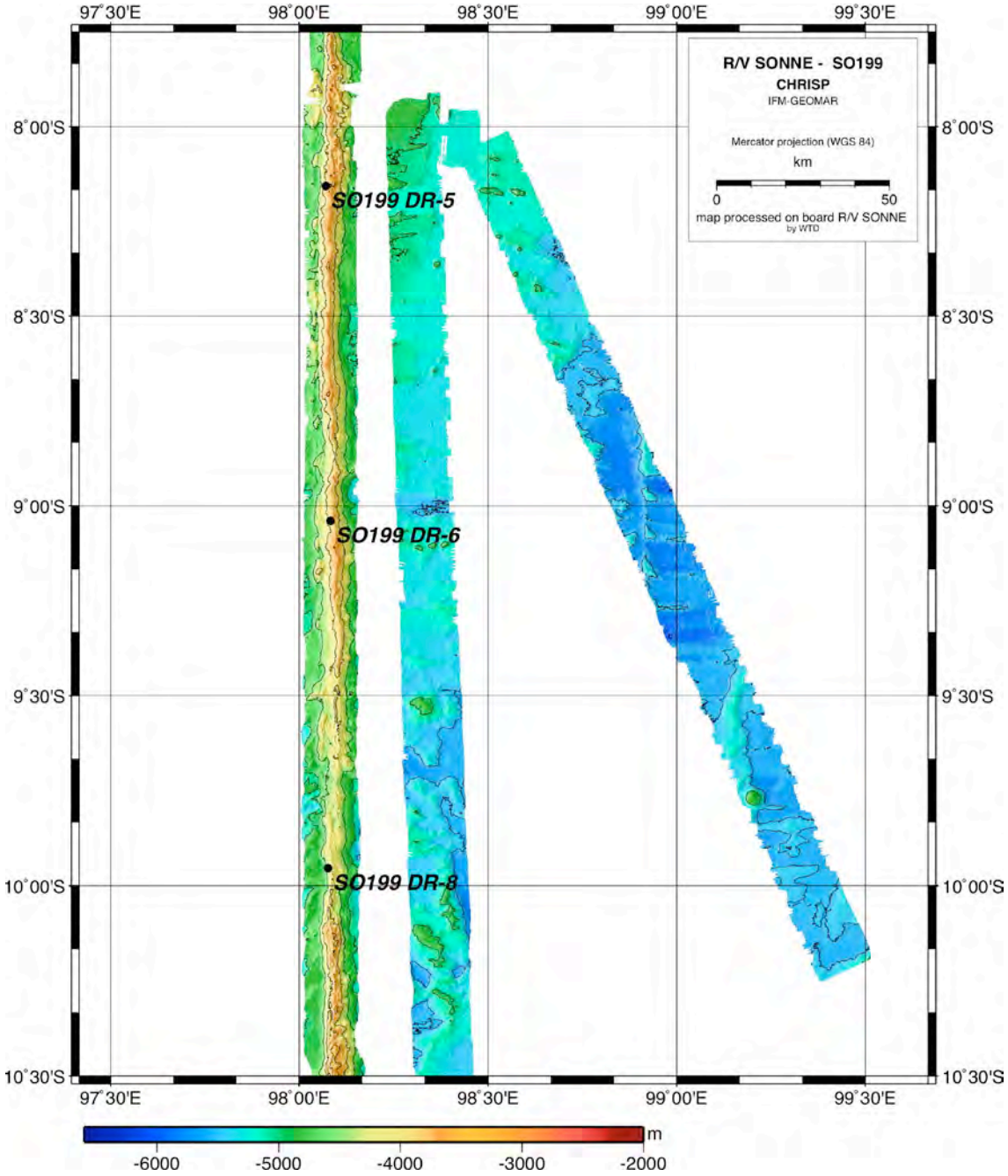

Fig. 5.5.: *Dredge sites DR 5, 6 and 8 at the northern Investigator Ridge.*

mainly consist of feldspar crystals, several mm to 20 mm in size, that sometimes show ductile deformation. Minor mm-sized pyroxene also occurs. These plutonics are probably leuco-gabbros. In the breccia sample DR 6-10 a large clast of a feldspar phyric volcanic rock has been recovered and has been initially described as subvolcanic rock. However, in contrast to the subvolcanics described above, the groundmass of this particular sample is highly oxidized and the fact that this sample is feldspar porphyric while the subvolcanics are aphyric makes it more likely that this rock is a lava fragment. The last group of igneous rocks (DR 6-11 through

–16) comprises variably serpentinized and sometimes strongly foliated plutonics (gabbros and possibly peridotites).

A TVG station (TVG 7) in close vicinity of DR 6 has been carried out on the crest of the Investigator Ridge in ~3,500 water depth. Although loose (?) rocks were observed the sampling attempt had to be interrupted due to a malfunction of the communication system with the TVG.

DR 8: Northern Investigator Ridge at 9°57´S

This dredge site is located at the northern end of the second continuous sub-ridge (Fig. 5.5.), extending from ~9°50'S to 10°55'S along the Investigator Ridge. Here the ridge is located in relatively deep waters of 4,000 to 5,000 m b.s.l. before it rises to 3,000 m b.s.l. further south. The ridge has also narrowed to a single bathymetric high - in other words the small western ridge as observed further north has disappeared in this segment. DR 8 has been carried out between 4,925 to 4,290 m b.s.l. along the steepest west facing slope in the area. A full dredge with heterolithological lava and pillow fragments with very minor glassy margins was obtained. The most abundant lithofacies is an olivine-feldspar phyric basalt (DR 8-6 through –12) that has <1% open or zeolite lined vesicles (2 - 3 mm). Olivine occurs in varying amounts of 1 - 4% as altered phenocrysts (0.5 – 1 mm), while the feldspar content is of similar range but has a relatively fresh appearance. The groundmass ranges from light to dark grey leading to an overall slightly to medium altered degree of alteration. In the larger samples of this group small and dark lithic fragments are also present, but some are several centimeters long and have curved margins to the surrounding host rock, indicating soft deformation or assimilation during incorporation into the lava flow. Minor lava types include (1) fresh, non-vesicular, aphyric lava (DR 8-1 and -2), (2) pyroxene phyric (2 - 3% microphenocrysts) but medium altered lava (DR 8-3) and (3) lava with 3 - 4% fresh olivine microphenocrysts (0.5 – 1 mm) and 1%, 1 mm sized feldspar phenocryts in a fresh dark-grey to greenish groundmass (DR 8-4). In summary DR 8 recovered a series of extrusive rocks that range from primitive to more evolved compositions.

DR 9 and 10: Central Investigator Ridge at 10°53´S and 10°59´S

At the southern termination of the second continuous Investigator Ridge segment (Fig. 5.6.) this dredge has been conducted in 4,420 m b.s.l. when it got stuck at the very beginning of the track. Still a few olivine-feldspar phyric lava fragments were recovered. They are characterized by up to 5% sub-millimeter sized vesicles that are irregularly filled with calcite and overall have grey groundmass that classifies these rocks as being slightly altered. Olivine may achieve amounts of 5 to 8% and may get as large as 1 – 2 mm. In some samples olivine appears still fresh (DR 9-1 through –4). Feldspar occurs in small needles up to 1mm and generally appears quite fresh.

South of 10°55'S the main crest of the Investigator Ridge is ~10 km eastwardly offset. In particular the area between 10°55'S and 11°20'S is characterized by an up to 15 km broadening of the ridge crest above the 3,000 m b.s.l. contour in the mapped part while becoming as shallow as 2,300 m b.s.l. The region between 10°57'S and 11°20´S resembles a tilted block with unusual east-west striking contour lines at 10°57'S that bend into the common N-S direction at 98°07'E (Fig. 5.6.). The morphology of this curvature resembles the inner corner high at the end of mid ocean ridge transform faults and thus could reflect the existence of an east-west oriented spreading center nearby. The dredge track DR 10 is located in the corner region of the block within the upper part of the westward facing slope between 4,060 and 3,515 m b.s.l.. The dredge contained a few rocks comprising hyaloclastites, pillow lava, massive basalts and plutonics. The most unusual rocks of this dredge are a variety of gabbroic rocks that range from more mafic compositions (DR 10-1, Fig. 5.2.) with an equigranular (5 – 10 mm) assemblage of pyroxene (70%) and feldspar (30%) to more leucocratic compositions with 60% pyroxene and 40% feldspar (DR 10-2). Other gabbros show evidence for melt penetration as observed by pyroxene phyric melts migrating through a mush of large (1 – 2 cm) orthopyroxene crystals (DR 10-3) or dark grey aphyric areas (melt?) penetrating a grabbroic groundmass with irregular contacts (DR 10-4). Minor mafic cumulates with crystal layering of pyroxene and feldspar are also present (DR 10-5) as well as serpentinized olivine (?) gabbros (DR 10-7) and cataclastic ultramafic rocks (DR 10-8). The latter provide evidence for brittle deformation and testify the tectonic origin of this bathymetric anomaly. Coarse

grained, non-vesicular and aphyric rocks (DR 10-9 and –10) are medium altered and could either represent microgabbros or fragments of a massive lava flow. The only porphyric lava of the dredge is a strongly altered basalt with ~7% feldspar up to 2 – 3 mm in size, which however appear altered to a light reddish-brown color (DR 10-11). Aphyric pillow lava with <1% Fe-oxyhydroxide filled vesicles (DR 10-13 to –15) and 1 – 4 cm thick chilled margins that may contain chunks of fresh glass have mostly a very strongly altered groundmass except for DR 10-16 which is medium altered. This lithofacies makes up ~80% of the dredge. The presence of different intrusive and extrusive rocks in this locality suggests that a cross section of the ocean crust has assembled through tectonic processes.

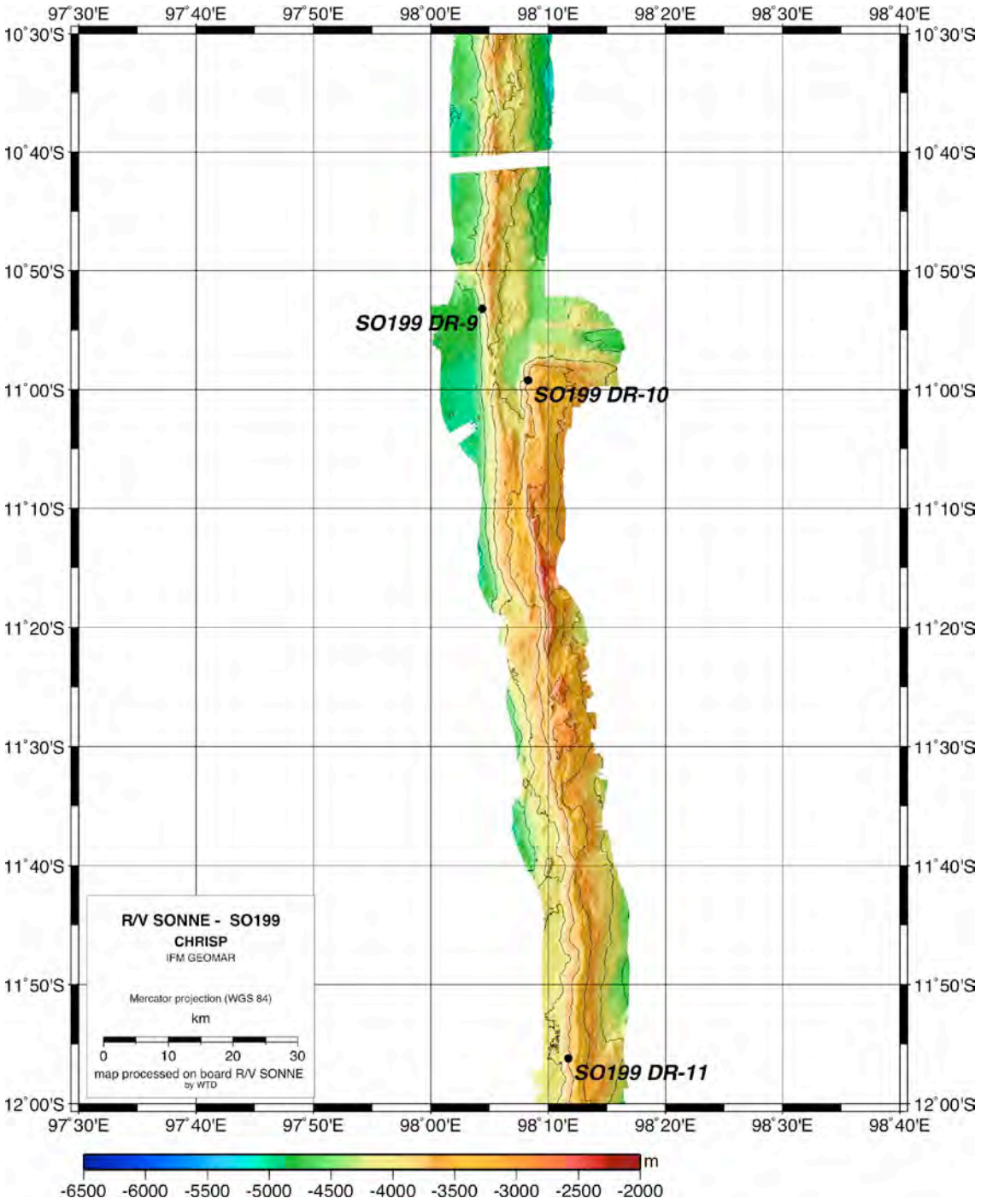

Fig. 5.6.: *Dredge sites DR 9 - 11 at the central Investigator Ridge.*

DR 11: Central Investigator Ridge at 11°56´S

This location lies in the area where the Investigator Ridge gradually changes strike from N-S towards NNW-SSE (Fig. 5.7.). The width of the ridge above the 4,000 m contour is with ~15

km broader than observed for the northern segments with <10 km. DR 11 lies in 3,953 to 3,700 m water depth within a relatively steep westward facing slope that resembles a slope failure (Fig. 5.7.). The dredge track was shorter than initially planned due to a hung up of the

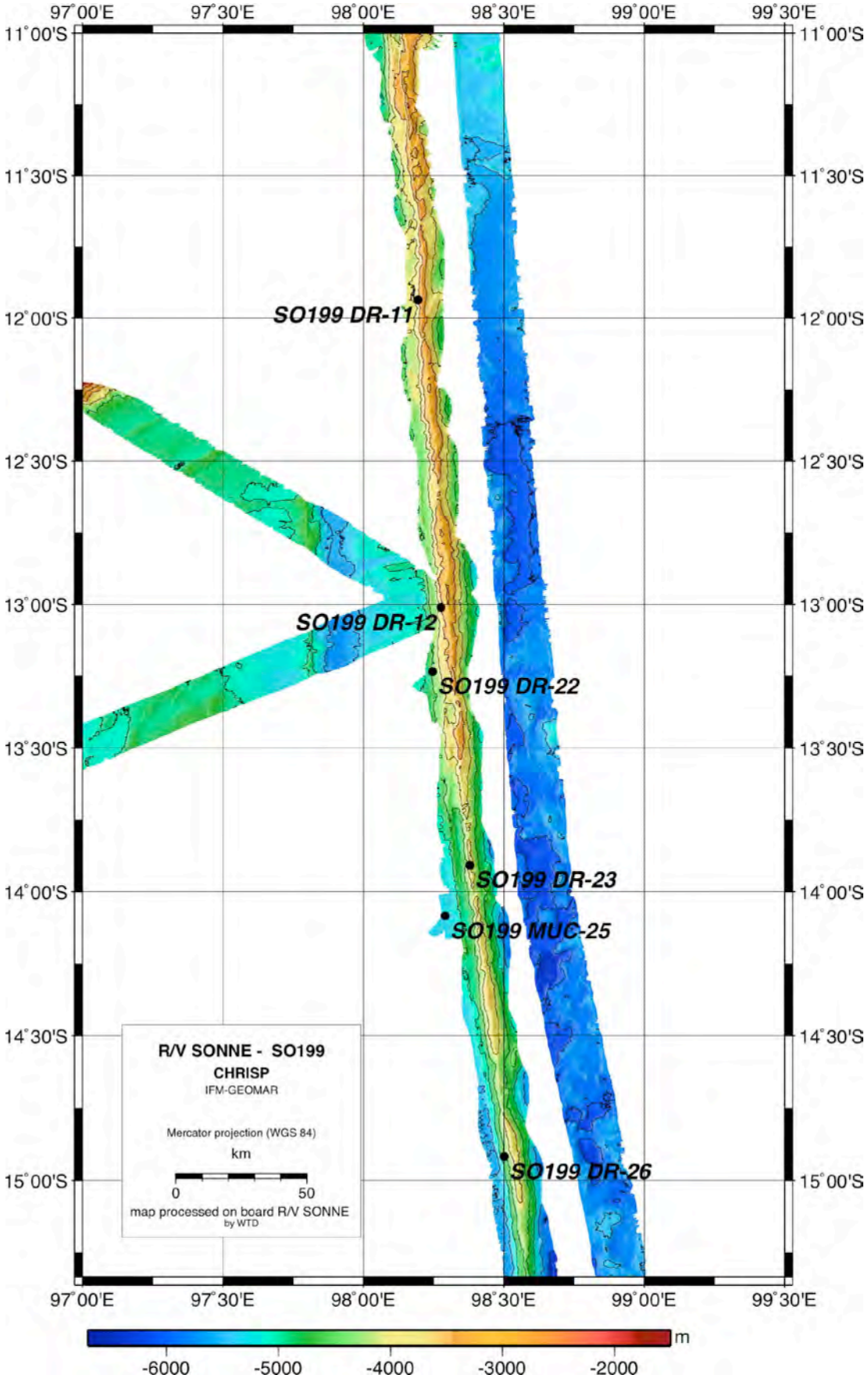

Fig. 5.7.: *Dredge sites DR 11, 12 and 22 - 26 at the central and southern Investigator Ridge.*

dredge reflecting the rough terrane at depth. Still the 1/4 full dredge sampled a variety of subvolcanic and plutonic rocks along with volcaniclastics and a single piece of highly altered sheet flow lava. The subvolcanic intrusives are characterized by abundant 40 - 50% feldspar phenocrysts up to 15 mm in a grey, relatively fresh groundmass (DR 11-1 to –3). A series of gabbroic rocks with fresh equigranular feldspar and pyroxene crystals up to 10 mm are sampled from DR 11-4 to –6 (feldspar rich) and DR 11-7 to –10 (increasing pyroxene content). Additional plutonic rocks (DR 11-11 to –14) have heterogeneous textures of coarse grained holocrystalline areas interconnected with dark to grey fine grained areas that resemble small melt pockets migrating through a crystal mush. These samples reflect repeated pulses of melt intrusions possibly within the lower oceanic crust. Finally a highly altered glassy sheet flow lava with wavy banding of 5 mm thick aphanitic beige-brown layers has been identified in sample DR 11-18. In summary location DR 11 again provides a cross section through the ocean crust with emphasis on subvolcanic and plutonic rocks.

DR 12 and 22: Central Investigator Ridge at 13°01´S and 13°14´S

This location lies in the central section of the Investigator ridge where it strikes towards 170° (Fig. 5.7.). Dredge sampling was carried out along the west facing slope between 3,994 and 3,504 m water depth. The dredge recovered only a few rocks of a breccia that contained rounded serpentinite clasts. The serpentinite consists of 60 - 70% altered olivine and 30% greenish-red serpentinite. Individual crystals are often elongated and in places a mylonitic texture developed reflecting ductile deformation of these upper mantle rocks.

Because of the poor recovery of DR 12, a second dredge was made ~13 nm further south after return from the Cocos/Keeling Seamount survey (see chapter 5.2.3.). DR 22 is located at the base of the western slope of the Investigator Ridge in 4,775 to 4,287 m water depth (Fig. 5.7.). Only a few angular rock fragments including a large pillow were obtained. The pillow was covered by a 3 – 4 mm thick manganese crust, which is has been uncommon for the hardrocks recovered in this area recovered thus far. The aphyric pillow contains 2% vesicles that are irregularly distributed, up to several mm in size and often filled with yellow-brown material that resembles palagonite. Some of these fillings are quite vesicular and it seems likely that the flow incorporated glass fragments. The groundmass has a greyish-green appearance, is coarse grained and contains feldspar microphenocrysts. Overall the whole rock is medium altered, but the chilled margins may possibly contain fresh glass (Fig. 5.2.).

DR 23: Central Investigator Ridge at 13°54´S

In this area the width of the Investigator Ridge has narrowed <10 km above the 4,000 m contour while maintaining a 170° strike. The dredge site has been chosen along a WNW facing slope below the ridge crest in 4,203 to 3,796 m b.s.l. (Fig. 5.7.) and recovered a 1/3 full dredge with very large pieces of mainly plutonic rocks and subordinate lava and Mn-crusts. The plutonics range from mafic olivine-pyroxene-feldspar gabbros (DR 23-2 to –12, Fig. 5.2.) to holocrystalline leuco gabbros with mainly feldspar and pyroxene (DR 23-13 to –21). Except for olivine all other phenocrysts phases appear fairly fresh. DR 23-1A is described as subvolcanic intrusiva with ~6% olivine (up to 6 mm) in a brown to grey fine-grained matrix. This rock contains a holocrystalline xenolith (DR 23-1B) consisting of up to 2 cm large olivine (30%), pyroxene (15%) und feldspar crystals (55%). Another, finer-grained xenolith (DR 23-3B) has been separated from one of the gabbros (DR 23-3A).

DR 26: Southern Investigator Ridge at 14°55´S

This location lies close to the southern termination of the 170° striking section of the Investigator Ridge along the lower WSW facing slope in 4,938 to 4,575 water depth (Fig. 5.7.). The dredge mainly recovered serpentinite and breccias. The serpentinites contain variable amounts of sometimes fresh pyroxene. A small, relatively fresh aphyric basalt clast was discovered in a mineral breccia that contains up to 1 cm pyroxene crystals.

DR 28: Southern Investigator Ridge at 16°00´S

This locations lies in the central part of a ridge segment (15°40’S to 16°20’S) where the Investigator Ridge forms an S-shaped bathymetric high curving from SSE to SE and then back to SSE (Fig. 5.8.). The dredge sampled the westward facing slope between 4,649 and 4,290 m b.s.l. and recovered primarily Mn-crusts along with a few igneous rocks. These include several fine grained microgabboic or diabase like rocks that may eventually contain partially fresh

feldspar although the rocks are strongly altered overall. A non-vesicular aphyric, rounded lava fragment in places still posses a light grey and relatively fresh groundmass. The third igneous lithology comprises very strongly altered serpentinite clasts of former ultramafic plutonics. Finally a solidified mudstone and 3 cm thick manganese crusts were sampled.

Approximately 8 nm north of DR 28, TVG 27 was successfully carried out along the eastern slope of the Investigator Ridge just below the ridge crest and recovered sediment (Fig. 5.8.).

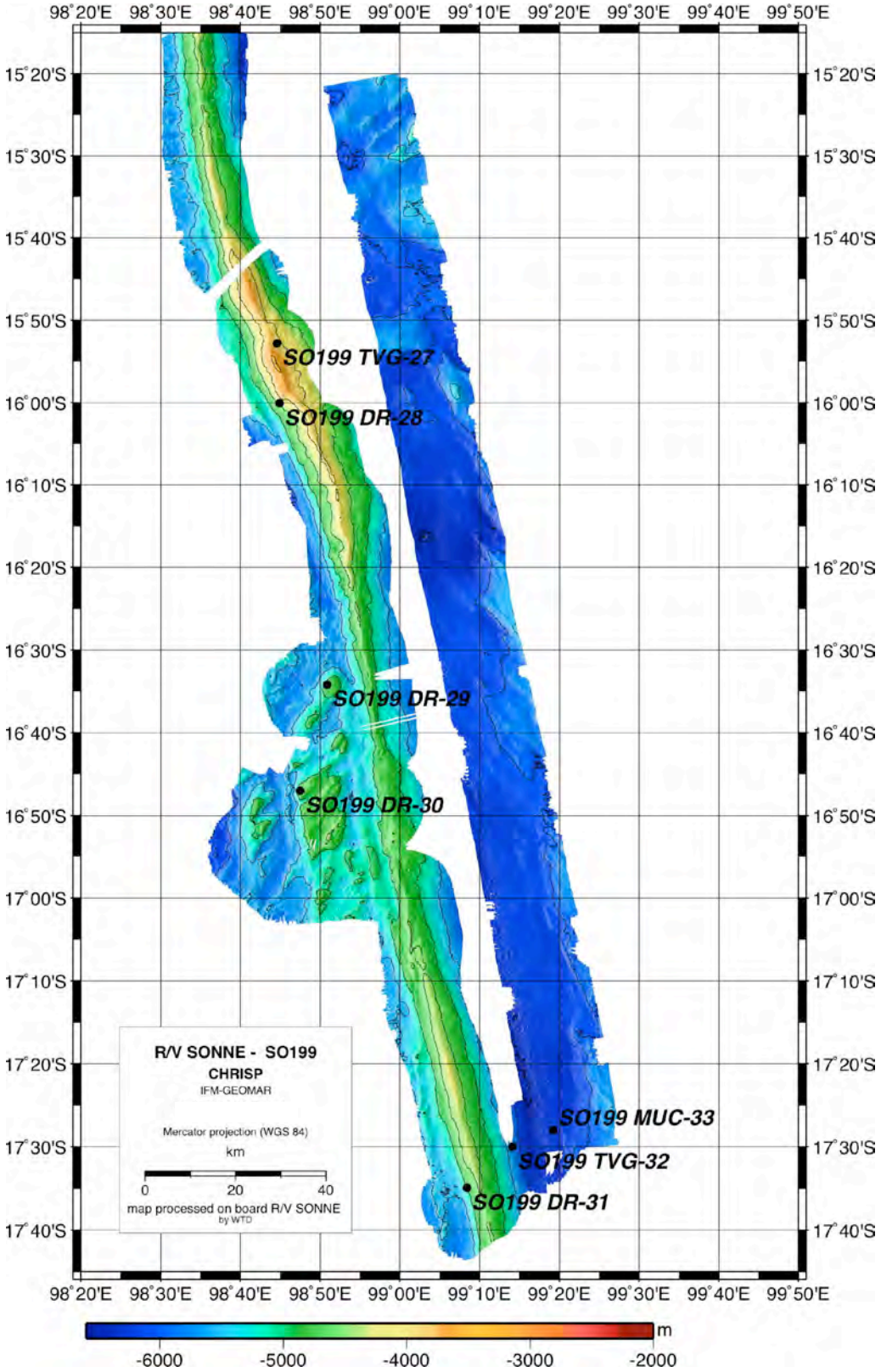

Fig. 5.8.: *Dredge sites DR 28 – 31 at the southern Investigator Ridge. TV-grab stations TVG 27 and 32 and multi corer station MUC 33 are also shown.*

DR 29 and 30: Southern Investigator Ridge at 16°34´S and 16°47´S

These two locations lie ~5 to 10 nm west of the Investigator Ridge (Fig. 5.8.). This region is characterized by several northeast-southwest striking ridges and plateaus that are of similar elevation (~5,000 m b.s.l.) as the Investigator Ridge and rise about 1,000 m above the surrounding seafloor. Notably these structures are separated from each other as well as from the main Investigator Ridge by deep canyons. The origin of these ridges remains somewhat enigmatic but could be related to transpression faulting and block rotation within the developing plate boundary between the Australian and the Indian plate. Site DR 29, initially identified as seamount based on - at that time - limiting mapping was located along the northwest flank of this structure in 5,262 to 4,813 m water depth. The dredge recovered ~20 rocks of heterolithological plutonics (Fig. 5.2.). They comprise fresh, equigranular (2 – 4 mm) feldspar-pyroxene leuco-gabbros (DR 29-1) and slightly altered olivine-pyroxene-feldspar gabbros with varying amounts of these minerals. DR 30 was carried on a very steep western slope (5,060 to 4,586 m b.s.l.) of the largest plateau-like ridge in the mapped area. Here several large, aphyric pillows with several centimeter thick chilled margins were obtained. While the crystalline groundmass of the pillows is very strongly altered the chilled margins appear to contain areas where fresh glass is still preserved. Separate pillow fragments without chilled margins are also aphyric and have <1%, 0.5 – 1 mm sized vesicles that are filled with greenish smectite. Besides these signs of alteration the coarse grained groundmass has a fairly fresh light grey color and occasionally fresh feldspar mircopehoncrysts are visible.

DR 31: Southern Investigator Ridge at 17°35´S

This is the southernmost location of the SO199 survey of the Investigator Ridge. Here the ridge has deepened to ~4,000 – 5,000 m b.s.l. and the across ridge geometry has become more and more symmetric (Fig. 5.8.). The dredge track lies along the western slope in 5,361 to 4,947 m water depth and has recovered a few strongly altered aphyric lava fragments.

5.2.3. Cocos/Keeling Island Province (DR 13 – DR 21)

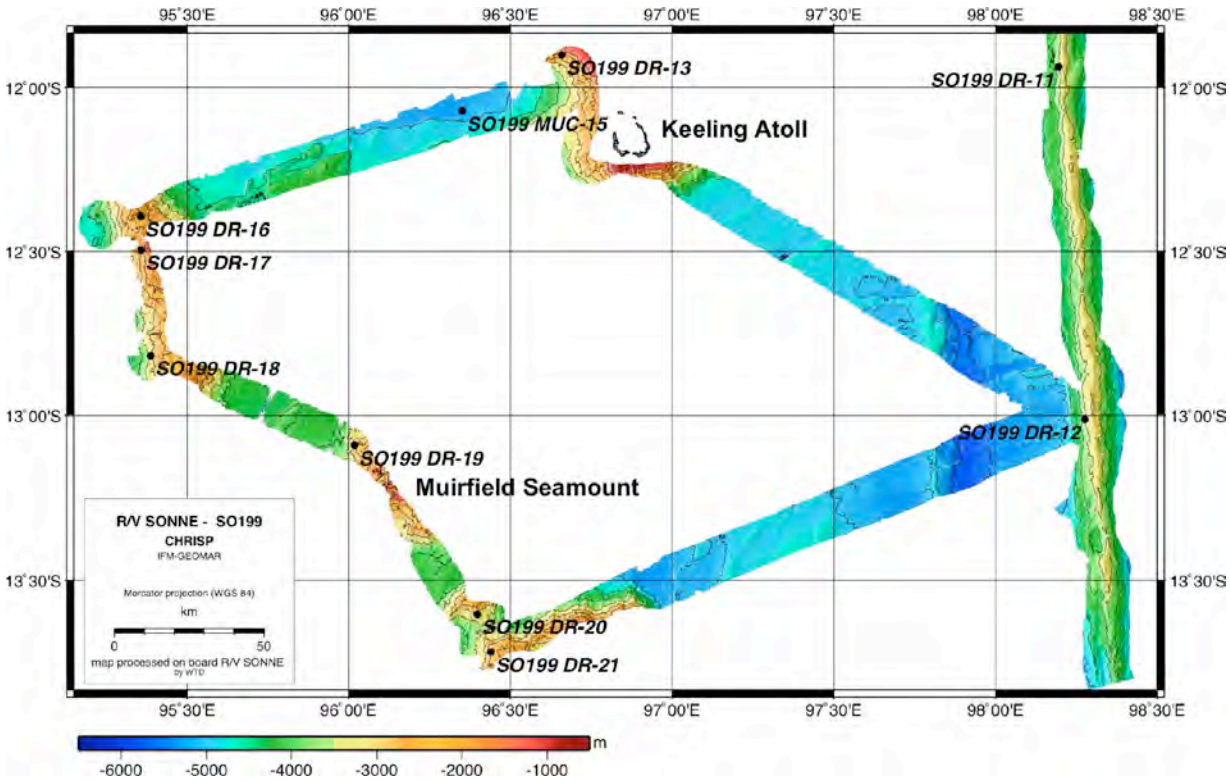

Fig. 5.9.: *SO199 multi-beam bathymetry of the Cocos/Keeling Island Province.*

The Cocos/Keeling Island Province refers to the Cocos/Keeling Atolls (~150 km west of the Investigator Ridge) and a group of seamounts to the south and southwest of the atolls (Fig. 5.9.). The survey was carried out by approaching the base of Keeling atoll from the southeast

and then continued in an anti-clockwise loop through the associated seamount cluster before returning to the Investigator Ridge at 13°S. On the way to and from this area, the seafloor topography displayed a north-south striking bathymetric depression 40 – 50 km west of the Investigator Ridge in ~6,000 m water depth. This trough has been interpreted as a “true” fracture zone along which younger and shallower ocean crust to the west is aligned against older and deeper ocean crust. The seafloor west of this second fracture zone displays northeast-southwest oriented bathymetric highs and lows, interpreted to represent abyssal hills running parallel to the ancient spreading axis (see chapter 6 for details). The Keeling atoll is a typical circular shaped atoll on top of a huge seamount with a base diameter of ~70 km. The seamounts to the southwest and south have a ridge like morphology and extend well over 50 to 80 km, striking NW-SE and ENE-WSW respectively. They do not possess guyot type plateaus, instead they are clustered with small volcanic cones and Muirfield Seamount becomes as shallow as 17 m b.s.l.. From seismic tomography (Montelli et al. 2004) a mantle velocity anomaly is postulated beneath the Cocos/Keeling Island Province, however Keeling atoll appears to be in an advanced stage of erosion and the hardrock sampling in this area - as shown below - did not provide any signs of recent volcanism.

DR 13: Cocos/Keeling Atolls

The only dredge along the base of Cocos/Keeling Atolls has been carried out along the southwestern slope in the northern part in 2,403 to 1,880 m water depth (Fig. 5.10.). DR 13 recovered only a few rocks consisting of lava fragments and volcaniclastics, including a lapilli tuff. The lava fragments are in most cases strongly altered and range from dense to 10 - 20% vesicularity. Phenorcryst phases are rare and do not exceed 1 - 3% abundance and 1 – 2 mm size. They include olivine, feldspar and possibly amphibole. The lava fragments often show a flow textures and banding.

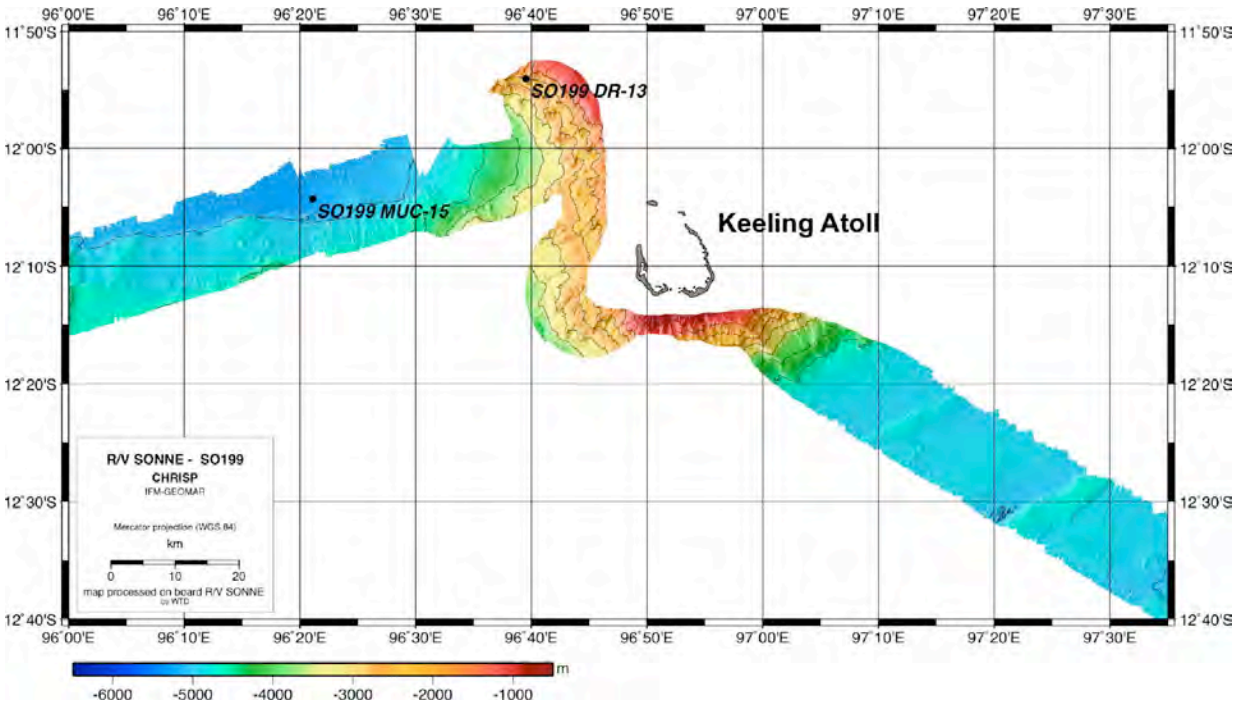

Fig. 5.10.: *Dredge site DR 13 and multi corer station MUC 15 at the Cocos/Keeling Atolls.*

DR 16 – DR 18: “Noel” Seamount

This dredge site is located on the western flank of “Noel” Seamount, named after the French word for Christmas. This seamount is actually a NNW-SSE striking ridge that rises 2,500 m above the surrounding 4,000 m deep seafloor (Fig. 5.9.) and has numerous small volcanic cones along its flanks and ridge crest.

DR 16 was made at the northern flank of “Noel” Seamount in 2,883 to 2,676 m water depth and recovered a few volcaniclastic rocks that contain lava fragments of different size and degree of groundmass alteration. The first group of lava clasts (DR 16-1 to –7) consist of fairly fresh, greyish-green groundmass with 5% unfilled vesicles and 2 - 5% amphibole phenocrysts

up to 1 mm. Notably, 2 - 3% altered nepheline up to 1 mm has been described in some samples as well. Judging from the abundant fuidflow textures and groundmass color, the lava has been cautiously interpreted to be of alkalic and probably silica undersaturated composition. The second group of lava clasts occurs as small angular fragments in a calcite cemented volcaniclastic breccia. The groundmass in the vast majority of these clasts is very strongly altered and the clasts are probably of similar composition as the first group since they also contain amphibole and nepheline (?) in similar amounts and size.

The location of DR 17 is approximately 15km south of DR 16 in the top region of the ridge and has been carried out along a southwest facing slope in 2,247 to 1,839 m water depth. The dredge obtained a few volcaniclastic rocks from which several larger basalt clasts were recovered. These are mostly aphyric, non-vesicular, rounded to angular basalt fragments with a relatively fresh dark-grey to light grey groundmass (DR 17C-1A, -2A and 3A). A single feldspar (1%, <1 mm) and amphibole (1%, 1 – 2 mm) phyric basalt clast with 1%, 0.2 mm sized open vesicles has been also sampled (DR 17C-2B). One of the volcaniclastic rocks (DR 17C-3) also contained 2% fresh pyroxene (<1 mm) and has been saved for mineral separation.

DR 18 is the southernmost SO199 sampling site within the “Noel” Seamount complex and sampled near the base of a westward facing slope in 3,540 to 3,053 m b.s.l.. Only a single volcaniclastic rock was recovered that contained a very strongly altered basaltic pebble in its center. Minor (<1%) feldspar laths (<0.5 mm) appear however fresh.

DR 19: Muirfield Seamount

The Muirfield Seamount rises from 4,000 m depth to 17 m b.s.l. and was named after the British war ship that was damaged when it was temporarily grounded here. DR 19 was carried out at the northwestern slope of the seamount in 3,002 to 2,634 m water depth (Fig. 5.11.) and yielded mainly angular to rounded lava fragments. The lavas are highly vesicular (25%, 1 – 2 mm) with mostly unfilled vesicles and show a fresh dark grey groundmass that contains small, microphenocrystic feldspar needles (<1%, <1 mm). A similar lava type except for 1% altered olivine microphenocysts has been separated as rounded pebble from a volcaniclastic rock.

DR 20: “Klaus” Seamount

This small seamount lies ~90 nm south of the Cocos/Keeling Atolls, immediately north of the larger, 60 km long ESE-WSW trending “Santa” Ridge complex (see below). The seamount has been named “Klaus”, the German name for “Claus”. DR 20 has been carried out within a

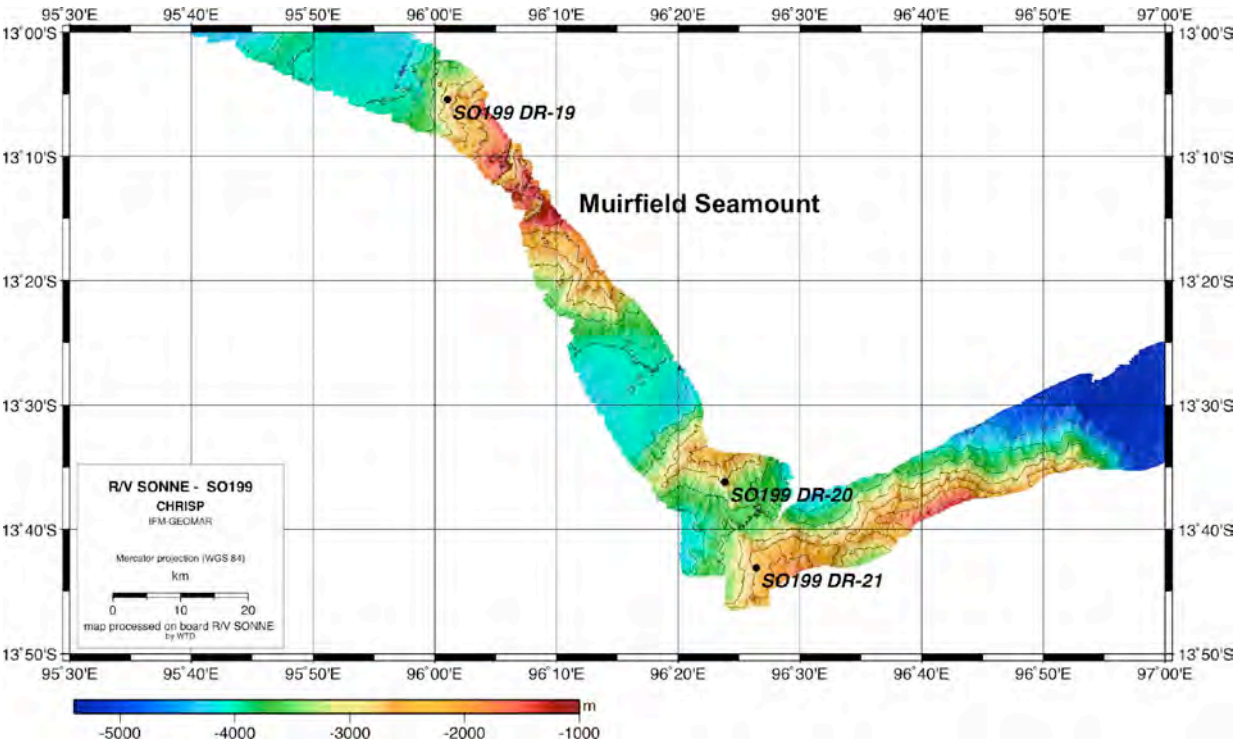

Fig. 5.11.: *Dredge sites DR 19 - 21 at Muirfield and “Klaus” Seamounts and “Santa” Ridge.*

southward trending rift structure between 3,140 and 2,819 m b.s.l. (Fig. 5.11.). The dredge was 1/6 full and recovered a variety of evolved phonolitic basalts and ignimbritic (?) tuffs together with volcaniclastic rocks. The phonolitic lavas (DR 20-1 to -5) are characterized by a greenish groundmass with 10% elongated, oval shaped vesicles (0.5 – 1 mm) that are mostly open or sometimes lined with manganese. A yellowish 2 – 3 cm thick alteration halo could represent a chilled pillow margin. Feldspar microphenocrysts (2%) are < 0.5 mm in size and appear slightly altered, but require further petrographic inspection. An ignimbrite-like tuff (?) has 15% highly elongated, up to 10 mm long and 1 mm wide vesicles and consists of a light brown groundmass. Minor amounts of phenocryst phases identified include <1% feldspar (1 mm) and <0.5% amphibole (?).

DR 21: "Santa" Ridge

The only dredge location of the "Santa" Ridge is located along a southwest facing slope along a nose above a NW-SE striking erosional valley in 2,783 to 2,296 m water depth (Fig. 5.11.). The dredge recovered a few rocks of angular lava blocks and volcaniclastic material. The lava is largely aphyric with very minor (<<0.5%) feldspar and pyroxene phenocrysts (<0.5 mm). The groundmass is completely oxidized and contains abundant manganese spots. Only in sample DR 21-3 a less altered basaltic core has been identified.

5.2.4. Northwestern Christmas Island Seamount Province (DR 35 – DR 53, DR 88 – DR 90)

This subprovince extends west of Christmas Island from ~105°E to 99°E, immediately east of the Investigator Ridge and stretches from 10°S to 12°S in north-south direction. It comprises roughly 15 - 20 larger bathymetric highs on predicted bathymetry maps. They range from circular seamounts, elongated ridges to complex combinations of small plateaus and seamounts. Most seamounts in this area are referred to the Vening Meinesz Seamounts in the literature. Our mapping and sampling program was carried out in eastward direction after finishing the second magnetic profile over 580 nm parallel to the Investigator Ridge on its eastern side. Mapping and sampling of this area ended at Christmas Island.

DR 35, DR 36, DR 38 and DR 39: "Rudolf" Seamount

The first seamount (working name "Rudolf") approached, turned out to be a guyot with c. 50 km base diameter (Fig. 5.12.) that rises ~3.000 m above the surrounding seafloor (5,500 m b.s.l.). The plateau edge (DR 35) lies at ~2,800 m b.s.l. and a small volcanic cone was identified in the southwest corner of the plateau (DR 36) and presumably testifies for rejuvenated volcanism after the volcano submerged below sea level. The southern flank of the volcano is characterized by a broad ridge that runs southward and connects along the 4,500 m b.s.l. contour with the next seamount "Scrooge" in 60 km distance to the SSW. About 18 km south of "Rudolf" Seamount a volcanic edifice with ~5 km diameter is located in the center of this ridge with its cone reaching to ~3,400 m b.s.l. (DR 38), but without any morphological evidence that this volcano ever emerged above sea level. DR 35 was carried out along the northwestern slope of "Rudolf" Seamount in 3,084 to 2,700 m b.s.l. just below the plateau edge. The dredge tack proved difficult and the dredge had to be recovered after 200 m of pulling. Nevertheless it yielded a large piece (39 x 23 x 22 cm) of freshly broken pillow lava. The aphyric, non-vesicular lava has for the most part a strongly oxidized groundmass with characteristic alteration halos along cooling fractures. Only in a few areas a greyish groundmass is preserved and very small feldspar microphenocrysts are visible. Overall the sample is very strongly altered. The small volcanic cone on the plateau of "Rudolf" Seamount was sampled at DR 36 in 2,548 to 2,230 m water depth, but recovered only some rocks of strongly altered lava, Mn-crusts and volcaniclastics. The lava fragments are covered by fairly thick Mn-crusts (1 - 3 cm) and have 7 - 10% vesicles that are mostly open or lined with calcite or zeolites. The groundmass is thoroughly altered to dark brown and phenocryst phases comprise 5% altered olivine up to 5 mm and 3% feldspar needles that appear also altered. Only at places minor amounts of fresher, grey groundmass are visible. DR 38 carried out along the steep western flank of the small volcano along the ridge between "Rudolf" and "Scrooge" in 4,381 to 3,853 m b.s.l. returned empty. A final attempt to obtain fresher rocks of this structure was undertaken at DR 39 on the southwestern flank of Rudolf Seamount in 3,100 to 2,711 m b.s.l. just below the plateau edge, but returned only one piece of carbonate.

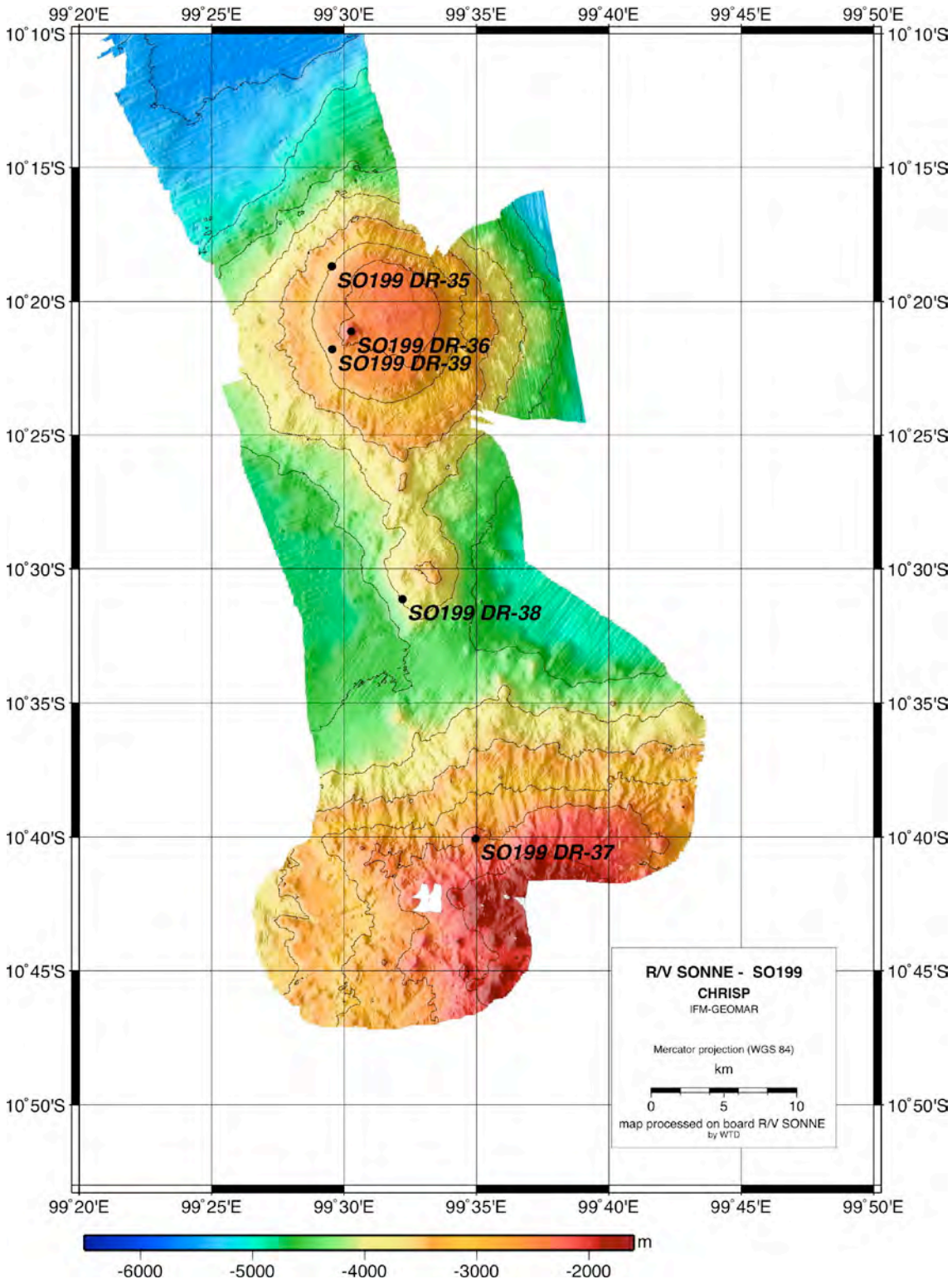

Fig. 5.12.: *Dredge sites DR 35 - 39 at "Rudolf" and "Scooge" Seamount.*

DR 37: "Scrooge" Seamount

This seamount was only partially mapped along its western and northern section (Fig. 5.12.). In contrast to "Rudolf" Seamount; "Scrooge" rises from 5,000 m b.s.l. to considerably shallower depth of ~1,900 m b.s.l.. The top region of "Scrooge" is covered by numerous cones of probably volcanic origin. A clear plateau edge similar to "Rudolf" Seamount could not be observed, possibly reflecting limited mapping of the structure. In any case we note that clear morphological evidence for a guyot is missing, although the structure is at least 700 m shallower than nearby "Rudolf" Seamount. This observation may imply different ages of these two volcanoes. DR 37 was located along the west facing slope of a small cone at the northern

flank of the seamount in 2,475 to 2,272 mb.s.l.. Unfortunately only carbonate was recovered from here.

DR 40: "Gringe" Ridge

This structure is the first seamount belonging to the Vening Meinesz Seamounts and was mapped as NW-SE trending, oval shaped seamount that resembles more closely a ridge than a typical seamount (Fig. 5.13.). It rises from 5,500 to less than 4,000 m b.s.l. and extends over ~25 km along the ridge axis. The top region is sided by steep northeast and southwest facing flanks without any signs of an erosional plateau, indicating that this structure never emerged above sea level. Dredging along the SW flank in 4,306 to 3,791 m water depth recovered aphyric and slightly feldspar phyric, Mn-encrusted pillow lavas. The first sample group (DR 40-1 and -2) are slightly to medium altered, vesicular (3 - 5%, 1 – 5 mm, unfilled) lava fragments with a light grey groundmass and 2 - 3% feldspar phenocrysts (1 – 2 mm, fresh). The second, more abundant lithology of this dredge (DR 40-3 to –5) is aphyric pillow lava with 10% open vesicles (2 – 15 mm, lined with Fe-oxyhydroxide) that are sometimes strongly elongated with an aspect ratio of 7:1. They could either reflect degassing pipes or indicate a relatively high viscosity of the melt.

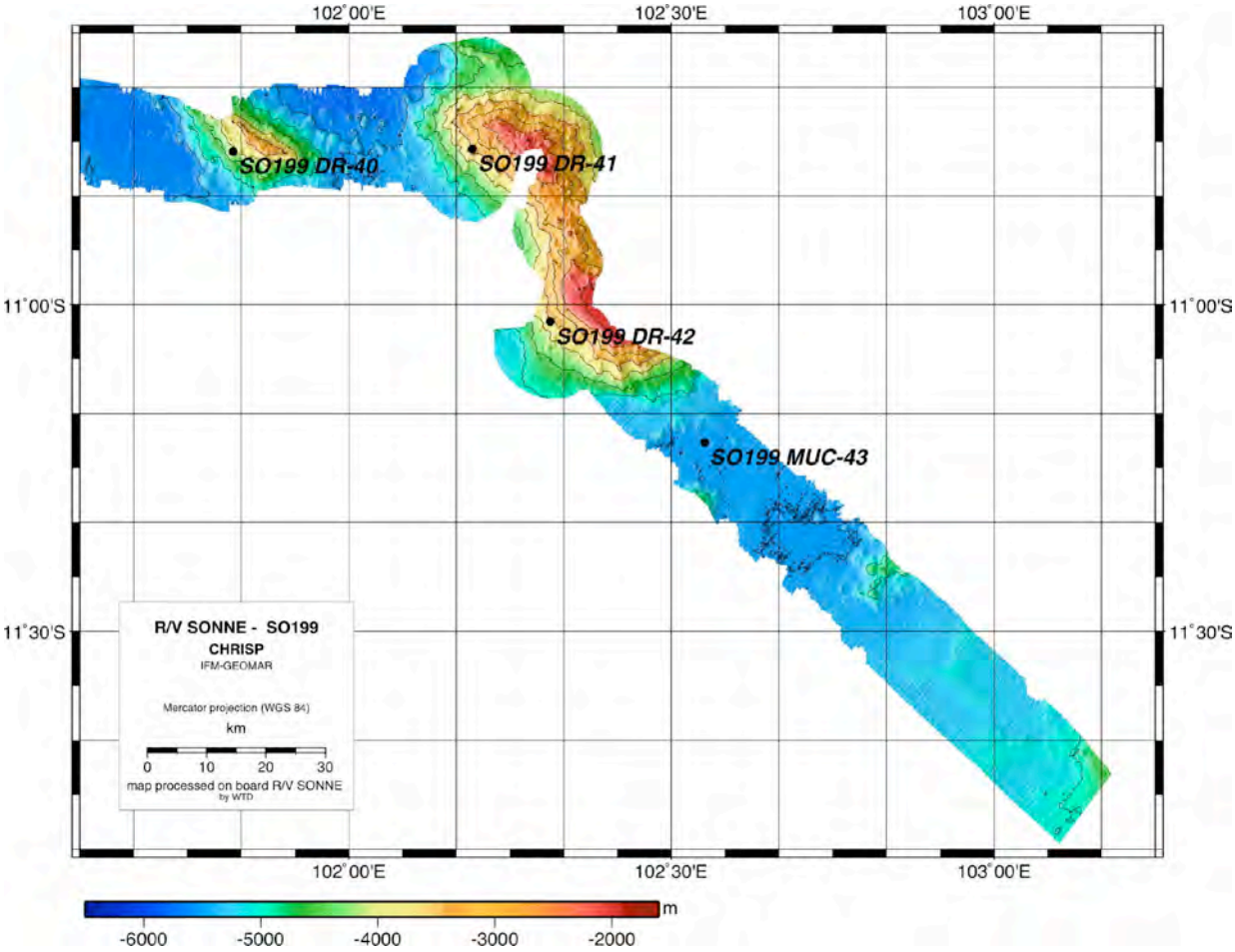

Fig. 5.13.: *Dredge sites DR 40 - 43 at "Gringe" Ridge and "Mt. Melchior" and "Lucia" Seamounts.*

DR 41 and 42: "Mt. Melchior" and "Lucia" Seamounts

Somewhat similar to "Grinch Ridge" the overall structure turned out to be a NW-SE oriented ridge structure. In detail it seems that this ridge actually consists of two separate oval shaped seamounts, both striking NW-SE, that are connected along a broad north-south ridge forming a ridge like seamount with a base diameter of 70 km along its central axis (Fig. 5.13.). Notably the northwestern seamount "Mt. Melchior" reaches from 5,000 to slightly more than 3,500 m b.s.l. with numerous volcanic cones in its top region, while the southeastern seamount "Lucia" reaches from a similar base depth to less than 2,000 m b.s.l. and appears to have developed a

guyot type plateau. DR 41 sampled the southwest flank of the northeastern sub-seamount from 3,754 to 3,280 m b.s.l. and obtained several pillow lava fragments, lapilli tuffs and bioturbated micritic carbonates. The pillow lava appears homogeneous and is characterized 10 - 25% vesicles that are mostly empty and lined with zeolites but in places filled with calcite. A common feature are varying amounts of altered olivine phenocrysts (3 - 7%, 1 – 3 mm) while 3 - 5% altered feldspar is only described from DR 41-1. Location DR 42 was carried out along the SW flank of "Lucia" in a similar depth range (3,963 – 3,441 m b.s.l.) than DR 41. Again a few lava fragments and lapilli tuffs were recovered. The lavas are highly vesicular consisting of 5 - 25% rounded vesicles that are mostly unfilled. Observed phenocryst phases include 1 - 2% altered olivine (up to 2 mm), 7 - 10% feldspar or foides that are up to 12 mm in diameter, greyish-white and have an unusual shape. Finally 1% pyroxene up to 2 mm is described in DR 42-3.

DR 44: "Attention" Seamount

This seamount marks the beginning of the central section of the Vening Meinesz Seamounts. "Attention" Seamount rises from 5,000 m b.s.l. to less than 2,500 m b.s.l. and has a roughly oval shaped base diameter of ~40 km with a WNW-ESE striking axis (Fig. 5.14.). The seamount flanks are oriented orthogonal to each other leading to a pyramid like appearance. A small oval shaped plateau (8 x 3 km) with an irregular surface topography is developed along its top. Yet, the bathymetry does not provide unequivocal evidence for emergence of this volcano above sea level. Dredge DR 44 was carried out in the southwest corner (2,525 to 2,036 m b.s.l.) along the west facing slope below the ridge formed by the interconnection of the southern and western flank. The dredge recovered only very few rocks comprising a single lava fragment, Mn-crusts and carbonate. The lava fragment is non-vesicular basalt containing altered olivine, foides (1%, up to 2 mm) and fresh pyroxene or amphibole (1%, up to 2 mm). The groundmass is dark-grey and the overall degree of alteration estimated to be medium altered.

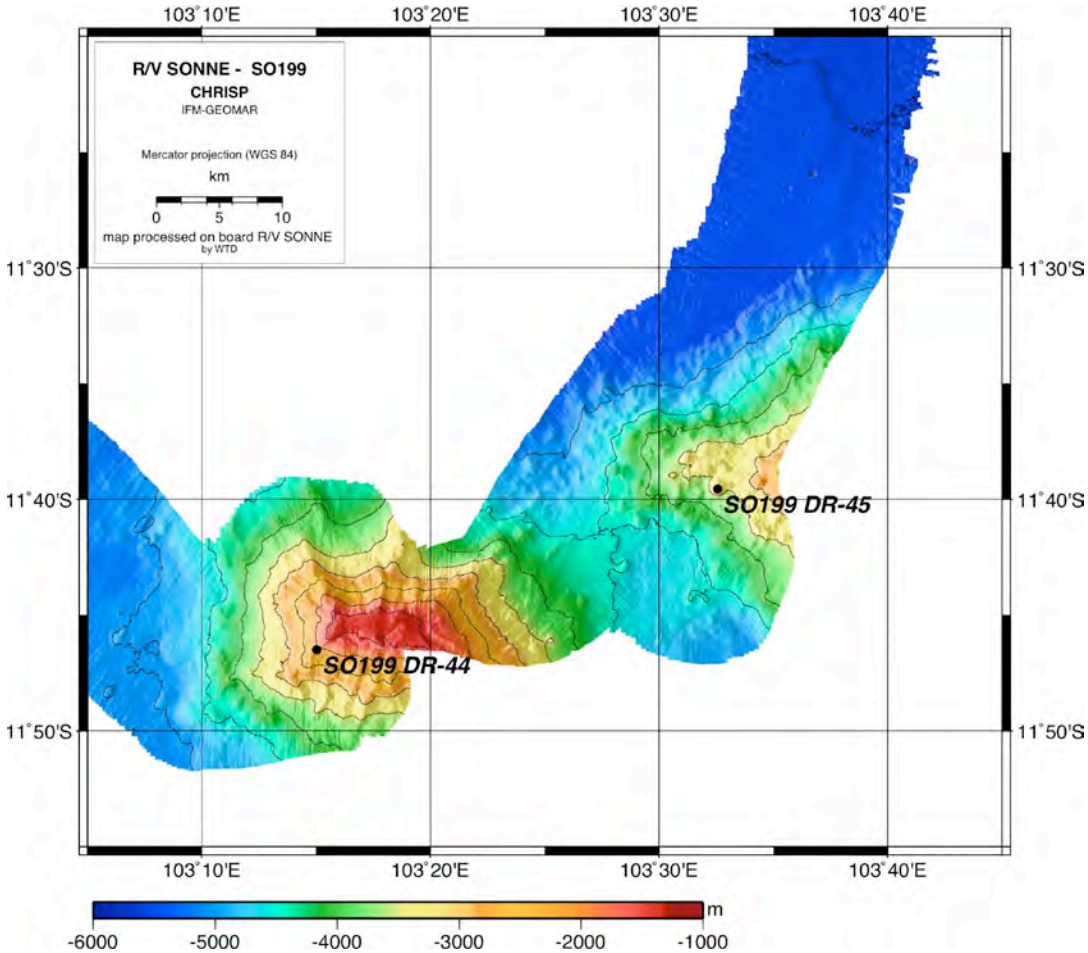

Fig. 5.14.: *Dredge sites DR 44 - 45 at "Attention" and "Glögg" Seamounts.*

DR 45: "Glögg" Seamount

"Glögg" Seamount lies ~10 nm ENE of "Attention" Seamount and was only partially mapped along its western flank (Fig. 5.14.). Judging from the curvature of contour lines, this seamount seems to be larger in volume but the oval shape of its base with an approximately east-west striking long axis is quite similar to the previous seamount. Sampling was conducted along the western tip of the seamount (3,746 to 3,273 m b.s.l.) which consists of several small cones and ridges causing a quite irregular bathymetry. Two types of highly vesicular tuff or lava of probably tephritic to phonolitic composition were recovered with the main difference being greenish versus grey groundmass color. The variety with greyish-green to dark green groundmass has 15 - 25% vesicles or pore space. Individual cavities have extreme irregular shape and are 0.2 to 0.5 mm in size. It is nor clear whether they are true degassing structures or rather pore space in between grains. Although quite aphyric about 1% of fresh, 2 – 4 mm sized feldspar or foide crystals are present. The overall degree of alteration ranges from slightly altered (DR 45-1 and -6) to medium and strongly altered (DR 45-2 to -5). The variety with the greyish groundmass (DR 45-7 to –11) has a similar overall texture as the ones with green groundmass, but the vesicles are more rounded (20%, 0.1 -0.4 mm) and are more likely to have formed through degassing of a melt. Again ~1% fresh feldspar or foide phenocrysts (1 – 2 mm) are present. In summary the base of the western seamount flank provided evolved volcanics of probably tephritic to phonolitic composition, but the type of deposit (lava or tuff) awaits further petrographic investigations.

DR 46: "Halley" Seamount

Mapping of "Halley" Seamount (named after the comet discovered on 25th Dec. 1758 by Edmond Halley) revealed a large WNW-ESE striking oval shaped seamount (~60 km base diameter) consisting of a western and an eastern volcano that are connected by small ridge along the 4,500 mb.s.l. contour (Fig. 5.15.). Both reach from 5,500 m b.s.l. to less than 3,500 m b.s.l.. Their tops are relatively flat and contain cones of probably volcanic origin along the

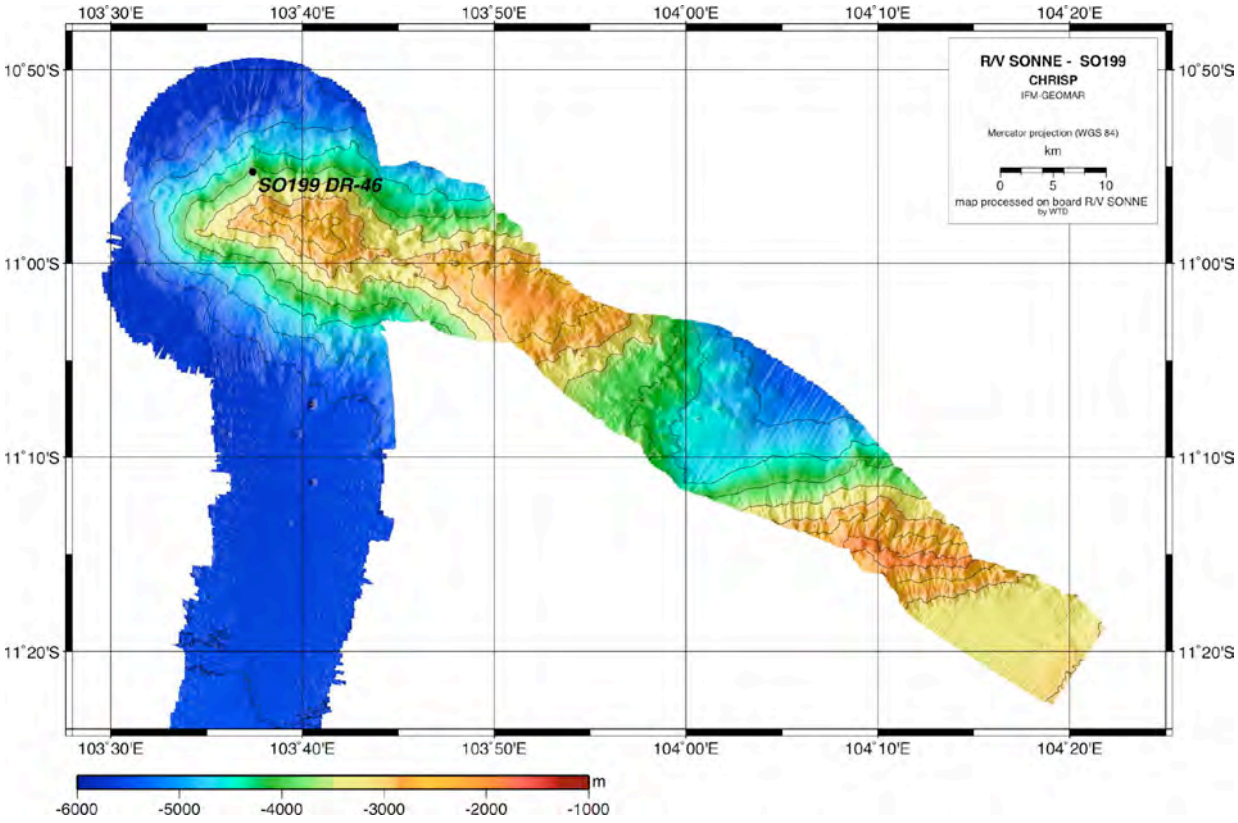

Fig. 5.15.: *Dredge site DR 46 at "Halley" Seamount.*

plateau edges. Dredge sampling was carried out along a northwest facing erosional ridge of the western seamount and recovered pillow lava fragments and lapilli tuffs. The majority of lava fragments are quite vesicular (15 - 20%, up to 20 mm, mostly open, filled with calcite

when more altered) and contain up to 20% altered olivine (up to 2 mm) and 10% fresh feldspar (1 mm) phenocrysts (DR 46-1 to –4). The groundmass is greyish-brown and the overall degree of alteration considered medium altered. A second lava type (DR 46-5A, B to –6) is characterized by more abundant filling of the vesicles with calcite, fairly fresh groundmass with feldspar microphenocrysts and 1 - 2% pyroxene or amphibole phenocrysts with single crystals up to 10 mm.

DR 48: "Balthazar" Seamount

This is a very large SW-NE striking guyot-type seamount (Fig. 5.16.) rises from 6,000 to less than 1,500 m b.s.l. along its southeastern flank, while the northwestern flanks only drops from the plateau edge to 3,000 m b.s.l.. From here onwards an abyssal plain connects to an east-west striking ridge that shallows to 2,000 m b.s.l. with its top being formed by a ridge crest with steep northern and southern flanks. DR 48 used a small plateau of the SE flank in 2,500 m b.s.l., covered by at least 4 - 5 volcanic satellite cones that were surveyed during TVG 47 (Fig. 5.16.). The western flank of the easternmost cone was sampled from 2,202 to 2,082 m b.s.l. only due to a stuck dredge testifying the rough grounds observed during TVG 47 at this location. Still a few rocks comprising pillow lava fragments with attached volcaniclastics, volcaniclastics and carbonate were recovered. The lava is moderately altered and partially covered by a 5 mm thick manganese crust. Vesicularity ranges from 10 to 20% and are open in the least altered sample DR 48-1 and filled with calcite in DR 48-2 where a large vug (4 cm) is partially filled with calcite that has developed "sharp teeth" like crystals. Phenocryst phases observed include either altered olivine and 2% feldspar needles (1 – 2 mm) and additional pyroxene (<1%, 2 mm) in sample DR 48-2.

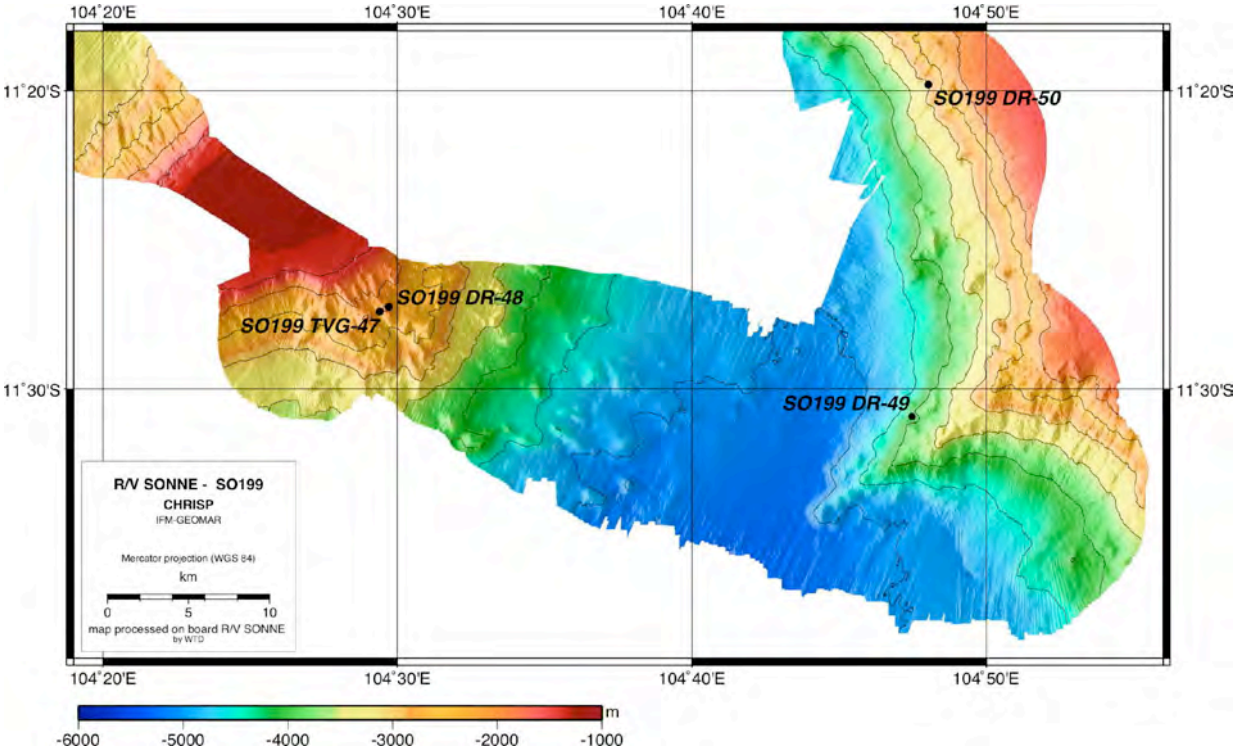

Fig. 5.16.: *Dredge sites DR 48 - 50 at "Balthazar" and "Apollo 8" Seamounts.*

DR 49 and DR 50: "Apollo 8" Seamount

This guyot-type seamount (working name "Apollo 8" named after the first manned moon mission that circled the back side of the moon on 24th Dec in 1968) has been mapped over 60 km along its western flank that rises from 5,000 to at least 2,000 m b.s.l. where a flat top region appears to develop in the mapped part (Fig. 5.16.). The southwest corner houses a characteristic southwest striking ridge that has been sampled by DR 49 along an erosional valley located at the northwestern flank from 4,582 to 4,050 m b.s.l.. The dredge contained at least three different pillow lava lithologies and a single piece of solidified carbonate. The most abundant and characteristic lavas (DR 49-1 to –7) are porphyric pillow fragments with 2%

altered olivine (up to 2 mm) and 7 - 10% fresh feldspar or foide phenocryts (3 – 15 mm). The latter occur as transparent grey angular laths or rounded crystals which could reflect an overall platy habitus combined with cutting effects. A feldspar or nepheline origin awaits thin section microscopy. These rocks are highly variable in the amount and size of unfilled vesicles, ranging from 2 to 20% and 0.5 to 3 mm, respectively. The groundmass ranges from grey where fresh to slightly greyish-brown where oxidized leading to a slightly to moderately altered appearance. A near aphyric lava type is sampled in DR 49-8 (Fig. 5.2.), that has <1% fresh feldspar phenocrysts (<1 mm), 10 - 15% unfilled vesicles up to 3 mm in diameter with some elongated to oval shapes. The light brown to greyish groundmass leads to a moderately altered character. The third and volumetrically second most abundant lithology is a relatively dense, non-vesicular lava (3 - 5%, 0.1 to 1 mm, mostly open vesicles with minor feldspar laths (<3%, up to 1 mm) and greyish to light brown groundmass (DR 49-9 to –17).

The second dredge (DR 50) at “Apollo 8” Seamount has been carried in the northwest corner along its western flank in 3,125 to 3,022 m water depth (Fig. 5.16.) with the intention to sample a higher stratigraphic level in the area just beneath the plateau edge. Although the dredge got stuck some heterolithological rocks were obtained including lava fragments and lapilli tuffs. The lava fragments include non-vesicular basalts (DR 50-1 to -3) that range from strongly feldspar/foide porphyric (20%, 1 – 6 mm) to less phyric (5%, 1 – 4 mm) varieties. Minor amounts of altered olivine and pyroxene (both <1% abundance and 0.5 – 1 mm in size) were also observed. In general the groundmass of the non-vesicular lavas is light to dark grey and the freshest parts range from slightly to moderately altered. A second type of lava fragments is characterized by 10 to 40% vesicularity but show large variations in phenocryst content that ranges from aphyric (DR 50-4 and –7) to 5% feldspar/foide phyric lavas (DR 50-5, -6 and -8). The groundmass of the vesicular lavas is mostly brown, in some areas greyish so that the overall degree of alteration in this sample group is strongly to very strongly altered.

DR 52: Sherbakov Seamount

This officially named seamount marks the last and easternmost structure of the Vening Meinesz Seamounts sampled during SO199. The seamount rises relatively steep from 5,000 m b.s.l. to less than 1,500 mb.s.l. over a distance of ~10 km at its southern flank while it takes almost 60 km for the same drop in elevation at the northeastern side (Fig. 5.19.). The plateau top strikes towards ENE-WSW and has a relatively flat topography. However, it can not be stated with certainty that the plateau formed through wave erosion. Dredge DR 52 was carried out at the southwestern end of the seamount below the plateau edge in an area that is characterized by several cones. The western slope of one of these cones has been dredged from 2,820 to 2,229 m b.s.l. and several pillow lava fragments, volcaniclastics and sediments were obtained. The pillows basalt stems from a single lithology that is characterized by 10 - 15% vesicles with a zoned size distribution from 0.2 to 1.5 mm going from the pillow center to the chilled margin. The vesicles are often filled with calcite and together with the greyish brown groundmass color classify this rock medium to strongly altered. Observed phenocryst phases include 3% altered olivine (0.5 – 2 mm) and fresh plagioclase microphenocrysts (1%, 1 x 0.1 mm).

DR 88 and DR 89: “Giana” Seamount

This seamount has been mapped and sampled at its northern end and represents only a small fraction of a giant seamount complex extending 150 km in southward and 80 km in eastward direction according to the predicted bathymetry. In the mapped part the seamount flank rise relatively smooth from the 4,400 m contour to 2,000 m b.s.l. over a distance of ~10 km (Fig. 5.17.). The 2,000 m b.s.l. contour also marks a plateau edge where the slope gradient significantly decreases and the topography rises only another 400 m over a distance of ~5 km. The mapped northern and southwestern flanks consist of a series of ridges and noses with erosional valleys in-between. DR 88 and DR 89 were carried out along the northwest corner of the seamount from 3,626 to 3,141 m b.s.l. and 4,266 to 3,848 m b.s.l., respectively. DR 88 returned a few highly altered lava fragments and lapilli tuffs. The lava has 20%, 2 – 5 mm sized vesicles that are mostly filled with calcite and zeolites. The groundmass is totally oxidized to brown and 1 - 3% altered feldspar (1 – 2 mm) and olivine (<1 mm) phenocrysts are also present. DR 89, carried out at the base of the seamount returned a few large, Mn-encrusted (up to 7 cm) lava fragments and lapilli tuffs. The lava fragments are most likely

originate from pillows based on their shape. They contain 5 - 10%, 2 – 10 mm sized oval shaped vesicles that are empty or filled with calcite or Fe-Oxyhydroxide. Minor feldspar and pyroxene phenocrysts (<1%, 2 – 3 mm) seem also present. The described altered olivine are most likely misidentified vesicle fillings. The groundmass color ranges from dark grey in the center to brownish along the edges of samples leading so that degree of alteration is zoned from slightly to moderately altered.

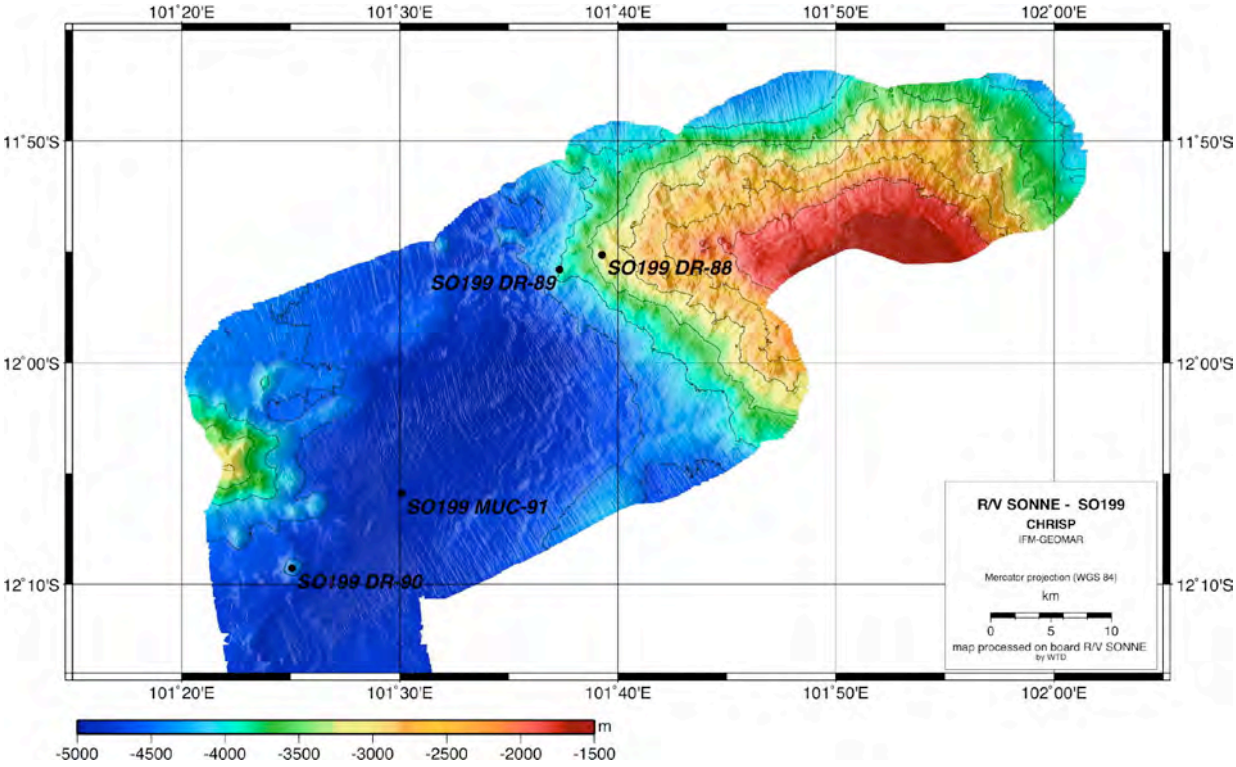

Fig. 5.17.: *Dredge sites DR 86 - 90 at "Giana" and "Leibniz" Seamounts as well as multi corer Station MUC 91 on the abyssal plain between both seamounts.*

DR 90: "Leibniz" Seamount

This seamount (working name "Leibniz" named after Gottfried Wilhelm Freiherr von Leibniz [1646 – 1716], a famous German philosopher, mathematician and physicist) is a small volcanic cone 35 km WSW of "Giana" Seamount (Fig. 5.17.). It has a base diameter of only 2 km and does not elevate more than 600 m above the surrounding seafloor at 4,800 m b.s.l.. Overall the structure lies at the southern flank of an east-west striking seamount, located 10 km further NNW. DR 90 has been carried out along the entire southwestern flank from 4,722 to 4,260 m b.s.l. and recovered Mn-crusts and Mn-encrusted pillow lava. The pillow lavas are olivine-pyroxene phyric basalts that are quite similar with minor differences in vesicularity and phenocryst abundance. The freshest piece (DR90-1, Fig. 5.18.) has 10 - 15%, 1 – 3 mm sized vesicles with one half filled or lined with calcite and the other half open. The groundmass is dark grey with a brownish discoloration leading to a medium altered impression. Altered olivine (3%) occurs as 0.5 – 2 mm sized crystals together with 5 - 8%, 1 – 4 mm sized fresh pyroxene. Samples DR 90-2 and –3 are slightly higher in vesicularity (20%), have less olivine (1%) and pyroxene (2%) and overall are more strongly altered.

5.2.5. Eastern Christmas Island Seamount Province (DR 54 – DR 66)

This area includes Christmas Island and all eastward lying seamounts between 105°E and 111°E.

DR 54 and DR 55: Christmas Island

Christmas Island belongs to Australia and owes its existence to tectonic uplift at the outer rise of the nearby Java trench. Two thirds of the island are wildlife protected area and the island is home to 120 Mill. species of the famous endemic red colored Christmas Island crab

(*Gecarcoidea natalis*). In 2006 ~1,400 people were still living on the island with phosphate mining in operation since 1890. The characteristic coastal outline of Christmas Island with pronounced curved bays on the northern, southern and western coast are an indication that land slides may have occurred along the seamount flanks in the geological past. Indeed SO199 multi-beam mapping (Fig. 5.19.) outside the 3 nm territorial zone along the southern, western and northern flanks of Christmas Island (the eastern flank was not mapped due to time constraints) confirms at least one major slope failure at Flying Fish Cove, the harbor of Christmas Island. Here the 2000 to 2700 mb.s.l. contour lines show a characteristic bend

Fig. 5.18.: *Representative hard rocks yielded by dredging on the second part of SO199.*

towards the island, running parallel to the coastline while the contour lines below 2,700 m b.s.l. show a pronounced bend away from the island. These observations are consistent with a slope failure in the area of the inward bend contours and the corresponding debris flow deposit at greater depth where the contours are bend outward. A similar situation appears on the southern flank of Christmas Island but requires confirmation by further mapping. Mapping within the 3nm zone is also needed to reveal further details of these flank collapses. Dredging was carried along the southwestern flanks of Christmas Island in 3,626 to 3,146 m b.s.l. (DR 54) and 1,891 to 1,427 m b.s.l. (DR 55) (Fig. 5.19.) with both dredge hauls obtaining a few rocks only. A single lava fragment was recovered during DR 54 that is characterized by a relatively fresh grey groundmass with <1 mm sized feldspar needles, 2 - 3% altered olivine (2 mm) and 10 - 15% mostly empty vesicles. Surprisingly fresh, crystal rich lava with abundant xenoliths was recovered from DR 55 (Fig. 5.19.). The angular fragments appear to be freshly broken *in situ* lava with a brown to olive groundmass color that contains 2% open vesicles and 5% amphibole laths up to 8 mm that can also occur as large macrophenocryts (5 x 10 mm). Fresh feldspar or foides are up to 6 mm in size and reach 10%. This evolved lava (tephrite?) also contains holocrystalline, plutonic xenoliths that probably stem from the intrusive part of the island or less likely from the underlying ocean crust.

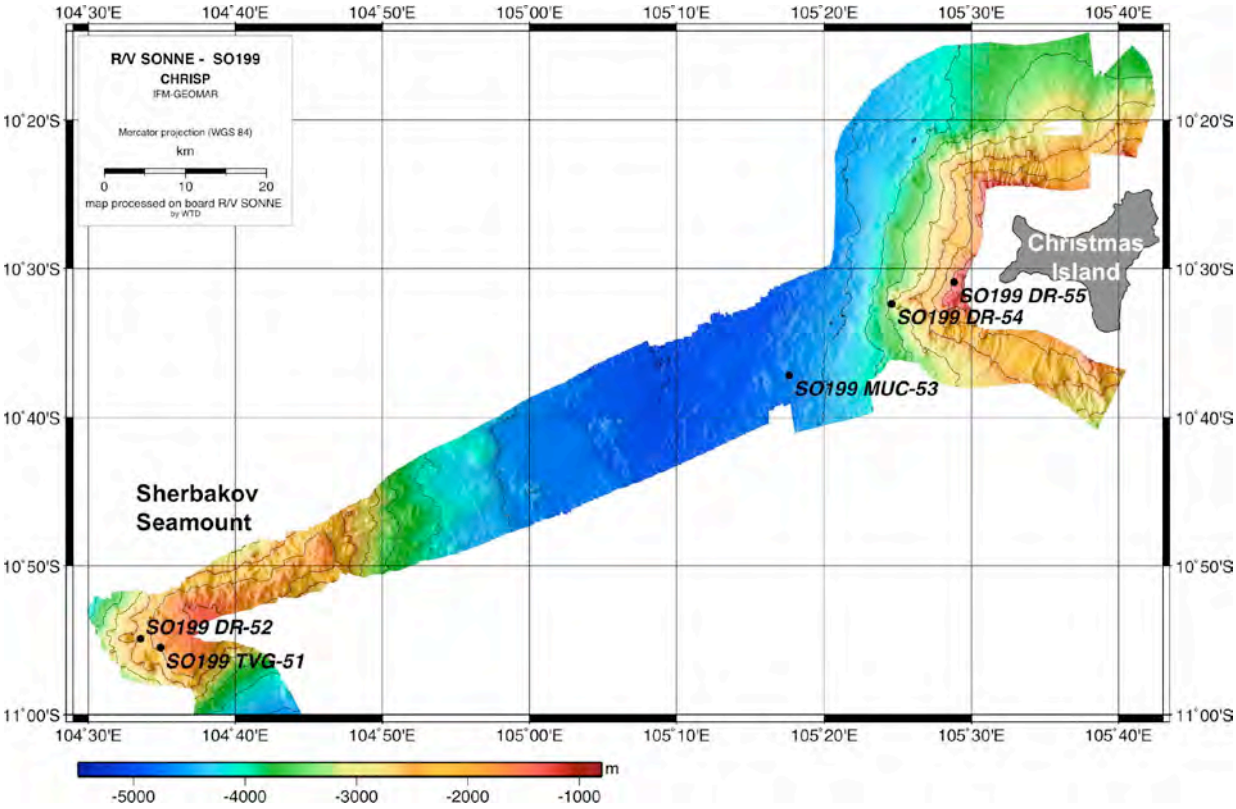

Fig. 5.19.: *Sampling sites at Sherbakov Seamount and at the base of Christmas Island. Note the depression in the northern coast and flank of Christmas Island which most likely has been formed by slope failure. The deposits of this slumping form a distinct elevation north of the island.*

DR 56: "Royal Mary" Seamount

This conical shaped seamount has been informally named "Royal Mary" after the ship of the East-India Company that discovered Christmas Island on 25th December in 1643 under the command of Captian William Mynors. The base of this structure lies at 5,800 m b.s.l. and has a diameter of 25 km with its near circular flanks rising to less than 3,000 m b.s.l. where a small steep sided plateau is developed (Fig. 5.20.). The overall morphology indicates that this volcano has been under water at all times. A well filled dredge with different lava lithologies and volcaniclastics has been obtained from 3,997 to 3,338 m b.s.l. in the middle slope of the western flank. The first lava type (DR 56-1 to –3) is highly porphyritic with 20-25%, up to 15

mm slightly elongated feldspar or foide crystals along with 1 - 2% up to 10 mm sized pyroxene crystals. The vesicularity is estimated to be 10% with 50% being filled with calcite and the groundmass color is grey so that the overall degree of alteration is estimated to range from slightly altered to moderately altered. The second lava type is medium altered, less vesicular (1 - 5%) with a grey to brownish groundmass and 5% feldspar/foide phenocrysts up to 10 mm in size along with <1 mm altered olivine (DR 56-4 and –5). The third lava lithology (DR 56-6 to –10) has a greenish to light grey groundmass, is highly vesicular (15 - 30%, 1 – 25 mm) and has somewhat similar amounts of 25%, fresh feldspar or foides (<6 mm) and 3% pyroxene (<3 mm). A single piece (DR 56-10) contains a 10 x 4 cm coarse crystalline crustal xenoliths with diffuse margins to the groundmass.

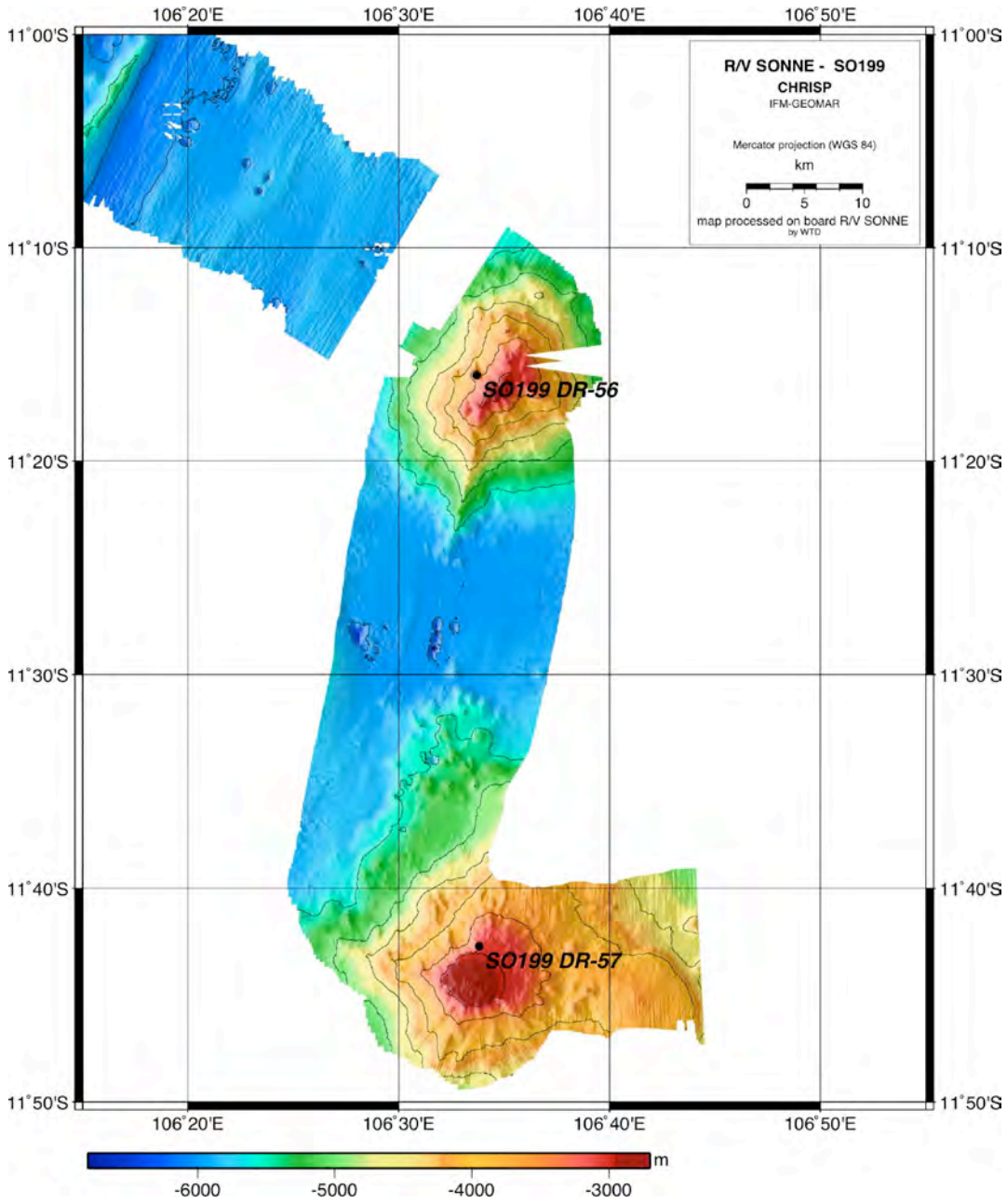

Fig. 5.20.: *Dredge sites DR 56 at "Royal Mary" Seamount and DR 57 at "Elena Seamount"..*

DR57: "Elena" Seamount

The mid-sized "Elena" seamount lies 25 km south of "Royal Mary" Seamount and similarly rises from near 6,000 m b.s.l. to 3,200 m b.s.l.. Although a more pronounced flat plateau is developed above the 3,000 m b.s.l. contour it is unclear whether this volcano emerged above sea level. The base diameter is in the order of 40 – 50 km and is near circular along the steep southern, western and northern flank. The eastern flank has a much more gentle slope that

only drops over 15 km to ~5,000 m b.s.l. where a flat abyssal plain connects with the next seamount “Max” in the east. Dredging was carried out just beneath the plateau edge along the northwestern flank (Fig. 5.20.) and recovered some lava fragments and volcaniclastics. The vast majority of lava fragments belong to the same lithological unit (DR 57-1 to –6) and are non-vesicular, slightly pyroxene (3%, up to 10 mm) and feldspar phyric (2%, up to 2 mm long needles) basalts. The groundmass color is mostly grey, fine crystalline and quite fresh in the best preserved samples giving the rocks a slightly to moderate degree of alteration. A single piece of lava with 10% unfilled vesicles and a reddish oxidized groundmass resembles subaerial erupted scoria.

DR58 and DR 59, TVG 60: “Max” Seamount

This guyot type structure has only been mapped along its southwestern corner and seems to be the volumetrically largest seamount in this area. In the mapped area, it rises from 5,000 m b.s.l. to 2,000 m b.s.l. with a pronounced plateau edge along the 2,400 m depth contour (Fig. 5.21.). Dredge sampling was carried out at DR 58 along a northwest facing slope from 3,609 to 3,113 m b.s.l. in the southwest corner and at a small cone (DR 59) located well below the plateau between 3,173 to 2,733 m b.s.l.. DR 58 was well filled and obtained a variety of

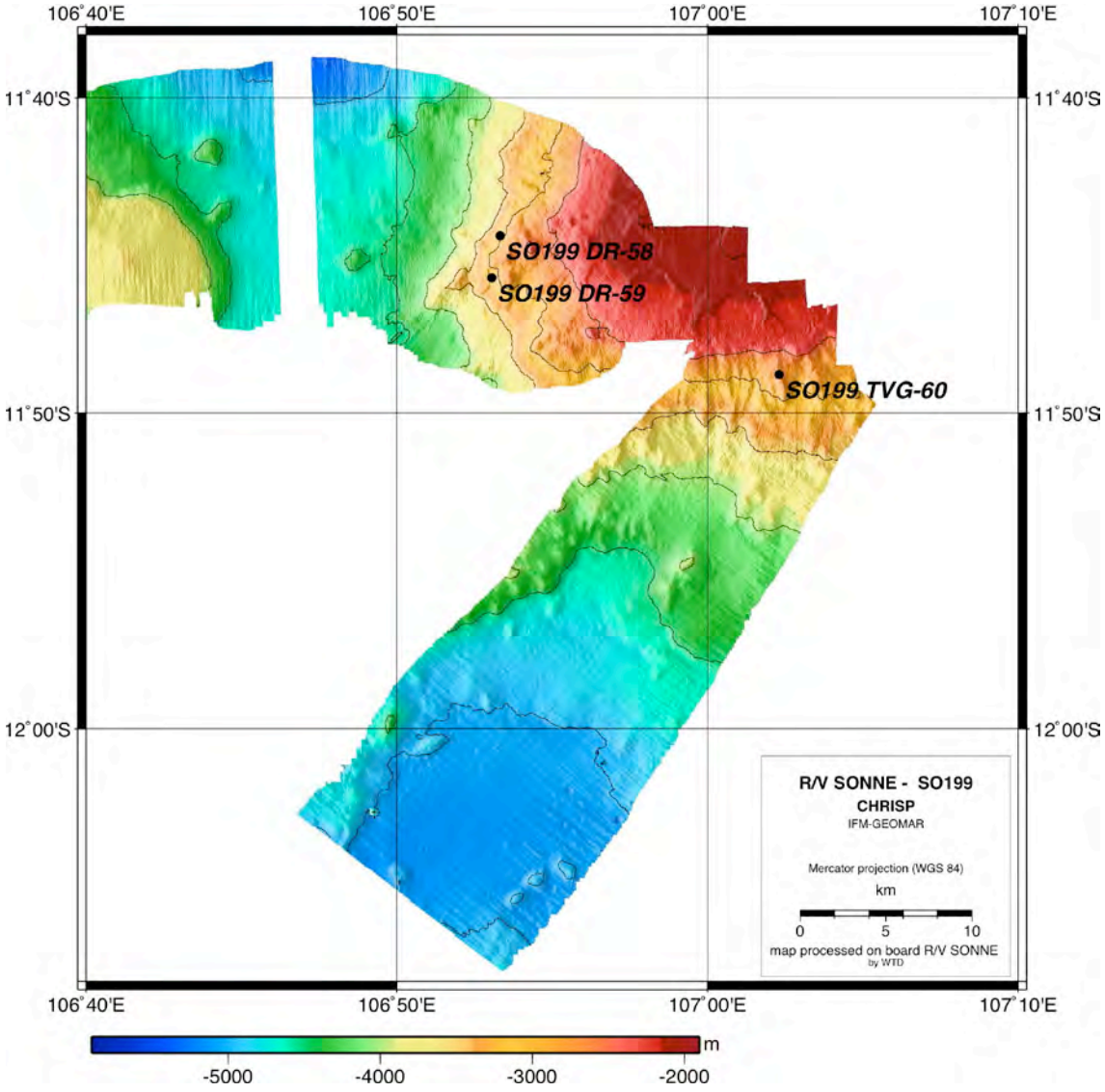

Fig. 5.21.: *Sampling sites at “Max” Seamount.*

feldspar porphyric pillow lava (DR 58-1 to –4, Fig. 5.19.), aphyric tuffaceous lava resembling ignimbrites (DR 58-5 and –6) and strongly altered, highly vesicular feldspar phyric lava (DR 58-7). Furthermore lapilli tuffs and bioturbated carbonate were also found. The porphyric pillow lavas contain 5 - 10%, 3 – 8 mm sized fresh feldspar phenocrysts with minor amounts (2%) of

1 – 4 mm sized pyroxene phenocrysts (sample DR 58-1 only). The groundmass contains 3% open vesicles that are lined with yellowish material (smectite or Fe-oxyhydroxide?) leading to a somewhat greyish-brown groundmass discoloration. Some vesicles are more elongated and aligned orthogonal to the pillow margin as it is typical for degassing pipes. Overall these rocks appear medium altered and the 2 – 4 cm thick chilled margins are in most cases completely altered except DR 58-8B where fresh glass for microanalyses may still be preserved. The second igneous rock type is aphyric with strongly aligned vesicles that are oval shaped (10 x 2 mm) and sometimes bend around darker, dense inclusion. This observations suggests that the melt was highly viscous and degassing occurred during emplacement. The brownish-red groundmass although strongly oxidized appears quite fresh. Flow bending of reddish groundmass and darker areas is also observed, but it remains unclear whether this rock formed as lava or as compacted hot (?) ash flow. The third lava type of this dredge is represented by sample DR 58-7, a strongly altered, highly vesicular, 2 - 3% feldspar phyric lava (0.5 – 1 mm).

DR 59 mainly recovered a freshly broken piece of a highly altered lapilli tuff, a few lava fragments and a calcite cemented basalt breccia. The lava fragments represent a single lithological unit characterized by 25% vesicles (1 – 2 mm mostly, some up to 2 cm) that are largely filled with calcite. The aphyric groundmass is light grey and relatively fresh and occasionally contains minor amounts of plagioclase microphenocrysts (<0.1 mm). Still the overall degree of alteration is strongly altered but useful groundmass is present if filled vesicles are avoided. TVG 60 was carried out on a small plateau on the southern flank just beneath the plateau edge (Fig. 5.21.) and recovered pelagic sediment.

DR 61: "Nia" Seamount

This seamount is a solitaire, near circular structure with a base diameter of 15 km that rises from 5,200 m b.s.l. to 3,200 m b.s.l. with a cone shaped top (Fig. 5.22.). The overall structure is somewhat similar to "Royal Mary" seamount, e.g. without any indication that the volcano ever emerged above sea level. A dredge was conducted in the middle part of the steep western flank between 4,674 and 3,988 m b.s.l., but returned empty.

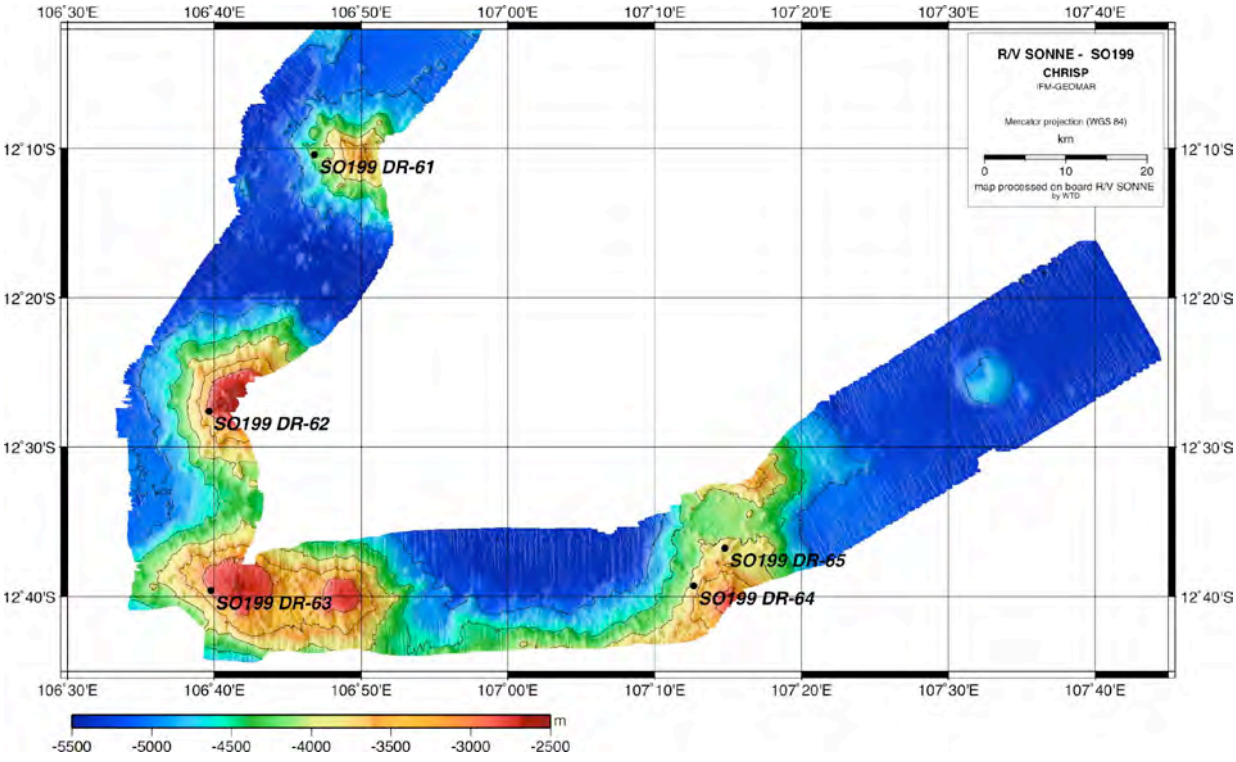

Fig. 5.22.: *Dredge sites DR 61 at "Nia", DR 62 at "Janne", DR 63 at "Helmholtz" and DR 64 and 65 at "Waltrud" Seamount.*

DR 62 "Janne" Seamount

This seamount is part of a U-shaped alignment of several seamounts that occur along a 100 km wide southward facing half circle and is open to the north (Fig. 5.22.). From the

mapped part of “Janne” Seamount it appears to be a circular shaped, guyot-type seamount, that rises from 5,200 to 2,600 m b.s.l. along its northern flank and has developed a flat plateau that is 7 km in diameter along the 2,800 – 3,000 m b.s.l. contour, while the base diameter ranges from 25 to 30 km. The flat lying erosional plateau indicates emergence above sea-level and subsequent erosion. The steep western slope below the plateau edge was sampled during DR 62 from 3,477 to 2,898 m b.s.l. and recovered pillows, pillow fragments and lapilli tuffs. In principle two lava types were sampled. The first is a dense, non-vesicular feldspar-pyroxene-olivine phyric lava with a dark grey groundmass in the unaltered core. About 8% fresh feldspar (1 – 4 mm) are present, followed by 3% fresh pyroxene (2 – 6 mm) and <1% altered olivine (<1 mm). The second lava type is a near aphyric, vesicular pillow lava with minor amounts (<0.5%) of 1 – 2 mm sized fresh pyroxene. Feldspar phenocrysts may be also present but are difficult to identify due to the overabundance of calcite filled vesicles (15 - 20%, 0.5 – 1 mm). The groundmass has a greenish-grey color and appears relatively fresh, still the mainly filled vesicles classify these rocks as strongly altered.

DR 63: “Helmholtz” Seamount

This seamount has been informally named after Hermann von Helmholtz, a famous German physicist to celebrate his 187th birthday. This structure turned out to be a large east-west elongated seamount 20 km south of “Janne” Seamount. The seamount actually consists of two volcanic edifices, both rising from 5,000 to 2,800 m b.s.l. and with two small erosional plateaus of 7 and 3 km above the 3,000 mb.s.l. contour line (Fig. 5.22.). Dredging along the southwestern flank within a small valley just beneath the plateau edge only yielded a single rock of a pervasively altered, aphyric lava fragment. The completely oxidized groundmass contains a few <0.2 mm sized feldspar mircophenocryst and a single 2 mm sized feldspar on the cut surface. A small medium altered zone is preserved and might be used for reconnaissance geochemical analyses.

DR 64 and DR 65: “Waltrud” Seamount

This seamount forms the southeast corner of the U-shaped aligned series of seamounts (Fig. 5.22.). To the north ”Waltrud” connects along a ridge at the 4,000 m b.s.l. contour with another unnamed and only partially mapped circular shaped seamount. To the west “Waltrud” connects along an east-west striking ridge in the mapped part, but additional volcanic edifices may be present along this ridge to the south. The mapped part of “Waltrud” shows a steep northwestern flank that rises from the 5,200 m b.s.l. contour to 2,800 m water depth. A small plateau edge may be present along the 3,000 m b.s.l. contour, but the plateau has only a diameter of 2.5 km and thus is too small to be identified with certainty as having formed through wave erosion. However, we note that the presumed plateau depth lies in a similar water depth than those of nearby “Helmholtz” and “Janne” Seamounts which may indicate broadly similar ages and subsidence histories. Two dredge attempts were carried out. While the first (DR 64) used the northwestern flank in 3,709 to 3,781 m b.s.l. got stuck at the very beginning and did not return any rocks, the second dredge (DR 65) used a small cone along the northern slope in 3,942 to 3,626 m water depth and returned a few rocks. These are feldspar porphyric lava fragments with 7 - 10% up to 22 mm sized fresh feldspar crystals, 2% altered olivine up to 5 mm and <1%, 2 mm sized pyroxene crystals. The groundmass is described as grey in the freshest sample (DR 65-1) and gives this rock a moderately altered appearance.

DR 66: “Finn” Seamount

Located ~80km northeast of “Waltrud” Seamount, this structure forms a near circular seamount with a 25 km base diameter that rises from 5,200 to less than 3,000 m b.s.l. (Fig. 5.23.). Again a small plateau (2.5 km in diameter) is developed above the 3,000 m b.s.l. depth contour that may have formed through erosion at sea level. Dredge haul DR 66 has been carried along the mid section of the northwestern flank in 3,907 to 3,381 m water depth and obtained a full dredge of pillows, pillow fragments, large blocks of lapilli tuffs and Mn-crusts. In principle a feldspar porphyric and a less phyric to near aphyric lava lithologies were recovered. The feldspar porphyric lavas (DR66-1 to –4, Fig. 5.18.) are almost non-vesicular with 0.5% of 0.5 – 1 mm sized vesicles that are filled with green smectite(?). The groundmass is light grey along the outer rim of sample DR 66-1 while the inner core is light brown reflecting a higher abundance of cracks (and thus fluid pathways) in the center of the sample causing a slightly to

a medium altered character of this particular sample. In contrast the groundmass of samples DR 66-2 and –3 is light grey throughout giving them a fresh to slightly altered appearance. About 7%, 0.5 – 4 mm sized, fresh feldspar phenocryts and <1%, <0.5 mm olivine give these rock a porphyric character. Possibly fresh olivine is described in sample DR 66-3. The second lava type (DR 66-5 and –6) is also non-vesicular but near aphyric with only 0.5 - 1%, 1 mm sized feldspar phenocrysts. The groundmass color ranges from grey to brownish-grey giving these rocks a slightly to medium altered character. Samples DR 66-7 and –8 are somewhat similar to the porphyric samples described above, but the amount of ± fresh feldspar phenocrysts (1 – 5 mm) is with 15 - 20% significantly higher and the groundmass is also completely oxidized to light and dark brown making these rocks very strongly altered. A rather unusual rock is sample DR 66-9 which is similar to the aphyric samples but has a texture that resembles mixing of different melts as expressed by dark grey areas curving around greenish brown material. In particular the curved contacts do not look like alteration fronts.

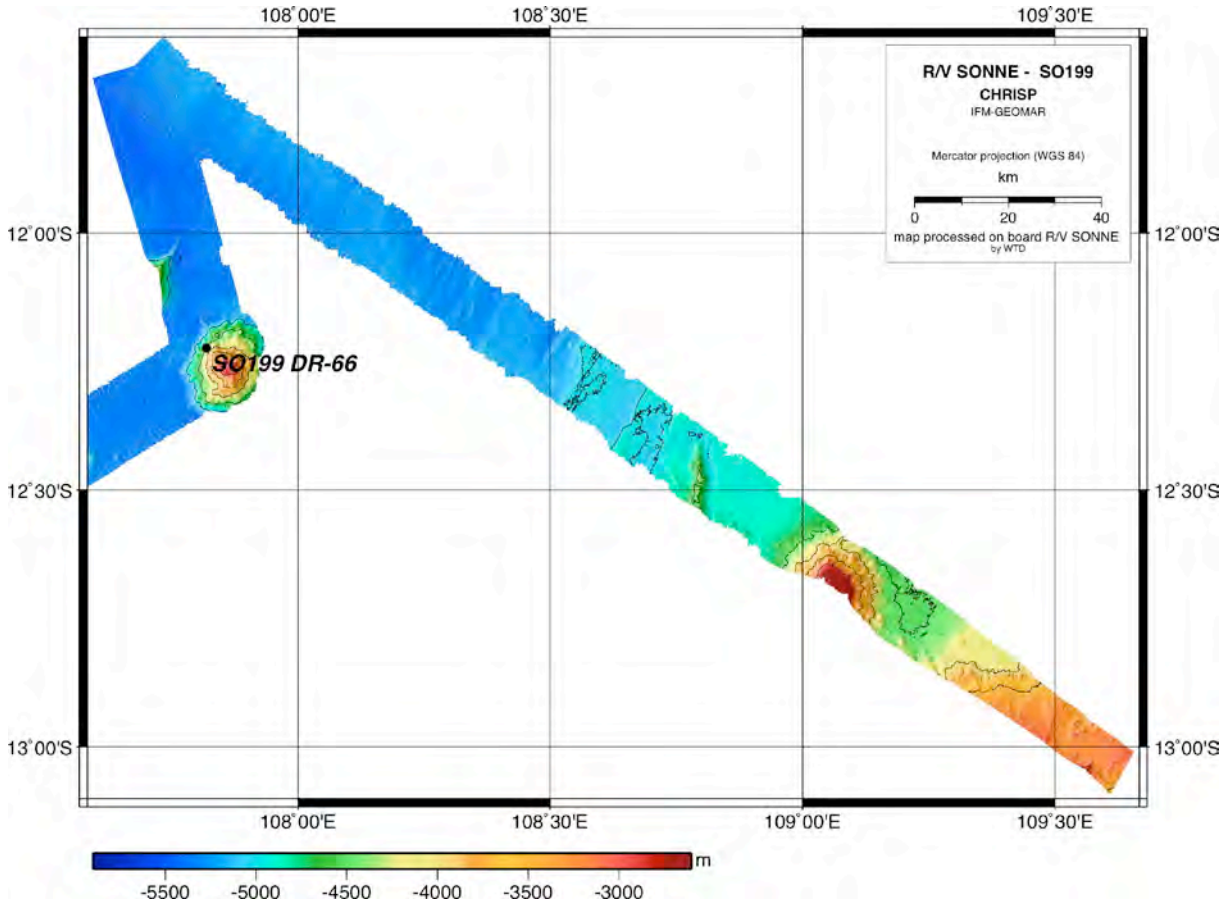

Fig. 5.23.: *Dredge site DR 66 at "Finn" Seamount.*

5.2.6. Southern Christmas Island Seamount Province (DR 73 – DR 87)

The Southern Christmas Island Seamount Province includes all bathymetric features in the area south of 13°S and west of 110°E.

DR 73: "Annegret" Seamount

This structure lies at the western end of a huge plateau that extends from 109°35'E to 108°30'E. Here the western slope rises from 5,000 m b.s.l. to less than 3,000 m b.s.l. over a distance of 12 km. A single dredge was carried out at DR 73 from 4,331 to 3,983 m b.s.l. (Fig. 5.24.) and obtained a few lava fragments and lapilli tuffs. The lavas are described as slightly altered basalts with 15 - 20% fresh feldspar phenocrysts (up to 2 mm) and minor altered olivine (3%, up to 5 mm). The vesicularity and vesicle size ranges from 10 - 15% and up to 5 mm to 1 - 5% and 1 – 2 mm. The vesicles are often open but can be also filled with zeolites.

DR 75: "Kirk" Seamount

This structure lies ~50 nm northwest of "Annegret" Seamount and is based on predicted bathymetry maps apparently part of the same plateau structure to which "Annegret" also belongs. Only the southern margin was mapped and rises from 5,200 to 3,000 m b.s.l. over a distance of ~20 km (Fig. 5.24.). DR 75 targeted a southwest facing slope along the southern margin of the seamount in 3,639 to 3,260 m water depth and obtained only two very strongly altered lava fragments. While DR 74-1 is a non-vesicular, slightly feldspar phyric basalt (<1%, <0.5 mm, fresh), DR 74-2 is also non-vesicular but contains 5% pyroxene (1 - 10mm). Both lavas have a strongly oxidized groundmass causing an overall strong degree of alteration.

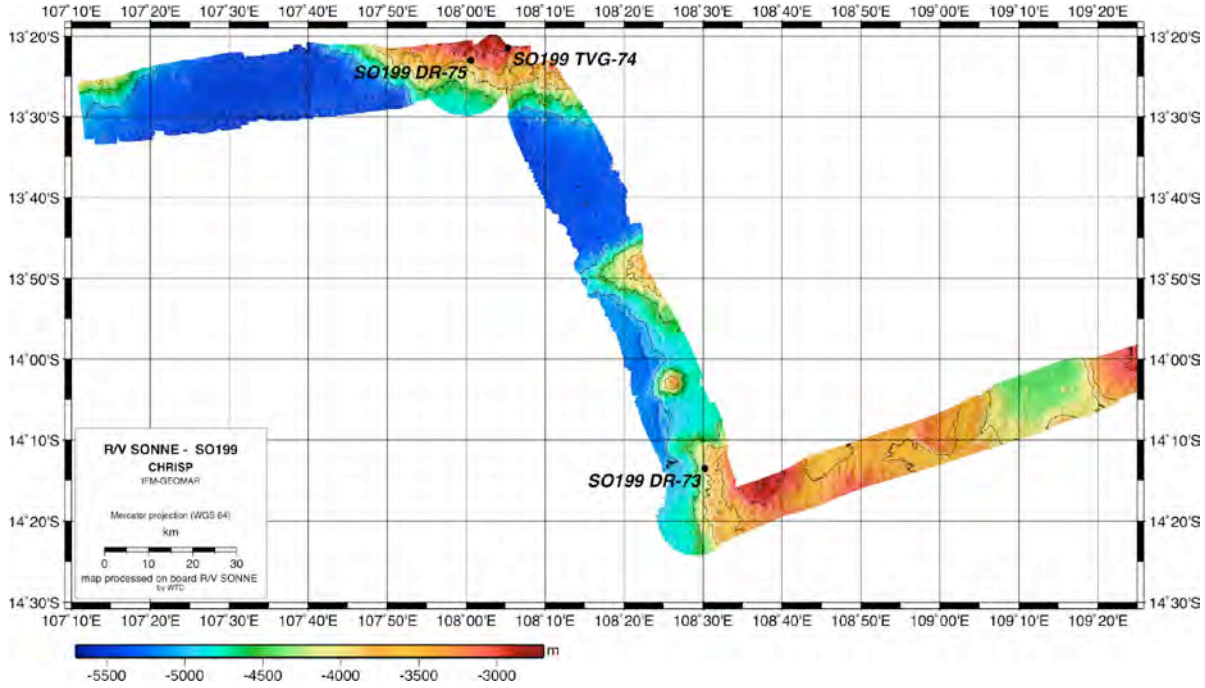

Fig. 5.24.: *Dredge sites DR 73 at "Annegret" Seamount and DR 75 at "Kirk" Seamount.*

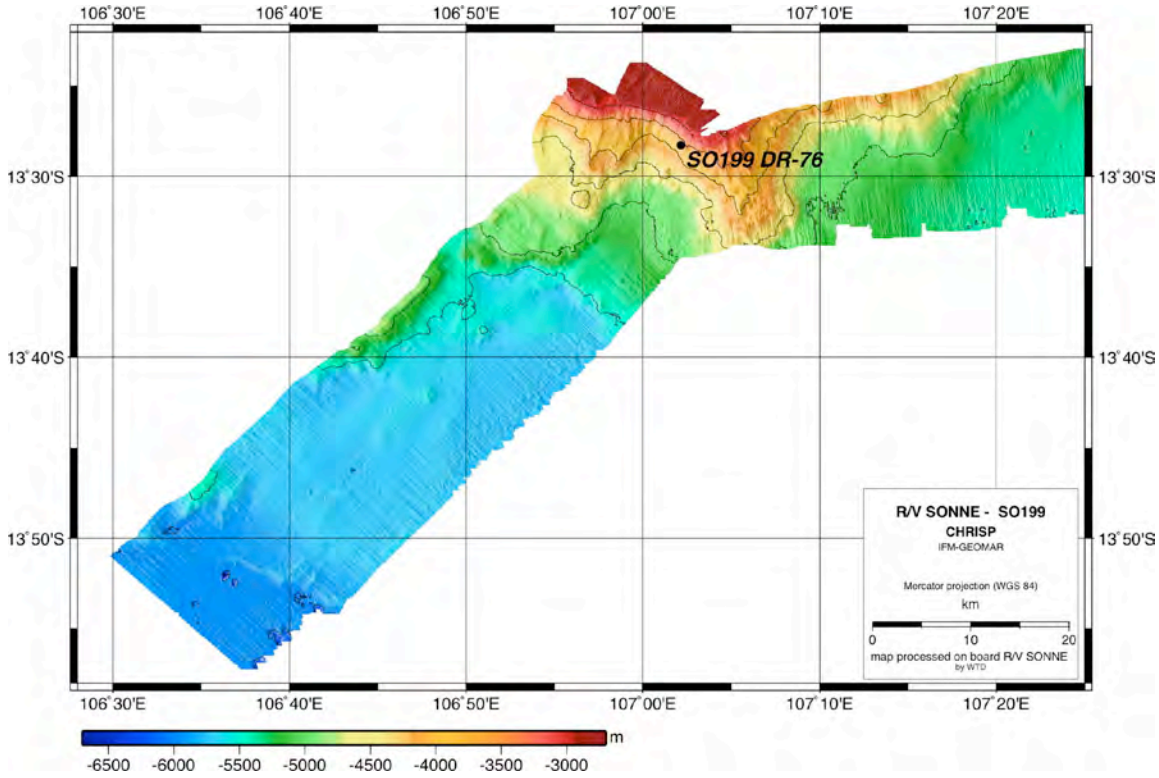

Fig. 5.25.: *Dredge site DR 76 at "Günter" Seamount.*

DR 76: "Günter" Seamount

This structure lies at the southern termination of a northeast-southwest trending ridge on predicted bathymetry maps. The mapped part of the structure reveals a steep southern flank rising from 5,600 to 3,000 m b.s.l. where a flat lying plateau appears to be developed (Fig. 5.25.). The southern margin is also characterized by a series of erosional valleys and ridges. DR 76 was attempted on a steep southwest facing slope in 3,500 m b.s.l. below the plateau edge, but got stuck at the very beginning and returned empty. Due to time constraints no further dredging was carried out here.

DR 77: "Isabel" Seamount

This seamount lies ~55 nm southwest of "Günter" Seamount and appears as solitaire seamount on predicted bathymetry maps. From the mapped western half of "Isabel" seamount the structure seems elongated in east-west direction with relatively smooth northern and southern slopes that elevate from 5,400 to 3,400 m b.s.l. over ~15 km while the western slope has the same drop in elevation over half the distance (Fig. 5.26.). The overall structure rather resembles a volcanic ridge than a classical cone shaped seamount. A successful dredge was carried at DR 77 at the southwestern corner beneath the top in 4,257 to 3,730 m water depth and returned pillow lava along with massive lapilli tuffs. The pillow lava and pillow fragments belong to a single lithological unit characterized by up to 50% vesicles that are 0.1 to 1 mm in size and unfilled in the freshest sample (DR 77-1) while the vesicles in the other samples are partially filled or lined with yellowish-green to brown material which is probably a mixture of smectite and Fe-oxyhydroxide. The groundmass is dark grey in the freshest sample and contains 2%, 1 – 3 mm sized, often idiomorphic fresh feldspar phenocrysts.

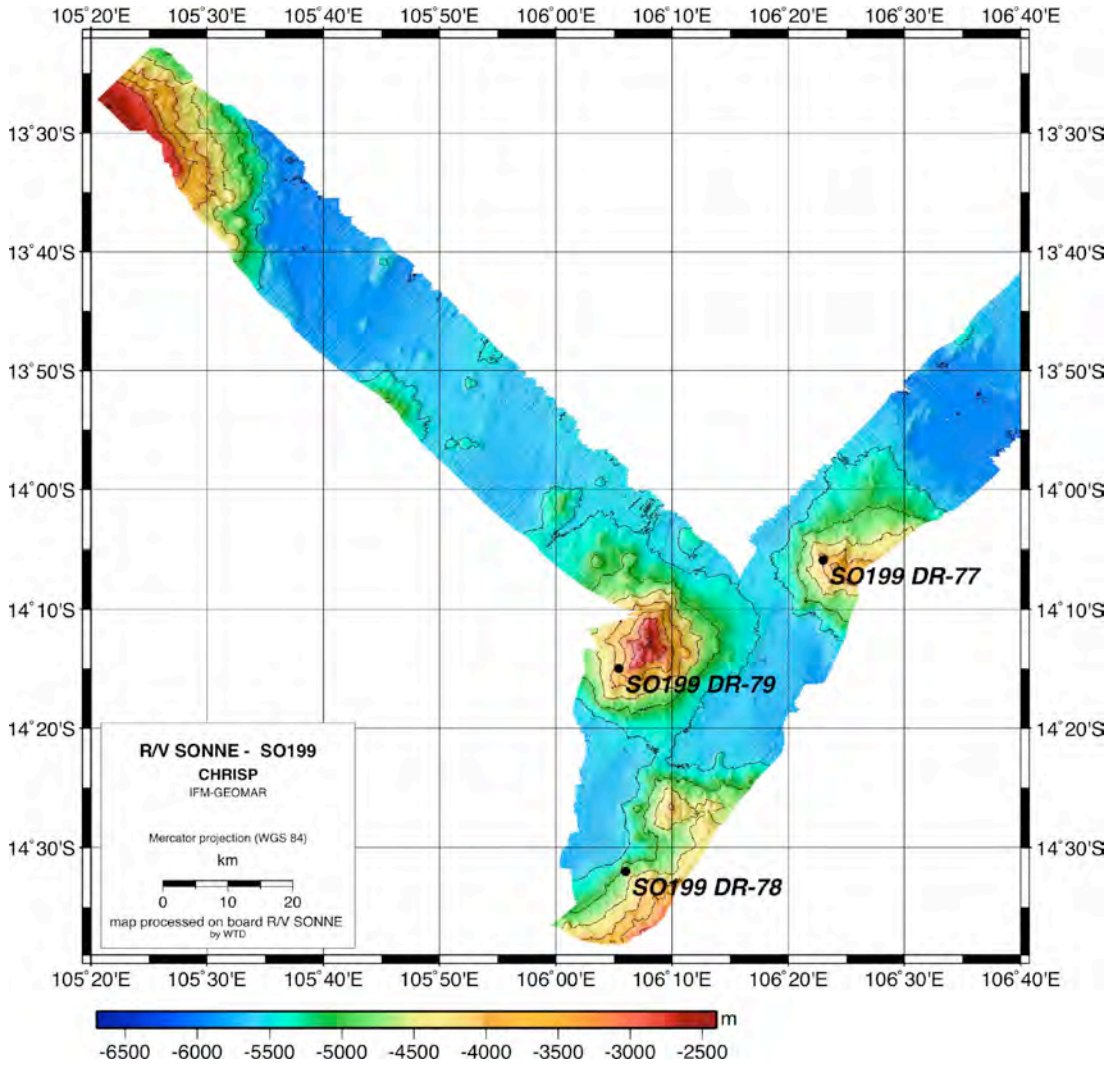

Fig. 5.26.: *Dredge sites DR 77 at "Isabel" Seamount, DR 78 at "Helga" Seamount and DR 79 at "Bente" Seamount.*

DR 78: "Helga" Seamount

This seamount is the southernmost seamount of the Christmas Island Seamount Province mapped and sampled during SO199. Only the northwestern flank was mapped which rises from 5,600 to at least 3,200 m b.s.l., while the top region of the seamount has not been mapped (Fig. 5.26.). DR 78 aimed at the base of a small erosional ridge in 5,088 to 4,591 m water depth and returned a well filled dredge of lava fragments, lapilli tuff and bioturbated carbonate. The lavas are aphyric with 1 - 5% vesicles, some showing flow banding. The groundmass ranges from dark grey in the freshest samples (DR78-1 and –2, Fig. 5.18.) to greyish brown and brown in the more altered and more vesicular (10 - 15%) samples (DR 78-3 through –10)

DR 79: "Bente" Seamount

This cone shaped seamount lies ~20 nm southwest of "Isabel" Seamount. "Bente" Seamount has a base diameter of ~30 km along the 5,400 m b.s.l. contour and rises to less than 2,600 m b.s.l. where a steep sided peak is developed (Fig. 5.26.). The conical shaped morphology indicates that this volcano never emerged above sea level. DR 79 was carried out along the southwestern slope in ~3,800 m water depth. Although the dredge got stuck and had to be pulled up near the bottom contact it returned a quarter full dredge of different lava lithologies and lapilli tuffs. The first lithology is a crystal rich tuff or lava (DR 79-1 and –2, (Fig. 5.18.) that shows a characteristic flow alignment of large (1 x 20 mm) feldspar or foide crystals. These fresh crystals make up 10% of the rock and are aligned in a parallel curved texture. In orthogonal cuts these crystals appear as hexagonal platy minerals that have dimensions of 3 – 20 mm while being only 1 – 3 mm thick. We speculate that this could be nepheline but awaits further thin section and microprobe inspection. The groundmass is fairly fresh (dark to light grey) and only in places shows a slight brownish discoloration where altered. The vesicularity is about 4% and the size of the mostly unfilled vesicles ranges from 0.2 to 2 mm showing a zoned distribution within the sample. Notably the vesicles are irregular and angular in shape and are not elongated or aligned as observed for the phenocrysts. From this we conclude that degassing occurred after deposition of the tuff or lava and after flow alignment of the feldspar or foide crystals. The second lithology (DR 79-3 and –4) is somewhat similar to the first group, but has a light green groundmass color that resembles a phonolite and is with 10%, 0.2 - 2 mm sized unfilled vesicles slightly more vesicular. The feldspar or foide content and size is with 8% and 1 - 4 mm also smaller but the phenocrysts are not aligned. Similarly to the first group the vesicles have a very irregular shape and angular contacts with the groundmass, however, from the macroscopic observations it remains unclear whether these rocks formed as tuffs or lava. The third lithological group comprises pillow lava with altered chilled margins, 6 - 10%, 0.2 - 3 mm sized, rounded vesicles that are in most cases filled or lined with calcite or zeolites. The phenocryst content is restricted to 2 - 5% of 1 – 5 mm sized, fresh feldspar phenocrysts (DR 79-5 and –6) while DR 79-7 appears near aphyric with a single 3 mm feldspar. The probably freshest pillow type sample is represented by DR 79-13 which in contrast to the others has a relatively coarse grained light grey groundmass with <1% of 1 – 2 mm sized fresh feldspar phenocrysts.

DR 80 – DR 82: "Clara-Marie" Seamount

This seamount lies ~75 nm northwest of "Bente" and forms a huge triangular shaped, north-south elongated guyot-type seamount (Fig. 5.27.). The base diameter along the north-south axis is estimated to be in the order of 90 km while the east-west diameter yields 50 km in the north and 60 – 70 km in the south. The seamount rises from the 6,000 m depth contour to 3,000 m b.s.l. where a pronounced erosional plateau edge is developed. The relatively flat plateau covers a triangular area of 45 x 30 x 10 km but elevates internally another 600 m towards the central north-south axis. Notably numerous, presumably volcanic, cones cover the plateau region indicating reactivation of volcanism after the seamount drowned below sea level (Fig. 5.27.). Dredging operations concentrated along the entire length of the western slope at different depth intervals. DR 80 was carried out in the northwestern corner across the plateau edge from 3,220 to 2,712 m b.s.l. and returned a single lava fragment and 2 epiclastic conglomerates. The lava fragment is strongly rounded and almost non-vesicular (<1%, <1 mm sized vesicles) with a greyish-greenish groundmass that contains 2 - 3%, highly elongated feldspar or foide crystals (1 – 2 mm). The overall degree of alteration is estimated to be slightly

altered. DR 81 carried out in the mid-section of the western flank in 4,400 to 3,970 m water depth recovered spectacular columnar jointed lava columns (Fig. 5.28.) together with lapilli tuff and bioturbated carbonate. The columnar lava is aphyric and has about 15% mostly empty, 1 - 5 mm sized vesicles that are either round or irregular shaped. The groundmass is surprisingly non-crystalline with a brown to brownish grey color that possibly shows flow banding textures. The overall degree of alteration appears moderately to strongly altered. DR 82, located in the southwest corner in 3,835 m b.s.l. got stuck very early and obtained only two small pillow fragments. Sample DR 82-1 has a freshly broken side, suggesting that this piece was sampled in-situ. The 2 cm thick chilled margin is completely oxidized to light brown, while the interior parts are in places still dark grey. The lava is aphyric and contains about 5% vesicles that are 0.2 to 1 mm in size and mostly open or lined with Fe-oxyhydroxide with only a few being filled with calcite. The overall degree of alteration reaches moderately to medium altered in the freshest groundmass sections.

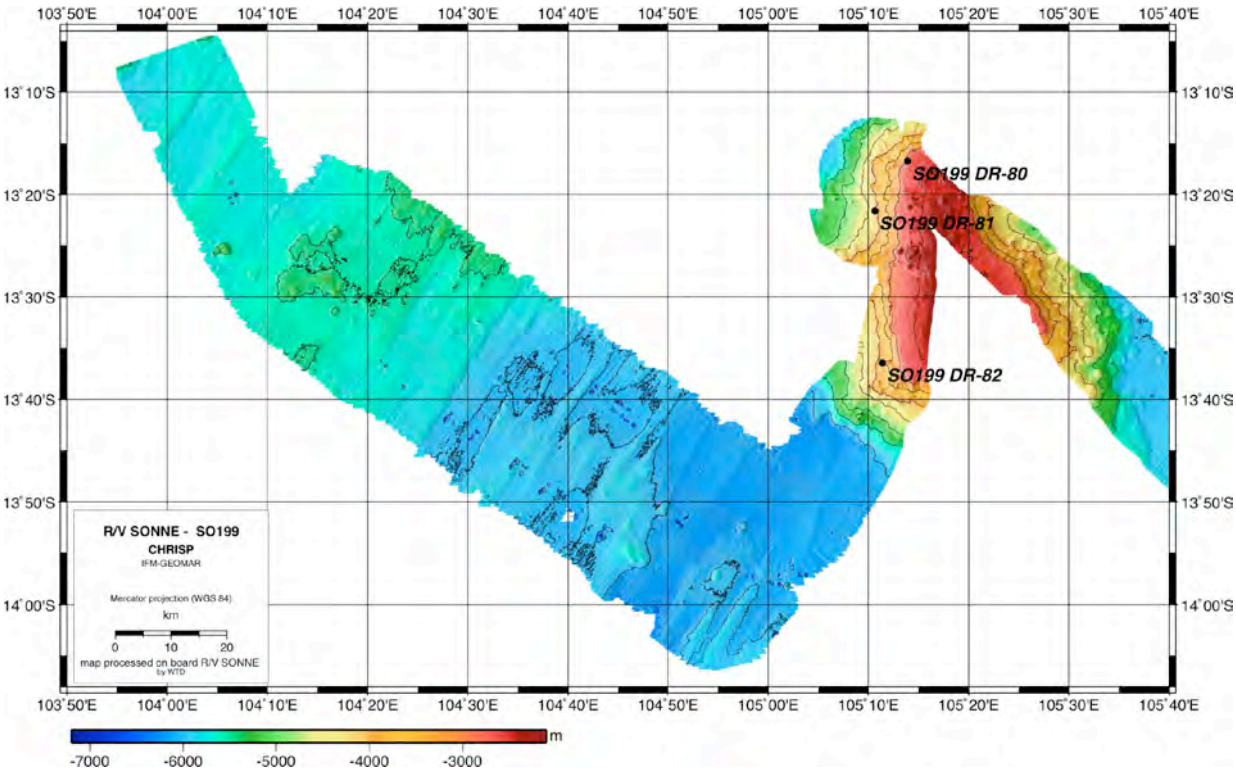

Fig. 5.27.: *Dredge sites DR 80 - 82 at "Clara Marie" Seamount. Note the "step" on the abyssal plain to the west of the seamount. From magnetic anomalies it is suggested that this area aligns ocean crust of different ages.*

Fig. 5.28.: *Basalt column dredged at "Clara Marie" guyot in the southern „Christmas Island Seamount Province".*

DR 84: "Ulrike" Seamount

The southwestern flank of this seamount has been mapped in detail (Fig. 5.29.). It rises from 5,800 m b.s.l. to 3,000 m b.s.l. where a pronounced plateau edge is developed. The shallowest part of the plateau lies at less than 2,600 m b.s.l.. While the southeastern and eastern flanks appear relatively steep the western and northwestern flanks, although only partially mapped, seem to have a much shallower angle and give the overall structure the character of a tilted crustal block. Notably the 60° strike direction of the depth contours over the next 120 km towards the southwest is somewhat different to the 30° strike direction of abyssal hills mapped in detail on the seafloor to the southeast of "Ulrike" Seamount during magnetic profiling (Fig. 5.27.). From the magnetic anomalies it is suggested that this area aligns ocean crust of different ages so that it is feasible that "Ulrike" Seamount and associated depth anomalies could be associated with uplift of preexisting ocean crust or with rejuvenated volcanism along deep reaching fault zones. DR 84 aimed for a southwest facing slope well below the southwestern plateau edge in 3,542 to 3,239 m water depth and obtained a few non-vesicular, aphyric lava fragments with a dark grey and fairly fresh groundmass (Fig. 5.18.).

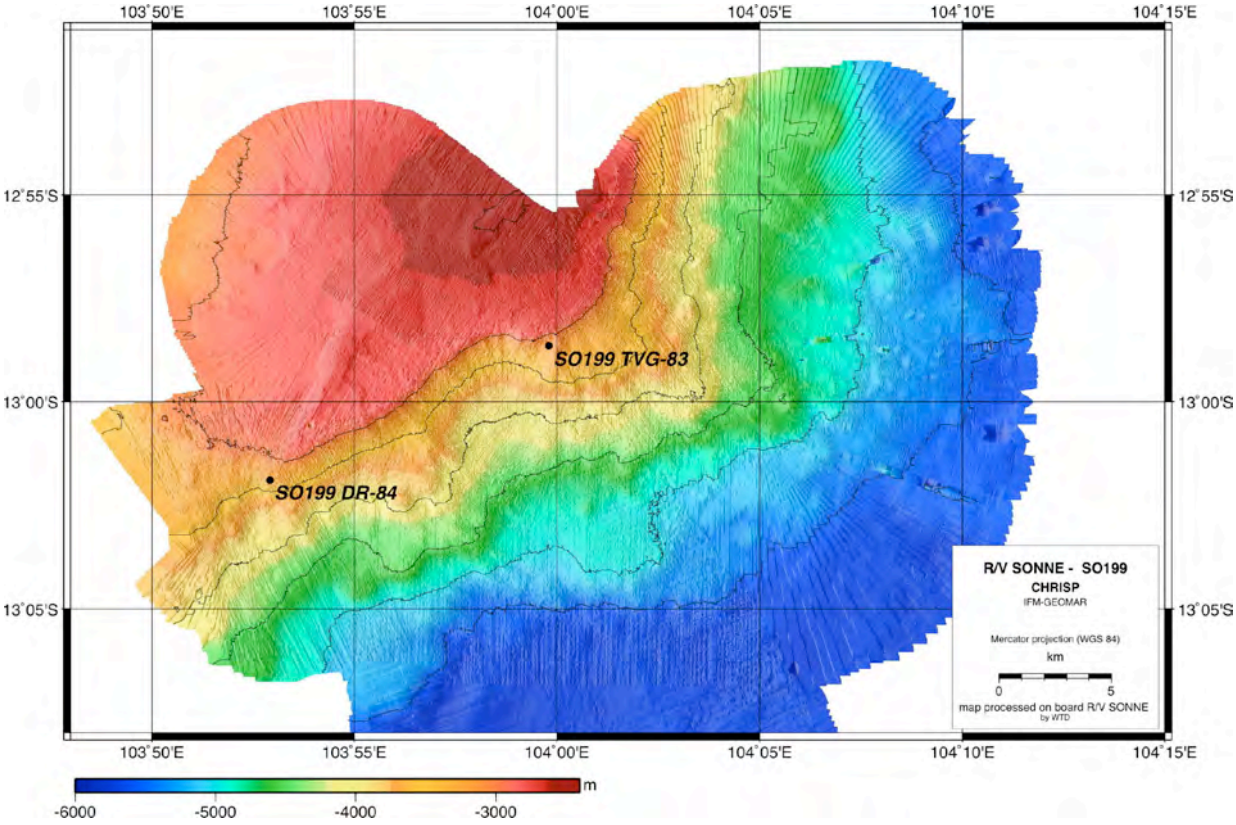

Fig. 5.29.: *Dredge site DR 84 and TV-grab station TVG 83 at "Ulrike" Seamount*

TVG 86 and DR 87: "Ronja" Seamount

This seamount consists of a NNE-SSW striking volcanic ridge and a triangular shaped volcanic cone in the northwest that may owe its morphology to the intersection of three volcanic rifts (Fig. 5.30.). The base diameter of the whole structure (ridge + cone) is roughly 30 x 20 km. Both structures rise from 5,000 m b.s.l. to less than 2,800 m at the ridge and less than 2,600 m at the volcanic cone. All morphological features indicate that these volcanoes were always submarine. After repeated exchanges and tests of the electronic boards and cabling during the entire cruise TVG 86 was the last attempt to make use of the TV grab during this cruise but unfortunately also failed this time despite the constant working efforts of the technical ship personal over the past weeks. DR 87 was located at the northern end of the ridge within a small, northwest striking erosional valley just below the ridge crest in 3,377 to 2,960 m b.s.l.. A well filled dredge returned several lava lithologies and volcaniclastic material. The first lava type (DR 87-1 through –6) is a highly feldspar porphyric lava that occurs as subangular to rounded fragments. It contains 10 - 15%, up to 5 mm sized feldspar phenocrysts

that often have a reddish discoloration which may reflect alteration. From DR 87-3 very rare 2 - 3 mm long, dark phenocrysts are described which could be pyroxene. The groundmass has 3 - 10% irregularly shaped vesicles that are often filled with a light green secondary mineral which could be smectite. Otherwise the groundmass has a dark grey to dark brown color that gives these rocks a medium altered status. A variety of the first lava type is represented by samples DR 87-7 and DR 87-8 that are characterized by a higher vesicularity (25%, up to 5 mm) and a less feldspar phenocrysts (5 - 7%). The groundmass in these samples is dark grey and the overall degree of alteration as medium altered due to the abundant smectite filling of vesicles. The third lava type (DR 87-9 through –12) is also a highly vesicular (10 - 15%) lava that is however almost aphyric with <1% feldspar phenocrysts (1 – 2 mm) and has a dark grey to brown groundmass.

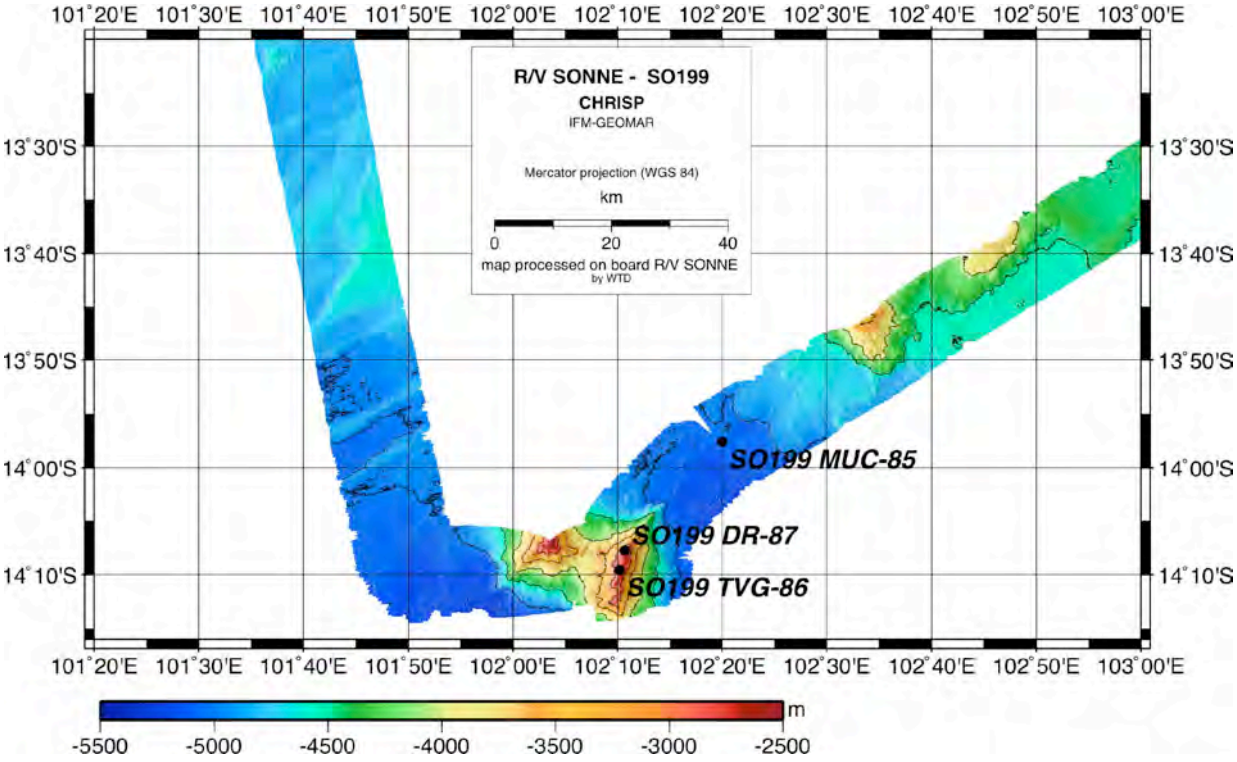

Fig. 5.30.: *Sampling sites at "Ronja" Seamount.*

5.2.7. Areas Adjacent to the Argo Basin (DR 67 – DR 72)

After finishing mapping and sampling of the Eastern Christmas Island Province at "Finn" Seamount a 547 nm long magnetic profile into the Argo Basin followed. A solitaire, circular guyot-type seamount was crossed at 109°05'E/12°40'S, has a diameter of 25 km at its base and rises from 4,400 to less than 2,800 m water depth (Fig. 5.23.). A small erosional plateau is developed above the 2,800 m contour. Further to the southeast two large, probably east-west striking plateaus of ~70 km and ~100 km length are crossed in steering direction. Both plateaus rise from 5,000 – 4,400 m b.s.l. to 3,000 m b.s.l. with most of the plateau area occurring above the 3,800 m b.s.l. contour line. A prominent north-south striking seamount (working name "Michael") has been mapped and sampled in the 15°S/114°10'E area at the western margin of the Argo Basin (DR 67 – DR 69). A second location (working name "Iris") at the northwestern margin of the Argo Basin (12°20'S/113°44'S) has been mapped and sampled (DR 71 and DR 72).

DR 67 – DR 69: "Michael" Seamount

Located at the western margin of the Argo Basin, this seamount forms a guyot type seamount that is slightly elongated in north-south direction and has an estimated east-west base diameter of ~50 km while the north-south extension is certainly in excess of 70 km, but can not be stated with certainty due to incomplete mapping (Fig. 5.31.). The Argo Basin facing flank rises from 5,600 mb.s.l. to 3,400 mb.s.l. where a prominent plateau edge is developed.

The plateau has a diameter of 25 km and rises to less than 2,800 m water depth. Dredging was carried out along the western flank at three locations within the steepest sections between 4,000 and 3,400 m b.s.l.. The interference of dredging with long-line fishery suggests that "Michael" Seamounts also represents an important depth anomaly that causes upwelling of nutrients that lead to the presence of fish swarms. Although DR 67, carried out between 3,733 and 3,595 m b.s.l., could not be finished due to a drifting long-line fishing cable crossing the dredge track; it still managed to recover a few lava fragments and lapilli tuffs. The lavas fall into two groups, the first is a non-vesicular (DR 67-1 to –5) lava with 10 - 15% altered olivine and 10%, 1 mm long, fresh feldspar microphenocrysts. The groundmass is for the most part strongly oxidized making these lavas strongly altered overall. The second lava type (DR 67-6 to –8) has 15%, mm sized vesicles that are mostly open in DR 67-6 or are filled with calcite in the other samples. Again altered olivine phenocrysts occur in 1 mm varieties but is with 3% much less abundant and fresh feldspar occurs as 1 mm sized needles at around 5%. DR 68 was conducted between 3,826 and 3,355 m water depth and recovered only a few lava fragments and lapilli tuff. The lava is with 3%, <1 mm sized, calcite filled vesicles and an apyhric greyish-brownish groundmass containing <1%, <1 mm feldspar and altered olivine mircrophenocrysts broadly similar to those of the previous station. Overall these lavas appear medium to strongly altered. Only two lava fragments with a similar petrography than observed at DR 68 were recovered at DR 69 from 4,020 to 3,541 m water depth.

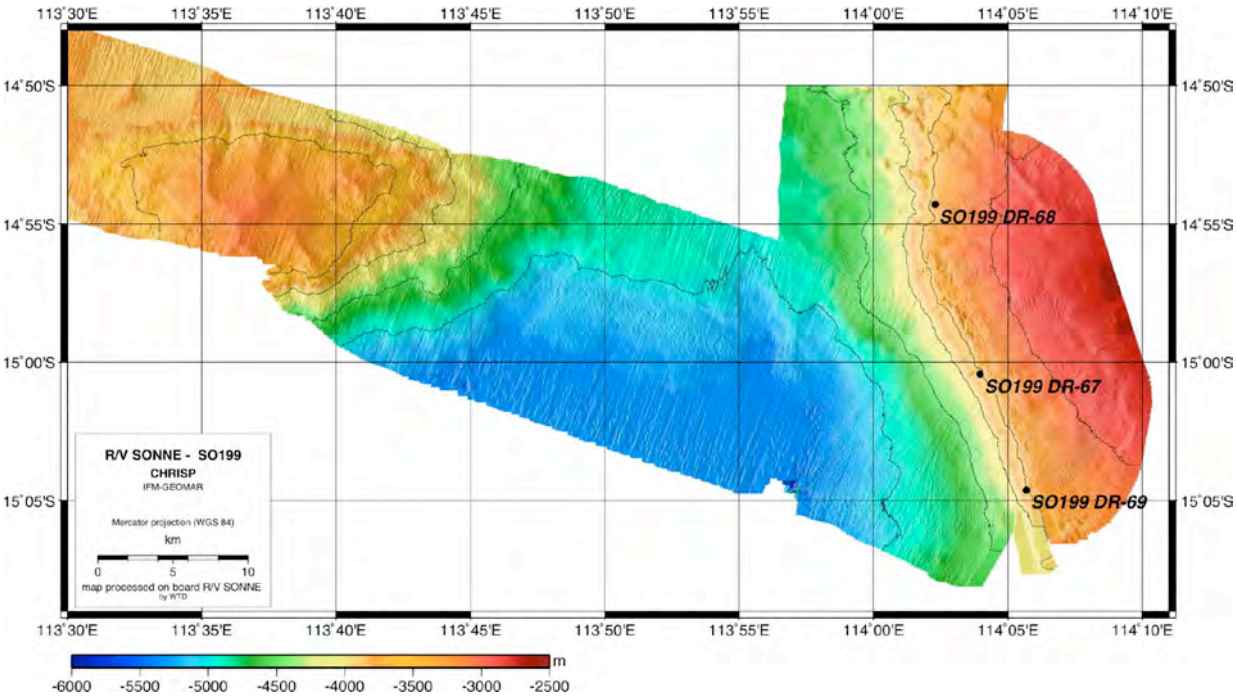

Fig. 5.31.: *Dredge sites DR 67 – 69 at "Micheal" Seamount.*

DR71 and DR72: "Iris" Seamount

This location (working name "Iris") lies at the northwestern boundary of the Argo Basin and is part of a huge plateau that extends from 109°E to 115°E and 9°S to 13°S on predicted bathymetry maps. The morphology of the "Iris" Seamount is somewhat unusual with respect to its asymmetric flanks, with a steep northwestern flank from 5,000 to 4,000 m b.s.l. where a plateau edge is developed and the plateau itself shallowing another 600 meters (Fig. 5.32.). The western flank rises with a shallower angle from 5,200 to 4,000 m b.s.l. before bending into the plateau region. The southern flank is characterized by a very steep slope just beneath the plateau edge from 3,800 to 4,200 m and then turns into a smooth slope towards the abyssal plain at 5,400 m water depth. Our mapping indicates a sharp offset of depth contours towards the seamount in the top region and away from the seamount in the lower part of the southern flank. Both observations indicate a slope failure in this part of the seamount. Another observation in this area is the predominance of SW-NE oriented structures. "Iris" Seamount as well as a small plateau 20 nm to the northwest (Fig. 5.32.) and a partially mapped seamount

40 nm to the southwest show this orientation. Dredging of “Iris” Seamount has been carried at two location along the northeastern flank in 4,925 to 4,321m water depth (DR 71) and from 4,378 to 3,919 m b.s.l. at DR 72. DR 71 recovered strongly altered olivine phyric lava fragments together with Mn-crusts and sediments. The lavas have 2% vesicles that are presumably filled with zeolites. The groundmass is strongly oxidized and only a few dark grey areas are preserved leading to a strongly altered character of these rocks. About 5% of <1 mm sized olivines are also present indicating a relatively mafic composition of the rock. A very fresh and highly porphyric lava lithology was obtained by DR 72 that contains 10-15%, 0.5-3mm sized fresh feldspar, 4-5% fresh pyroxene of similar size than the feldspars and <0.5%, 0.5-1mm fresh(!) olivine (only DR72-1, Fig. 5.18.). The lava is non-vesicular with a very fresh dark grey groundmass so that sample DR 72-1 appears only slightly altered. The other samples (DR 72-2 and –3) have a partially oxidized groundmass leading to a brownish discoloration and medium to strong degree of alteration.

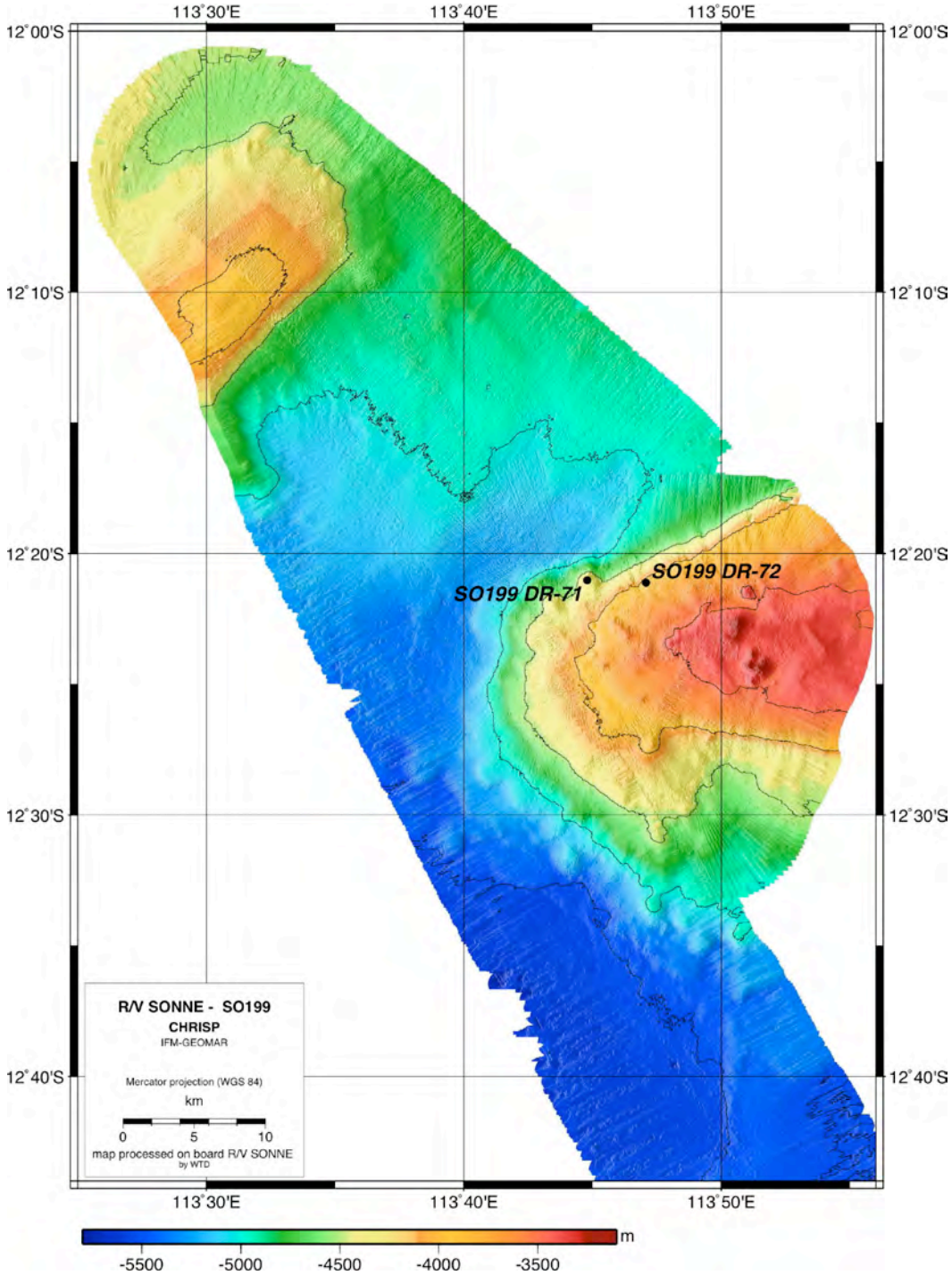

Fig. 5.32: *Dredge sites DR71 and 72 at “Iris” Seamount.*

5.2.8. Bathymetry and Hard Rock Sampling Summary

R/V SONNE cruise SO199 has achieved its major goals, i.e. bathymetric mapping and the first representative hard rock sampling of seamounts of the „Christmas Island Seamount Province“ and of the Investigator Ridge. Complementing 5,694 nm of SIMRAD EM120 multi beam mapping of the ocean floor and Parasound sub-bottom profiling, a total of 70 dredges were carried out during SO199 for mapping and hard rock sampling (Fig. 5.33.). Of these deployments, 65 (or 92,9%) recovered magmatic or sedimentary rock.

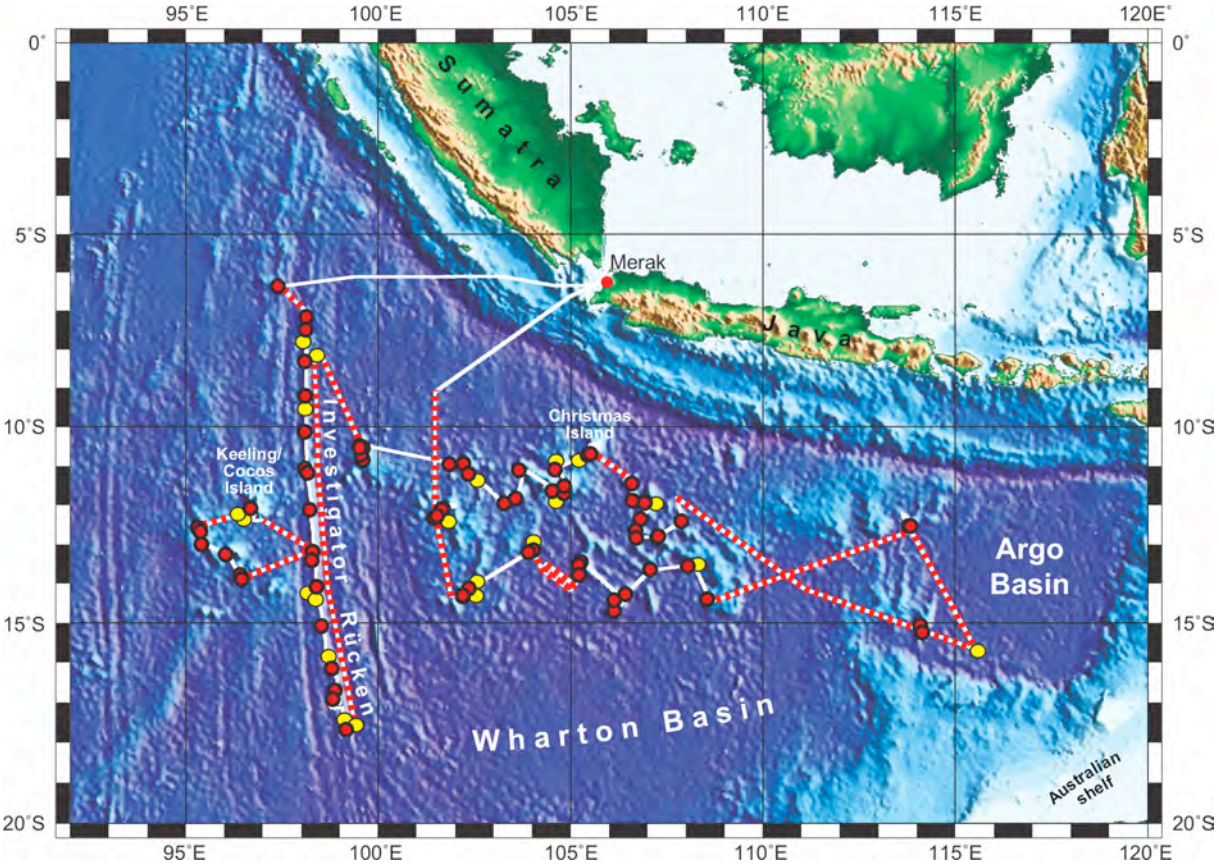

Fig. 5.33.: *Sampling stations and magnetic profiles of RV SONNE expedition SO199 (red dots: dredge stations; yellow dots: TV-grab and multi corer stations, red dashed lines: magnetic profiles; white line: ship's track).*

As described in detail above, SO199 recovered a broad variety of magmatic rocks from the Investigator Ridge and adjacent features, the Christmas Island Seamount Province, and from seamounts along the western margin of the Argo Basin. Dredging at the Investigator Ridge yielded a spectacular array of rock types representing a full cross section through the entire ocean crust into the upper mantle. These include samples of pillow basalts and sheeted dikes (upper crust), a wide variety of mafic and felsic intrusives as well as layered cumulates (lower crust) and diverse serpentinites (upper mantle). Nearly the full range of these rock types has been often recovered even in single dredges. At the seamounts, (highly) porphyric sheet and pillow lavas dominate, but various types of volcaniclastic rocks are also common, some of them indicate subaerial or shallow water volcanic activity and/or deposition (see chapter 5.3.). Minor lithologies include, among others, evolved lavas (e.g., trachytes?, phonolites?) and sedimentary rocks (mainly carbonates). The overall degree of alteration of these rocks varies from strongly altered to surprisingly fresh. Although alteration of magmatic rocks in a submarine environment for some 10 Mill. years can negatively influence geochemical analyses and radiometric age dating, we are confident that SO199 yielded a comprehensive set of samples being suitable for shore-based analyses including methods like Sr-Nd-Pb-Hf isotope and noble gas analyses as well as Ar/Ar age dating.

Although the major results of SO199 CHRISP are still to be obtained by detailed on-shore analyses of data and samples within the next 2 years, some preliminary conclusions can be drawn right after the cruise (see also chapters 5.3., 6., and 7). Some of them as well as some major observations made on SO199 are summarized in the following paragraphs.

Investigator Ridge and Adjacent Areas

Along almost the entire mapped length of the Investigator Ridge, the eastern ridge is asymmetric with a steep west-facing scarp and a more gentle east-facing slope. We interpret the steep west-facing scarp to represent recent reactivation of the fracture zone. The morphology of features adjacent to the Investigator Ridge also suggests reactivation of fracture zones in this area. For example, the north-south elongation of "Outsider" Seamount most likely reflects formation of the seamount (possibly through a fissure style eruption) along an existing north-south lineament in the crust, possibly an older fracture zone that may have been reactivated. After the seamount formed, left-lateral movement along the north-south fracture formed the ravines in the northern and southern flanks of the seamount and offset the eastern side of the top to the north (Fig. 5.1.). Left-lateral reactivation of older seafloor fractures is consistent with the regional tectonic concept that this area is part of a diffuse but developing plate boundary between the eastern (Australian) and the western (Indian) parts of the Indo-Australian Plate. Due to the collision of India with Asia, the western part of the Indo-Australian Plate (roughly west of the Ninetyeast Ridge, a part of the Kerguelen hotspot track) cannot move northwards anymore. On the other hand, due to northward verging subduction beneath Indonesia, the eastern half of the plate with Australia continues to move northwards. Movements between the two halves of the plates occurs in a diffuse zone east of the Ninetyeast Ridge along north-south aligned fracture zones in the ocean crust that have been/are being reactivated as left-lateral strike-slip faults. The morphology of the Investigator Ridge and Outsider Seamount thus shows evidence of the recent left-lateral reactivation of former north-south striking structural features in the Wharton Basin seafloor.

Multi-beam mapping of the seafloor between the Investigator Ridge and "Outsider" Seamount (between 6 - 7°S) and the Cocos/Keeling Islands and seamounts (between 12°20' - 13°40'S) revealed the morphology of the presumed Paleogene and Cretaceous (based on published magnetic data) seafloor. An ~15 km wide trough with a steeper west wall was mapped ~35 - 50 km west of the Investigator Ridge in both areas (Figs. 5.4. and 5.9.). On the satellite-altimetry-based bathymetric map, this feature appears to run sub-parallel to the Investigator Ridge along its full length. Our preliminary interpretation of the steep western side of the trough is that it represents a reactivated fracture zone. Two magnetic profiles (see chapter 6) show that the general E-W trend of seafloor spreading anomalies is sharply interrupted at the western flank of the trough, confirming that the structure likely represents a fracture zone. The drastically different morphology of these two generally north-south trending, sub-parallel structures (ridge versus trough), coupled with the somewhat unusual ridge-like morphology of the Investigator Ridge and the steep westward facing scarp along most of the eastern part of the Investigator Ridge, also suggest relatively recent reactivation of this former fracture zone linked to the diffuse plate boundary between India and Australia. The SIMRAD mapping between the Investigator Ridge and the trough-like fracture zone near Cocos/Keeling Atolls also revealed bands (~1 - 10 km in width) with several hundred meters difference in elevation between the fracture zones, with a roughly east-west orientation (strike of ~80°) or roughly perpendicular to both fracture zones. These bands are believed to reflect original seafloor morphology, presumably crust formed at different spreading rates. On the western side of the trough-like fracture zone, the bands have the same orientation, but at about 97°30'E, the bands change strike by ~10°S (strike of ~70°S).

Christmas Island Seamount Province

Multi-beam mapping of the Vening Meinesz Seamounts revealed several guyot-type seamounts which represent former island volcanoes. However, the recent depth of their erosional platforms imply different ages of these volcanoes and non-uniform subsidence rates of ~2,500 – 1,200 m. Uneroded volcanic cones on the guyot platforms as well as uneroded seamounts being higher than the guyots indicate revival of volcanic activity after subsidence of the guyots below sea level. Similar observations has been made in the eastern part of the Christmas Island Seamount Province where SO199 investigated a cluster of 12 seamounts

which rise from > 5,000 m water depth up to 2,000 m below sea level. Some of the seamounts mapped from this cluster show a guyot-like from. The recent water depth of the erosional platforms varies between ~3,000 m and ~2,000 m, indicating also different ages of these volcanoes and/or non-uniform subsidence rates. The other seamounts in this area do not show any clear evidence for erosion in their top areas but have partly a somewhat untypical morphology resembling rather tilted blocks than volcanoes. However, all dredge hauls conducted at these seamounts yielded volcanic rocks, among them highly porphyric lavas in places and a wide range of volcaniclastic rocks.

In particular the southern part of the Christmas Island Seamount Province is characterized by an unusual and changing seafloor morphology. This area is dominated by large plateau-like structures with an uneven surface which extend over an area of up to ~15,000 km^2 and rise from ~5,500 m up to 1,500 – 2,000 m above the surrounding ocean floor. Adjacent to these „plateaus“, the predicted bathymetry (based on satellite altimetry) reveals several isolated, up to 3,000 m high seamounts with roughly circular or oval bases as well as NE-SW elongated ridge-like structures. Four of these volcanoes, which do not show any evidence for erosion at water level, have been mapped and successfully sampled by SO199. The dredges recovered mainly vesicular to highly vesicular sheet and pillow lavas, various volcaniclastica and highly crystal rich rocks which may be strongly welded tuffs (ignimbrites?). Two other seamounts mapped and sampled by SO199 in this area proved to be huge, up to 3,500 m high guyots measuring ~60 x 40 km and ~40 x 40 km, respectively, at their bases. The present water depth above its plateau edge suggests ~2,800 m subsidence for the elongated guyot and ~2,000 m subsidence for the circular guyot since their erosion. Several small, up to 400 m high volcanic cones are located on the erosional plateau of the elongated guyot, implying a second phase of volcanic activity after erosion and subsidence of this former volcanic island. In the center of the southern Christmas Island Seamount Province, another somewhat unusual feature exists. This seamount is marked by a steep, ~2,500 m high southeastern flank and flat northwestern slope, being the typical morphology of a tilted crustal block. A dredge haul at its southeastern flank recovered dense, aphyric lava fragments. Approximately 120 nm southwest of this feature SO199 mapped an isolated, uneroded twin seamount which rises form more than 5,000 m water depth up to ~2,500 m above the surrounding sea floor.

Finally, SO199 also discovered several small, only some 100 m high volcanic cones which mainly occur isolated on the ocean floor in the central and northwestern part of the Christmas Island Seamount Province. Dredging at a ~500 m high, circular volcanic cone, measuring ~1.5 km diameter at its base, yielded highly vesicular, olivine und pyroxene phyric pillow lavas.

In summary, uneroded volcanic cones on the guyot platforms as well as uneroded seamounts being higher than the guyots indicate revival of volcanic activity after subsidence of the guyots below sea level, being inconsistent with a stationary plume source below a moving plate. Moreover, the varying depths (~1,200 – 3,000 m) of the erosional platforms of the guyots, the variety of morphologies ranging from small, isolated volcanic cones to huge plateau-like structures, and the occurrence of rocks formed in different environments indicate a complex, long-lasting history of the Christmas Island Seamount Province including intense tectonic movements and several phases of volcanic activity. Shore-based analyses of rocks and data yielded on SO199 will contribute to a better understanding of these processes and will allow us to fulfill the major objectives of the research project CHRISP.

5.3. VOLCANICLASTIC ROCKS *(D. Maicher)*

Dredging during cruise SO199 successfully retrieved volcaniclastic material from a variety of sea floor morphologies, which comprises peaked and guyot-like seamounts and, less frequently, small spurrs and cones as well as the Investigator Ridge. The types of volcaniclastic deposits recovered include primary pyroclastic and hyaloclastic as well as reworked epiclastic material. By grain size, the most common deposits are lapilli tuffs, while tuffs and tuff breccias are rare. The samples, generally 10 – 20 cm in diameter, were often loose on the oceanfloor, in the form of rounded cobbles or nodules entirely coated in ferromanganese crusts. Strictly speaking, these samples have been redeposited downslope and are thus out of their original context. In this study however we focus on the internal

textures of the rocks which are used to discern the rock's original processes of formation, that is eruptive mechanisms and fragmentation, transport and depositional processes.

After a brief introduction of how volcaniclastic rocks are classified, a description of the recovered material, how it formed, its relationship to the other dredged lithologies and the morphologies it is derived from are presented.

5.3.1. Classification of Volcaniclastic Rocks

The term "volcaniclastic" in a broad sense encompasses deposits which contain clasts of volcanic origin. To describe and classify the rocks in more detail, the mechanisms of clast fragmentation, transport and deposition, inferred from the rock's textures, are considered. The approach taken in this chapter follows White and Houghton (2006) who introduce a non-genetic classification scheme closely following the sedimentological grain size divisions. They distinguish *primary volcaniclastic* from reworked *epiclastic deposits*. Primary volcaniclastics are directly related to a volcanic eruptive event which forms the clasts during violent explosive eruptions or during passive effusion of lava and from which they are deposited without interim storage. Epiclastic deposits in contrast are formed by weathering and reworking of material by sediment gravity transport processes and are not directly related to any volcanic activity. This kind of deposits is given ordinary sedimentological terms with volcanigenic modifiers, e.g. basaltic coarse sandstone.

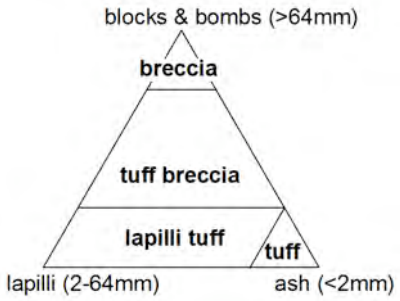

Fig. 5.34.: *Grain size ternary diagram for naming primary volcaniclastic rocks (modified from White and Houghton 2006). Divisions are at 25% and 75% from the apices. Blocks are angular large clasts while bombs are fluidal shaped.*

Critical features used to discern primary volcaniclastic deposits include componentry, clast size and shape (see Fig. 5.34.), sorting and sedimentary structures. In addition, aspects such as vesicle characteristics, packing, matrix, cementation and alteration are considered. The components include juvenile clasts, i.e. clasts derived from newly erupted magma as well as lithic clasts, e.g. older clasts derived from the country rock, sediment or biogenic debris, which are merely entrained during transport and deposition. Criteria are for instance a monomict versus a polymict clast assemblage which gives an indication about post-eruptive componentry modification. And the clast shapes are diagnostic for fragmentation processes as well as for transport processes, i.e. clast rounding.

The types of primary volcaniclastics expected to occur in a subaqueous environment are hyaloclastites, pyroclastic deposits and peperites. Hyaloclastites, including pillow breccia, are formed subaqueously during effusive volcanism when extruding magma or flowing lava is chilled and fragmented by thermal quenching in contact with water. Pyroclastic deposits are formed by explosive eruptive activity subaerially as well as subaqueously. Peperites form during shallow intrusion of magma into unconsolidated sediment by fragmentation of magma or lava as it mingles with the debris; the deposit is generally in situ (Skilling et al. 2002).

5.3.2. CHRISP Volcaniclastic Deposits

SO199 recovered 137 volcaniclastic samples, including 54 epiclastic deposits, 40 primary volcaniclastics and 26 possibly primary volcaniclastics as well as several uncertain lithologies from 42 stations (see Appendix III). Primary volcaniclastics comprise in situ pillow and lava flow breccias as well as massive and bedded hyaloclastic and pyroclastic deposits, while peperitic lithologies have not been confidently identified. Epiclastic deposits are highly variable and occur frequently. In many instances, a clear distinction between primary and reworked deposit is not possible, for example in heterolithic deposits where the genetic origin of some of

the components might either be related to primary processes (e.g. wall rock erosion during eruption) or reworking (e.g. rip-up clasts). In the following, the rocks are illustrated by showing typical examples of each type of deposit.

Epiclastic Volcanogenic Deposits

Many of the recovered epiclastics are sandstones and conglomerates, commonly with a micritic carbonate matrix, and contain clasts of volcanic heritage and bioclasts. Fig. 5.35 shows a heterolithic volcanigenic conglomerate with bivalves and coral fragments. Conspicuous are the different types of volcanic lithics, variably rounded, including differently coloured dense clasts and a large scoriaceous clast with very large, irregularly shaped vesicles (right). This specimen is interpreted to be formed by sediment gravity flows of slope debris, which probably derived from shallow water depth.

Fig. 5.35.: *Epiclastic deposit DR 21-6C: heterolithic volcanigenic conglomerate with bioclasts, note scoriaceous clast with large, irregularly shaped vesicles (dashed line)*

Hyaloclastic Pillow and Sheet Flow Breccias

This type of deposit is characterized by their close genetic association with either pillows or sheet flow lava. Called “breccias”, however the deposits are coarse as well as fine grained (cf. Fig. 5.36.). The clasts, generally glassy (=hyalo), are characterized by angular blocky and small splinter-shaped particles formed by the thermal shattering of extruding magma. They are generally monomict in composition and in situ, as indicated by jigsaw fit textures, or show very little transport after formation (Schmincke and Bednarz 1990).

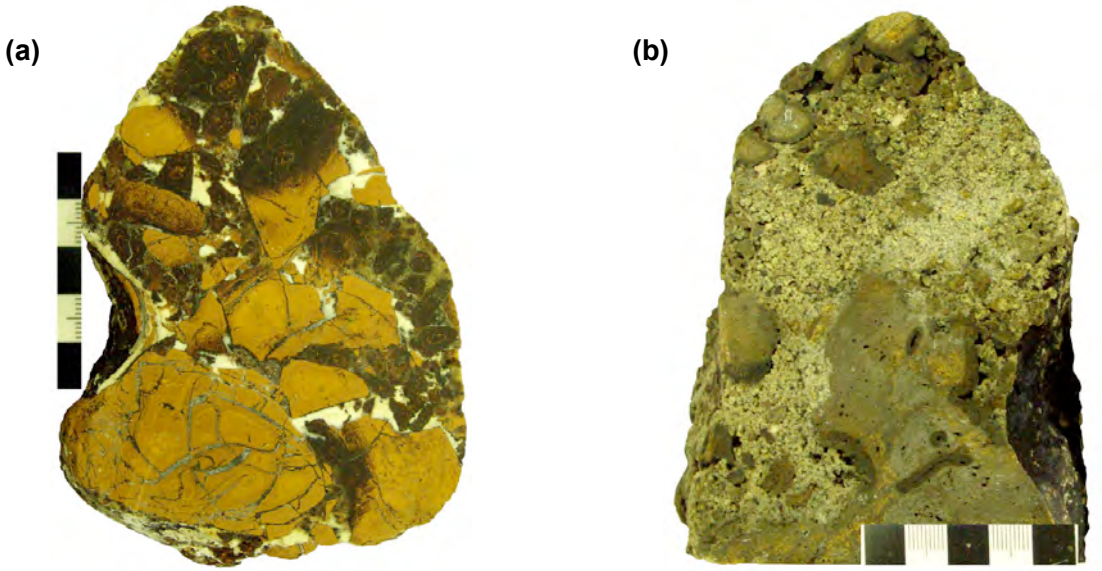

Fig. 5.36.: ***(a)*** *glassy pillow breccia DR30-10C, note jigsaw fit of clasts (bottom left);* ***(b)*** *lava flow with hyaloclastite DR16-1C; note dark glassy lava margins.*

In Fig. 5.36. (a), a pillow breccia (coarse lapilli tuff to tuff breccia by grain size classification) consisting of angular blocky and minor small splinter-shaped clasts is shown. The clasts, non-vesicular, are aphanitic altered and hydrated light to dark brown volcanic glass. The sample, dredged from an irregular topographic rise off-axis off the Investigator Ridge, is found associated with small pillows of the same petrographic characteristics. Fig. 5.36. (b) shows

fragments of irregularly shaped lava flow fronts set in hyaloclastite consisting of (surprisingly well-sorted) coarse ash sized, blocky angular particles. The rims of the lava are surrounded by jigsaw fitting clasts. The deposit is possibly formed by intrusion of lava into a hyaloclastic carapace, and thus of peperitic nature.

Hyaloclastite, Massive and Bedded

Characterized by non- to poorly vesicular angular particles, hyaloclastite is glassy debris formed by essentially non-explosive processes related to rapid aqueous cooling of magma. This process of quenching is accompanied by a volume decrease that leads to fragmentation of the glass (Batiza and White 2000). Clast formation is furthermore driven by the continued movement and jostling of the lava spalling its outer chilled carapace. Subsequent emplacement is driven by gravitational processes in response to continuing effusive eruption, for instance as density currents forming blankets of sheet hyaloclastite (finer grained deposits) and granular debris flows (coarser grained deposits). Hyaloclastite deposits are most commonly found on deep seamounts (>1,500 – 2,000 m b.s.l.) compared to other tectonic settings. Recent findings question a purely passive quenching origin and invoke superimposed magmatic explosive processes (e.g. Maicher et al. 2000, Head and Wilson 2003, White et al. 2003). SO199 recovered several specimens of this type of deposit, and further study of the samples will hopefully contribute to this debate.

A typical example of a sheet hyaloclastite is shown in Fig. 5.37. (a). The deposit is a well bedded, normally graded tuff and fine lapilli tuff with faintly aligned clasts. The aphanitic clasts are monomict, poorly vesicular blocky and rare splinter- and irregular-shaped juveniles. Their deposition occurred most likely close to their site of formation from dilute density currents.

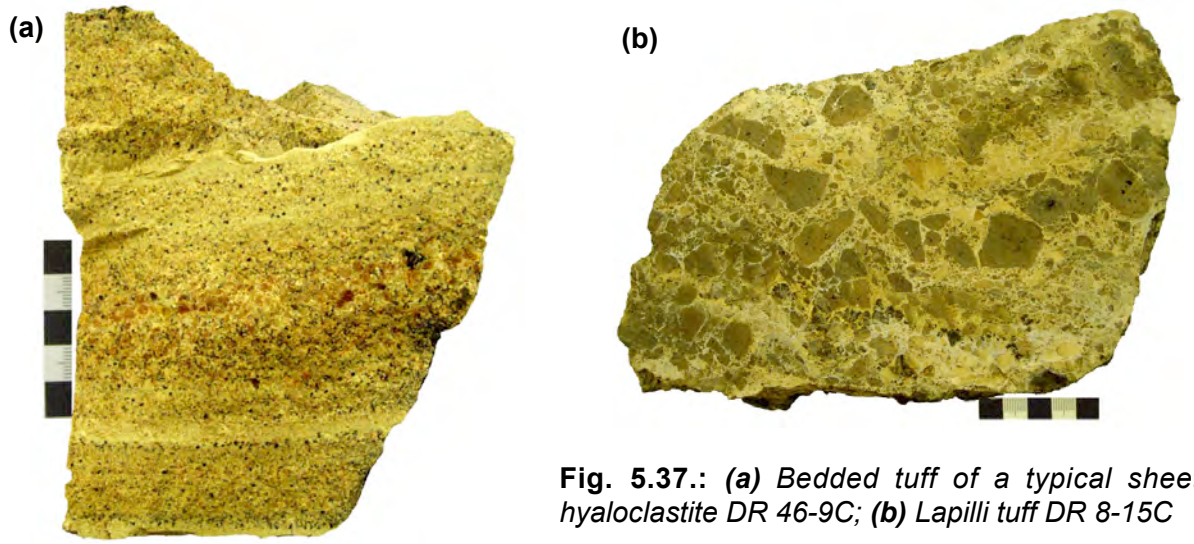

Fig. 5.37.: ***(a)*** *Bedded tuff of a typical sheet hyaloclastite DR 46-9C;* ***(b)*** *Lapilli tuff DR 8-15C*

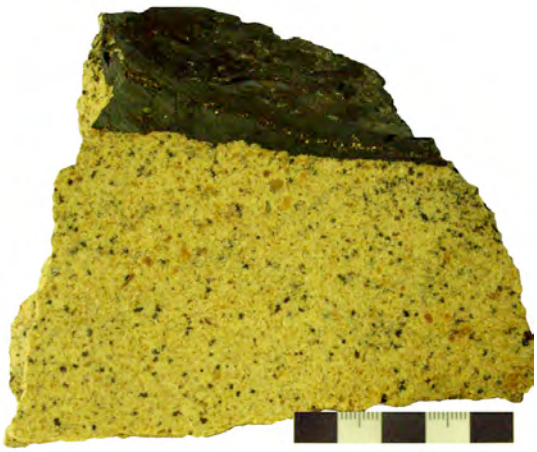

Fig. 5.38.: *Massive tuff DR 46-10C.*

In contrast, Fig. 5.37. (b) shows a coarse grained example of a faintly, wavy bedded, clast- to matrix-supported, moderately sorted hyaloclastite with partly aligned clasts. The particles are monomict, poorly vesicular angular to subangular olivine-feldspar-phyric basaltic juvenile clasts petrographically very similar to dredge associated lava fragments.

Fig. 5.38. shows a homogeneous massive deposit composed of randomly oriented, angular blocky and less commonly splinter- and irregularly shaped clasts. The deposit is moderately sorted, closely packed and is coated with a dark ferromanganese crust on top. The deposition is inferred to have occurred from high-concentration fallout or vertical density currents through the water column. By both these processes, a high particle concentration inhibits grain sorting as commonly seen in dilute water-settled deposits (Sohn and Chough 1993).

Pyroclastic Tuffs and Lapilli Tuffs, Massive and Bedded

Primary pyroclastic deposits are frequently collected during the cruise SO199. The deposits comprise mainly massive lapilli tuffs and less commonly bedded lapilli tuffs as well as coarser and finer grained tuff breccias and tuffs, both bedded and massive. They are recovered from many of the dredged seamounts but not from the locations along the Investigator Ridge. The deposits are characterized by relatively high vesicularities (20 – 30%, rarely up to 50%), irregular, often delicate clast shapes and clast outlines broken across vesicles and an often cryptocrystalline groundmass which indicates slower cooling as compared to a glassy groundmass. In many specimens, larger clasts show reddish oxidation colours which possibly indicate subaerial eruption and transport. The transport mechanisms associated with primary pyroclastics are driven directly by the magmatic energy, e.g. explosive expelling of particles forming tephra jets, plumes and pyroclastic flows. For instance, submarine Surtseyan explosions eject tephra jets, which evolve into eruption-fed density currents (e.g. Maicher 2003, White et al. 2003). Subsequent deposition of primary pyroclastics occurs from traction, by suspension settling and/or en masse freezing.

A critical distinction of pyroclastic from hyaloclastic deposits is based on the clast shape reflecting the fragmentation process, with the grain size range of very fine ash (4f) being diagnostic (Büttner et al. 1999). This, however, requires fresh, unaltered material and more detailed work for a detailed evaluation. For a preliminary assessment aboard the vessel, a more practical approach is taken here to discern the deposit types: we consider those clasts as pyroclasts which are less glassy, have rugged, irregular shapes and a higher vesicularity whereas typical hyaloclasts are non- to poorly vesicular, glassy and have angular blocky and splinter-like shapes.

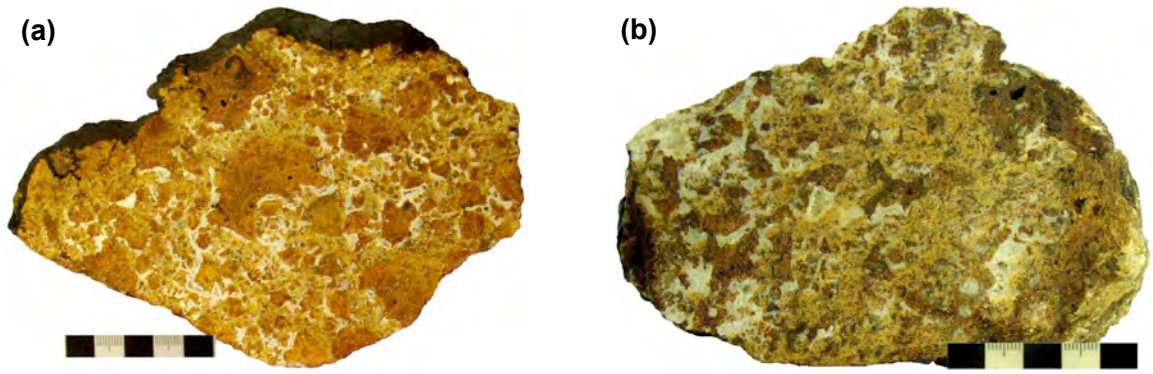

Fig. 5.39.: *Massive lapilli tuffs, note irregular and occasionally delicate clast shapes (some resemble broken cauliflower bombs);* ***(a)*** *scoriaceous sample DR 48-3C;* ***(b)*** *moderately vesicular, inhomogeneous lapilli tuff DR 62-6C.*

Fig. 5.39. illustrates primary pyroclastic lapilli tuffs composed of poorly sorted, variably closely packed monomict clasts which have delicate, irregular shapes. Deposition is inferred to have occurred without any substantial transport distance or turbulence due to the lack of clast abrasion. In Fig. 5.39. (a), the sample consists of basaltic juvenile clasts. Their vesicularity of the large clasts ranges from 20 to 30% (visual estimate) while small clasts show a much wider range from ~5 - 20%. This is indicative of vesiculating clasts being quenched and thus “freezing” the degassing progress at various stages. It occurred probably in a more shallow marine setting than the present dredged location or even emergent-subaerially. This is

supported by the reddish colour of the larger clasts, which possibly indicates subaerial oxidation. Fig. 5.39. (b) shows a deposit of aphanitic vesicular juvenile particles with an inhomogeneous patchy distribution of the matrix (yellowish fine grained material) and cement (white sparitic calcite). Some areas are matrix-supported while others show clasts floating in the cement which could indicate a volume increase during cementation.

Fig. 5.40.: *Bedded tuff DR 17-7C*

The sample shown in Fig. 5.40. consists of monomict angular blocky and irregular shaped particles of fine to coarse ash size. Some of the clasts potentially are bubble wall shards, i.e. tripod-like junctions of a highly vesicular, finely fragmented foam. The sedimentary texture shows finely laminated parallel ash laminae. They are overlain by a coarser grained, apparently massive ash bed which shows at the base an erosional scour. The scour is filled with more vesicular particles of coarse ash to fine lapilli size, the lighter coloured “snow flakes” visible in the right half of the picture. The depositional history includes quiet settling from suspension forming the fine laminae, and subsequent turbulent density current(s) eroding into the laminae and en masse deposition of the coarser material.

Miscellaneous Deposits

Some enigmatic samples have been collected during the cruise. In dredge DR 8 (northern part of the Invesigator Ridge) and DR 13 (lower flank of Keeling Atoll), several rocks resembling agglutinated lapilli tuffs, i.e. welded fragmental deposits, have been recovered. DR 8-17C and DR 8-18C both are monomict samples which consist of glassy and cryptocrystalline fine to coarse lapilli-sized particles of subangular shape closely packed in a dark matrix which cannot be resolved with a binocular microscope. These unusually hard competent rocks appear aglutinated. Sample DR 13-12C consists of wavy bands of dark brown apparently coherent material, and interspersed between the bands are reddish blocky vesicular lapilli. This is possibly explained by fluid lava having incorporated the blocky clasts, aligned in flow bandings. Alternatively, fluidal spatter-like clasts (which fused / agglutinated) are interbedded with the blocky reddish clasts. Agglutination implies a well isolated eruptive (submarine?) setting where the formed particles were able to retain their heat long enough to allow for post-depositional agglutination.

From two separate locations, DR 73 (“Annegret” Seamount, a large complex-shaped seamout edifice with scalloped flanks) and DR 87 (“Ronja” Seamount, a ridge-like seamount), a lithology named “tuffaceous lava” has been recovered. It is composed of an apparently homogeneous groundmass of mottled grey and yellowish colour. The rock texture is porous with irregular shaped, mm-sized voids and idiomorph feldspar phenocrysts. Possible origins include (a) a clastic origin of a very fine, crystal-bearing tuff which is thermally fused or weathered obscuring the particulate nature of the groundmass, and which underwent secondary vesiculation generating the observed voids. Or (b), a diffusely banded lava flow of possibly more evolved composition in which the irregular shaped voids represent vesicles concentrated in layers.

5.3.3. Dredge Assemblages and Morphologies

The variety of rock types is dredged from a variety of seafloor morphologies (see chapter 5.2 and Appendix II). In a preliminary attempt, the morphological forms and the dredge assemblages are correlated with the types of volcaniclastic deposits. This is done to test for any common features which may help to characterize the submarine eruptive processes related to the evolution and growth of the seamounts and the formation of the volcaniclastic deposits.

The morphological elements are grouped into (a) the Investigator Ridge with adjacent features, seamounts with (b) peaked tops and (c) guyot-like structures with truncated tops, and (d) seamounts with late-stage small cones present (either truncated or not). Seamounts are of variable elevation and size, and of circular, elongate or ridge-like shape. Volcaniclastic samples are derived from six stations along the Investigator Ridge, from two stations on atolls/island flanks, from 18 stations on guyots or possible guyot-like structures and from ten stations on peaked seamounts. The most common lithological assemblages with volcaniclastic and epiclastic deposits include sheet and/or pillow lava; less common are carbonate sediments and plutonic rocks. The observations include:

- Lava and volcaniclastic samples of a given dredge often appear to be of the same composition, indicating a common source.
- A very close genetic link is given by single samples composed of pillow or sheet lava together with in situ hyaloclastite showing jigsaw fit textures (e.g. DR 2-19C, DR 10-22C, DR 48-2C and Fig. 5.36.).
- Pillows together with primary volcaniclastics are found mainly along the Investigator Ridge (DR 2, DR 10, DR 30 with several small pillow-hyaloclastite couples) and on seamounts which are not truncated (e.g. DR 40, DR 46, DR 79, DR 87). They are rare on guyots (DR 52, DR 62).
- In general, the different types of volcaniclastic deposit appear to lack a distinctive distributional trend across the investigated area. For instance, there is no correlation of primary or epiclastic deposits versus present-day water depth, nor versus seamount shape (guyot-like or peaked, circular or ridge-like seamounts). Exceptions are:
  - Along the Investigator Ridge and in the eastern part of the seamount province, the volcaniclastics tend to be less vesicular than those recovered in the western part of the province, despite being derived from similar present-day water depths.
  - Primary pyroclastic deposits are more common on guyot-type seamounts (e.g. DR 1-8C, DR 50-9C, -10C, DR 58, DR 59, DR 81-7C, DR 88-4C, DR 89-2C and Fig. 5.39.) while rarely found on peaked seamounts (e.g. DR 46, DR 77).
- Samples from the Investigator Ridge are exceptional in having plutonic rocks of the oceanic crust incorporated into epiclastic deposits as accidental lithics.
- Samples from the atoll/island flanks yielded primary volcaniclastic and epiclastic deposits as well as the enigmatic rocks described above (DR 13-12C, -13C).
- Volcaniclastic deposits occur together with carbonate sediments on all dredged morphologies; they are, however, predominantly found on guyots (e.g. DR 48, DR62, DR 81, DR 88).

To conclude, the cruise SO199 retrieved a wide variety of volcaniclastic rocks, many of which with well-preserved textures. Post-cruise detailed studies, including age dating, geochemical and textural analysis of the recovered rocks, will hopefully constrain the types of volcaniclastics as well as the rock assemblages and importantly, contribute to the greater understanding of the evolution of the Christmas Island Seamount Province.

6. MAGNETICS

(U. Barckhausen, A. Gibbons, M. Zeibig)

6.1. MAGNETIC DATA ACQUISITION AND PROCESSING (*U. Barckhausen, M. Zeibig*)

The BGR magnetometer array used during cruise SO-199 consisted of two independent magnetometer types which can be operated simultaneously on one cable:

(1) the SeaSpy gradiometer system with two Overhauser magnetometer sensors and

(2) one oriented Magson fluxgate sensor.

Overhauser sensors measure the scalar absolute value of the total magnetic field while fluxgate magnetometers measure the magnetic field vector in its three components.

6.1.2. Marine Magnetics SeaSpy™ Gradiometer

The SeaSpy™ Marine Gradiometer System manufactured by Marine Magnetics Corp. consists of two proton precession magnetometers, enhanced with the Overhauser effect. Two exactly equivalent magnetometers are towed 150 meters apart as a longitudinal array about 700 meters astern of the ship, where the ship's magnetic field is already decayed well below 1 nT. Both sensors measure the total intensity of the magnetic field simultaneously. The difference between the two measurements is an approximation for the longitudinal gradient of the field in the direction of the profile line. Provided that the time variations are spatially constant over the sensor spacing, the differences are free from temporal variations and their integration restores the variation-free total intensity or magnetic anomaly (apart from a constant value).

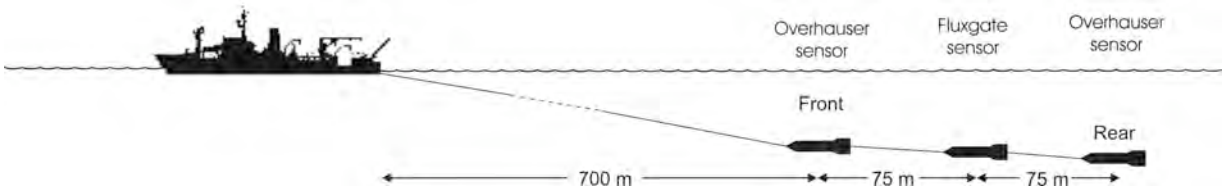

Fig. 6.1.: *Schematic sketch of a typical setup consisting of a towed gradiometer system (front and rear Overhauser sensor) and one fluxgate towfish in-between.*

A standard proton precession magnetometer uses a strong DC magnetic field to polarize itself before a reading can be taken. Overhauser sensors work similarly to proton magnetometers with the exception that the excitement of the proton spin (polarization) is done by radio waves, which excite the spin of the electrons in an organic fluid within the sensors. Then the electrons transfer their spin to the protons in the fluid via a quantum mechanical process called Overhauser effect. Similar to every other proton magnetometer, the relaxation frequency of the protons is a measure for the magnitude of the ambient magnetic field. However, the polarization power required is much smaller and the AC field may be left active while the sensor is producing a valid output signal. This allows the sensor to cycle much faster and to produce more precise results than a standard sensor. The signal is digitized by the electronics assembly within the tow fishes, which then transmit the digital data strings via a two conductor tow cable to the vessel. The tow cable is connected to a deck leader, which is in turn connected to the power supply and the logging computer. As configured for this survey, the Overhauser sensors had a cycle time of one second. The sensors are specified with a noise level of 0.01 nT/√Hz, a resolution of 0.001 nT, and an absolute accuracy of 0.2 nT.

During the whole cruise, the SeaSpy™ magnetometer system operated in 'gradient mode' using both sensors. The instrument was powered by a set of external batteries avoiding grounding problems and providing 24 V; while a second set of batteries was recharged automatically. The smart transceiver within the electronics unit provided the cable voltage of 70 V and was protected against overheating by a ventilation fan. The current strength was displayed continuously – it allows an online diagnosis of the magnetometer array. Each

Overhauser sensor consumes 45 mA and the fluxgate 35 mA and, if the current strength is below the expected sum, sensor failure or connector problems are indicated.

6.1.2. Magson™ Fluxgate Magnetometer

The Magson fluxgate was designed by the BGR and built by the Magson Company in Berlin. The first sensor was built 2004 and modified 2005, a second sensor was built 2006 as a slightly modified copy of the first sensor.

The system consists of i) a digital 3-axis Magson fluxgate magnetometer yielding excellent precision, ii) a two-axis tilt-meter, type 900H made by Applied Geomechanics Ltd., iii) a two-axis and single axis accelerometer, types ADXL203 and ADXL103 made by Analog Devices, iv) sensors for temperature, pressure, and humidity, and v) a data acquisition microprocessor unit built by Magson. Fluxgate and inclinometers are mounted on a common platform. All components, shown in Fig. 6.1, are placed inside a pressurized glass-fibre tube of the same brand as the sensors of our standard SeaSpy™ gradiometer.

Fig. 6.2.: *Components inside the fluxgate magnetometer towfish.*

The Magson fluxgate uses the principle of vector-compensating the three ring-core-sensors by means of three independent Helmholtz-coils. The internal feedback circuit, using digitally controlled DC-currents fed into the Helmholtz-coils maintains precise nulling of the field inside the ring-core. Thus the amplitude of this current can be used as a signal to measure the vector components of the magnetic field. A scalar fluxgate calibration is required to provide offset, scale factor and non-orthogonality angle for each axis. All electronic components are integrated on the board of the data acquisition microprocessor. Fluxgate magnetometers with digitally compensated ring-core-sensors maintain a considerably higher accuracy over non-compensated instruments. In addition, they yield higher stability over time and temperature. The Magson fluxgate sensor is specified with a noise level of 0.02 nT/√Hz, a resolution of 0.008 nT and a long term stability < 10 nT/year.

Inside the towfish, a special platform is used to mount the fluxgate and both tilt-sensors. The first tilt-sensor by Applied Geomechanics (900H) measures pitch and roll angles by a conductive liquid in a half-filled glass vial. The tilt angle is derived by the height of liquid covering five electrodes. The angular range covers a span of ± 25°/± 40° (first/second Magson towfish) with an accuracy of about 0.01° of arc (noise level 0.005°). The second type of tilt-sensors are dual axis accelerometers by Analog Devices (ADXL203), measuring pitch and roll angles over a span of ± 50°/± 20° (first/second Magson towfish) resolving 0.05° of arc (noise level 0.095°). A third accelerometer for the vertical axis (ADXL103) allows detecting unintended towfish positions beyond the inclinometer range. The accuracy of the Applied Geomechanics sensor is significantly higher, but the calibration function is non-linear and temperature dependent. The Analog Devices sensor has a faster response (cross correlation indicated a 0.1 s difference), the calibration function is linear and almost temperature independent, but it suffers a higher noise level increased by a factor of two. Both tiltmeters measure not only the static acceleration, which would provide the needed true roll and pitch angles. Instead, they principally measure dynamic accelerations due to the linear and angular accelerations of the continuously moving towfishes. This source of error can be reduced by filtering.

A high precision of the measured tilt angle is necessary to rotate the field components from the sensor's coordinate system of the moving fluxgate towfish into the geomagnetic coordinate system. By rotation about the Euler angles the vertical and horizontal vector components are obtained. The accuracy of the vector data is limited by the accuracy of the rotation angles. For example, a 0.01° tilt deviation may result in 7 nT component error in the survey area. Without any yaw angle estimation, the orientation of the horizontal field vector (i.e. the north and east

component), remains unknown. A crude first approximation is given by the ship's course. Utilising magnetic heading from the fluxgates themselves (compass yaw), removes seafloor anomalies by default; however, a numerical yaw approximation separating seafloor anomalies from towfish movements in water by wavelength filtering has been introduced by Engels et al. (2008).

An embedded microprocessor with a flash disc is used to store all fluxgate and tilt-meter readings. The storage capacity of 1 GB is sufficient to allow 11 days of continuous operation at the selected sampling rate of 10 Hz. However, a convenient online monitoring and recording of all magnetometer data via the tow cable is intended for the future.

6.1.3. Fluxgate Calibration

A fluxgate magnetometer has to be calibrated regularly against a precisely known reference field in order to estimate the calibration parameters. These parameters are offset, scale factor, and non-orthogonality angle for each axis - thus a total of nine parameters for a three-axis vector magnetometer. During a scalar calibration, the fluxgate sensor is rotated around all axes and the total field reading is adjusted to the reference field. This optimization of calibration parameters is done by a least squares fit of the measurements (here: downhill simplex method; one variant keeping the non-orthogonality angles fixed, which are regarded stable; codes by Jeff Gee, SIO). By this procedure, one combination of calibration parameters is obtained which minimizes deviations from the reference field for all attitudes of the sensor.

Calibration parameters drift slowly with time and changes may also occur after long-distance transportation to different latitudes. Furthermore calibration parameters are temperature dependent, which means that laboratory calibrations have to be repeated at different temperatures. In addition to a laboratory calibration, where the sensor is rotated around all axes at different temperatures, a calibration figure cruise is required in the survey area waters. The latter provide a fine adjustment to the local magnetic field conditions and water temperatures. Therefore, calibration parameters should be estimated at the beginning and end of each survey in order to account for a possible drift.

6.1.4. Magnetic Data Processing

Onboard processing of the magnetic data included the removal of the International Geomagnetic Reference Field (IGRF2005, Maus et al. 2005) from the data and a thorough control of the data quality. The survey area was located relatively far away from the magnetic dip equator (inclination 0°) which at this longitude lies 8 degrees north of the geographic equator. Therefore it is unlikely that the so-called equatorial electrojet and other ionospheric current systems which often contribute to large daily variations and strong irregular changes during magnetic disturbances in the vicinity of the geomagnetic equator have influenced the measurements even on the northernmost lines.

The gradiometer worked satisfyingly well throughout the cruise. However, reconstruction of variation-free magnetic anomalies from the gradient is only possible after intensive data processing which could only be carried out during the cruise for a limited number of profiles. The reconstruction of magnetic anomaly data from gradient measurements and all related problems are described by Eilers et al. (1994). Also, the detailed processing and evaluation of the vector magnetic data will be done after the cruise for lines, where appropriate. Single sensor fluxgate data provide additional anomalies in all three components (e.g. Z-anomaly), which may contain a variation contribution. Vector data analysis opens additional interpretation tools (Engels et al., 2008): magnetic boundary strike ellipses in time-space domain locate magnetic contrasts, their direction and dimensionality; spectra analysis provides estimates of the depth of magnetic sources and their wavenumber range, it also detects distortions by external variations and resolves magnetic strike directions even from single profiles.

Tab. 6.1.: Magnetometer sensor and cable configurations applied during all cruise profiles and calibration loop.

Profiles	Sensors	Cables
BGR08-201 through BGR08-204	Overhauser 13141 (Front) Overhauser 13140 (Rear)	600-1 150-2 AB
BGR08-205 through BGR08-207, Calibration	Overhauser 13141 (Front) Magson 13143 Overhauser 13140 (Rear)	600-1 75-6 AB 75-7 AB
BGR08-208 through BGR08-218A	Overhauser 13140 (Front) Magson 13143 Overhauser 13141 (Rear)	600-1 75-6 AB 75-7 AB

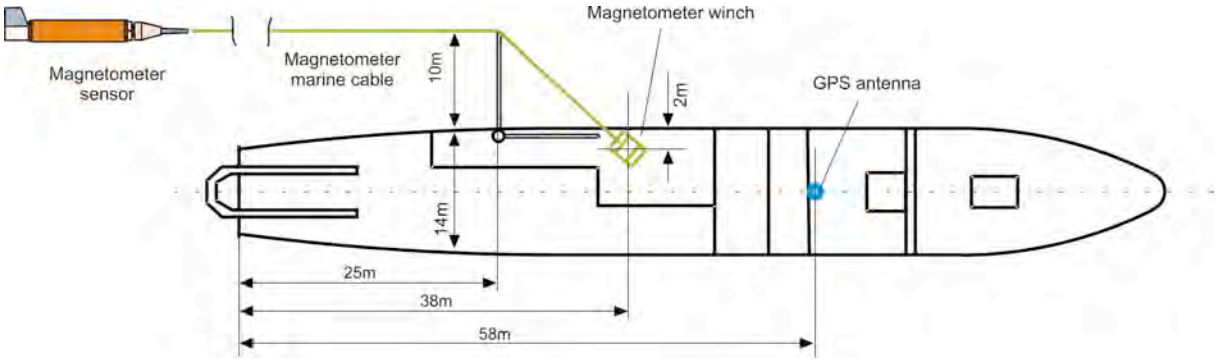

Fig. 6.3.:: *Deck plan of RV Sonne.*

Tab. 6.2.: Magnetic profiles surveyed during cruise SO-199

Line Number	Date	Time	Latitude	longitude	course	Profile km
BGR08-201	06.08.2008	07:17:00	6.410433 S	97.57332 E		
	06.08.2008	12:37:00	6.966400 S	98.16407 E	133°	89.92
BGR08-202	10.08.2008	15:03:00	12.99771 S	98.26289 E		
	10.08.2008	23:30:20	12.26647 S	97.02814 E	301°	156.60
BGR08-203	11.08.2008	16:36:40	12.08147 S	96.33398 E		
	11.08.2008	22:40:40	12.09580 S	96.30836 E	253°	111.58
BGR08-204	13.08.2008	18:52:20	13.70566 S	96.47202 E		
	14.08.2008	05:58:20	13.00701 S	98.23232 E	068°	205.52
BGR08-205	18.08.2008	12:13:40	17.49794 S	99.37997 E		
	19.08.2008	08:48:00	13.99852 S	98.65005 E	349°	
BGR08-205A	19.08.2008	08:48:20	13.99759 S	98.64993 E		
	20.08.2008	02:00:00	10.99941 S	98.39962 E	355°	
BGR08-205B	20.08.2008	02:00:20	10.99844 S	98.39955 E		
	20.08.2008	04:10:40	10.62393 S	98.38717 E	358°	
BGR08-205C	20.08.2008	04:23:20	10.58736 S	98.38553 E		
	20.08.2008	19:14:40	7.99938 S	98.30022 E	358°	1062.31

Tab. 6.2.: continued

Line Number	Date	Time	Latitude	longitude	course	Profile km
Kalib. 1	20.08.2008	19:15:00	7.99854 S	98.30017 E		
	20.08.2008	20:21:40	7.98629 S	98.30096 E		
BGR08-206	21.08.2008	03:16:20	8.04085 S	98.48847 E		
	21.08.2008	18:17:20	10.30782 S	99.48850 E	157°	274.92
BGR08-207	28.08.2008	22:12:00	10.65620 S	105.69122 E		
	29.08.2008	04:10:00	11.22277 S	106.54991 E	124°	112.95
BGR08-208	01.09.2008	07:44:20	12.20806 S	107.82598 E		
	01.09.2008	11:09:20	11.67012 S	107.68278 E	344°	59.26
BGR08-209	01.09.2008	11:09:40	11.67074 S	107.68342 E		
	02.09.2008	10:46:00	14.00000 S	111.00000 E	126°	444.55
BGR08-209A	02.09.2008	10:46:20	14.00050 S	111.00090 E		
	03.09.2008	04:55:40	15.02460 S	114.00141 E	110°	342.20
BGR08-209B	04.09.2008	00:15:20	15.02654 S	114.00648 E		
	04.09.2008	08:34:00	15.49251 S	115.37706	110°	155.89
BGR08-210	04.09.2008	13:30:20	15.51355 S	115.40732 E		
	05.09.2008	12:19:00	12.10590 S	113.50355 E	331°	431.06
BGR08-211	06.09.2008	04:48:40	12.49678 S	113.77840 E		
	07.09.2008	12:52:00	14.32102 S	108.53694 E	250°	605.96
BGR08-212	11.09.2008	05:09:40	13.62771 S	105.19599 E		
	11.09.2008	06:55:40	13.87423 S	105.03834 E	212°	33.60
BGR08-213	11.09.2008	06:56:00	13.87495 S	105.03768 E		
	11.09.2008	12:16:00	13.35282 S	104.30081 E	307°	98.92
BGR08-214	11.09.2008	12:48:40	13.41312 S	104.24588 E		
	11.09.2008	18:09:40	13.94406 S	104.96645 E	127°	98.90
BGR08-215	11.09.2008	18:39:00	14.00967 S	104.92271 E		
	11.09.2008	23:57:20	13.48503 S	104.18492 E	307°	98.88
BGR08-216	11.09.2008	23:57:40	13.48435 S	104.18429 E		
	12.09.2008	02:53:40	13.03756 S	103.96788 E	335°	59.34
BGR08-217	13.09.2008	16:25:40	14.14881 S	102.20502 E		
	13.09.2008	18:34:20	14.16572 S	101.84293 E	267°	39.91
BGR08-218	13.09.2008	18:34:40	14.16569 S	101.84199 E		
	14.09.2008	07:09:00	12.08312 S	101.41623 E	349°	236.11
BGR08-218A	15.09.2008	13:14:00	12.08138 S	101.41658 E		
	16.09.2008	07:43:00	8.99899 S	101.41635 E	0°	342.62
Total						5061.00

6.2. PRELIMINARY INTERPRETATION OF THE MAGNETIC PROFILES (*U. Barckhausen, A. Gibbons*)

6.2.1. Magnetic Anomalies of the Wharton Basin

A compilation of magnetic lineations in the world's oceans (Cande et al. 1989), shows a system of abandoned spreading ridges in the Wharton Basin, which were active during the time span of chron 33 through to chron 20, (i.e. 79 – 43 Ma). The lineations were first published by Liu et al. (1983). No attempt for an improved interpretation of the magnetic anomalies in the Wharton Basin seems to have been made since then. Especially east of the Investigator Ridge, Liu et al. (1983) found only a few magnetic lineations, which seem to indicate a large left-lateral offset along the Investigator Ridge. This is identified as a fracture zone (Fig 6.4.).

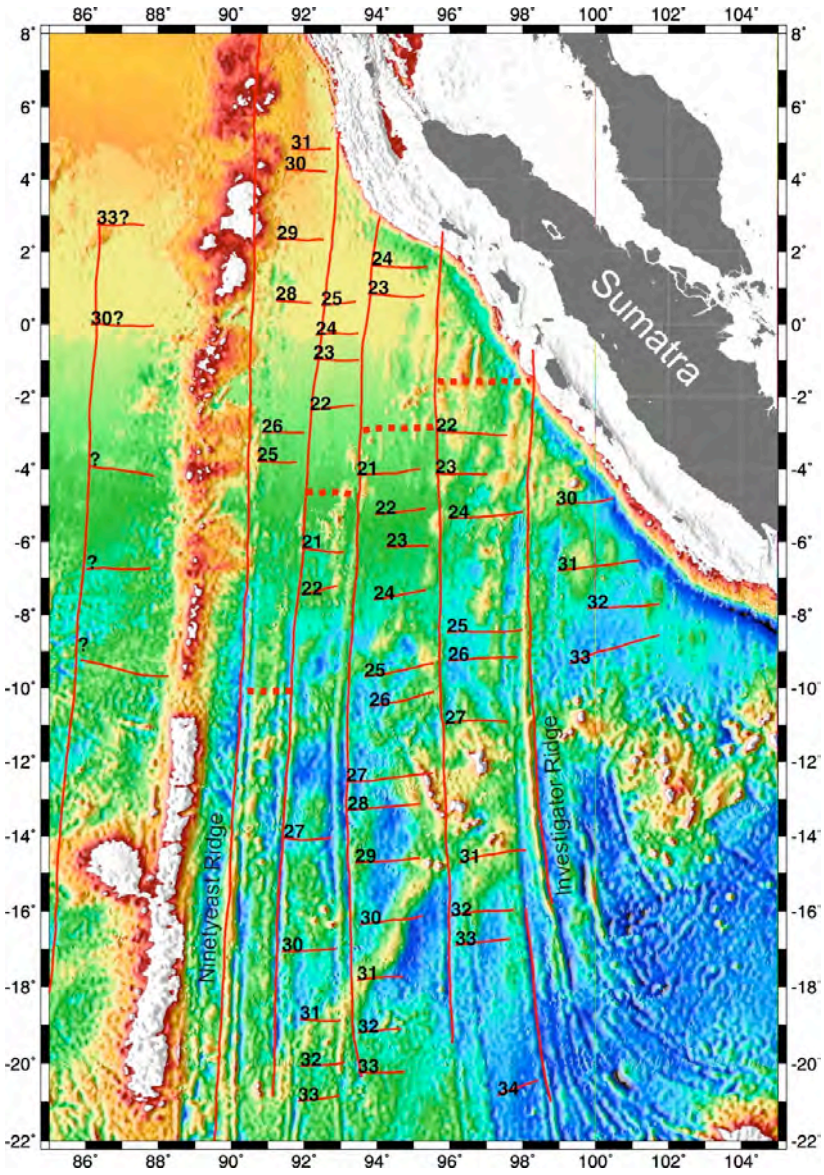

Fig. 6.4.: *Magnetic anomalies and fracture zones of the Wharton Basin after Liu et al. (1983). Dotted lines indicate abandoned spreading ridges.*

During cruise SO199, only limited magnetic profiling was done west of the Investigator Ridge. The coverage is not sufficient and the profiles are not long enough to seriously test the seafloor spreading anomaly interpretation of Liu et al. (1983) in this area. However, in the area between the Cocos Islands and the Investigator Ridge, the new magnetic data clearly indicate that one additional fracture zone exists which is running subparallel to the Investigator Ridge

at about 40 km distance to it (Fig 6.5.). This finding is also strongly supported by the high resolution swath bathymetry data.

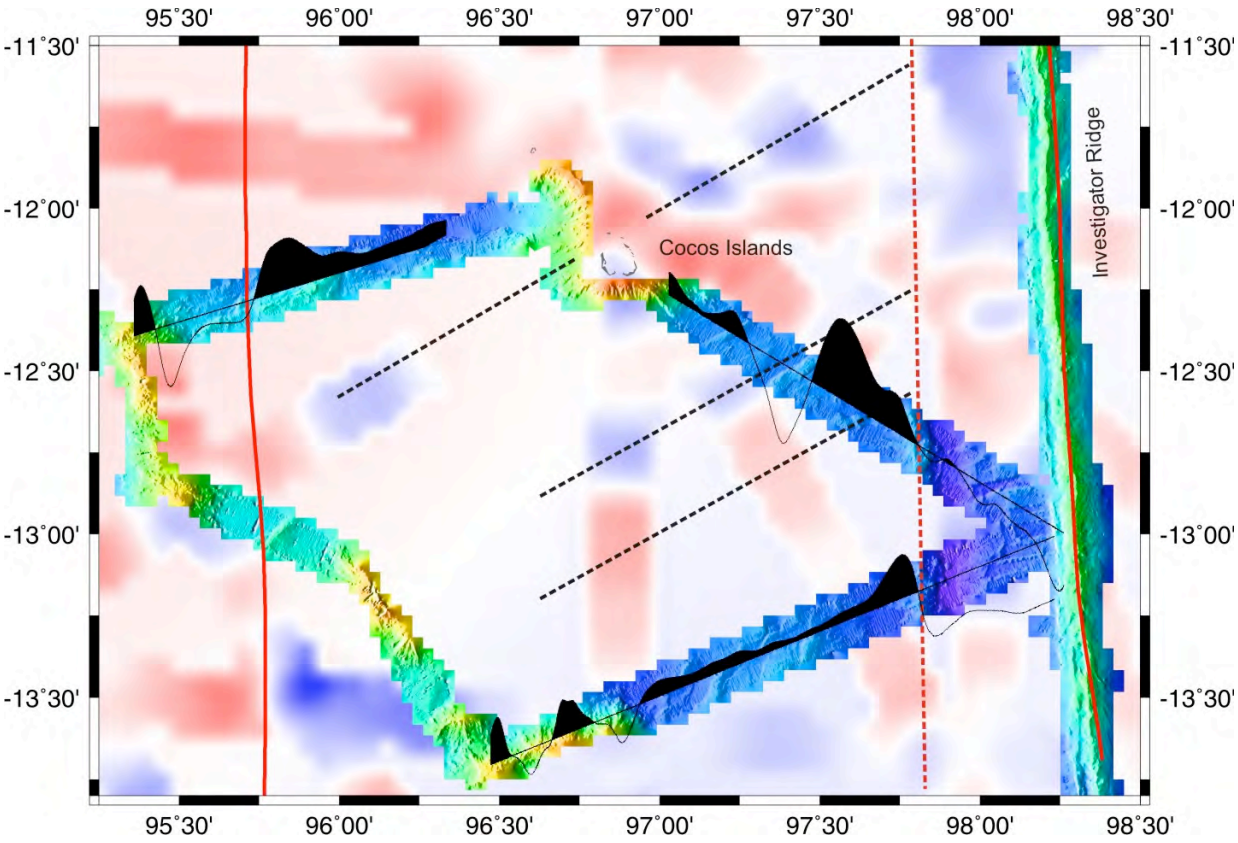

Fig. 6.5.: *Compilation of magnetic anomaly data (wiggle traces) and multibeam bathymetry data collected in the area around the Cocos Islands. Solid red lines: fracture zones after Liu et al. (1983), dotted red line: additional fracture zone. Dotted black lines: assumed trend of seafloor spreading anomalies. Background: Gridded magnetic anomalies of the World Digital Magnetic Anomaly Map (Maus et al. 2007) with positive anomalies shown in red, negative anomalies in blue.*

East of the Investigator Ridge, two very long profiles and one shorter magnetic profile were measured parallel to the ridge in order to possibly identify seafloor spreading anomalies in the area. According to the interpretation of Liu et al. (1983), these profiles should show anomaly 33 at their northern ends and extend deep into the Cretaceous Normal Superchron to the south. However, on the long magnetic profile (BGR08-205), just east of the Investigator Ridge, we found clear magnetic seafloor spreading anomalies in the southern part between 17.7° S and 12° S (Fig 6.6.). The low amplitudes of the anomalies in connection with water depths exceeding 6000 m in many places on the profile point to a high crustal age. In a first attempt to correlate the anomalies with a synthetic profile calculated from a magnetic reversal timescale, Jurassic anomalies M25 through M12 with an abandoned spreading center near 14.2° S were interpreted on this part of the profile (Fig 6.7.).

North of 12° S, the amplitudes of the magnetic anomalies become significantly larger and the water depth decreases by ~1,000 m. These clearly younger anomalies were tentatively interpreted as chrons 25 through 21 with an abandoned spreading center near 9.5° S. These data need to be compared with other magnetic profiles from the area extending further to the north in order to reliably identify the seafloor spreading anomalies.

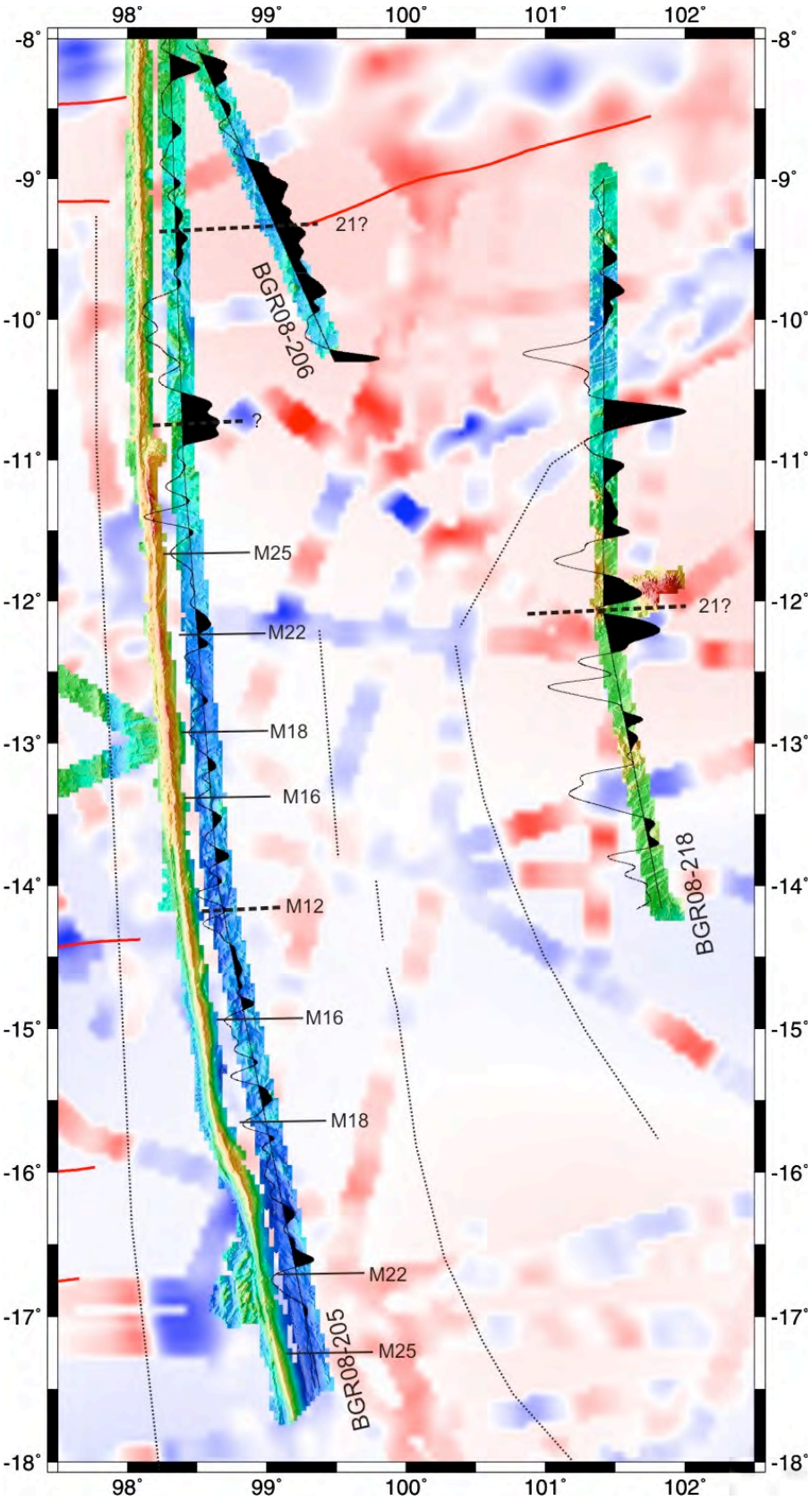

Fig. 6.6.: *Compilation of magnetic anomaly data (wiggle traces) and multibeam bathymetry data collected in the eastern Wharton Basin. Dotted lines: possible fracture zones. Black lines and numbers: seafloor spreading anomalies and chrons. Background: Gridded magnetic anomalies of the World Digital Magnetic Anomaly Map (Maus et al. 2007) with positive anomalies shown in red, negative anomalies in blue.*

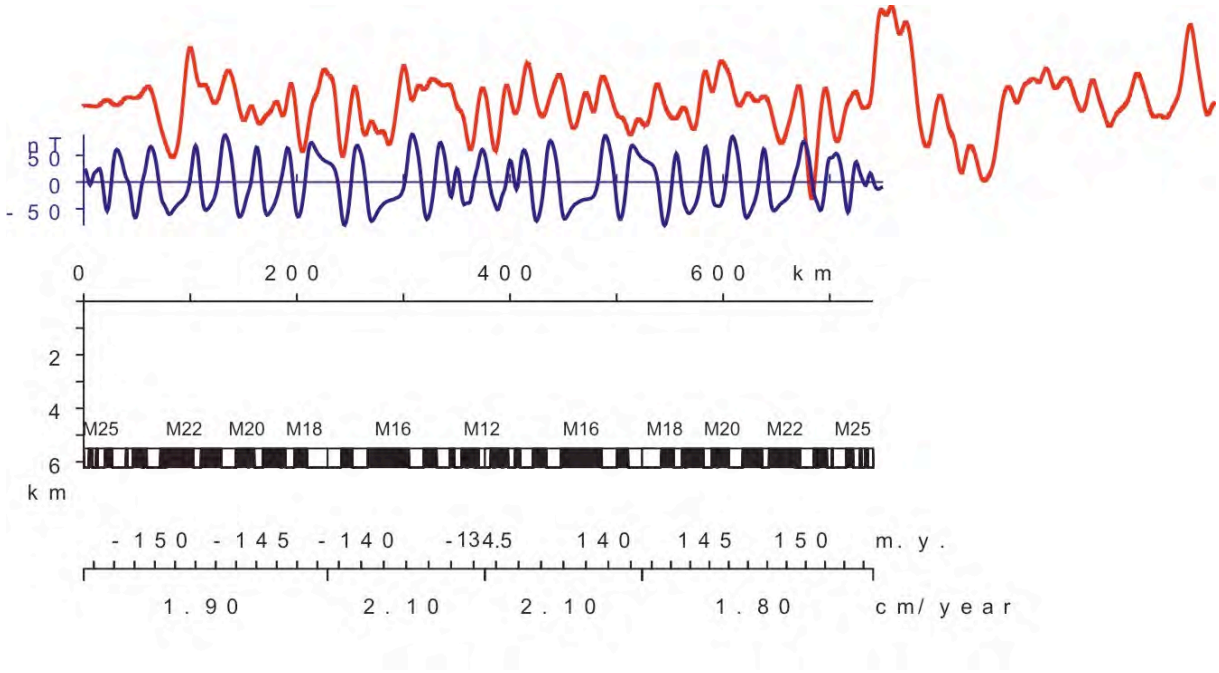

Fig. 6.7.: *Profile BGR08-205 (red) correlated with a synthetic profile. Magnetic reversal timescale of Gradstein et al. (1994).*

Profile BGR08-218 runs ~250 km further to the east but also parallel to the Investigator Ridge (Fig 6.6.). The course was selected carefully to avoid crossing the Vening Meinesz seamounts as far as this was possible in order to obtain magnetic anomalies of the oceanic crust undisturbed by local anomalies of seamounts. The water depth and amplitude of the anomalies are comparable to those in the northern part of profile BGR08-205. Therefore it seems likely that crustal ages are comparable as well. A striking similarity in the shape of the anomalies is observed. However, on the eastern profile the apparent spreading rate seems to be lower than that observed further west. In analogy to profile BGR08-205, an abandoned spreading center was interpreted tentatively 12° S. The seafloor morphology in the northern part of the profile does not show a uniform seafloor spreading fabric. Instead, changing strike directions of the fabric may indicate ridge jumps or changing spreading directions. Since profile BGR08-218 was run at the very end of the cruise, no further interpretation can be provided at this stage.

The gridded data of the World Digital Magnetic Anomaly Map show sharp changes in magnetic polarity along a line running subparallel to the Investigator Ridge roughly at 101° E (Fig 6.6.). This may indicate the trace of another so far undetected fracture zone offsetting seafloor spreading anomalies between profiles BGR08-205 and BGR08-218. The distance to the Investigator Ridge at ~200 km is similar to the distances that the major fracture zones further west are set apart.

6.2.2. Magnetic Anomalies of the Roo Rise and the Argo Abyssal Plain

According to the compilation of Cande et al. (1989), the youngest anomaly of the M-series (M0) is found in the area of the Roo Rise (Fig.6.8.). The crust west of this anomaly is supposed to have formed during the Cretaceous Normal Superchron where no age dating with the help of seafloor spreading anomalies is possible. An age discontinuity between anomalies M16 and M4 associated with a significant change in the strike direction of the magnetic lineations is found in the Roo Rise area at ~113°E (Fig 6.8.).

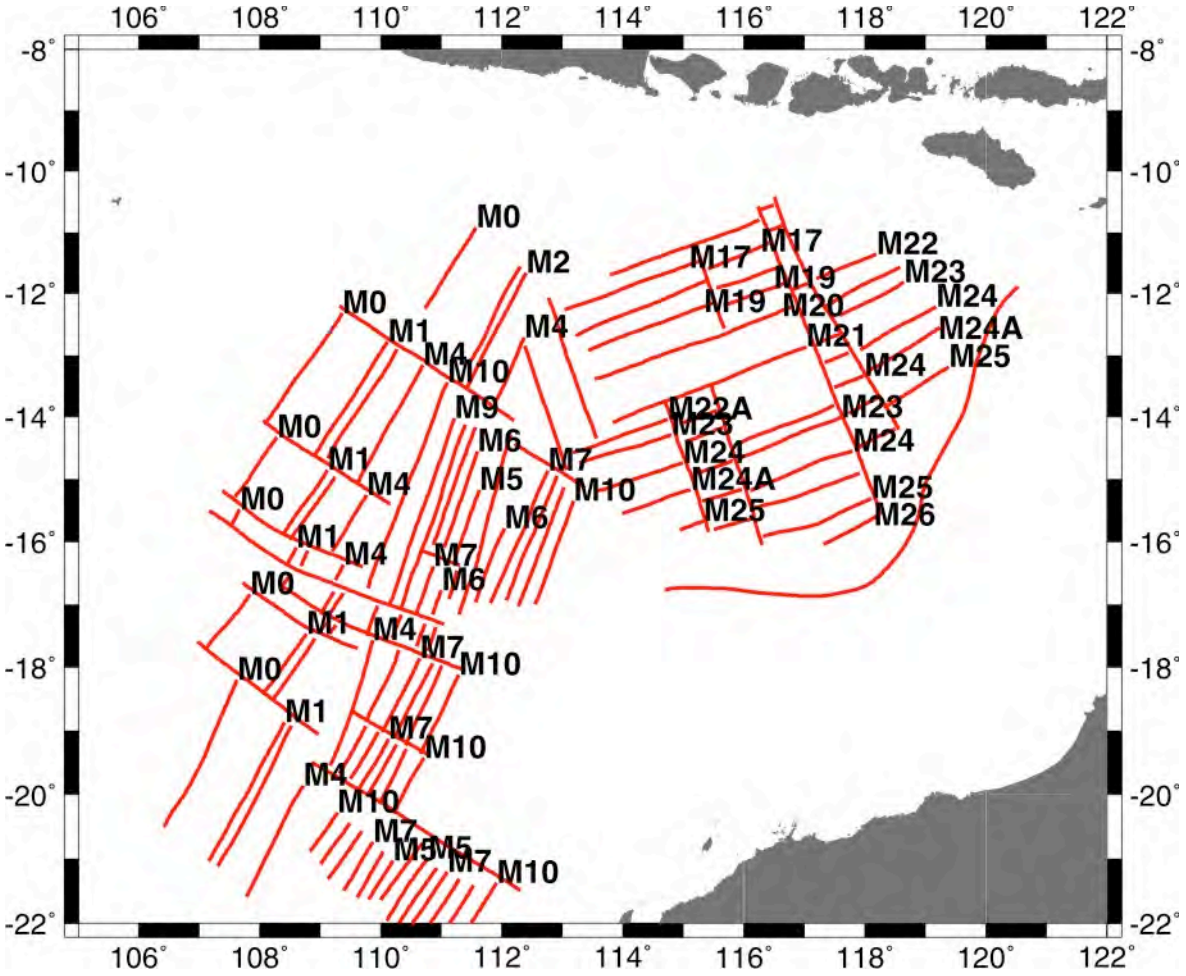

Fig. 6.8.: *Magnetic anomalies of the Argo Basin after Cande et al. (1989)*.

The magnetic profiles BGR08-209 and BGR08-211 cross the Roo Rise at different angles (Fig 6.9). Some anomalies with very high amplitudes are obviously related to seamounts or massively thickened crust, both of them being likely the result of volcanic activity of unknown age overprinting the Mesozoic oceanic crust (Müller et al. 1998). However, the course was chosen in such a way that the profiles crossed areas with deeper water and little morphology wherever possible in order to obtain the remains of the original seafloor spreading anomaly pattern. In those areas, e.g. around 110.5° E, the magnetic anomaly pattern does not correlate well with the published magnetic lineations (Fig 6.9.). In addition, in the westernmost part of profile BGR08-209, which should according to those published lineations, lie in the Cretaceous Normal Superchron, clear magnetic anomalies are observed over smooth and undisturbed seafloor morphology. In a preliminary interpretation we correlate the anomalies on the two profiles with chrons M0 through M10 (Fig 6.10.). However, it seems likely that this interpretation needs to be updated when more pre-existing data from the area are combined with the new profiles.

The Argo Abyssal Plain (AAP) is situated in the easternmost part of the Indian Ocean, just beyond the continental margin of northwest Australia (including the Exmouth Plateau, Rowley Terrace and Scott Plateau). ODP drilling sites and magnetic isochrons indicate that the opening of the AAP began in the Late Jurassic with the northward rifting of a continental sliver from South Gondwana. Now, newly acquired magnetic data from the CHRISP research cruise, as well as existing data obtained in 2008 from GEODAS (a free online geophysical database), has been used to refine earlier conflicting magnetic anomaly interpretations.

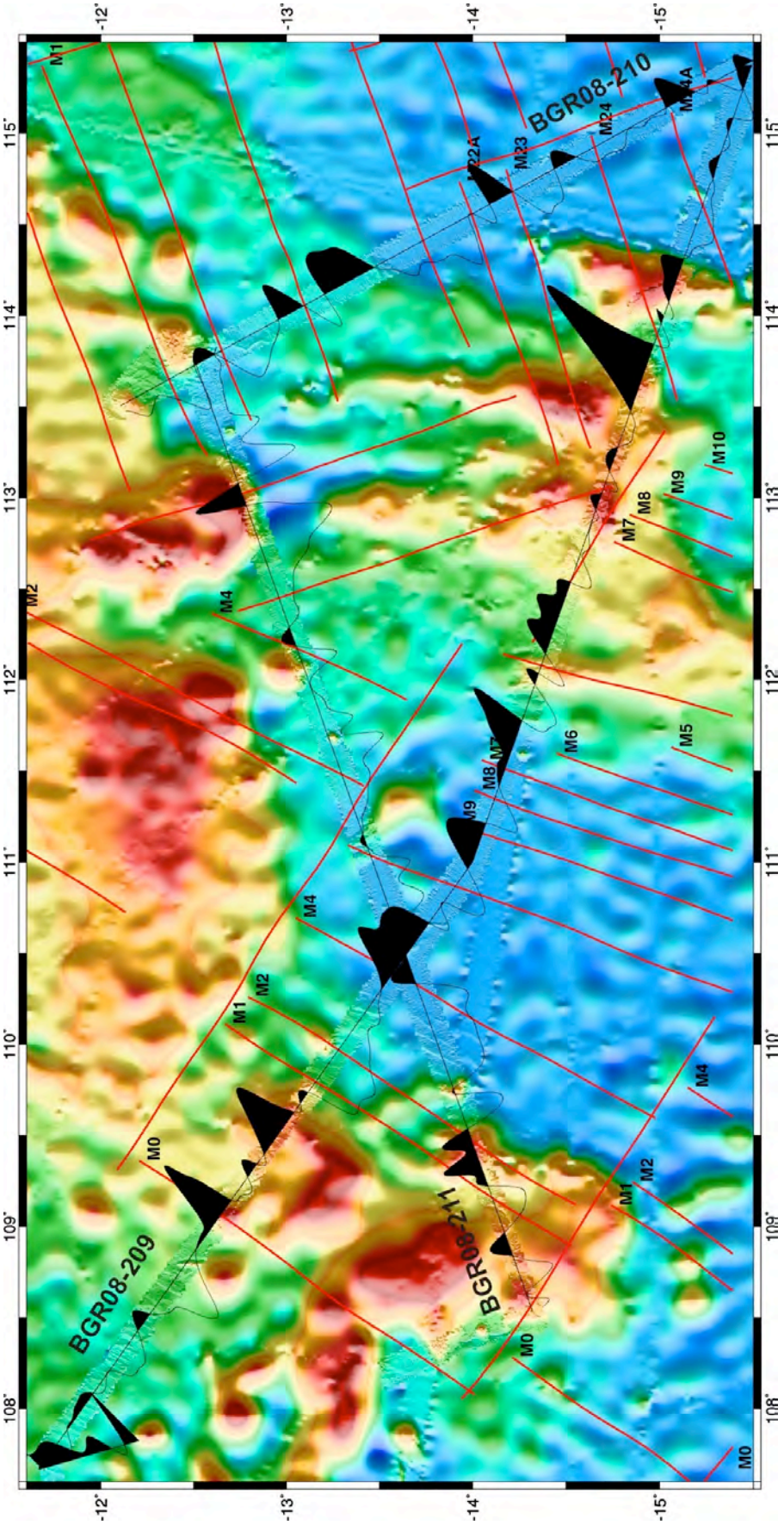

Fig. 6.9.: *Compilation of magnetic anomaly data (wiggle traces) and multibeam bathymetry data collected in the Roo Rise and Argo Basin area. Red lines and numbers: seafloor spreading anomalies, fracture zones, and chrons after Cande et al. (1989).*

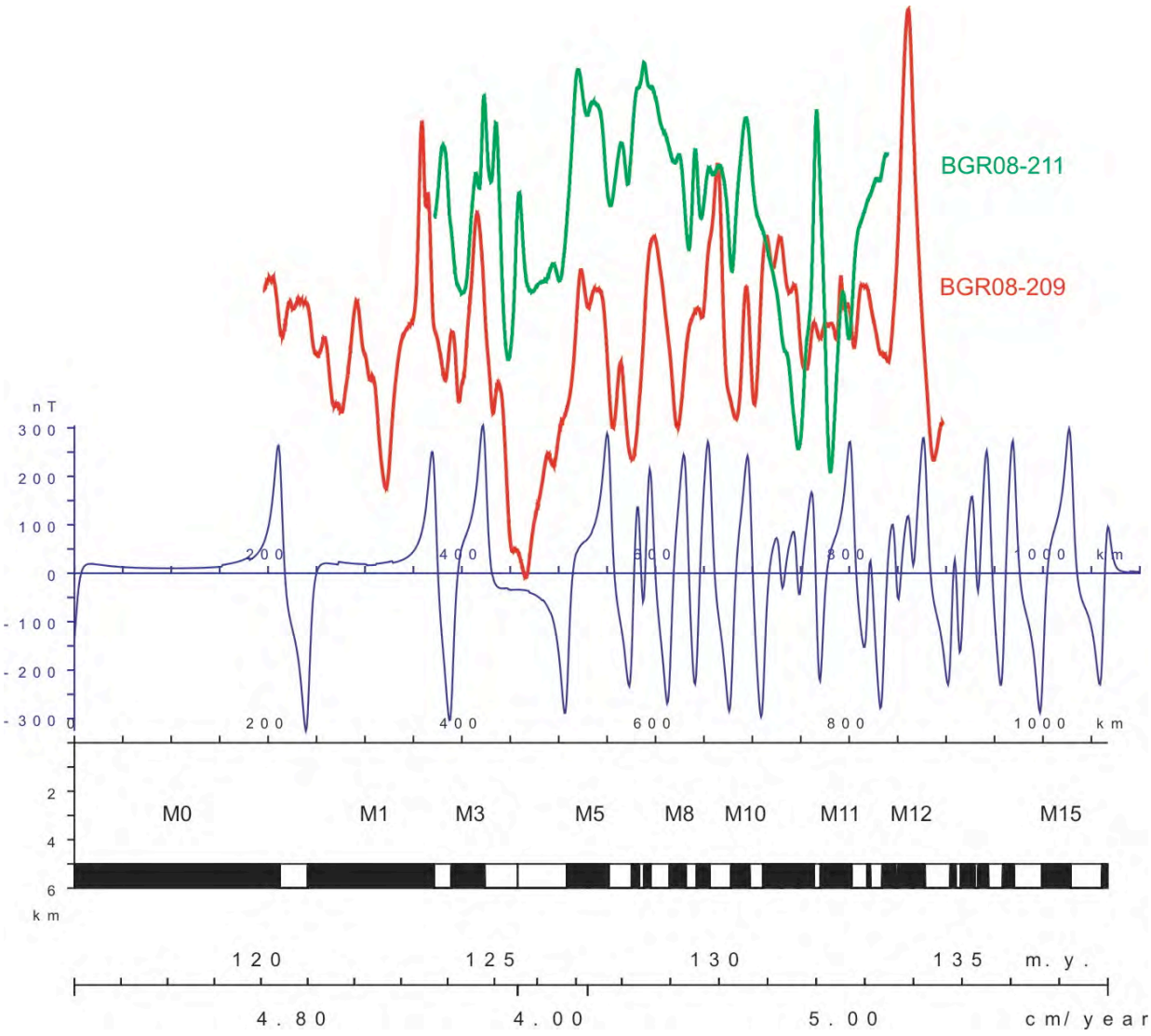

Fig. 6.10.: *Profiles BGR08-209 and BGR08-211 correlated with a synthetic profile. Magnetic reversal timescale of Gradstein et al. (1994).*

The new magnetic profile BGR08-210 lies just east of the Joey Rise and runs along a transect oriented 29 degrees to north. This new track is a good match to the orientation of the earlier preferred profiles for the AAP. These are namely a9314 (the 4,000 – 4,400 km strip), which lies just to the west of the new profile and um63 (the 1,000 - 1,400 km strip), which lies just to its east. The new profile was specifically chosen to fill one of the largest gaps between these original tracks (roughly 100 km), where the magnetic anomalies also proved more difficult to correlate.

The new interpretation, (still in progress), currently does not incorporate a southward-directed ridge jump at M13 (134 Ma), as featured in the most recent interpretation by Heine et al. (2004). Instead, it appears similar to interpretations by Fullerton et al. (1989) and Sager et al. (1992), which account for anomalies M16 to M26, invoking fracture zones and asymmetric, slow spreading rates. The new interpretation does, however, have subtle differences including the exact placement of some isochrons, fracture zones and a more complete correlation in the AAP just east of the Joey Rise.

Next steps include investigating whether these magnetic anomalies can be continued over the seamounts of the Joey and Roo Rises and into the Gascoyne Abyssal Plain (just southwest of the AAP), and then to the rest of the Wharton Basin where the other CHRISP magnetic profiles will help constrain the anomalies currently thought to belong to the Cretaceous Normal Superchron.

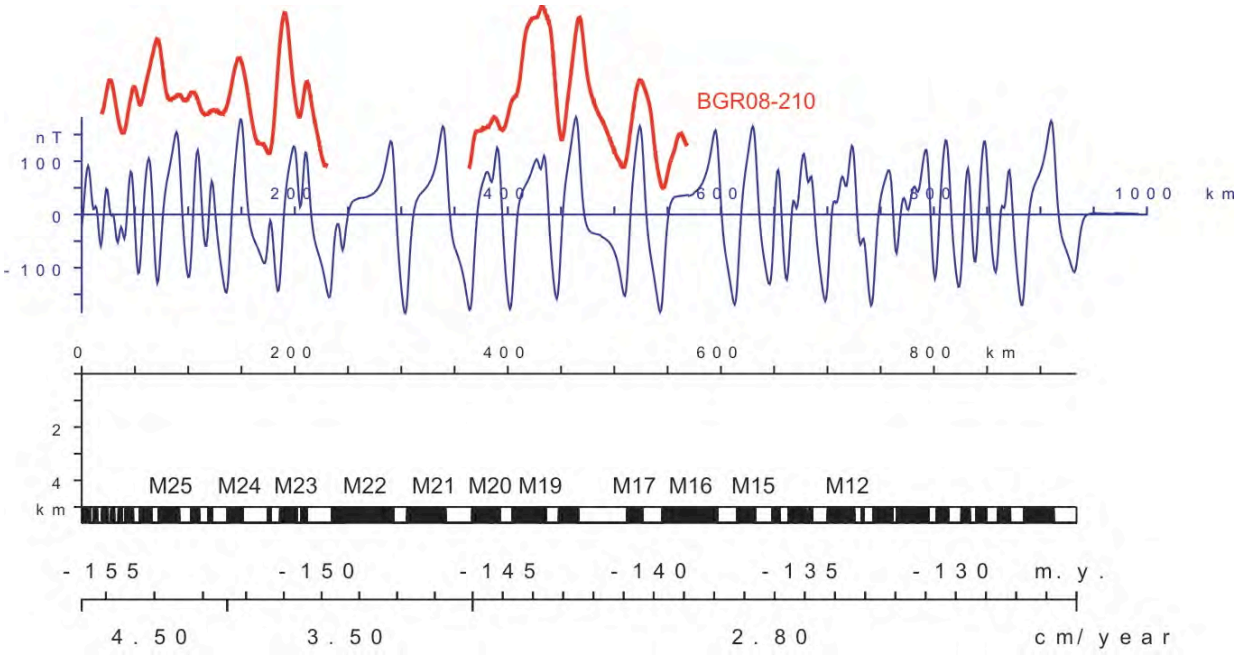

Fig. 6.11.: *Profile BGR08-210 (red) correlated with a synthetic profile. Magnetic reversal timescale of Gradstein et al. (1994).*

7. BIOLOGY

(C. Lüter, B. Neuhaus, A. Roth, R. Seidel)

7.1. METHODS

7.1.1. Shipboard Collecting Procedures

Biological material was collected by deployment of (i) a geological chain bag dredge, (ii) a TV-grab (TVG) and (iii) a multicorer (MUC). All boulders and rocks collected with the dredge were scanned for encrusting benthic invertebrates. Additionally, four sediment trap tubes (length: 21 cm, diameter: 4 cm) were fixed in the dredge to collect a disturbed sediment sample from each dredging site. Nine so-called biological stations were identified using maps of predicted bathymetry by Smith and Sandwell (1997), in order to collect undisturbed sediment samples and the inhabiting meiofaunal community with the MUC. The sites were carefully chosen using PARASOUND and SIMRAD EM 120 profiling to avoid damaging the MUC on hard grounds. Where necessary, the sea floor was first checked with the TVG over a transect of about 200 m to secure its soft nature and to avoid damaging the MUC by landing on rocks. Additionally, the TVG's video-sequence capturing the way down to the sea bed and along the transect allowed for macrofauna observation (planktonic and benthic) and collection. As a side-effect, a disturbed sediment sample could be collected with the TVG at two stations, providing additional material for meiofauna investigation. The TVG was also intended to be used for collecting boulders with encrusting macrofauna, but this was only possible at two stations on a cone in the area of the Vening Meinesz seamounts and at the Sherbakov seamount. The video sequences recorded with the TVG showed rather rich planktonic and also benthic communities. All video sequences were recorded using two shipboard LG HDD/DVD recorders (b/w and colour) and subsequently burnt on DVDs for analysis of the sediment/rock structure and the nature of the recorded deep-sea plankton and benthos.

7.1.2. Meiofauna

Sediment sampled by four sediment trap tubes (length: 21 cm, diameter: 4 cm) inside the geological chain bag dredges was fixed immediately in cold 6% formaldehyde buffered with buffer tablets for haematology (Merck # 1.09468.10100, pH 7.2). After at least one day of fixation at 4 - 8° C, the sediment was washed carefully with plenty of tap water on a 40 µm-sieve and centrifuged (THERMO Heraeus Multifuge 3s) three times for 5 minutes with three times the amount of Levasil 200A/40% at 4,000 rpm in order to quantitatively extract the meiofauna. After rinsing with tap water on a 40 µm-sieve, specimens were stored in 75% ethanol. Sediment was sampled with the TV-grab together with macrofaunal specimens whenever possible. The entire haul from the TV-grab was carefully checked for additional macrofaunal organisms buried in deeper layers of the sediment. About 6 kg of near-surface sediment were fixed in cold 6% formaldehyde and processed as described above. From the multicorer, only the upper 5 cm of sediment in each core (inner core diameter: 9.5 cm) were taken. Samples were split into three portions, if enough sediment was sampled: Most of the sediment of the upper 5 cm layer was fixed in cold 6% formaldehyde. This material was later washed with tap water on a 40 µm-sieve, centrifuged for meiofauna and finally stored in 75% ethanol. About 100 g of sediment (sediment at 6-8 cm depth) were dried on glass petri dishes in an oven at 50° C for about 2 - 4 days and stored in plastic bags for later analysis of TOCs (= total organic carbon), TC (total carbon) and grain size. If enough sediment was collected, about 1 kg of sediment from the upper 5 cm layer was additionally fixed in 1.5% formaldehyde plus 3.75% glutardialdehyde in 0.1 M cacodylate buffer for electron microscopy at 4 - 8° C for at least one day and processed as described in the previous paragraph. Additional sediment samples were taken for GEOSCIENCE Australia: we used sediment from 5-10 cm depth, 10 - 20 cm and 20 - 30 cm from one core and preserved it unprocessed and with no additives in plastic bags in a fridge. Meiofaunal organisms were sorted on board R/V SONNE with a dissecting microscope Zeiss Stemi 2000.

7.1.3. Macrofauna

Macrofaunal organisms found on dredged rocks or in TVG samples were picked using scalpel blades and forceps and immediately fixed in (i) 99% pure ethanol, or (ii) 4% formaldehyde buffered with buffer tablets for haematology (Merck # 1.09468.10100, pH 7.2), or (iii) in RNAlater depending on planned investigation methods. After 24 hrs formaldehyde-fixed organisms were rinsed 2x in tap water for at least 24 hrs each and finally preserved in 80% ethanol. These specimens are mainly voucher specimens for the Museum collection and can be used for histological sectioning and staining procedures. Specimens fixed in pure ethanol will be used for morphological studies (especially hard parts like tests and shells) and their soft tissues will be available for DNA-analysis and –sequencing. Within a co-operative project with Prof. G. Wörheide, LMU München, some sponges were fixed in RNAlater for preservation of RNAs present in sponge-inhabiting bacteria at the time of fixation. Spectacular organisms found in the samples were digitally photographed prior to fixation for documentation of original shape and colours.

7.2. PRELIMINARY RESULTS AND DISCUSSION

7.2.1. General Observations and Collecting Report

The collecting results during the present cruise somehow resemble those during the last deep-sea expedition with R/V SONNE to the Manihiki Plateau in the Central Pacific (SO193). The collected benthos organisms (macrofauna) are mainly small and, with few exceptions, represent only five animal groups, such as sponges, cnidarians, polychaetes, bryozoans and tunicates. In contrast to the conditions observed at the Manihiki-Plateau, the water column showed rich plankton communities (TV-grab video) and at certain sites also a highly diverse benthic fauna. Especially at the Vening Meinesz seamounts, we observed octocoral gardens, consisting of several different species of gorgonians. Between the corals at least two species of stalked crinoids could be observed in high abundances (during a 200 m long transect we counted about 30 crinoids). Unfortunately we couldn't collect these animals due to a rather steep seafloor morphology, which is unsuitable for successful deployment of the TV-grab.

Especially the slopes of the seamounts, where ambient currents provide nutrient-rich conditions, were encrusted with benthic filter feeders. Unfortunately, this supposedly species-rich community could be collected neither with the TVG nor with geological dredges. We have no clearcut explanantion for this, but several aspects have to be taken into account. The TVG may be unsuitable for collecting along slopes, since it needs flat seabottom areas to reliably close its shovel and keep the collected samples. This kind of habitat was rather rare in the research area and, if present, did not contain diverse invertebrate communities (as recorded with the onboard camera system of the TVG). Additionally, the TVG's overall reliability during the whole cruise was problematic. Technical problems with the data transmission from the TVG to the shipboard computer system led to only 3 successful TVG stations (total TVG-operations: 12). With regard to the numerous benthos-depleted rock samples collected with the geological chain bag dredge, we also may have had a systematic problem imminent in the dredging procedure. In order to successfully collect rocks from the deep slopes of seamounts and ridges, the vessel has to be oriented windwardly and against the surface current. This means that the dredged slopes always represented the leeward sides of the hardbottom structures. During SO199 the wind and the surface currents constantly came from E to SE, i.e. the dredged slopes were always the western slopes of the Investigator ridge and the seamounts. Provided that the ambient currents in several thousand meters depth come from similar directions as the surface currents, filter feeders may prefer to sit in current-exposed habitats, which in our case were the eastern slopes. Additionally, many dredged rocks were rather roundish to smooth and looked like material from large debris fans. Driven by currents, this material constantly moves downhill and, therefore, provides an unsuitable settling ground for larger sessile invertebrates. Even if larvae of these animals try to settle on this material, they will be eroded by rock movement, before they reach maturity and their average size. Thus, it is impossible for these animals to establish a stabile community on these unfirm grounds. Another aspect which may explain the small number of animals collected in the dredges is depth. During SO199 the mean depth of all dredging stations was 3.900 m. From

several investigations we know that abundances of benthic invertebrates decrease with increasing depth due to a variety of reasons like food depletion and difficulties to produce calcified skeletons (carbonate compensation). Availability of organic food particles in the deep may be mirrored in total organic carbon contents of sediments, which will be measured using representative sediment samples collected during the whole cruise. The species numbers and diversity of the meiofaunal organisms extracted from sediment samples during the cruise lead to the assumption that food depletion, if at all, plays only a minor role in shaping the benthic communities in the research area.

Macrofaunal organisms were recovered at 50 (47 geological dredges, 1 TVG, 2 MUCs) out of 91 collecting stations (71 geological dredges, 11 TVGs and 9 MUCs). Seventyfive stations revealed sediment samples (65 sediment traps, 2 TVGs, 8 MUCs). During the cruise, a total of 9.132 meiofaunal organisms could be isolated from about 60 kg of sediment. For a detailed list of the collected taxa and the number of specimens per taxon see Appendix IV.

7.2.2. Meiofauna

The sediment samples from the dredge and biological stations revealed species from most marine invertebrate groups of the animal kingdom, and demonstrated the diversity of animal life on the seamounts and plains East and West of the Investigator Ridge. During the cruise, samples from 52 of 75 hauls (geological dredge, TVG, multicorer) yielding sediment were pre-sorted for meiofauna, 9.132 specimens of the meiofauna were isolated already. Further sorting in Berlin is expected to reveal many more specimens, since it is rather difficult to trace especially the smaller sized meiofauna groups such as Kinorhyncha, Loricifera, and Tardigrada with a stereo microscope at magnifications of 32x on board a moving ship.

Foraminifera and Nematoda outnumbered by far all other meiofaunal groups followed by the Copepoda. Specimens of several other taxa have been recovered at far lower densities from the pre-sorted samples. Tardigrada, Loricifera and Kinorhyncha (species of the genera *Echinoderes, Campyloderes, Antygomonas* and *Pycnophyes*) were found regularly. Whereas the life cycle of Kinorhyncha is straight forward from an egg via 6-7 juvenile stages to the adult stage and well documented (comp. Neuhaus and Higgins 2002), the situation is different for the Loricifera. The finding of probably all live history stages of Loricifera such as larva, postlarva, ghost larva, mega-larva and adult, many of them in the process of moulting, is especially thrilling, because this may allow reconstruction of the entire life cycle of at least a few species. The life cycle of Loricifera varies considerably among different species and is still not fully understood. It seems generally to be more complex in species of the deep sea and on seamounts of the open ocean (Gad 2005a, b; Heiner and Kristensen 2008; Heiner and Neuhaus 2007). In addition to sexual reproduction via eggs, several Higgins-larvae and adults, species of the Pliciloricidae (Lorcifera) may reduce a postlarva, become mature at an earlier stage (pedogenesis) by parthenogenetic reproduction and develop a cyst-forming mega-larva (Gad 2005a, b; Heiner and Kristensen 2008; Heiner and Neuhaus 2007).

Regularly, worm-like organisms were discovered but could not be identified with certainty under the stereo microscope. Probably, these animals belong to the Gastrotricha and Plathelminthes. Both groups are rarely reported from the deep sea (Gambi and Danovaro 2006, Higgins and Thiel 1988, Schewe 2001, Soltwedel et al. 2000).

The number of meiofaunal specimens found in the sediment samples on this cruise is due mainly to the four sediment traps mounted in each geological dredge revealing some 60 kg of sediment and to the extensive usage of the density centrifugation method. This latter technique is supposed to recover meiofaunal organisms quantitatively from any kind of sediment be it mud or deep-sea clay or sand (Higgins and Thiel 1988). The THERMO Heraeus Multifuge 3s with its large centrifugation volume of 4 x 600 ml (taking 4 x 150 ml of sediment at a time) allowed to process the enormous amount of about 60 kg of sediment on board of R/V SONNE in a reasonable amount of time.

7.2.3. Macrofauna

The benthic communities found on the dredged boulders and rocks consisted of small to very small sessile invertebrates. Species composition was dominated by sponges and sedentary polychaetes. Bryozoans were found in surprisingly low numbers. Living brachiopods were completely absent, so were gastropod molluscs except a few dead shells found in

sediment samples. With the TVG macrofauna collection was impossible during the whole cruise (see above). The video recordings are mainly restricted to planktonic organisms captured by the TVG camera system on the way down to the seabed. At two stations we also recorded rather rich bottom dwelling communities (see above). At the Sherbakov seamount (station TVG 51) we were able to observe a swimming holothurian *Enypniastes eximia*, which "danced" into the picture at ~1800 m depth. The following dredge at Sherbakov seamount (station DR 52) even revealed a heaviliy damaged specimen of this impressive sea cucumber, pieces of which were preserved in alcohol for DNA studies.

The collected sponge species were dominated by tiny hexactinellids, presumably belonging to the genus *Asbestopluma*. This is interesting, because *Asbestopluma*-spieces are described as carnivorous, i.e. they are not simple filter feeders, but "hunt" planktonic organisms. In the deep, they may largely thrive by eating radiolarians.

Most of he sedentary polychaetes collected during the cruise belong to only a few families, i.e. Amphinomidae, Maldanidae, Serpulidae and Sabellariidae. A few sabellariids found at stations 1, 2, 8, and 59 were similar to species found during a previous cruise SO193 in the central Pacific. As in all other groups, identification by specialists is needed to confirm, whether the specimens found in the Indian Ocean are conspecifics to the Pacific ones or different but nevertheless closely related species.

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APPENDICES:

I. Sampling Summary
II. Rock Description (dredge station locations and rock sample descriptions)
III. Volcaniclastic Rocks
IV. Biological Sampling (station locations and biological sample descriptions)
V. Overview Map (SO199 sampling sites)

Appendix I (Sampling Summary)

Type	Stat.	Location	total volume	Rock summary	on bottom		off bottom		depth (m)		**Mag**	**Mn**	**Sed**	**Volcani-**
					lat °S	long °E	lat °S	long °E	max	min	rock		rock	clastic
DR	1	"Outsider Seamount"	full	pillow and sheet lava fragments	6,227	97,373	6,229	97,380	4036	3546	1	0	0	0
DR	2	Northern Investigator Ridge	2/3 full	intrusiva, lavas and volcaniclastic rocks	7,013	98,107	7,013	98,107	4602	4135	1	0	0	1
DR	3	Northern Investigator Ridge	--	dredge lost because of broken bolt	7,345	98,087	7,347	98,096	4789	4125	0	0	0	0
TVG	4	Abyssal plain west of Invest. R.	empty	failed due to technical problems							0	0	0	0
DR	5	Northern Investigator Ridge	few rocks	pillow fragments, few volcaniclastic rocks	8,157	98,597	8,157	98,070	4357	3805	1	0	0	0
DR	6	Northern Investigator Ridge	1/10 full	intrusiva, volcanic and sepentinized rocks	9,041	98,074	9,040	98,083	4135	3704	1	0	0	1
TVG	7	Crest of N Investigator Ridge	empty	failed due to technical problems					3500	3588	0	0	0	0
DR	8	Northern Investigator Ridge	full	pillow fragments, few volcaniclastic rocks	9,953	98,067	9,955	98,076	4925	4290	1	0	0	1
DR	9	Central Investigator Ridge	few rocks	pillow fragments	10,887	98,079	10,887	98,073	4700	4259	1	0	0	0
DR	10	Tilted block W of Invest. Ridge	1/10 full	lava fragments and coarse cristalline rocks	10,988	98,130	10,987	98,138	4060	3515	1	0	1	1
DR	11	Central Investigator Ridge	1/4 full	intrusiva, volcanic and volcaniclastic rocks, Mn crusts	11,938	98,192	11,937	98,195	3953	3701	1	1	0	1
DR	12	Central Investigator Ridge	few rocks	breccia with serpentinite clasts	13,015	98,268	13,012	98,277	3994	3504	1	0	0	0
DR	13	Cocos/Keeling Island complex	1/10 full	lava fragments and volcaniclastic rocks	11,906	96,651	11,901	96,659	2402	1880	1	0	0	1
TVG	14	Abyssal plain west of Keeling Is.	empty	failed due to technical problems							0	0	0	0
MUC	15	Abyssal plain west of Keeling Is.	little	soft sediment	12,072	96,352	12,072	96,352	5231	5231	0	0	0	0
DR	16	Muirfield Seamount group	few rocks	volcaniclastic rocks with lava clasts	12,394	95,288	12,394	95,290	2883	2676	1	0	0	1
DR	17	Muirfield Seamount group	few rocks	volcaniclastic rocks with lava clasts	12,499	95,353	12,495	95,358	2247	1839	1	0	0	1
DR	18	Muirfield Seamount group	one rock	volcaniclastic rock with lava clasts	12,805	95,377	12,818	95,387	3549	3053	1	0	0	1
DR	19	Muirfield Seamount	few rocks	volcaniclastic rocks with lava clasts	13,089	96,006	13,091	96,020	3002	2607	1	0	1	1
DR	20	Muirfield Seamount group	1/6 full	lava fragments and volcaniclastic rocks	13,606	96,389	13,603	96,397	3140	2819	1	0	0	1
DR	21	Muirfield Seamount group	few rocks	lava fragments	13,721	96,430	13,718	96,440	2783	2295	1	0	0	0
DR	22	Central Investigator Ridge	few rocks	pillow lava	13,236	98,236	13,235	98,246	4775	4287	1	0	0	0
DR	23	Central Investigator Ridge	1/3 full	intrusiva and Mn crusts	13,903	98,371	13,907	98,379	4203	3796	1	1	0	0
TVG	24	Abyssal plain west of Invest. R.	empty	failed due to technical problems							0	0	0	0
MUC	25	Abyssal plain west of Invest. R.	3 tubes	soft sediment	14,085	98,291	14,085	98,291	5406	5406	0	0	0	0
DR	26	Southern Investigator Ridge	1/4 full	breccia with lava clasts, serpentinite (?)	14,920	98,492	14,918	98,501	4938	4575	1	0	1	1
TVG	27	Lower E-slope of S-Invest. R.	1/3 full	soft sediment	15,881	98,736	15,880	98,743	3830	3883	0	0	0	0
DR	28	Southern Investigator Ridge	1/3 full	Mn crusts with variuos magmatic clasts	16,002	98,739	16,001	98,500	4649	4290	1	1	1	0
DR	29	Seamount W of Invest. Ridge	few rocks	various intrusiva and volcanic rocks	16,565	98,839	16,570	98,848	5262	4813	1	0	0	0
DR	30	Seamount W of Invest. Ridge	1/5 full	pillows and pillow fragments	16,783	98,785	16,784	98,792	5060	4586	1	0	0	0
DR	31	Southern Investigator Ridge	few rocks	volcanic and sedimentary rocks	17,585	99,117	17,582	99,140	5361	4947	1	0	1	0
TVG	32	Lower E-slope of S-Invest. R.	empty	failed due to technical problems							0	0	0	0
MUC	33	Abyssal plain W of S-Invest. R.	1 tube	soft sediment	17,465	99,320	17,465	99,320	6260	6260	0	0	0	0
MUC	34	Abyssal plain W of N-Invest. R.	2 tubes	sof sediment	8,028	98,401	8,028	98,401	5226	5226	0	0	0	0
DR	35	Vening Meinesz Seamounts W	1 rock	pillow lava fragment	10,312	99,491	10,312	99,492	3084	3060	1	0	0	0
DR	36	Vening Meinesz Seamounts W	few rocks	lava fragments, volcanoclastic rocks, thick Mn crusts	10,352	99,500	10,352	99,574	2548	2230	1	1	1	1
DR	37	Vening Meinesz Seamounts W	few rocks	carbonate	10,668	99,574	10,668	99,583	2475	2272	0	0	1	0
DR	38	Vening Meinesz Seamounts W	empty		10,519	99,528	10,517	99,537	4381	3853	0	0	0	0

Appendix I (Sampling Summary)

Type	Stat.	Location	total volume	Rock summary	on bottom		off bottom		depth (m)		**Mag**	**Mn**	**Sed**	**Volcani-**
					lat °S	long °E	lat °S	long °E	max	min	rock		rock	clastic
DR	39	Vening Meinesz Seamounts W	one rock	carbonate	10,366	99,486	10,363	99,493	3100	2711	0	0	1	0
DR	40	Vening Meinesz Seamounts C	1/4 full	pillow lava fragments, volcaniclastic rocks, Mn crusts	10,765	101,812	10,765	101,821	4306	3791	1	0	1	1
DR	41	Vening Meinesz Seamounts C	1/4 full	lavas, volcanoclastic rocks, Mn crusts, carbonate	10,759	102,176	10,761	102,192	3754	3282	1	1	1	1
DR	42	Vening Meinesz Seamounts C	few rocks	lava fragments and volcaniclastic rocks	11,030	102,304	11,026	102,312	3963	3441	1	0	0	1
MUC	43	Abyssal Plain S of V.M. Smts.	1/3 tube	soft sediment	11,211	102,552	11,211	102,552	5484	5484	0	0	0	0
DR	44	Vening Meinesz Seamounts E	few rocks	one small lava fragment, carbonate, Mn crusts	11,775	103,241	11,775	103,251	2525	2036	1	1	1	0
DR	45	Vening Meinesz Seamounts E	1/6 full	tuffaceous rocks or highly vesicular lava?	11,663	103,534	11,659	103,543	3746	3277	1	1	0	1
DR	46	Vening Meinesz Seamounts E	1/5 full	pillow fragments, volcaniclastic rocks, sandstones	10,915	103,617	10,922	103,624	4361	3769	1	0	1	1
TVG	47	Cone on slope of a V.M. Seamount	empty		11,455	104,494	11,456	104,496	1922	2018	0	0	0	0
DR	48	Vening Meinesz Seamounts E	few rocks	lava fragments, volcaniclastic rocks and carbonate	11,457	104,488	11,456	104,490	2202	2098	1	0	1	1
DR	49	Vening Meinesz Seamounts E	1/3 full	pillows fragments, rounded volcaniclastic (?) pebbles	11,512	104,783	11,517	104,792	4582	4050	1	0	1	1
DR	50	Vening Meinesz Seamounts E	few rocks	lava fragments and volcaniclastic rocks	11,331	104,783	11,330	104,800	3125	3022	1	0	0	1
TVG	51	Sherbakov Seamount (V.M. Smts)	empty		10,922	104,578	10,925	104,583	1787	1832	0	0	0	0
DR	52	Sherbakov Seamount (V.M. Smts)	few rocks	pillow fragments, volcaniclastic rocks, carbonate	10,908	104,534	10,915	104,559	2820	2229	1	0	1	1
MUC	53	Abyssal plain SW of Christmas Is.	7 tubes	soft sediment	10,620	105,294	10,620	105,294	4688	4688	0	0	0	0
DR	54	Christmas Island	few rocks	lava fragments, volcaniclastic rocks and carbonate	10,540	105,403	10,540	105,410	3626	3156	1	0	1	1
DR	55	Christmas Island	few rocks	lava fragments and carbonate	10,514	105,474	10,516	105,480	1891	1427	1	0	1	0
DR	56	Seamount group SE of Christmas Is.	1/3 full	lava fragments and volcaniclastic rocks	11,263	106,555	11,267	106,562	3997	3338	1	0	0	1
DR	57	Seamount group SE of Christmas Is.	1/6 full	lava fragments and volcaniclastic rocks	11,710	106,554	11,712	106,564	3501	3050	1	0	0	1
DR	58	Seamount group SE of Christmas Is.	1/3 full	pillow and sheet lava, volcaniclastic rocks, sediments	11,737	106,880	11,740	106,889	2609	3113	1	0	1	1
DR	59	Seamount group SE of Christmas Is.	1/4 full	lava fragments and volcaniclastic rocks	11,761	106,884	11,762	106,893	3173	2733	1	0	0	1
TVG	60	Seamount group SE of Christmas Is.	1/2 full	soft sediment	11,813	107,038	11,813	107,038	2739	2728	0	0	0	0
DR	61	Seamount group SE of Christmas Is.	empty		12,175	106,773	12,174	106,780	4674	3988	0	0	0	0
DR	62	Seamount group SE of Christmas Is.	few rocks	pillow fragments, volcaniclastic rocks, sediments	12,457	106,650	12,460	106,661	3477	2898	1	0	1	1
DR	63	Seamount group SE of Christmas Is.	one rock	1 pillow fragment w/ Mn crusts	12,662	106,654	12,659	106,663	3388	2918	1	1	0	0
DR	64	Seamount group SE of Christmas Is.	empty		12,654	107,213	12,655	107,211	3709	3781	0	0	0	0
DR	65	Seamount group SE of Christmas Is.	few rocks	lava fragments and volcaniclastic rocks	12,610	107,239	12,613	107,246	3952	3626	1	0	0	1
DR	66	Seamount group SE of Christmas Is.	full	pillow and sheet lava, volcaniclastic rocks, Mn-crusts	12,230	107,826	12,236	107,835	3907	3381	1	1	0	1
DR	67	Seamounts on W-margin of Argo B.	few rocks	lava fragments and volcaniclastic rocks	15,009	114,063	15,007	114,066	3733	3629	1	0	0	1
DR	68	Seamounts on W-margin of Argo B.	few rocks	lava fragments and volcaniclastic rocks	14,909	114,030	14,905	114,038	3826	3355	1	0	0	1
DR	69	Seamounts on W-margin of Argo B.	few rocks	lava fragments	15,074	114,085	15,077	114,095	4020	3541	1	0	0	0
MUC	70	Argo basin, abyssal plain	6 tubes	soft sediment	15,514	115,418	15,526	115,414	5689	5707	0	0	0	0
DR	71	Seamounts on W-margin of Argo B.	1/6 full	lavas, Mn crusts, sedimentary rocks	12,342	113,741	12,350	113,746	4908	4321	1	1	1	0
DR	72	Seamounts on W-margin of Argo B.	1/2 full	lava fragments and volcaniclastic rocks	12,347	113,779	12,352	113,785	4398	3914	1	1	1	1
DR	73	Southeastern Christmas Is. Prov. Smts.	few rocks	lava fragments, volcaniclastic rocks and carbonate	14,230	108,496	14,225	108,504	4331	3983	1	0	1	1
TVG	74	Southeastern Christmas Is. Prov. Smts.	empty	failed due to technical problems							0	0	0	0
DR	75	Southeastern Christmas Is. Prov. Smts.	few rocks	lava fragments	13,388	108,003	13,384	108,010	3639	3260	1	0	0	0
DR	76	Southeastern Christmas Is. Prov. Smts.	empty		13,467	107,036	13,469	107,030	3564	3807	0	0	0	0

Appendix I (Sampling Summary)

Type	Stat.	Location	total volume	Rock summary	on bottom		off bottom		depth (m)		**Mag**	**Mn**	**Sed**	**Volcani-**
					lat °S	long °E	lat °S	long °E	max	min	rock		rock	clastic
DR	77	Southeastern Christmas Is. Prov. Smts.	3/4 full	lava fragments and volcaniclastic rocks	14,100	106,375	14,098	106,383	4257	3730	1	0	0	1
DR	78	Southeastern Christmas Is. Prov. Smts.	1/3 full	lava fragments, volcaniclastic rocks and carbonate	14,533	106,091	14,535	106,991	5088	4592	1	0	1	1
DR	79	Southeastern Christmas Is. Prov. Smts.	1/4 full	lava fragments and volcaniclastic rocks	14,249	106,090	14,250	106,091	3787	3820	1	0	0	1
DR	80	Southeastern Christmas Is. Prov. Smts.	few rocks	lava fragments and sedimentary rocks	13,274	105,225	13,279	105,232	3220	2707	1	0	1	0
DR	81	Southeastern Christmas Is. Prov. Smts.	few rocks	lava fragments, volcaniclastic rocks and carbonate	13,360	105,168	13,360	105,177	4400	3970	1	0	1	1
DR	82	Southeastern Christmas Is. Prov. Smts.	few rocks	pillow fragments	13,607	105,187	13,607	105,190	3861	3728	1	0	0	0
TVG	83	Southeastern Christmas Is. Prov. Smts.	empty	failed due to technical problems							0	0	0	0
DR	84	Southeastern Christmas Is. Prov. Smts.	few rocks	lava fragments	13,036	103,875	13,032	103,882	3542	3239	1	0	0	0
MUC	85	Southeastern Christmas Is. Prov. Smts.	empty		13,960	102,333	13,960	102,333	5032	5032	0	0	0	0
TVG	86	Southeastern Christmas Is. Prov. Smts.	empty	failed due to technical problems							0	0	0	0
DR	87	Southeastern Christmas Is. Prov. Smts.	1/3 full	lava fragments and volcaniclastic rocks	14,120	102,172	14,126	102,178	3377	2960	1	0	0	1
DR	88	Central Ghristmas Island Seamount Prov.	few rocks	lava fragments, volcaniclastic rocks and sed. rocks	11,917	101,645	11,919	101,655	3626	3141	1	0	1	1
DR	89	Central Ghristmas Island Seamount Prov.	1/6 full	lava fragments, volcanoclastic rocks, Mn crusts	11,933	101,616	11,934	101,626	4290	3847	1	1	0	1
DR	90	Central Ghristmas Island Seamount Prov.	1/6 full	lava fragments, sedimentary rocks, Mn crusts	12,161	101,407	12,155	101,418	4722	4255	1	1	1	0
MUC	91	Central Ghristmas Island Seamount Prov.	3 tubes	soft sediment	12,099	101,502	12,099	101,502	4917	4917	0	0	0	0
									Total:		63	13	27	41

Dredge Stations (DR): 70
TV-grab Stations (TVG): 13 (incl. several tests)
Multicorer Stations (MUC): 9
Magnetometer profiles: 15 (total 2787 nm)
EM120 and PARASOUND surveys: 5694 nm

SO199 - DR1
Seamount W of Investigator Ridge at its N termination; +/- circular morphology; track along steepest part of W-facing slope
Dredge on bottom UTC 05/08/08 00:05hrs, lat 6°13,59'S, long 97°22,35'E, depth 4036m
Dredge off bottom UTC 05/08/08 01:32hrs, lat 6°13,75'S, long 97°22,79'E, depth 3546m
total volume: full
Comments: sheet and pillow lavas

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR1-1	1. Rock Type: Fragment of sheet lava flow 2. Size: 14 x 16 x 12cm 3. Shape/Angularity: angular 4. Encrustations: no encrustation 5. Vesicularity: < 1% 6. Vesicle Filling: vesicles empty 7. Matrix Color: greyish 8. Primary Minerals: Plag microlites, slightly alterated, ca. 20%, sub mm 9. Secondary Minerals: none 10. Overall Degree of Alteration: slightly alterated 11. Comment: in situ lava flow (pillow lava and sheet lava)	x	x	x							
DR1-2	1. Rock Type: Fragment of sheet lava flow, similar to DR1-1 2. Size: 11x9x8cm 3. Shape/Angularity: angular 4. Encrustations: no encrustations 5. Vesicularity: <1% 6. Vesicle Filling: vesicles empty 7. Matrix Color: greyish matrix 8. Primary Minerals: Plag microlites, ca. 20%, fresh to slightly alterated 9. Secondary Minerals: none 10. Overall Degree of Alteration: ca. 2cm outer alteration 11. Comment: in situ pillow lava	x	x	x							
DR1-3	1. Rock Type: Fragment of sheet lava flow, same as DR1-2 2. Size: 11x8x1cm	x	x	x							
DR1-4	1. Rock Type: Fragment of sheet flow, similar to DR1-2 2. Size: 12x12x8cm 4. Encrustations:minor Mn and Fe coating <0.2mm 6. Vesicle Filling: partly filled with calcit or lined with Zeoliths	x	x	x							
DR1-5	1. Rock Type: Fragment of sheet flow, similar to DR1-2 2. Size: 20x17x10cm 10. Overall Degree of Alteration: matrix appears more alterated	x	x	x							
DR1-6	1. Rock Type: Fragment of sheet flow, similar to DR1-2 2. Size: 10x10x7cm	x	x	x							
DR1-7	1. Rock Type: Fragment of sheet flow, similar to DR1-2 2. Size: 10x12x7cm 11. Comment: thin glass rim attached on two pieces	x	x	x		x					
DR1-8C	1. Rock Type: Volcaniclastic rock 2. Size: 13x7x8cm 3. Shape/Angularity: subrounded 4. Encrustations:no encrustation 5. Vesicularity: clasts non-vesicular, angular blocky, platy, irregular, sub mm-22mm 8. Primary Minerals: heterolithic: aphryc basalt, Palagonite, manganese and ? silicate zementation 9. Secondary Minerals: 10. Overall Degree of Alteration: generally highly alterated 11. Comment: faint bedding/aligument of clasts, debris flow							x			
DR1-9	1. Rock Type: tephra (?) clast 2. Size: 6x4x3cm 3. Shape/Angularity: rounded 4. Encrustations:Mn-coating <0.2mm 5. Vesicularity: no vesicles 8. Primary Minerals: lots of dendritic Mn 11. Comment: unclear origin, most likely not insitu	x									
DR1-10	1. Rock Type: similar to DR1-2, but from largest preserved pillow diameter 5m 2. Size: 10x10x7cm 4. Encrustations: abundand fresh glass margins up to 1.5cm 9. Secondary Minerals: Palagonit is also present 11. Comment: GC comes from pillow interior		x			x*					*Fx small packages + 2 larger slab
DR1-11	1. Rock Type: 5 cut area of pillow rim 11. Comment: 5 cut area of pillow rim, 1-2cm thick rims					x					
DR1-12	1. Rock Type: 4 cut pillow rims 11. Comment: 4 cut pillow rims up to 2cm thick + 5 small pieces in extra bag					x					
DR1-13	1. Rock Type: small pillow 11. Comment: small pillow, diameter 10cm with 1cm glass rim, cut into two pieces					x					
DR1-14	1. Rock Type: pillow rims 11. Comment: 4 cut pillow rims, up to 1cm thick glass					x					

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR1-15	1. Rock Type: single piece of lava 11. Comment: single piece of lava with 5-9 cm glass rim on both sides					x					
DR1-16	1. Rock Type: 11. Comment: two cut off pillow rims up to 2cm					x					
DR1-17	1. Rock Type: 2. Size:5x11x3cm 11. Comment: 2x cut of pillow rims, up to 1cm glass rim					x					
DR1-18	1. Rock Type: pillow rim fragment 2. Size: 3x3x2cm 11. Comment: glass					x					
DR1-19	1. Rock Type: pillow rim fragment 2. Size: 3x2x2cm 11. Comment: 0.5cm glass					x					
DR1-20	1. Rock Type: pillow rim fragment 2. Size: 4x3x2cm 11. Comment: 0.5cm glass					x					
DR1-21	1. Rock Type: glass 2. Size: two times: 25x10x4cm pillow rim, two times: 30x15x20cm pillow inside fresh 11. Comment: 0.5cm glass					x					
DR1-22	1. Rock Type: pillow rim 2. Size: 7x3x3cm 11. Comment: < 0.5cm glass rim					x					
DR1-23	1. Rock Type: glass 11. Comment: various cut off glass margins with <0.5cm glass rims					x					
DR1-24	1. Rock Type: glass 11. Comment: various cut off glass margins with <0.5cm glass rims					x					
DR1-25	1. Rock Type: glass 11. Comment: various cut off glass margins with <0.5cm glass rims					x					
DR1-26	1. Rock Type: glass 11. Comment: various cut off glass margins with <0.5cm glass rims					x					
DR1-27	1. Rock Type: Glass 11. Comment: various cut off glass margins with <0.5cm glass rims					x					
DR1-28	1. Rock Type: glass 11. Comment: various cut off glass margins with <0.5cm glass rims					x					
DR1-29	1. Rock Type: glass 11. Comment: various cut off glass margins with <0.5cm glass rims					x					
DR1-30	1. Rock Type: glass 11. Comment: various cut off glass margins with <0.5cm glass rims					x					
DR1-31	1. Rock Type: glass 11. Comment: various cut off glass margins with <0.5cm glass rims					x					
DR1-32	1. Rock Type: glass 11. Comment: various cut off glass margins with <0.5cm glass rims					x					
DR1-33X	1. Rock Type: 5 pillow fragments with glass rims					x	x				

SO199 - DR2
Investigator Ridge, Northern End, west facing slope of N-S trending ridge
Dredge on bottom UTC 07/07/08 16:07hrs, lat 7°0,76'S, long 98°06,40'E, depth 4602m
Dredge off bottom UTC 07/07/08 17:17hrs, lat 7°0,80'S, long 98°06,40'E, depth 4135m
total volume: 2/3 full
Comments: sheet and pillow lava

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR2-1	1. Rock Type: gabbroic rock? 2. Size: 19x15x7cm 3. Shape/Angularity: angular 4. Encrustations: Mn and Fe coating <0.2mm 5. Vesicularity: non-vesicular 7. Matrix Color: fine-crystalline matrix, yellow-grey patchy 8. Primary Minerals: Fsp needles up to 1mm, fresh to altered; microphenocrysts Ol, altered reddish, often as clusters, 10-20%; minor Px sub-mm sized, variably 1-5% 9. Secondary Minerals: Mn-Fe-hydroxides outlining crystal rims 10. Overall Degree of Alteration: fresh inner grey core, outer alteration halo reddish, 2-3cm thick	x	x	?							
DR2-2	1. Rock Type: similar to DR2-1 2. Size: 16x11x11cm	x	x	?							
DR2-3	1. Rock Type: similar to DR2-1 2. Size: 21x16x12cm	x	x	?							

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR2-4	1. Rock Type: Porphyric basalt 2. Size: 15x12x9cm 3. Shape/Angularity: angular 4. Encrustations: Mn and Fe coating <0.2mm 5. Vesicularity: non-vesicular 7. Matrix Color: grey 8. Primary Minerals: Ol up to 1mm, mostly altered, 10%; Fsp needles, fresh to altered; Px 9. Secondary Minerals: Mn-Fe-hydroxides infilling micro-cracks 10. Overall Degree of Alteration: reddish alteration halo 2-4cm thick, inner core fresh grey 11. Comment: potential for fresh Fsp for dating	x	x	x?							
DR2-5	1. Rock Type: similar to DR2-4 2. Size: 24x12x9cm 8. Primary Minerals: Ol up to 3mm with fresh clear green core; minor Px sub-mm sized	x	x	x?							
DR2-6	1. Rock Type: similar to DR2-4 2. Size: 16x13x9cm 10. Overall Degree of Alteration: alteration halo 5cm, grey inner core only 1cm	x	x	x?							
DR2-7	1. Rock Type: Basalt with microphenocrysts 2. Size: 16x13x7cm 3. Shape/Angularity: angular 4. Encrustations: Mn and Fe coating <0.2mm 5. Vesicularity: non-vesicular 7. Matrix Color: grey 8. Primary Minerals: Ol up to 5mm, fresh and altered, 5%; Fsp needles appear altered; minor Px 1% 9. Secondary Minerals: Mn-Fe-hydroxides infilling micro-cracks 10. Overall Degree of Alteration: altered										
DR2-8	1. Rock Type: similar to DR2-7 2. Size: 13x13x13cm 8. Primary Minerals: Px 1%										
DR2-9	1. Rock Type: similar to DR2-7 2. Size: 12x8x8 8. Primary Minerals: less Ol, <5% 10. Overall Degree of Alteration: appears little altered 11. Comment: best sample for dating of the group DR2-7 to DR2-11	x	x	x?							
DR2-10	1. Rock Type: similar to DR2-7 2. Size: 11x11x6cm 8. Primary Minerals: Ol about 5%, minor Px	x	x	x?							
DR2-11	1. Rock Type: similar to DR2-7 2. Size: 21x11x8cm 8. Primary Minerals: Ol about 5%, up to 3mm										
DR2-12	1. Rock Type: basaltic rock with few phenocrysts 2. Size: 13x12x10cm 3. Shape/Angularity: angular 4. Encrustations: Mn and Fe coating <0.2mm 5. Vesicularity: non-vesicular 7. Matrix Color: beige-grey 8. Primary Minerals: Fsp needles probably fresh; Ol up to 2mm partly fresh, 5-10%; minor Px and/or Fe-Ti-Oxides 10. Overall Degree of Alteration: faint alteration halo of 1cm thickness	x	x								
DR2-13	1. Rock Type: similar to DR2-9 2. Size: 13x11x9cm 11. Comment: low priority										
DR2-14	1. Rock Type: similar to DR2-4 to DR2-6 2. Size: 35x20x20cm 3. Shape/Angularity: angular 4. Encrustations: Mn and Fe coating <0.2mm 5. Vesicularity: non-vesicular 8. Primary Minerals: abundant Ol up to 1mm; Fsp microlites coarser than in previous samples 10. Overall Degree of Alteration: reddish alteration halo of 1cm thickness, inner core fresh grey rock 11. Comment: potentially suitable for dating	x	x	x?							

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR2-15	1. Rock Type: Pillow fragments with glassy rim 2. Size: 20x15x14cm 3. Shape/Angularity: angular 4. Encrustations: Mn and Fe coating <0.2mm 5. Vesicularity: non-vesicular 7. Matrix Color: beige to grey 8. Primary Minerals: Ol >1mm 10%; Px up to 4mm 10%; minor Fsp needles 10. Overall Degree of Alteration: appears fairly fresh 11. Comment: glass rim about 10mm, grey transition zone, interior cryptocrystalline; DR2-15 to DR2-17 very similar, DR2-16 freshest sample										
DR2-16	1. Rock Type: similar to DR2-15 2. Size: 16x11x10cm 7. Matrix Color: grey 8. Primary Minerals: minor Px <1mm 11. Comment: TS1:glass rim, TS2: pillow interior	x	x	x							
DR2-17	1. Rock Type: similar to DR2-15 2. Size: 10x9x8cm	x	x	x							
SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR2-18	1. Rock Type: glassy crust of a pillow 2. Size: 11x5x3cm 3. Shape/Angularity: angular 4. Encrustations: Mn and Fe coating <0.2mm 5. Vesicularity: non-vesicular 7. Matrix Color: black 8. Primary Minerals: aphyric 9. Secondary Minerals: altered mineral of green colour - epidot? 10. Overall Degree of Alteration: fresh										
DR2-19C	1. Rock Type: volcaniclastic rock 2. Size: 12x8x6cm 3. Shape/Angularity: irregular shaped, angular 4. Encrustations: Mn and Fe coating <0.2mm 11. Comment: Clasts non-vesicular, 1-4mm sized glassy, partly altered and two fragments of pillow (type DR2-15) with a glassy rim spalling off, deposit non-bedded, very poorly sorted; probably hyaloclastitic pillow fragment breccia	x						x			

SO199 - DR3
Investigator ridge Northern End, west facing slope
Dredge on bottom UTC 07/08/08 00:38hrs, lat 7°20,71'S, long 98°05,23'E, depth 4798m
Dredge off bottom UTC 07/08/08 02:00hrs, lat 7°20,79'S, long 98°05,75'E, depth 4125m
total volume: --
Comments: dredge lost due to brockenor loose bolt

SO199 - DR5
Investigator ridge Northern End, west facing slope of N-S trending ridge
Dredge on bottom UTC 07/08/08 12:58hrs, lat 8°9,41'S, long 98°3,58'E, depth 4357m
Dredge off bottom UTC 07/08/08 14:35hrs, lat 8°9,40'S, long 98°4,20'E, depth 3805m
total volume: few rocks
Comments: pillow lava fragments, very few small volcaniclastics

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR5-1	1. Rock Type: lava fragment 2. Size: 20x20x15cm 3. Shape/Angularity: angular 4. Encrustations: Mn crust coating 1mm 5. Vesicularity: 3-4% filled vesicles on one side of sample 6. Vesicle Filling: CC? 7. Matrix Color: dark grey 8. Primary Minerals: >1% slightly altered Ol? 9. Secondary Minerals: Mn filing along cracks 10. Overall Degree of Alteration: fairly fresh, appears to be freshest rock in dredge 11. Comment: vesicle free zone appears best for dating	x	x	x							

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR5-2	1. Rock Type: lava fragment, aphyric 2. Size: 16x8x6cm 3. Shape/Angularity: angular to subangular 4. Encrustations: minor surface coating with Mn and <<0.5mm weathering 5. Vesicularity: non-vesicular 7. Matrix Color: dark grey to black 8. Primary Minerals: fresh groundmass consisting of Px and Fsp 9. Secondary Minerals: CC along cracks 10. Overall Degree of Alteration: medium to slightly altered 11. Comment: fresh groundmass good for Ar but too small for geochemistry slab	x		x							
DR5-3	1. Rock Type: porphyric lava fragment 2. Size: 11x10x4cm 3. Shape/Angularity: subrounded 4. Encrustations: none 5. Vesicularity: <1% open vesicles 0.1-0.3mm 6. Vesicle Filling: unfilled 7. Matrix Color: brownish red 8. Primary Minerals: ca 7% Fsp phenocrysts, 2-4mm appear fresh 9. Secondary Minerals: CC or Zeolites 10. Overall Degree of Alteration: medium altered but has fresh Fsp and open vesicles 11. Comment: most porphyric rock in dredge with most evolved composition?	x	*	x							*too small
DR5-4	1. Rock Type: similar to DR5-3 2. Size: 10x5x5cm	x	*	x							*too small
DR5-5	1. Rock Type: small aphyric lava fragment 2. Size: 7x7x3cm 3. Shape/Angularity: subangular 4. Encrustations: no coating but very minor weathering 5. Vesicularity: <1% <<0.2mm 6. Vesicle Filling: unfilled 7. Matrix Color: dark grey 8. Primary Minerals: <1% altered Ol 9. Secondary Minerals: Fe-Oxyhydroxides along crack in one section of sample 10. Overall Degree of Alteration: medium 11. Comment: groundmass is fairly fresh	x	*	x							*too small
DR5-6	1. Rock Type: similar to DR5-5 2. Size: 12x7x3cm	x	*	x							*too small
DR5-7	1. Rock Type: lava fragment, possibly pillow interior 2. Size: 14x13x10cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn coating 5. Vesicularity: << 1% vesicles 6. Vesicle Filling: CC 7. Matrix Color: redish-brown matrix with a few grey areas 8. Primary Minerals: 2% Px and 1% Fsp (diam. 1-2mm) 9. Secondary Minerals: oxidized matrix 10. Overall Degree of Alteration: medium to slightly altered 11. Comment: majority of rocks from this dredge are similar to this sample	x	x								
DR5-8	1. Rock Type: similar to DR5-7, but altered 2. Size: 9x8x4cm	x	*								*too small
DR5-9	1. Rock Type: lava fragment, aphyric 2. Size: 8x8x4cm 3. Shape/Angularity: subangular 4. Encrustations: none 5. Vesicularity: <5% vesicles, diam. <<< 1mm, a few vesicles are several mm and filled with CC 6. Vesicle Filling: mostly open visicles when small 7. Matrix Color: yellow brown 8. Primary Minerals: Fe-Oxyhydroxide in matrix groundmass 10. Overall Degree of Alteration: strongly altered	x	*								*too small
DR5-10	1. Rock Type: chilled margin 2. Size: 5x5x3cm 3. Shape/Angularity: subangular 4. Encrustations: 1 cm thick glass zone, glass is completely altered	x									
DR5-11	1. Rock Type: glass fragments, breccia 10. Overall Degree of Alteration: completely altered										

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR5-12C	1. Rock Type: heterolithic lapilli tuff 2. Size: 9x7x7 cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn coating 5. Vesicularity: some clasts non vesicular, some clasts up to 1% vesicles 6. Vesicle Filling: empty or filled with CC 7. Matrix Color: reddish grey 8. Primary Minerals: clasts appear to be derived from other lithologies of the dredge incl. glas fragments 9. Secondary Minerals: minor Mn-OH overgrowth on cement 10. Overall Degree of Alteration: reddish altered, no fresh remains 11. Comment: subrounded, sub-mm to 15mm clasts, light red&white cement possibly Zeolites, bedded deposit	x						x			
DR5-13C	1. Rock Type: heterolithic lapilli tuff, similar to DR5-12VC 2. Size: 19x10x10 cm 3. Shape/Angularity: irregular-subangular 4. Encrustations: very minor Mn crust 7. Matrix Color: yellowish Palagonite alteration 10. Overall Degree of Alteration: completely altered 11. Comment: more altered/differently alterated, clasts sizes sub-mm to 30mm, no bedding or grading							x			
DR5-14X	1. Rock Type: three separated pieces similar to DR5-2 but more altered 2. Size: 10x5x4cm						x				
DR5-15X	1. Rock Type: six separate pieces of lithology similar to sample DR5-7 2. Size: 20-30cm						x				
DR5-16X	1. Rock Type: five pillow margins similar to DR5-11 (rim inkl whole rock) have been archived. Very strongly altered to yellow-orange						x				

SO199 - DR6
Investigator Ridge ca 60 nm S of DR5, West-facing slop below circular shaped volcanic structure
Dredge on bottom UTC 08/08/08 22:53hrs, lat 9°02,44'S, long 98°4,45'E, depth 4135m
Dredge off bottom UTC 09/08/08 01:30hrs, lat 9°2,42'S, long 98°4,98'E, depth 3704m
total volume: several rocks
Comments: intrusiva and volcanic rocks, probably slope debris

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR6-1	1. Rock Type: fine crystalline rocks 2. Size:9x7x6cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn crust 5. Vesicularity: non vesicular 7. Matrix Color: grey with mottled beige patches 8. Primary Minerals: very few Fsp microlites, possibly altered Ol 9. Secondary Minerals: majority of rock altered 10. Overall Degree of Alteration: strongly altered 11. Comment: mm sized dark aphyric grey dikes "intruding" with diffuse contacts, may represent sheeted-dike complex of the oceanic crust	x	x								
DR6-2	1. Rock Type: similar to DR6-1 2. Size: 6x6x5cm 3. Shape/Angularity: subangular 11. Comment: no dike intrusions, abundant Fsp needles up to 1mm, fresh	x	x								
DR6-3	1. Rock Type: similar to DR6-1 2. Size: 6x6x5cm 3. Shape/Angularity: roundish 7. Matrix Color: dark grey with white patches 8. Primary Minerals: Fsp very minor, altered	x	x								
DR6-4	1. Rock Type: aphanitic rock 2. Size: 10x8x8cm 3. Shape/Angularity: subrounded 4. Encrustations: minor Mn crust 5. Vesicularity: non vesicular 7. Matrix Color: grey-beige 9. Secondary Minerals: 1mm thick black veins irregularily cross cut rock 10. Overall Degree of Alteration: strongly altered 11. Comment: secondary texture: ca. 1cm cryptocrystalline part with diffuse intrusive contact, contains Fsp, poss. basaltic dike, sample possibly suitable for GC, TS of both textures along contact	x	x								
DR6-5X	1. Rock Type: similar to DR6-1						x				

Appendix II (Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR6-6	1. Rock Type: Microcrystalline subvolcanic rock 2. Size: 12x8x7cm 3. Shape/Angularity: round 4. Encrustations: minor Mn crust 5. Vesicularity: non vesicular 7. Matrix Color: grey 8. Primary Minerals: white-light grey possibly Fsp 10. Overall Degree of Alteration: appears altered 11. Comment: 1/4 of of surface with 1cm thick red mud coating, containing 1-5mm heterolithic clasts	x	x								
DR6-7	1. Rock Type: crystalline intrusive rock 2. Size: 11x8x6cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 7. Matrix Color: hotocrystalline 8. Primary Minerals: 2 types of Fsp, grey & elongate white laths up to 20mm, minor mm-sized black minerals 10. Overall Degree of Alteration: reasonably fresh 11. Comment: Plagiogranitic intrusion	x	x*								x* careful picking
DR6-8	1. Rock Type: similar to DR6-7 2. Size: 40x30x30cm, only fresher core parts kept 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 8. Primary Minerals: mmc to 2cm sized grey Fsp, white Fsp, minor dark minerals 10. Overall Degree of Alteration: variable fresh and altered, needs careful picking	x	x*								*fresh grey suitable
DR6-9	1. Rock Type: white-grey rock, similar to DR6-7 with a swirly texture 2. Size: 12x11x4cm 3. Shape/Angularity: angular 4. Encrustations: no crust 8. Primary Minerals: grey angular mineral of Fsp, white swirly domains inbetween (deformed Fsp?) 10. Overall Degree of Alteration: mostly alterated 11. Comment: tentatively interpreted as a coarse grained holocrystalline plutonic rock that is tectonically deformed										
DR6-10	1. Rock Type: clastic rock of intrusive and volcanic clasts 2. Size: 16x12x10cm 3. Shape/Angularity: subrounded 4. Encrustations: one side 10mm Mn-crust, rest thin coating 11. Comment: large intrusive clast: 12x10x9cm, brown-matrix altered, phenocrysts 0.5-1mm clear white (Fsp?); small volcanic and subvolcanic clasts angular-subangular, sub mm to 15mm, some vesicular basalt	x*1	x*2					x			x*1: big & small clast; x*2: big clast only
DR6-11	1. Rock Type: foliated crystalline rock 2. Size: 15x12x8cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 7. Matrix Color: dark green-grey groundmass, very fine grained, subparallel veining 8. Primary Minerals: 3-5mm reddish altered, fractured min (possibly Ol) 10. Overall Degree of Alteration: serpentinitization 11. Comment: coarse- crystalline mafic intrusive tectonically strongly sheared										
DR6-12	1. Rock Type: serpentinized rock 2. Size: 11x9x8cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 7. Matrix Color: serpentinized fine black-green matrix 8. Primary Minerals: 5-8mm crystals (Px?) 10. Overall Degree of Alteration: strong serpentinization 11. Comment: plutonic rock of the oceanic crust										
DR6-13	1. Rock Type: similar to DR6-12 2. Size: 9x8x7cm 11. Comment: aphantic light to dark grey green marbled, strongly serpentinized rock										
DR6-14	1. Rock Type: similar to DR6-13 2. Size: 13x9x4cm 11. Comment: strongly foliated, light green wavy bands with white 5mm sized Fsp "eyes", serpentinized										

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR6-15	1. Rock Type: similar to DR6-13 2. Size: 11x8x5cm 11. Comment: alphanitc green, foliated-wavy domains and cluster of 5mm sized Px(?), highly serpentinized										
DR6-16	1. Rock Type: similar to DR6-12, serpentinized intrusive rock 2. Size: 8x7x6cm 7. Matrix Color: core has grey matrix 8. Primary Minerals: 1-5mm crystals (Px?) 10. Overall Degree of Alteration: 2cm alteration halo of strongly serpentinized material										
DR6-17C	1. Rock Type: monolithic volcaniclastic rock 2. Size: 9x7x2cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 7. Matrix Color: dark grey matrix, no bedding, clasts anglar-blocky, <1-10mm 8. Primary Minerals: clasts of lithologie DR6-8 11. Comment: short transport, rock fall into mud							x			
DR6-18C	1. Rock Type: monolithic volcaniclastic rock 2. Size: 10x8x5cm 3. Shape/Angularity: irregular angular 4. Encrustations: minor Mn crust 7. Matrix Color: reddish, radiolarian ooze, no bedding closely packed 8. Primary Minerals: microcrystalline angular clasts of sub mm to 10mm size 11. Comment: see above DR6-17C							x			
DR6-19C	1. Rock Type: volcaniclastic 2. Size: 11x7x6cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn crust 7. Matrix Color: grey, grainy 8. Primary Minerals: similar to DR6-8 11. Comment: appears as a homogeneous rock instead of volcaniclastic rock							x			
DR6-20C	1. Rock Type: heterolithic volcaniclastic rock 2. Size: 9x7x5cm 3. Shape/Angularity: irregular 4. Encrustations: minor Mn crust 7. Matrix Color: grey, grainy 8. Primary Minerals: clast sub mm to 40mm subangular, moderately closely packed 11. Comment: clasts: vesicular basaltic, intrusive (DR6-8) individual crystals of Fsp no bedding or sorting	x						x			
DR6-21C	1. Rock Type: heterolithic volcaniclastic rock 2. Size: 8x6x5cm 3. Shape/Angularity: subrounded 4. Encrustations: minor Mn crust 7. Matrix Color: beige inhomogeneous muddy and possibly Zeolite cement (white) 8. Primary Minerals: clasts sub-mm-15mm subangular to subround, blocky, all lithologies of DR6 and poss. basaltic, faint clast alignment and bedding and grading 11. Comment: debris flow possibly	x*						x			
DR6-22C	1. Rock Type: similar to DR6-10 2. Size: 6x5x2cm 3. Shape/Angularity: irregular 4. Encrustations: upper half 15mm Mn crust, otherwise none 8. Primary Minerals: clasts up to 30mm 11. Comment: too small for further interpretation										
DR6-23C	1. Rock Type: similar to DR6-21C 2. Size: 9x8x6cm 7. Matrix Color: matrix inhomogeneous, light very fine (or cement) and medium grey-beige grainy 8. Primary Minerals: clasts up to 55mm	x						x			
DR6-24X to -35X	1. Rock Type: Arcive samples representing the lithological range of the dredge						x				

SO199 - DR8
Investigator Ridge, steepest W-facing slope of ridge in this area
Dredge on bottom UTC 15:18 hrs, lat 9°57,19'S long 98°04,03'E 4925m depth
Dredge off bottom UTC 16:51hrs, lat 9°57,28'S long 98°04,55´E 4290m depth
total volume: full
Comments: Pillows and pillow fragments, very minor glass crusts, few pillow breccias

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR8-1	1. Rock Type: lava fragment, freshest piece of dredge 2. Size: 22x17x14cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn and FeOH coating <<0.1mm 5. Vesicularity: non-vesicular 7. Matrix Color: dark grey 8. Primary Minerals: aphyric groundmass consists of Px-Fsp and possibly fresh Ol 9. Secondary Minerals: CC along 0.2mm wide veins 10. Overall Degree of Alteration: fresh 11. Comment: only aphyric rock of the dredge, choosen as first sample due to its freshness	x	x	x							
DR8-2	1. Rock Type: similar to DR8-1 2. Size: 13x15x10cm 8. Primary Minerals: <1% Px phenocrysts 9. Secondary Minerals: abundant CC filling of veins and cracks up to 1cm 10. Overall Degree of Alteration: slightly altered 11. Comment: sample chosen due to it's large original size - two additional pieces of same block are saved in the archive	x	x	x			x				2 pcs: 20cm
DR8-3	1. Rock Type: Px-phyric lava fragment, possibly pillow 2. Size: 15x16x10cm 3. Shape/Angularity: angular 4. Encrustations: Mn coating and weathered surface 5. Vesicularity: <5% <5mm 6. Vesicle Filling: white secondary mineral, CC? 7. Matrix Color: dark grey to slightly greenish, groundmass is fresh 8. Primary Minerals: 2-3% Px microphenocryts, appears fresh 9. Secondary Minerals: see 6 10. Overall Degree of Alteration: medium 11. Comment: only Px-phyric rock of the dredge	x	x	x			x				2 pcs: 20-25cm
DR8-4	1. Rock Type: pillow with abundant fresh Ol phenocrysts 2. Size: 19x14x12cm 3. Shape/Angularity: angular 4. Encrustations: complete Mn coating however very thin <0.1mm 5. Vesicularity: dense 6. Vesicle Filling: none 7. Matrix Color: dark greenish-grey 8. Primary Minerals: 3-4% Ol microphenocrysts, 0.5-1mm 9. Secondary Minerals: CC filling of cracks, 1% Fsp phenocryst, 0.1mm 10. Overall Degree of Alteration: slightly altered 11. Comment: appears to also contain lithic fragments up to 1-2cm. This rock also contains the best preserved Ol of the dredge	x	x	x							
DR8-5	1. Rock Type: similar to DR8-4 but more coarsley grained, not clear whether it is a pillow 2. Size: 17x12x12cm 3. Shape/Angularity: subangular original bloc 7. Matrix Color: dark grey to reddish where Ol is altered 8. Primary Minerals: 5-7% Ol microphenocryts 0.5mm no Fsp visible 9. Secondary Minerals: Ol is more altered in this sample 10. Overall Degree of Alteration: medium 11. Comment: sample choosen due to original size and preservation of Ol with three pieces saved for archive	x	x	x							
DR8-6	1. Rock Type: pillow lava, largest and freshest sample of the most abundant lithofacies of this dredge: Ol-basalt ±Fsp. Sample was extremely difficult to break with sledge hammer due to it's fresh matrix 2. Size: 17x12x12cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn coating 5. Vesicularity: <1% large 2-3mm 6. Vesicle Filling: filled or lined with Zeolites? 7. Matrix Color: light grey 8. Primary Minerals: 3-4% altered Ol, 0.5-1mm, <0.5% Fsp laths 9. Secondary Minerals: Ol altered to iddingsite and Fe-oxyhydroxite 10. Overall Degree of Alteration: slightly altered except for the Ol 11. Comment: most representative lithology of dredge, largesst and best preserved piece. Contains small 1cm lithic fragments	x	x	x							

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR8-7	1. Rock Type: pillow margin, Fsp-Ol phyric basalt 2. Size: 12x12x13cm 3. Shape/Angularity: subangular 4. Encrustations: thin Mn coating covering entire piece <<0.1mm 5. Vesicularity: dense for most part except large vugs elongated up to 2cm and 0.5cm wide. 6. Vesicle Filling: filled with yellowish secondary mineral 7. Matrix Color: dark grey appears fresh 8. Primary Minerals: 3-4% Plag microphenocrysts <1mm, 1-2% Ol, 0.5mm altered to Fe-oxyhydroxide 9. Secondary Minerals: see above 10. Overall Degree of Alteration: medium 11. Comment: only lithology that contains abundant Fsp microphenocryst for dating, more evolved than sample DR8-6	x	x	x							
DR8-8	1. Rock Type: similar to DR8-7 2. Size: 22x12x11cm 3. Shape/Angularity: 11. Comment: serves as backup sample for Fsp-separation	x	x								
DR8-9	1. Rock Type: similar to DR8-7 2. Size: 12x7x7cm 11. Comment: sample has been taken since it contains large 3cm lithic fragments for petrography	x									
DR8-10	1. Rock Type: similar to DR8-7 but with abundant lithic fragments up to 7cm elongated and deformed, were probably picked up by new flow when they were still hot and ductile 2. Size: 18x13x9cm	x	x								
DR8-11	1. Rock Type: similar to DR8-7 2. Size: 14x14x10cm 11. Comment: the ony pillow that had a glassy margin with possibly fresh	x	x				x 2pc				
DR8-12	1. Rock Type: similar to DR8-7 2. Size: 19x11x12cm 10. Overall Degree of Alteration: medium to strongly altered 11. Comment: has been saved fin order to have sufficient Plag phyric basalts from this location	x	x								
DR8-13	1. Rock Type: similar to DR8-1 but with c. 1% vesicles filled with CC 2. Size: 14x13x10cm	x	x								
DR8-14	1. Rock Type: small pillow with cm sized attached fragments 2. Size: 10x9x6cm 7. Matrix Color: greyish 10. Overall Degree of Alteration: core relatively fresh 11. Comment: <1cm sized rim with possibly fresh glass					?					
DR8-15C	1. Rock Type: bedded volcaniclastic 2. Size: 20x20x11cm 3. Shape/Angularity: subangular 4. Encrustations: no crust 7. Matrix Color: light beige, grainly and clear CC cement 11. Comment: clasts sub mm -20mm blocky angular to slightly abraded edges, monolithic Ol and Fsp phyric basalt with <1% vesicularity - geopedal structures. Clasts party alighned, bedding diffuse and slightly curved, sorting moderate, alteration pervasive. Successions of locally sourced sediment density currents							x			
DR8-16C	1. Rock Type: heterolithic volcaniclastic 2. Size: 14x9x7cm 3. Shape/Angularity: irregular 4. Encrustations: very minor Mn crust 7. Matrix Color: greyish-yellow fine probably pelagic ooze, 1mm sized to fossil detritus (bivalve fragments) 11. Comment: matrix supporeted coarse ashe to lapilli 150mm, subrounded, unbedded, no clast orientation. Clasts variable basaltic lithologies previsously described in this dredge and altered glass clasts							x			
DR8-17C	1. Rock Type: monolithic volcaniclastic 2. Size: 21x16x13cm 3. Shape/Angularity: irregular 4. Encrustations: minor Mn crust 11. Comment: angular blocky clasts to 30 mm very closely packed, interstitial matrix dark grey, no bedding or sorting. In situ brecciated lava, clasts cemented of fused thermally. Clasts monolithic Fsp-phyric with tiny vesicles							x			

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR8-18C	1. Rock Type: monolithic volcaniclastic 2. Size: 2320x8cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 7. Matrix Color: dark grey, appears very fine, microcrystaline 11. Comment: clasts vesicular, Fsp-phyric basalt, angular, blocky, no orientation of bedding, clast to matrix supported. Clasts re-incorporated into a lava flow or very strongly cemented clastic material	x						x			

SO199 - DR9
Investigator Ridge at 10°53S, S of E-ward kink on Smith & Sandwell map
Dredge on bottom UTC 09/08/08 01:30hrs, lat 10°53,20'S, long 98°04,72'E, depth 4700m
Dredge off bottom UTC 09/08/08 04:45hrs, lat 10°53,19'S, long 98°04,40'E, depth 4259m
total volume: few rocks
Comment:Dredge stuck at the beginning of the profile, lava fragments of very similar appearance

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR9-1	1. Rock Type: lava fragment 2. Size: 16x12x11cm 3. Shape/Angularity: irregular-angular 4. Encrustations: minor Mn crust <1mm 5. Vesicularity: sub-mm sized vesicles, 5% 6. Vesicle Filling: CC-filled and unfilled vesicles, variably distributed 7. Matrix Color: grey 8. Primary Minerals: Fsp needles, appear fresh; Ol in some areas fresh otherwise altered 10. Overall Degree of Alteration: mostly fresh 11. Comment: high potential for dating, fresh Ol for further studies	x	x	x							
DR9-2	1. Rock Type: lava fragment with two different textures 2. Size: 7x5x5cm 3. Shape/Angularity: round-subangular 4. Encrustations: minor Mn crust <1mm 5. Vesicularity: two areas: (a) larger non-vesicular part, (b) poorly vesicular coarser crystalline part, vesicularity 2% 6. Vesicle Filling: empty 7. Matrix Color: grey 8. Primary Minerals: Fsp needles appear fresh; Ol partly altered 10. Overall Degree of Alteration: fresh to slightly altered 11. Comment: TS includes both areas (a) and (b); two GC blocks, one of each (a) and (b); coarser part potential for dating; interpretation: two phases of magma or a chilled aphanitic rim with a better crystallized core; Note, after cutting, interior of (a) shows vesicles as well, both GC blocks thus very similar	x	x *	x?							x *: (a) and (b)
DR9-3	1. Rock Type: lava fragment 2. Size: 8x6x4cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust <0.1mm 5. Vesicularity: 2% 6. Vesicle Filling: occasionally filled with CC 7. Matrix Color: grey 8. Primary Minerals: Fsp needles up to 1mm; Ol altered 10. Overall Degree of Alteration: fresh to slightly altered 11. Comment: potential for dating	x	x	x?							
DR9-4	1. Rock Type: lava fragment 2. Size: 8x8x4cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust <0.1mm 5. Vesicularity: 5% 6. Vesicle Filling: outer part unfilled vesicles, inner core CC-filled vesicles 7. Matrix Color: grey 8. Primary Minerals: Fsp probably altered; Ol altered 10. Overall Degree of Alteration: slightly altered	x									
DR9-5	1. Rock Type: lava fragment 2. Size: 11x11x8cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn crust <0.1mm 5. Vesicularity: 5% 6. Vesicle Filling: CC 7. Matrix Color: greyish 8. Primary Minerals: Fsp needles altered; Ol mostly altered 10. Overall Degree of Alteration: slightly altered 11. Comment: possibly a few fresh Ol for further study	x									
DR9-6X	1. Rock Type: lava fragment with CC-filled vesicles, appear altered 2. Size: 8x6x6cm						x				

SO199 - DR10
Central Investigator Ridge , Northern End of tilted block W of the ridge
Dredge on bottom UTC 09/08/08 10:51hrs, lat 10°59,25'S, long 98°07,82'E, depth 4060m
Dredge off bottom UTC 09/08/08 12:12hrs, lat 10°59,22'S, long 98°08,30'E, depth 3515m
total volume: several rocks
Comments: lava fragments and coarse cristalline rocks

SAMPLE #	SAMPLE DESCRIPTION	TS	CH	Ar	Res	GL	AB	VH	SE	MN	NOTES
DR10-1	1. Rock Type: gabbro 2. Size: 19x11x9 3. Shape/Angularity: rounded clast 4. Encrustations: no encrsutation, minor yellow sediment attached on one side 5. Vesicularity: plutonic rock non vesicular 7. Matrix Color: appears mafic in cut section 8. Primary Minerals: Px 50% black +/- fresh 0.5-1cm, Opx 20% altered to red material Fe-Oxyhydroxide, when fresh dark green 0.5-1cm, Fsp 30% +/- fresh 0.5-1cm 9. Secondary Minerals: Opx altered to Fe-Oxyhydroxide 10. Overall Degree of Alteration: fairly fresh Px-Fsp gabbro 11. Comment: Deeper part of oceanic crust: Thermobarometry?, Fsp are ok for dating	x	x	x							
DR10-2	1. Rock Type: leuco gabbro with Px and Fsp 2. Size: 9x7x6cm 3. Shape/Angularity: rounded to subangular clast 4. Encrustations: no encrustations, 2-5mm thick weathering rind 5. Vesicularity: plutonic, non vesicular 7. Matrix Color: light grey colour on cut surface 8. Primary Minerals: 60% Px not clear whether Opx or Cpx, fresh 0.5-1cm intergrown with Fsp 40%, fresh up to 1cm 10. Overall Degree of Alteration: fresh leuco gabbro 11. Comment: again represents part of the plutonic section of the oceanic crust	x									
DR10-3	1. Rock Type: gabbro 2. Size: 7x6x4cm 3. Shape/Angularity: subangular 4. Encrustations: no encrustation, minor weathering rind 7. Matrix Color: dark overall appereance 8. Primary Minerals: Opx partly fresh, but mostly altered, crystals are not homogeneously distributed, Opx 40% in clusters 1-2cm; black spots 1-2mm floating in a greyish-blueish matrix could be melt penetrating the gabbro. This lithology makes up 60% of the rock 9. Secondary Minerals: Opx partly altered to Fe-Oxyhydroxide 10. Overall Degree of Alteration: This is a complicate rock with melt migrating through the Opx-mush. The black spots within this melt are of unclear orgin. melt droplets? Cpx?	x									
DR10-4	1. Rock Type: contact zone between gabbroic crystals mush and aphyric melt 2. Size: 9x7x7cm 3. Shape/Angularity: rounded 4. Encrustations: minor Mn spots and thin 1-2mm weathering rind 7. Matrix Color: light grey matrix of later melt 8. Primary Minerals: Opx 20-30% mostly altered to red-brown, 0.5-1cm 9. Secondary Minerals: Fe-Oxyhydroxide replacing Opx 10. Overall Degree of Alteration: medium altered 11. Comment: contact zone of melt and gabbro with melt penetrating through antire gabbro	x									
DR10-5	1. Rock Type: mafic plutonic cumulate with layering of chrystals, quite heavy 2. Size: 8x7x7cm 3. Shape/Angularity: angular 4. Encrustations: no encrustations 5. Vesicularity: does not apply 7. Matrix Color: black in cut section with bright layered minerals 8. Primary Minerals: 20-30% bright mineral, layered 0.5-2cm long and 0.5cm thick Px (?) or Fsp (?). This mineral is surrounded by black dense material that has no specific geometry 9. Secondary Minerals: bright minerals are partially altered to Fe-Oxyhydroxide 10. Overall Degree of Alteration: medium altered 11. Comment: The mineralogy of this rock is not clear and awaits thin section petrography. It most likely is a gabbroic cumulate from the plutonic or section of the oceanic crust	x									
DR10-6	1. Rock Type: similar to DR10-1 2. Size: 11x10x9cm 3. Shape/Angularity: rounded 11. Comment: has cataclastic rim attached on the sample exterior. cataclasts consist of grinded gabbroic material. This piece is evidence for the tectonics playing an important in bringing the rocks to the surface	x									

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR10-7	1. Rock Type: serpentinized Ol gabbro? 2. Size: 16x13x9cm 3. Shape/Angularity: rounded 4. Encrustations: minor Mn spots 2-4mm weathering rind 7. Matrix Color: greenish-red in cut section 8. Primary Minerals: Px 40-60% 1-2cm poorly preserved, Ol ? 20% serpentinized 9. Secondary Minerals: Serpentine mostly along cracks 10. Overall Degree of Alteration: very strongly altered 11. Comment: might have been originally the most mafic gabbro in this dredge however sample is very strong altered	x									
DR10-8	1. Rock Type: ultramafic cataclasite 2. Size: 13x10x10cm 3. Shape/Angularity: subangular 4. Encrustations: Mn-coating < 0.1mm 5. Vesicularity: non vesicular 7. Matrix Color: brown to black in cut section 8. Primary Minerals: Px, probably Opx with gold-like reflecting surfaces <<2% up to 5mm. Most of the rock consists of black clasts that are dissected by cracks (filled with CC) 9. Secondary Minerals: present but unable to identify 10. Overall Degree of Alteration: strongly altered 11. Comment: this is a tectonized rock that looks ultramafic but a plutonic origin is unclear	x									
DR10-9	1. Rock Type: microgabbro or massive lava 2. Size:14x10x9cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn coating 5. Vesicularity: non vesicular, dense 7. Matrix Color: dark grey 8. Primary Minerals: groundmass consists of Fsp & Px, Ol is altered 9. Secondary Minerals: iddingsite replacing Ol 10. Overall Degree of Alteration: medium altered	x	x				x*				*5 pieces
DR10-10	1. Rock Type: similar to DR10-9 2. Size: 9x8x5cm 11. Comment: This sample has more Ol, however altered	x	x				x*				*2 pieces
DR10-11	1. Rock Type: porphyric lava, only porphyric lava of dredge 2. Size: 13x8x5cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn coating 5. Vesicularity: non vesicular 7. Matrix Color: brown to grey 8. Primary Minerals: 7% light brown phenocryst , Fsp (?) appears altered, 2-3mm in diameter 9. Secondary Minerals: not able to identify 10. Overall Degree of Alteration: strongly altered 11. Comment: If this is a volcanic rock it is the only porphyric of the dredge	x									
DR10-12	1. Rock Type: similar to Dr10-9, but more altered 2. Size: 14x11x7cm 4. Encrustations: minor Mn crust <0.1mm	x	x								
DR10-13	1. Rock Type: pillow with fresh (?) glass chunks in chilled margin, ca. 1cm thick 2. Size: 19x13x11cm 3. Shape/Angularity: pillow tube like 4. Encrustations: no encrustation 5. Vesicularity: dense 7. Matrix Color: groundmass is brown-greenish to partly grey 8. Primary Minerals: aphyric 9. Secondary Minerals: Palagonite in glass rim 10. Overall Degree of Alteration: whole rock is very strong altered 11. Comment: pillow lava indicates that extrusive sections has also been sampled. Pillows make up the largest fraction of the dredge 80%. Dating is needed to determine the relation to the intrusive rocks. Fresh glass is abundant in this sample and probably of good quality	x				x					
DR10-14	1. Rock Type: similar to DR10-13 2. Size: 12x11x7cm 11. Comment: sample entirely consists of a glassy margin, 4cm thick	x				x					
DR10-15	1. Rock Type: similar to DR10-13 2. Size: 9x7x7cm 4. Encrustations: minor Mn crust <0.1mm	x				x					

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR10-16	1. Rock Type: probably pillow fragment freshest whole rock piece of the pillow lithology 2. Size: 11x9x6cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn coating in spots 5. Vesicularity: <<1% vesicles 6. Vesicle Filling: dark red secondary material, Fe-Oxyhydroxide? 7. Matrix Color: brownish grey groundmass 8. Primary Minerals: 1-2% Fsp microphenocrysts up to 1mm, fresh 10. Overall Degree of Alteration: medium altered	x	x								
DR10-17	1. Rock Type: similar to DR10-16, definetly pillow with altered glass rim 2. Size: 13x11x10cm 6. Vesicle Filling: filled with Mn 7. Matrix Color: brownish groundmass 8. Primary Minerals: abundant Fsp in groundmass 10. Overall Degree of Alteration: groundmass ist strongly oxidized 11. Comment: Fsp microphenocryst are ok for dating check TS!	x		x							
DR10-18	1. Rock Type: Similar to DR10-16, but more coarsely grained 2. Size: 12x9x9cm 6. Vesicle Filling: filled with Mn 7. Matrix Color: light brown 10. Overall Degree of Alteration: very strongly altered 11. Comment: serves a back up for extrusives rock	x									
DR10-19	1. Rock Type: similar to DR10-16 2. Size: 11x11x8cm 4. Encrustations: 1mm thick Mn crust	x									
DR10-20S	1. Rock Type: clay? rich sediment fine layering in mm scale layer are folded in places slumpstructure?	x							x		
DR10-21C	1. Rock Type: breccied lava flow 2. Size: 14x12x6cm 3. Shape/Angularity: irregular 4. Encrustations: minor Mn crust <0.1mm 5. Vesicularity: jigsaw fitting angular clasts up to 5cm of microcrystalline and glassy lava flow, cement Zeolites, glass crust up to 2cm thick, appears hydrated, very closely packed, non vesicular 9. Secondary Minerals: Mn-hydroxides around clasts 10. Overall Degree of Alteration: altered 11. Comment: in situ flow top or base breccia	x						x			
DR10-22C	1. Rock Type: hyaloclastite 2. Size: 10x7x5cm 3. Shape/Angularity: rounded 5. Vesicularity: glassy non vesicular angular clasts, partly of jigsaw fit texture, clasts size sub-mm to 10mm; larger blocky and smaller splinter-shaped; 35mm fragment of glassy lava spelling off particles, closely packed, poorly sorted, cement Zeolites 10. Overall Degree of Alteration: altered, glass hydrated and palagonized, possibly a few fresh clasts 11. Comment: in situ	x						x			
DR10-23C	1. Rock Type: similar to DR10-22C 2. Size: 12x7x6cm 10. Overall Degree of Alteration: more pervasively altered							x			
DR10-24C	1. Rock Type: hyaloclastite 2. Size: 11x8x5cm 3. Shape/Angularity: rounded 4. Encrustations: minor Mn crust 5. Vesicularity: angular blocky and minor splinter-shaped clasts sub-mm-15mm, glass fully hydrated and palagonized, closely packed, Zeolite cement and crack fillings, no bedding 10. Overall Degree of Alteration: highly alterated							x			
DR10-25C	1. Rock Type: similar to DR10-24C 2. Size: 11x9x6cm							x			

SO199 - DR11

Investigator Ridge Central Section east of Cocs/Keeling Seamount Province

Dredge on bottom UTC 09/08/08 22:09hrs, lat 11°56,26'S, long 98°11,50'E, depth 3953m

Dredge off bottom UTC 10/08/08 01:00hrs, lat 11°56,20'S, long 98°11,72'E, depth 3701m

total volume:1/4 full

Comments: intrusiva, volcanic and volcaniclastic rocks, manganese crusts

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR11-1	1. Rock Type: subvolcanic intrusiva 2. Size: 16x12x2cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust < 0.1mm 7. Matrix Color: dark grey 8. Primary Minerals: Fsp laths up to 15mm, 40-50%, interstitial mineral prob. Ol	x	x	x							

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR11-2	1. Rock Type: subvolcanic intrusiva, aphanitic 2. Size: 10x9x7cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 7. Matrix Color: greyish 10. Overall Degree of Alteration: fresh 11. Comment: rock cross cut by fractures which give rock a breccia-like appearance; Serpentine inclusion	x	x								
DR11-3	1. Rock Type: subvolcanic intrusiva, inhomogeneous texture 2. Size: 20x15x15cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn crust 8. Primary Minerals: possibly Fsp and unknown mafic min. 10. Overall Degree of Alteration: fresh 11. Comment: inhomogeneous coarse and cryptocrystalline textures, fractures and plastic deformation textures	x	x								
DR11-4	1. Rock Type: plutonic rock, "felsic gabbro", coarse-crystalline, homogeneous textture 2. Size: 22x19x11cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn- and alteration crust 8. Primary Minerals: Fsp, Opx up to 10mm, fresh, equigranular 10. Overall Degree of Alteration: fresh 11. Comment: DR11-4 to DR11-6 Fsp-rich gabbroitic rocks, DR11-7 to DR11-10 increasing Px	x	x								
DR11-5	1. Rock Type: similar to DR11-4 2. Size: 30x19x18cm 8. Primary Minerals: up to 15mm Fsp, Px 10mm 11. Comment: slightly more fractures	x	x				x				
DR11-6	1. Rock Type: similar to DR11-4 2. Size: 11x8x7cm	x									
DR11-7	1. Rock Type: plutonic rock, similar to DR11-4, but smaller crystals 2. Size: 19x17x16cm	x					x				
DR11-8	1. Rock Type: plutonic rock similar to DR11-4 with a higher proportion of Px 2. Size: 15x10x7cm 8. Primary Minerals: Fsp fresh, Opx fresh to slightly altered	x	x								
DR11-9	1. Rock Type: similar to DR11-8 2. Size: 10x9x6cm 8. Primary Minerals: Fsp and Opx appear slightly altered	x	x								
DR11-10	1. Rock Type: similar to DR11-8 2. Size: 15x12x11cm 8. Primary Minerals: Fsp and Opx altered on half the sample, other half fresh 11. Comment: further samples in Archive	x									
DR11-11	1. Rock Type: plutonic rock, inhomogeneous texture 2. Size: 23x18x15cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 8. Primary Minerals: Fsp fresh to slightly altered, black mineral?, mm sized Amph or Px are present 10. Overall Degree of Alteration: fresh 11. Comment: lower stockwerk of oceanic crust with repeated pulses of intrusions	x					x				
DR11-12	1. Rock Type: similar to DR11-11 2. Size: 15x8x6cm 9. Secondary Minerals: 5 mm alteration halo	x									
DR11-13	1. Rock Type: similar to DR11-11 2. Size: 8x5x5cm 11. Comment: 15mm thick "layer" of fibrous, needle like black min (Amph?)	x									
DR11-14	1. Rock Type: similar to DR11-11 2. Size: 15x10x6cm 11. Comment: fractures, small area cryptocrystalline poss. basaltic dike	x									
DR11-15C	1. Rock Type: volcaniclastic rock with thick knobbly Mn crust 2. Size: 58x40x18cm 3. Shape/Angularity: slab 4. Encrustations: 1-25mm thick Mn crust on top, 1mm on base 5. Vesicularity: clasts sub-mm to 10mm, blocky, subangular and splinter shaped, various types of basalt, some clasts vesicular: 30%, faint alignment and bedding, matrix pelagic ooze probably and Zeolite cement 10. Overall Degree of Alteration: altered 11. Comment: sediment gravity flow deposit	x					x	x			

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR11-16C	1. Rock Type: volcaniclastic rock 2. Size: 8x7x5cm 3. Shape/Angularity: rounded 5. Vesicularity: clasts up to 30mm, subangular, prob. altered glass, Zeolite cement 10. Overall Degree of Alteration: pervasively palagonized and altered, friable 11. Comment: hyaloclastic breccia							x			
DR11-17C	1. Rock Type: similar to DR11-16C 2. Size: 7x6x6cm 5. Vesicularity: clasts up to 50mm, angular, often with parallel Zeolite-veining, a vesicular microcrystalline basalt particle 11. Comment: hyaloclastic breccia							x			
DR11-18	1. Rock Type: highly altered glassy sheet lava (?) 2. Size: 18x12x7cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 5. Vesicularity: wavy banding of 5mm thick aphantic beige-brown bands and black cracks crosscutting bands										
DR11-19X	1. Rock Type: gabbroitic rocks, homogeneous textures						x				
DR11-20X	1. Rock Type: gabbroitic rocks, homogeneous textures						x				
DR11-21X	1. Rock Type: gabbroitic rocks, homogeneous textures						x				
DR11-22X	1. Rock Type: gabbroitic rocks, homogeneous textures						x				
DR11-23X	1. Rock Type: gabbroitic rocks, homogeneous textures						x				
DR11-24X	1. Rock Type: gabbroitic rocks, homogeneous textures						x				
DR11-25X	1. Rock Type: gabbroitic rocks, homogeneous textures						x				
DR11-26X	1. Rock Type: gabbroitic rocks, homogeneous textures						x				
DR11-27X	1. Rock Type: plutonic rocks, inhomogeneous textures						x				
DR11-28X	1. Rock Type: plutonic rocks, inhomogeneous textures						x				
DR11-29X	1. Rock Type: plutonic rocks, inhomogeneous textures						x				
DR11-30X	1. Rock Type: plutonic rocks, inhomogeneous textures						x				
DR11-31M	1. Rock Type: several pieces of Mn crust up to 30mm thick of DR11-15C									x	

SO199 - DR12

Central Investigator Ridge

Dredge on bottom UTC10/08/08 11:44hrs, lat 13°00,91'S, long 98°16,10'E, depth 3994m

Dredge off bottom UTC 10/08/0813:07hrs, lat 13°00,70'S, long 98°16,60'E, depth 3504m

total volume:very few rocks

Comments: breccia with rounded serpentinite clasts

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR12-1	1. Rock Type: serpentinite clast from breccia crust cemented in yellowish material 2. Size: 16x11x7cm 3. Shape/Angularity: rounded 4. Encrustations: in places covered with Mn <0.2mm 5. Vesicularity: plutonic rock, non vesicular 7. Matrix Color: reddish-brown in cut section 8. Primary Minerals: large Ol up to 8mm, 60-70% stronger altered to reddish brown material Fe-Oxyhydroxides and greenish serpentinite ? crystals often elongated reflecting ductile deformation, rock is cross cut by abundant veins and cracks that reflected tectonic deformation. The fractures are filled with Mn. 9. Secondary Minerals: see 8.) 10. Overall Degree of Alteration: very strongly altered 11. Comment: this rock represents a piece of the upper mantle and has been brought to the surface by tectonic processes associated with the Investigator Ridge	x									
DR12-2	1. Rock Type: similar to DR12-1 2. Size: 8x6x4cm 11. Comment: in places Px seems preseved, light green 5% up to 5cm	x									
DR12-3	1. Rock Type: similar to DR12-1 2. Size: 9x7x4cm 11. Comment: gneis like tecture, well preserved	x									
DR12-4X	1. Rock Type: Serpentinite clasts, similar to DR12-1, 4 pieces, 3-8cm						x				

SO199 - DR13
Southwest facing slope of northern Keeling Island
Dredge on bottom UTC11/08/08 17:05 hrs, lat 11°54,38'S, long 96°39,06'E, depth 2402m
Dredge off bottom UTC 11/08/08 19:13 hrs, lat 11°54.04'S, long 96°39,56'E, depth 1880m
total volume: about 10% full (few rocks)
Comments: few volcaniclastic rocks and lava fragments

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR13-1	1. Rock Type: lava flow (basaltic?) 2. Size: 13x10x9cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 5. Vesicularity: none 7. Matrix Color: variable - greyish to beige brown 8. Primary Minerals: Fsp or unknown mineral about 1% fresh and black, highly elongate minerals probably amphibole about 1% <1mm 10. Overall Degree of Alteration: aphanitic to cryptocrystalline groundmass appears altered (hydrated) 11. Comment: alkalic lava flow with flow textures, crystal alignment and partly brecciated margin. Has potential for dating	x	x	x?							
DR13-2	1. Rock Type: similar to DR13-1 2. Size: 10x7x7cm	x	x	x?							
DR13-3	1. Rock Type: similar to DR13-1 2. Size: 10x6x5cm 10. Overall Degree of Alteration: slightly less well preserved	x									
DR13-4	1. Rock Type: vesicular lava (basaltic) scoriaceous 2. Size: 11x8x6cm 3. Shape/Angularity: roundish 4. Encrustations: minor 5. Vesicularity: 10-20% 6. Vesicle Filling: smaller ones in center empty, larger ones near margin filled with CC 7. Matrix Color: chocolate brown 8. Primary Minerals: tiny Fsp and Ol, sub-millimeter sized 10. Overall Degree of Alteration: <1% Ol altered, Fsp appears fresh 11. Comment: possibly derived from a more shallow setting	x									
DR13-5	1. Rock Type: similar to DR13-4 2. Size: 8x5x4cm	x									
DR13-6	1. Rock Type: lava flow(more evolved?) 2. Size: 20x14x12cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 7. Matrix Color: pale olive brown 8. Primary Minerals: highly elongate crystals, Amph? 2% and Fsp 1%, both max 1mm and appear fresh 10. Overall Degree of Alteration: aphanitic groundmass appears to be altered by hydration 11. Comment: flow textures, banding, fragments of lava along sample margin - potential for dating	x	x	x?							
DR13-7	1. Rock Type: similar to DR13-6 2. Size: 13x10x6cm 8. Primary Minerals: Fsp 2-3% flow aligned 11. Comment: 6cm thick sheet flow fragment with glassy top and basal margins, glass highly altered	x	x	x?							
DR13-8	1. Rock Type: similar to DR13-6 2. Size: 12x9x8cm 11. Comment: intensive flow banding with more Fsp in darker bands, black mineral (amphibole?) up to 2mm	x	x	x?							
DR13-9	1. Rock Type: similar to DR13-6 2. Size: 16x14x8cm 4. Encrustations: on one side there is 15mm of Mn crust 8. Primary Minerals: Fsp about 3% <1-2mm appear fresh to slightly altered 11. Comment: intense brecciated margin										
DR13-10	1. Rock Type: similar to DR13-6 2. Size: 15x10x9cm 10. Overall Degree of Alteration: highly altered and fractured										
DR13-11C	1. Rock Type: volcaniclastic 2. Size: 19x15x13cm 11. Comment: subangular blocky clasts probably derived from lithology DR13-6, matrix supported, poorly sorted, no orientation or bedding. Matrix brown - probably pelagic ooze. Flow base breccia clasts higly altered, palagonized and hydrated	x						x			

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR13-12C	1. Rock Type: volcaniclastic with strong banding 2. Size: 15x13x6cm 3. Shape/Angularity: subrounded 4. Encrustations: minor Mn crust 10. Overall Degree of Alteration: fairly fresh 11. Comment: banded to 5mm, wavy and appears microcrystalline, coherent magmatic, interspersed are 5-10mm subrounded vesicular basaltic clasts (blocky) CC cement as vesicle fillings. Lava flow incorporating clasts or fluidal clasts interbedded with the blocky vesicular clasts (??)	x						x			
DR13-13C	1. Rock Type: lapilli tuff 2. Size: 24x20x20cm 3. Shape/Angularity: irregular 4. Encrustations: minor Mn crust 10. Overall Degree of Alteration: possibly fresh glass 11. Comment: closely packed clasts, sub mm to 25mm, blocky, poorly vesicular, monolithic bimodal gransize (medium ash and fine lapilli). No matrix, CC cement, no bedding or clast orientation. Hyaloclastitic deposit	x						x			
DR13-14 & 15X	1. Rock Type: similar to DR13-6 to 10						x				
DR13-13CX	1. Rock Type: volcaniclastic rock						x				

SO199 - DR16
NOEL seamount; SW of Keeling Island. This is the NW most seamount of the Muirfield seamount cluster
Dredge on bottom UTC 12/08/08 01:23 hrs, lat 12°23.49'S, long 95°17.29'E, depth 2883m
Dredge off bottom UTC 12/08708 03:25 hrs, lat 12°23.63'S, long 95°17.38'E, depth 2676m
total volume: few rocks
Comments: volcaniclastic rocks with lava clasts

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR16-1C	1. Rock Type: lava fragment and volcaniclastic rock 2. Size: 17x16x11cm 3. Shape/Angularity: irregular-subangular 4. Encrustations: minor Mn crust 5. Vesicularity: 5% 7. Matrix Color: dark greyish brown to olive grey 8. Primary Minerals: Amph up to 1 mm, 2% (TS, GC) 10. Overall Degree of Alteration: fairly fresh 11. Comment: 10cm sized lava piece spalling off small clasts, jigsaw fit textures, in situ lava flow breccia, clasts blocky; angular, closely packed, CC cement, strongly altered, fluid lava (sheet), light greenish; potential for dating, alkalic prob. Si undersaturated rock	x	x	x?				x			
DR16-2C	1. Rock Type: coarse volcaniclastic rock with 6 cm-lava fragment 2. Size: 8x6x5cm 3. Shape/Angularity: irregular-subangular 4. Encrustations: minor Mn crust 5. Vesicularity: 5% 6. Vesicle Filling: majority empty, some CC 7. Matrix Color: dark greyish-black 8. Primary Minerals: Amph 3-5%, fresh, <1-1mm, prob. Neph up to 2 mm (1%) 10. Overall Degree of Alteration: fresh, hydrated glassy rim of large fragment 11. Comment: potential for dating	x		x?				(x)			
DR16-3	1. Rock Type: lava fragment similar to DR16-2C 2. Size: 8x6x4cm	x		x?							
DR16-4	1. Rock Type: lava fragment similar to DR16-2C 2. Size: 9x6x5cm 5. Vesicularity: 5-20% 6. Vesicle Filling: mostly empty 7. Matrix Color: dark grey 8. Primary Minerals: Amph up to 1 mm (<1%), Neph altered up to 1 mm (2-3%) 10. Overall Degree of Alteration: margin hydrated, core fresher	x									
DR16-5C	1. Rock Type: matrix-supported volcaniclastic rock 2. Size: 7x6x5cm 3. Shape/Angularity: subrounded 5. Vesicularity: 3-5% 6. Vesicle Filling: mostly empty 7. Matrix Color: dark grey 8. Primary Minerals: Amph up to 2mm (1-2%), Neph (1%) 10. Overall Degree of Alteration: fresh 11. Comment: potential for dating	x		x?				x			

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR16-6C	1. Rock Type: similar to DR16-5C 2. Size: 11x9x7cm 11. Comment: volcaniclastic rock: poorly sorted (blocky), angular-irregular, shaped clasts <1-50mm, matrix prob. pelagic ooze, calcareous, no bedding or clasts orientation	x		x?				x			
DR16-7C	1. Rock Type: volcaniclastic rock, very similar to DR16-1C 2. Size: 15x9x7cm 11. Comment: clasts up to 5 cm, mostly altered, core of ca. 2 cm (diam.), appears fresh -> TS	x						x			
DR16-8C	1. Rock Type: scoriaceous reddish coarse volcaniclastic rock 2. Size: 19x17x10 cm 3. Shape/Angularity: irregular-angular 4. Encrustations: minor Mn crust 5. Vesicularity: varies between clasts, 5-30% 6. Vesicle Filling: generally filled with CC 7. Matrix Color: grey to brown, brow-reddish 8. Primary Minerals: Amph < 1%, Neph variably <1-2 % up to 2 mm, prob. Ol 9. Secondary Minerals: some clasts with Mn-hydroxydes 10. Overall Degree of Alteration: altered 11. Comment: heterolithic volcaniclastic rock with geopedal textures (hanging cements), cement CC, matrix very fine prob. volcaniclastic rock and/or pelagic ooze	x						x			
DR16-9C	1. Rock Type: similar to DR16-8C 2. Size: 14x14x7cm	x						x			
DR16-10C	1. Rock Type: similar to DR16-8C 2. Size: 11x10x7cm							x			
DR16-11CX to DR16-14CX	1. Rock Type: very similar to DR16-8C to DR16-10C						x	(x)			

SO199 - DR17

Muirfield Seamount group west of Keeling Island), NW summit at end of chain (Noel, some 14 km SSE of DR16), SW facing slope

Dredge on bottom UTC 12/08/08 07:03 hrs, lat 12°29,91'S, long 95°21,16'E, depth 2247m

Dredge off bottom UTC 12/08/08 09:07 hrs, lat 12°29,67'S, long 95°21,50'E, depth 1839m

total volume: few rocks

Comments: volcaniclastic rocks

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR17C-1A	1. Rock Type: basalt pebble from volcaniclastic 2. Size: 2x3x1cm (just the pebble) 3. Shape/Angularity: subrounded 7. Matrix Color: dark grey 8. Primary Minerals: aphyric 10. Overall Degree of Alteration: fresh 11. Comment: needs careful preparation to pick fresh basalt rock chips		x								
DR17C-1B	1. Rock Type: volcaniclastic with large fresh Amph or Cpx crystals - this is the matrix from which DR17C-1A was removed 2. Size: 15x10x10cm (3x4x4cm?) 5. Vesicularity: none to poorly vesicular 0-5% 6. Vesicle Filling: CC 7. Matrix Color: white CC cement 10. Overall Degree of Alteration: most clasts altered reddish brown but a few black glass clasts appear fresh 11. Comment: clasts irregular, sub-angular blocky, basaltic, probably monomict, sub mm to 15mm, closely packed, poorly sorted, no bedding. Geochem for abundant Amph/Cpx?		x					x			
DR17C-2	1. Rock Type: volcaniclastic containing basalt pebbles - 2A and 2B 2. Size: 20x20x10cm 3. Shape/Angularity: irregular slab 4. Encrustations: minor Mn crust but 5-10mm on top side 5. Vesicularity: poorly vesicular 7. Matrix Color: light grey-beige 8. Primary Minerals: calcareous ooze with foraminiferal and shell/coral debris and CC cement (changing) 10. Overall Degree of Alteration: reddish altered and fresher grey clasts 11. Comment: heterolithic volcaniclastic rock with basaltic clasts sub mm to 30mm, subangular mostly blocky, matrix-supported, poorly sorted, no bedding, clast orientation very faint - a recycled volcaniclastic rock of 3x1cm with closely packed 0.5mm clasts	x						x			

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR17C-2A	1. Rock Type: small coarse-grained basalt pebble from volcaniclastic rock 2. Size: 3x3x2cm 3. Shape/Angularity: subangular 5. Vesicularity: dense 7. Matrix Color: light grey aphyric, coarse grained 8. Primary Minerals: Fsp and Px in groundmass 9. Secondary Minerals: CC along veins 11. Comment: too small for TS		x								
DR17C-2B	1. Rock Type: porphyric basalt pebble removed from volcaniclastic rock 2. Size: 4x2x1cm 3. Shape/Angularity: rounded 4. Encrustations: minor Mn coating 5. Vesicularity: 1%, 0.2mm open vesicles 7. Matrix Color: dark grey in places but often red-orange 8. Primary Minerals: 1-2% Fsp microphenocrysts fresh <1mm, <1% Amph or Px fresh 1-2mm, <1% Ol 1mm, altered to Iddingsite 9. Secondary Minerals: Iddingsite 10. Overall Degree of Alteration: medium 11. Comment: Fsp might be useful		x								
DR17C-3	1. Rock Type: relatively fine-grained volcaniclastic rock with fresh Px crystals, 2% <1mm also contains larger basalt clast (see 3A) 2. Size: 30x30x30cm (7x7x4cm?) 4. Encrustations: minor Mn crust 5. Vesicularity: poor 6. Vesicle Filling: ratio of empty and filled vesicles is 1:1 7. Matrix Color: almost no matrix in coarser layer CC cement 10. Overall Degree of Alteration: partly altered grey to brownish rock 11. Comment: blocky clasts, angular to subangular, fairly well sorted, very closely packed, graded slightly wavy bed in 0.5cm thickness, sharp basal contact, monomict with occasional rip up lithic? Most of the sample went into working half for mineral separation. One sample went into volcaniclastic rock	x						x			
DR17C-3A	1. Rock Type: basalt clast recovered from volcaniclastic sediment 2. Size: 3x3x2cm 3. Shape/Angularity: rounded 5. Vesicularity: dense 7. Matrix Color: light grey 8. Primary Minerals: aphyric, very minor Px <<0.5% 0.5mm 10. Overall Degree of Alteration: slightly altered 11. Comment: could be older than volcaniclastic rock matrix. For geochemistry and dating										
DR17C-4	1. Rock Type: volcaniclastic rock 2. Size: 11x7x6cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 5. Vesicularity: mostly non-vesicular clasts, some poor vesicularity 6. Vesicle Filling: CC 7. Matrix Color: CC cement only 8. Primary Minerals: Amph and Fsp 9. Secondary Minerals: grey 10. Overall Degree of Alteration: grey 11. Comment: clasts blocky, subangular, closely packed, poorly sorted, no bedding or clast orientation, many glassy clasts, fresh glass and basaltic clasts (possibly monomict)							x			
DR17C-5	1. Rock Type: volcaniclastic rock (lapillistone) 2. Size: 13x9x8cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 5. Vesicularity: most clasts non to poorly vesicular, some 20-25% lined with dark substance, inner part empty 7. Matrix Color: beige fine grainy matrix (very little), CC cement, open pore space and brown Zeolites/ Palagonite 10. Overall Degree of Alteration: light brown beige rock, highly altered 11. Comment: appears evolved composition, clasts blocky, irregular-angular, verly closely packed, moderately sorted, grainsize 2-12mm no bedding or clast orientation	x						x			

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR17C-6	1. Rock Type: heterolithic volcaniclastic rock 2. Size: 15x12x8cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn cement 5. Vesicularity: most clasts non to poorly vesicular, some up to 20% 6. Vesicle Filling: CC 7. Matrix Color: fine grainy and CC cement 8. Primary Minerals: Fsp needles, Amph, possibly highly altered Ol 10. Overall Degree of Alteration: mostly altered 11. Comment: two zones: one CC cemented, the other with matrix and no cement. Components same otherwise: clasts dense to scoriaceous basaltic and possiby more evolved, blocky angular to subangular, moderately closely packed, faintly bedded (CC and matrix zones)	x						x			
DR17C-7	1. Rock Type: very fine possibly evolved volcaniclastic rock (tuff) 2. Size: 12x8x8cm 3. Shape/Angularity: roundish 4. Encrustations: minor Mn crust 7. Matrix Color: minor CC cement 9. Secondary Minerals: Mn-Fe-hydroxides 10. Overall Degree of Alteration: hightly altered 11. Comment: well bedded 1cm very fine ash layered, 6cm coarse ash bedded internally, homogenous, scouring ???? into fine layers clusters of coarse ash with CC cement otherwise no cement or matrix, well sorted, clasts angular blocky/rugged							x			
DR17C-8	1. Rock Type: volcaniclastic rock similar to DR17C-4 2. Size: 9x6x5cm 7. Matrix Color: minor matrix beige grainy and CC cement 11. Comment: heterolithic clasts (probably basaltic), subangular and moderately closely packed							x			
DR17C-9	1. Rock Type: volcaniclastic rock with fresh Px crystals - similar to DR17C-8 2. Size: 9x6x6cm 5. Vesicularity: 0-15% 6. Vesicle Filling: CC or empty 11. Comment: fresh glassy clasts common, heterolitthic (basaltic?) clasts							x			
DR17C-10	1. Rock Type: volcaniclastic rock similar to DR17C-8 2. Size: 8x5x4cm							x			

SO199 - DR18

Muirfield Seamount Cluster: small Seamount SE of NOEL Seamount

Dredge on bottom UTC 12/08/08 14:29 hrs, lat 12°48.31'S, long 95°22.64'E, depth 3549m

Dredge of bottom UTC 12/08/09 15:56 hrs, lat 12°49.05'S, long 95°23.23'E, depth 3053m

total volume: 1 rock

Comments: volcaniclastic rock, contained 1 basalt pebble

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR18-1	1. Rock Type: lava pebble embedded in volcaniclastic material 2. Size: 12x10x8cm 3. Shape/Angularity: rounded 4. Encrustations: minor Mn spots 5. Vesicularity: 2% vesicles 0.5-2mm 6. Vesicle Filling: lined with Mn 7. Matrix Color: brown 8. Primary Minerals: <1% Fsp laths <0.5mm appear fresh, Px up to 1.5mm, <0.5% fresh 9. Secondary Minerals: Fe-Oxyhydroxide replacing matrix, veins filled with Mn 10. Overall Degree of Alteration: strongly altered 11. Comment: this rock has been eroded and rounded before it was incorporated into the volcaniclastic sediment	x	x	x							

SO199-DR19
Muirfield Seamount: Western Slope
Dredge on bottom UTC 12/08/08 23:26 hrs, lat 13°05.34'S, long 96°00.34'E, depth 3002 m
Dredge of bottom UTC 12/08/08 00:42 hrs, lat 13°05.43'S, long 96°01.18'E, depth 2607 m
total volume: few rocks
Comments: volcaniclastic rocks with lava clasts

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR19-1	1. Rock Type: lava fragment 2. Size: 13x7x4cm 3. Shape/Angularity: irregular 4. Encrustations: Mn crust, 8mm 5. Vesicularity: 25% 6. Vesicle Filling: mainly empty 7. Matrix Color: greyish 8. Primary Minerals: fresh Fsp needles (ca. 1 mm, 1%), altered Ol 10. Overall Degree of Alteration: fresh to slightly altered 11. Comment: potential for dating, basalt	x		x?							
DR19-2	1. Rock Type: similar to DR19-1 2. Size: 15x10x9cm 4. Encrustations: Mn crust, 1cm	x	x	x?							
DR19C-3A	1. Rock Type: basalt pebble from volcaniclastic rock 2. Pebble Size: 11x8x6 3. Shape/Angularity: irregular 4. Encrustations: altered glass crust, 1 cm 5. Vesicularity: graduall transition from 0 to 20% 6. Vesicle Filling: mainly empty, beneath the glassy crust 1cm thin layer filled with CC 7. Matrix Color: mainly greyish 8. Primary Minerals: fresh Fsp needles (ca. 1 mm, 1%), altered Ol 10. Overall Degree of Alteration: fresh to slightly altered, glassy crust 11. Comment: potential for dating	x		x?							
DR19C-3B	1. Rock Type: volcaniclastic rock 11. Comment: submm- 10 mm subangular basaltic clasts, monomict, matrix pelagic ooze, fairly bedded, variable sorted, Mn crust in top up to 10 mm, overall altered rock										
DR19-4SX to DR19-8SX	1. Rock Type: Carbonate 11. Comment: with Mn crust & bioturbation and/or borings						x				

SO199-DR20
"Klaus" Seamount (Muirfield Seamount group): southward trending rift (?) structure
Dredge on bottom UTC 13/08/08 10:08 hrs, lat 13°36.36'S, long 96°23.36'E, depth 3140 m
Dredge off bottom UTC 13/08/08 11:28 hrs, lat 13°36.19'S, long 96°23.84'E, depth 2819 m
total volume: 1/6 full
Comments: lava fragments and volcaniclastic rocks

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR20-1	1. Rock Type: phonolitic (?) lava fragment 2. Size: 17x13x10cm 3. Shape/Angularity: subrounded 4. Encrustations: Mn coating <0.2mm 5. Vesicularity: 10%, slightly elongated to oval shape 6. Vesicle Filling: mostly unfilled and lined with Mn, some filled with Mn 7. Matrix Color: greenish-grey where fresh; alteration halo yellow brown up to 2-3cm thick 8. Primary Minerals: < 2% Fsp microphenocrysts, appear slightly altered 9. Secondary Minerals: CC along small veins 10. Overall Degree of Alteration: medium 11. Comment: evolved Si undersaturated volcanic rock. Fsp could be used for dating, although less abundant than initially estimated	x	x	x							
DR20-2	1. Rock Type: similar to DR20-1 2. Size: 16x13x11cm 5. Vesicularity: more elongated and up to 2-3 cm long while being only 1mm thick 8. Primary Minerals: appears aphyric 10. Overall Degree of Alteration: medium	x	x								
DR20-3	1. Rock Type: similar to DR20-1, however ±non vesicular, aphyric 2. Size: 12x10x9cm 10. Overall Degree of Alteration: medium to strongly altered 11. Comment: requires TS to evaluate freshness of matrix	x	x								
DR20-4	1. Rock Type: similar to DR20-3, but slightly more abundant & unfilled vesicles and Fsp microphenocrysts 2. Size: 13x10x9cm	x	x								
DR20-5	1. Rock Type: similar to DR20-4, appears slightly fresher with more Fsp phenocrysts 2. Size: 16x11x9cm										

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR20-6	1. Rock Type: "ignimbrite" like tuff 2. Size: 12x11x9cm 3. Shape/Angularity: subangular bloc 4. Encrustations: Mn coating in places overall <0.1mm thick 5. Vesicularity: 15% highly elongated open vesicles up to 1cm long and 1mm wide 6. Vesicle Filling: lined with Mn 7. Matrix Color: light brown 8. Primary Minerals: < 1% Fsp 1mm, fresh; < 0.5% Amph (?) 10. Overall Degree of Alteration: medium to strongly altered 11. Comment: this sample is the most tuff like sample of the dredge	x	x								
DR20-7	1. Rock Type: similar to DR20-3, but sample seems a bit fresher 2. Size: 12x8x8cm	x	x								
DR20-8	1. Rock Type: similar to DR20-3 2. Size: 12x7x11cm 9. Secondary Minerals: abundant Mn spots 11. Comment: probably most altered sample of the phonolitic rocks in this dredge	x	x								
DR20-9C	1. Rock Type: strongly altered tuff (?)							x			
DR20-10C	1. Rock Type: lapilli tuff (?)							x			
DR20-11C	1. Rock Type: lapilli tuff (?)							x			
DR20-12C	1. Rock Type: lapilli tuff (?)							x			

SO199-DR21
"Santa" Seamount: SE of Muirfield Seamount. SW slope near a NE-SW striking valley
Dredge on bottom UTC 13/08/08 15:42 hrs, lat 13°43.27'S, long 96°25.85'E, depth 2783 m
Dredge off bottom UTC 13/08/08 17:31 hrs, lat 13°43.10'S, long 96°26.40'E, depth 2295 m
total volume: few rocks (ca. 8 pieces)
Comments: lava fragments

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR21-1	1. Rock Type: strongly altered, angular lava fragment 2. Size: 15x12x9cm 3. Shape/Angularity: angular 4. Encrustations: very thin Mn coating 5. Vesicularity: dense 7. Matrix Color: dark-brown 8. Primary Minerals: mostly aphyric with very few << 0.5% Fsp and Px phenocrysts both < 0.5mm and fresh. 9. Secondary Minerals: groundmass is replaced by Fe-Oxyhydroxides 10. Overall Degree of Alteration: very strongly altered 11. Comment: rock is ok for reconaissance geochemistry; Ar-Ar dating questionable	x	x								
DR21-2	1. Rock Type: similar to DR21-1 2. Size: 8x7x7cm	x									
DR21-3	1. Rock Type: similar to DR21-1 but with less altered core 2. Size: 8x7x5cm 10. Overall Degree of Alteration: the fresher inner core contained a small volume of still fairly fresh material that might be used for Ar-Ar matrix dating. This part is too small for TS		x								
DR21-4C	1. Rock Type: heterolithic lapilli tuff with biogene components							x			
DR21-5C	1. Rock Type: heterolithic lapilli tuff similar to -4C							x			
DR21-6C	1. Rock Type: heterolithic lapilli tuff similar to -4C							x			
DR21-7C	1. Rock Type: heterolithic lapilli tuff similar to -4C							x			
DR21-8C	1. Rock Type: bedded, graded fine grained lapilli tuff							x			

SO199 - DR22
Central Investigator Ridge
Dredge on bottom UTC 14/08/08 11:14 hrs, lat 13°14.17´S, long 98°14,17´E, depth 4775m
Dredge off bottom UTC 14/08/08 12:18 hrs, lat 13°14.09´S, long 98°14,76´E, depth 4287m
total volume: few angular rock fragments
Comments: dredge recovered a single pillow that broke into 6 pieces

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR22-1A	1. Rock Type: pillow rim fragment from largest piece 2. Size: 24x16x10 3. Shape/Angularity: angular, typical V-shaped pillow fragment 4. Encrustations: Mn crust 3-4mm thick 5. Vesicularity: 2% vesicles, irregular distribution, diam. 0.5.up to 1 cm 6. Vesicle filling: large vesicles are prob. filled with yellow brown material (Palagonite?). The flow possibly incorporated glass fragments that were altered later, some of those fillings are however with highly vesicular and resemble vesicular lapilli 7. Matrix Color: greyish-green, coarse grained ground mass 8. Primary Minerals: few microphenocrysts, otherwise aphyric 9. Secondary Minerals: ground mass is slightly oxidized 10. Overall Degree of Alteration: medium altered 11. Comment: pillow rim contains fresh glass, --> seperated + 1xTS packed seperatly from other glass samples DR22-1B --> sample DR22-1B glass quality to be checked by TS	x	x	x?		x					
DR22-1B	1. Rock Type: 6x pillow pieces with possible fresh glass, glass is cut off from remaining sample, all pieces come from pillow DR22-1, glass rim between 1-2.5cm thick	x	x	x		x					
DR22-2	1. Rock Type:pillow fragment seperate piece, but very similar to DR22-1 2. Size: 25x17x9 3. Shape/Angularity: angular 4. Encrustations: thin <2mm Mn crust covering entire piece	x									
DR22-3	1. Rock Type: pillow fragment similar to DR22-2 2. Size:7x6x6	x									
DR22-1AX	1. Rock Type: 3 pieces diam. 15-20cm	x					x				

SO199 - DR23
Central Investigator Ridge, WNW facing slope beneath upper part of the ridge
Dredge on bottom UTC 14/08/08 20:54 hrs, lat 13°54,16´S, long 98°22,24´E, depth 4203m
Dredge off bottom UTC 14/08/08 22:15 hrs, lat 13°54,40´S, long 98°22,72´E, depth 3796m
total volume: 1/3 full
Comments: intrusive rocks and Mn crusts

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR23-1A	1. Rock Type: subvolcanic intrusiva 2. Size: 20x20x10cm 3. Shape/Angularity: subangular 7. Matrix Color: variable, from brown to grey cross cut by black veins 8. Primary Minerals: fine grained matrix with 5% Ol crystals to 6mm 10. Overall Degree of Alteration: fresh apart from the altered Ol 11. Comment: some parts appear recrystallised. Contains holocrystalline, coarse grained xenolith DR23-1B	x	x								
DR23-1B	1. Rock Type: xenolith from DR23-1A 2. Size: 6x5x1vm 8. Primary Minerals: altered Ol 30%, Px 15% and Fsp 55%up to 2cm 9. Secondary Minerals: Ol TBC 10. Overall Degree of Alteration: completely altered Ol 11. Comment: holocrystalline rock	x	x								slice taken
DR23-2	1. Rock Type: mafic plutonic 2. Size: 9x6x8cm 3. Shape/Angularity: subangular 8. Primary Minerals: grey translucent min 20% to 1mm, fully altered Ol 10% to 4mm, Px <1% about 2mm, black interstitial min 8% to 1mm 9. Secondary Minerals: 10. Overall Degree of Alteration: fresh apart from altered Ol	x	x								
DR23-3A	1. Rock Type: mafic plutonic contains xenolith DR23-3B 2. Size: 12x12x10cm 3. Shape/Angularity: subrounded 8. Primary Minerals: grey translucent min 20% to 4mm, fully altered Ol 10% to 2mm, black interstitial 10% to 3mm, Px 1%to 2mm, white Fsp 4% to 2mm 10. Overall Degree of Alteration: many cracks and altered Ol but other minerals appear fresher	x	x								same TS as 3B

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR23-3B	1. Rock Type: xenolith from DR23-3A 2. Size: 10x5x5cm 3. Shape/Angularity: subrounded 8. Primary Minerals: altered Ol 20% to 2mm, black interstitial min 5% to 1mm, grey translucent min 5% to 5mm, Px 2% to 2mm, white Fsp 1% to 1mm 10. Overall Degree of Alteration: fresh apart from Ol 11. Comment: finer grained than the host (DR23-3A)	x	x								same TS as 3A
DR23-4	1. Rock Type: mafic plutonic 2. Size: 18x15x6cm 3. Shape/Angularity: subrounded 4. Encrustations: Mn crust to 1cm 8. Primary Minerals: grey translucent min 8% to 6mm, dull brown Fsp? 12% to 2mm, altered Ol 4% to 2mm, Px <2% to 2mm, black interstitial min 5% to 1mm 10. Overall Degree of Alteration: fresh apart from altered Ol	x	x								
DR23-5	1. Rock Type: mafic plutonic 2. Size: 16x8x6cm 3. Shape/Angularity: subrounded 8. Primary Minerals: Ol 6% to 4mm, black interstitial mineral 5% to 2mm, grey-brown Fsp 20% to 4mm, grey translucent min 12%to 4mm, Px 2%to 5mm 10. Overall Degree of Alteration: fresh apart from the altered Ol	x	x								
DR23-6	1. Rock Type: mafic plutonic 2. Size: 18x19x8cm 3. Shape/Angularity: subangular 8. Primary Minerals: altered Ol 25% to 4mm, black interstitial min 3% to 2mm, grey translucent mineral 20% to 4mm, Px 1% to 1.5mm, grey-brown Fsp 10% to 1.5mm	x	x								
DR23-7	1. Rock Type: similar DR-6 2. Size: 25x16x12cm 8. Primary Minerals: less of the altered Ol <10% but more Px at 7%	x	x				x				
DR23-8	1. Rock Type: mafic plutonic 2. Size: 11x10x5cm 3. Shape/Angularity: subrounded 8. Primary Minerals: Ol 5% to 4mm, Px 1% to 6mm, grey translucent 16% to 4mm, black interstitial min 1% to 1mm, grey-brown Fsp 5% to 3mm 9. Secondary Minerals: 10. Overall Degree of Alteration: fresh apart from altered Ol 11. Comment: more altered around its edges	x									
DR23-9	1. Rock Type: similar to DR23-8 2. Size: 20x15x15cm 3. Shape/Angularity: subangular 8. Primary Minerals: altered Ol 2% to 5mm, Px <1% to 1mm, grey Fsp 3-5%to 5mm 10. Overall Degree of Alteration: slightly altered with altered Ol and filled cracks	x	x				x				
DR23-10	1. Rock Type: mafic plutonic 2. Size: 10x7x4cm 3. Shape/Angularity: subangular 4. Encrustations: Mn crust 5-10mm thick 8. Primary Minerals: altered Ol 7% to 15mm, kl(?) or Px 30% to 25mm, grey Fsp 10. Overall Degree of Alteration: lightly altered, filled cracks	x									
DR23-11	1. Rock Type:mafic plutonic 2. Size: 12x7x6cm 3. Shape/Angularity: subrounded 8. Primary Minerals: altered Ol, 2% up to 10mm, Px 1%, <1mm 10. Overall Degree of Alteration: altered	x									
DR23-12	1. Rock Type: mafic plutonic 2. Size: 24x12x8cm 3. Shape/Angularity: subrounded 8. Primary Minerals: altered Ol, 5%, 15mm; Fsp, 8% up to 4mm, black intestitial mineral, 4%, up to 8mm; Px, 2%, up to 3mm; brown min (Fsp) altered?, 6%, up to 1mm; grey semi-transparent, 20%, up to 8mm 10. Overall Degree of Alteration: partly altered, cracked within	x	x								
DR23-13	1. Rock Type: felsic plutonic 2. Size: 16x8x6cm 3. Shape/Angularity: subangular 8. Primary Minerals: Px, 4%, up to 3mm; Ol, 1%, up to 6mm; semi-transparent grey min, 20%, up to 4mm; black intestitial min, 4%, up to 4mm; dark grey min (Fsp), 6%, up to 6mm 10. Overall Degree of Alteration: mostly fresh except altered Ol	x									

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR23-14	1. Rock Type: felsic plutonic 2. Size: 23x15x8cm, piece from a large 60x45x40cm block 3. Shape/Angularity: subangular 8. Primary Minerals: light grey mineral, 20%, up to 4mm; dark grey min, 10%, up to 4mm; greenish-grey min., 3%, up to 7mm, (altered min along cracks); Fsp, 7%, up to 7mm; Px, 1%, up to 5mm 10. Overall Degree of Alteration: fresh, some cracks --> altered minerals 11. Comment: halocrystalline, coarsly grained, felsic	x	x				x				
DR23-15	1. Rock Type: similar to DR23-14 2. Size: 24x20x20cm 8. Primary Minerals: fresh grey Fsp, 25%, up to 5mm; Px, 5%, up to 1mm; white min concentrated along upper and lower edge; greenish-grey Fsp (altered), 3%, up to 5mm; AlFsp (reddish), <1%, up to 2mm 11. Comment: white mineral and altered greenish-grey Fsp located along the cracks and along the edges	x	x				x				
DR23-16	1. Rock Type: felsic plutonic 2. Size: 8x6x3cm 3. Shape/Angularity: subangular 8. Primary Minerals: light grey Fsp, 15%, up to 5mm; dark grey Fsp, 20%, up to 3mm; Px, 1-2%, up to 3mm; black mineral, 7%, up to 5mm; greenish-grey Fsp (altered), 15%, up to 3mm 10. Overall Degree of Alteration: partly altered 11. Comment: halocrystalline, coarsly grained, felsic	x									
DR23-17	1. Rock Type: felsic plutonic 2. Size: 9x7x6cm 3. Shape/Angularity: subangular 8. Primary Minerals: light grey Fsp, 3%, up to 5mm; dark grey Fsp, 10%, up to 3mm; greenish-grey Fsp (altered); 15%, up to 3mm; white Fsp, 10%, up to 5mm; black minerals, 2%, up to 2mm 10. Overall Degree of Alteration: partly altered 11. Comment: similar to DR23-16	x									
DR23-18	1. Rock Type: felsic plutonic 2. Size: 10x6x4cm 3. Shape/Angularity: subangular 8. Primary Minerals: grey semi-transparent mineral, 15%, up to 6mm; Px, 1%, up to 6mm (laths); black interstital, 1-2%, up to 1mm; dull brown mineral, 12%, up to 2mm 10. Overall Degree of Alteration: has altered bands, otherwise fresh, showing small crystals (1mm)	x	x								
DR23-19	1. Rock Type: holocrystalline felsic plutonic 2. Size: 10x7x6cm 3. Shape/Angularity: subangular 8. Primary Minerals: white Fsp, 25%, up to 1cm; Px, 25%, up to 6mm 10. Overall Degree of Alteration: partly altered close to the rim and along cracks 11. Comment: felsic	x									
DR23-20	1. Rock Type: felsic plutonic 2. Size: 9x7x5cm 3. Shape/Angularity: subangular 8. Primary Minerals: dark grey mineral, 15%; black mineral, <2%, Px, <1%; altered mineral (greenish) 10. Overall Degree of Alteration: fresh core, altered rim 11. Comment: felsic rock, halocrystalline	x									
DR23-21	1. Rock Type: similar to DR23-19 8. Primary Minerals: Px, 50%, up to 4mm; white Fsp, 20%, up to 5mm	x	x								
DR23-22_MA - DR23-22_MD	1. Rock Type: Four seperate pieces of manganese crust									x	
DR23-23X	1. Rock Type: subvolcanic intrusiva						x				
DR23-24X	1. Rock Type: subvolcanic intrusiva						x				
DR23-25X	1. Rock Type: subvolcanic intrusiva						x				
DR23-26X	1. Rock Type: subvolcanic intrusiva						x				
DR23-27X	1. Rock Type: subvolcanic intrusiva						x				
DR23-28X	1. Rock Type: subvolcanic intrusiva						x				
DR23-29X	1. Rock Type: subvolcanic intrusiva						x				
DR23-30X	1. Rock Type: subvolcanic intrusiva						x				
DR23-31X	1. Rock Type: subvolcanic intrusiva						x				
DR23-32X	1. Rock Type: subvolcanic intrusiva						x				
DR23-33X	1. Rock Type: subvolcanic intrusiva						x				
DR23-34X	1. Rock Type: subvolcanic intrusiva						x				
DR23-35X	1. Rock Type: subvolcanic intrusiva						x				
DR23-36X	1. Rock Type: subvolcanic intrusiva						x				

SO199 - DR26
Southern Investigator Ridge
Dredge on bottom UTC 15/08/08 16:28hrs, lat 14°55,18'S, long 98°29,54'E, depth 4938m
Dredge off bottom UTC 15/08/08 17:33hrs, lat 14°55,09'S, long 98°30,07´E, depth 4575m
total volume: 1/4 full
Comments: breccia with lava and serpentinite clasts, sedimentary rocks

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR26-1	1. Rock Type: aphyric basalt clast from breccia: breccia contains large Px (up to 1 cm). 2. Size: 7x6x4cm 3. Shape/Angularity: subangular 4. Encrustations: covered by yellowish matrix of breccia 5. Vesicularity: <0.5% open, <<0.2mm 7. Matrix Color: dark grey where fresh, red along oxidation halo 8. Primary Minerals: aphyric 9. Secondary Minerals: Fe-Oxyhydroxide replaces matrix 10. Overall Degree of Alteration: medium overall, fresh on one side 11. Comment: only sample in this dredge suitable for geochemistry, possibly dating. Must stem from eroded lava layer and has been mixed with serpentinite clasts.	x	x								
DR26-2	1. Rock Type: serpentinite? With portrailly fresh greenish minerals. Recovered on rounded clast. 2. Size: 10x6x6cm 3. Shape/Angularity: rounded 4. Encrustations: Mn-spots 5. Vesicularity: plutonic rock 7. Matrix Color: brown orange 8. Primary Minerals: <3% fresh? Light green Px crystals, 1-2mm 9. Secondary Minerals: serpentinite? Making up most of the rock 10. Overall Degree of Alteration: very strongly altered 11. Comment: sample has been choosen because it is the only containing fresh Px	x									
DR26-3	1. Rock Type: serpentinite? With large altered Px-crystals, but preseved texture of dredge 2. Size: 11x7x5cm 3. Shape/Angularity: subangular clast 4. Encrustations: completely covered by thin <0.2mm Mn-crust 7. Matrix Color: yellowish-brown 8. Primary Minerals: 60% altered Px, brownish-yellow; probably Opx; remaining material possibly serpentinite with abundand intersecting micro veins filled with Mn 9. Secondary Minerals: see 8) 10. Overall Degree of Alteration: very strongly altered 11. Comment: but preserved texture in dredge	x									
DR26-4	1. Rock Type: similar to DR26-3 2. Size: 13x9x4cm 8. Primary Minerals: ca. 10% preserved Px minerals, light green	x									
DR26-5	1. Rock Type: serpentinite? 2. Size: 11x10x7cm 3. Shape/Angularity: rounded clast 4. Encrustations: spots of thin manganese <0.2mm 7. Matrix Color: light green 8. Primary Minerals: this rock entirely consists of light green minerals --> serpentinite? 9. Secondary Minerals: see 8) 10. Overall Degree of Alteration: very strongly altered										
DR26-6X	1. Rock Type: 5 pieces of serpentinite, similar to DR26-2 to 5, 6-12cm						x				
DR26-7S	1. Rock Type: semi solidified sediment light yellow, mudstone 2. Size: 10x8x6cm 3. Shape/Angularity: rounded clast 11. Comment: microfossils?								x		
DR26-8S	1. Rock Type: similar to DR26-7S but slightly more brownish matrix color 2. Size: 12x10x8cm								x		

SO199 - DR28
Southern Investigator Ridge
Dredge on bottom UTC 16/08/08 08:40hrs, lat 16°00,09'S, long 98°44,32'E, depth 4649m
Dredge off bottom UTC 16/08/08 10:06hrs, lat 16°00,08'S, long 98°29,89'E, depth 4290m
total volume: 1/3 full
Comments: Mn crusts with variuos magmatic clasts

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR28-1	1. Rock Type: fine grained igneous rock clast; possibly diabase or microgabbro 2. Size: 13x6x6cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn coating 5. Vesicularity: non vesicular 7. Matrix Color: grey where fresh, overall greenish grey 8. Primary Minerals: groundmass consists of Fsp und Px. Fsp appears +/- fresh, Px altered to green secondary mineral 9. Secondary Minerals: numerous veins crossed sample and are filled with Mn. When cracks become wider, space is also filled with Mn. 10. Overall Degree of Alteration: strongly altered 11. Comment: with respect to size and degreee of alteration this is the most useful sample. Extreme care needs to be taken to avoid Mn veins and fillings.	x	x								
DR28-2	1. Rock Type: similar to DR28-1, possibly slightly more fresh, check TS, too small to prepare GC-sample. 2. Size: 9x5x5cm 4. Encrustations: minor Mn coating on one side 11. Comment: one piece has small Mn coating on the side, carefully avoid during rock preparation	x									
DR28-3	1. Rock Type: similar to DR28-1; groundmass more strongly oxidized to red 2. Size: 12x8x6cm 10. Overall Degree of Alteration: very very strongly altered	x									
DR28-4	1. Rock Type: similar to DR28-1 2. Size: 11x7x4cm 10. Overall Degree of Alteration: very strongly altered	x									
DR28-5	1. Rock Type: similar to DR28-1 2. Size: 9x5x4cm 10. Overall Degree of Alteration: very strongly altered	x									
DR28-6	1. Rock Type: similar to DR28-1, clast from within Mn crust 2. Size: 3x3x2cm 11. Comment: saved for completeness but probably not useful for analyse										
DR28-7	1. Rock Type: aphyric lava fragment 2. Size: 8x6x3cm 3. Shape/Angularity: rounded, strongly fractured 4. Encrustations: slightly covered with Mn 5. Vesicularity: non vesicular 7. Matrix Color: light grey where fresh, orange brown where altered 8. Primary Minerals: small areas of the groundmass still appears fresh, overall aphyric 9. Secondary Minerals: Mn spots in groundmass. Mn and CC along veins, greenish mineral (chlorite?) filling spaces and cracks 10. Overall Degree of Alteration: strongly altered 11. Comment: although heavily altered a few fresh spots of the groundmass seems ok for geochemistry, to small to cut GC-sample	x									
DR28-8	1. Rock Type: serpentinite? Cataclasite= 2. Size: 5x5x4cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn coating 7. Matrix Color: greenish red 8. Primary Minerals: not visible except for green layers which could be serpentinite 10. Overall Degree of Alteration: very strongly altered 11. Comment: could be serpentinized ultramafic	x									
DR28-9	1. Rock Type: plutonic rock, serpentinized, peridotite? 2. Size: 8x7x6cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn coating 7. Matrix Color: greenish red 8. Primary Minerals: <8% partially fresh Px, might be ok for spot analyses 9. Secondary Minerals: serpentinite, altered Px 10. Overall Degree of Alteration: very strongly altered 11. Comment: only rock in dredge with plutonic texture	x									
DR28-10	1. Rock Type: mudstone, solidified 2. Size: 12x6x3cm 3. Shape/Angularity: rounded clast 4. Encrustations: a few Mn spots										

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR28-11M	1. Rock Type: two pieces of Mn crust 2. Size: 21x12x9cm, 3cm thick Mn 15x10x6cm, 3cm thick Mn									x	

SO199 - DR29
Seamount west of southern Investigator Ridge
Dredge on bottom UTC 16/08/08 19:46 hrs, lat 16° 33,87´S, long 98° 50,31´E, depth 5262m
Dredge off bottom UTC 16/08/08 21:12 hrs, lat 16° 34,17´S, long 98° 50,86´E, depth 4813m
total volume: few rocks
Comments: range from plutonic to volcanic rocks

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR29-1	1. Rock Type: holocrystalline intrusiva 2. Size: 22x20x10cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn crust 7. Matrix Color: greyish 8. Primary Minerals: Fsp 2-3 mm, fresh, ca. 20%, Px 3-4 mm, fresh, ca. 30 % 10. Overall Degree of Alteration: fresh	x	x	x?							
DR29-2	1. Rock Type: intrusive rock, similar to DR29-4 2. Size: 17x10x8cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn crust 7. Matrix Color: greyish-beige 8. Primary Minerals: Fsp laths up to 1 mm, appear fresh or altered, <1mm - 1mm, ca. 10%, Px up to 3mm, 20-30%, black interstitial phase, minor component 10. Overall Degree of Alteration: fresh to slightly altered 11. Comment: potential for dating	x	x	x?							
DR29-3	1. Rock Type: similar to 29-2 2. Size: 14x11x8cm 3. Shape/Angularity: subangular 7. Matrix Color: greyish-rusty brown 8. Primary Minerals: Ol =<1mm, irregularly distributed 5-15%, highly altered, Px up to 5mm laths 30% 10. Overall Degree of Alteration: slightly altered	x	x								
DR29-4	1. Rock Type: plutonic 2. Size: 18x11x15cm 3. Shape/Angularity: subangular 8. Primary Minerals: Ol fully altered 8% to 2mm, black interstitial min 20% to 2mm, translucent green-grey min10% to 1.5mm, white Fsp? 1% to 1.5mm 10. Overall Degree of Alteration: fresh except Ol and a few cracks 11. Comment: a 1.5cm layer richer in Ol on one side	x	x								
DR29-5	1. Rock Type: plutonic 2. Size: 8x8x6cm 3. Shape/Angularity: subangular 8. Primary Minerals: Ol fully altered 25% to 1.5mm, black intersttiial min 15% to 1mm, grey-green mineral 5% to 1.5mm, brown Fsp? 20% to 2mm 10. Overall Degree of Alteration: fresh except Ol	x	x								
DR29-6	1. Rock Type: plutonic 2. Size: 11x9x9cm 3. Shape/Angularity: subangular 8. Primary Minerals: Ol fully altered 10% to 2mm, translucent grey Fsp? 8% to 2mm, brown Px? 25%, black interstitial min 1% to 0.5mm, dark grey Fsp? (in darker mafic? veins) 5% to 1mm 10. Overall Degree of Alteration: some parts may be altered to smaller sized crystals but fresh except for Ol	x	x								
DR29-7	1. Rock Type: plutonic 2. Size: 7x7x6cm 3. Shape/Angularity: subrounded 8. Primary Minerals: dark brown min 20% to 2mm, dark grey min 30% to 3mm, black Px? 4% to 1mm, grey-green single crystal <1% to 1mm 10. Overall Degree of Alteration: cracks filled with Fe-oxide? Brown appears altered, rest appear fresh 11. Comment: sample is very dark and difficult to identify crystals within	x	x								
DR29-8	1. Rock Type: plutonic 2. Size: 16x10x10cm 3. Shape/Angularity: subangular 8. Primary Minerals: Ol fully altered 15% to 4mm, Px <1%to 2mm, translucent grey Fsp megacrysts? 5% to 20mm, dark grey Px? 4%to 2mm, brown Fsp? 2% to 4mm 10. Overall Degree of Alteration: fresh except Ol 11. Comment: similar to DR29-12 but less altered and cracked	x	x								

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR29-9	1. Rock Type: crystalline intrusive 2. Size: 15x10x6cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 8. Primary Minerals: Ol altered 20% to 1mm, translucent light green min 10% to 2mm, Px? 3% to 2mm 10. Overall Degree of Alteration: altered	x	x								
DR29-10	1. Rock Type: similar to DR29-9 2. Size: 15x10x7cm 8. Primary Minerals: Ol slightly altered 20% to 1mm, Px? 20% to 2mm 10. Overall Degree of Alteration: slightly altered	x	x								
DR29-11	1. Rock Type: similar to DR29-5 2. Size: 9x8x7cm	x	x								
DR29-12	1. Rock Type: similar to DR29-8 2. Size: 9x8x6cm	x									
DR29-13X	1. Rock Type: similar to DR29-12						x				
DR29-14X-16X	1. Rock Type: lightly altered fine crystalline subvolcanics						x				
DR29-17X-18X	1. Rock Type: serpentinites						x				
DR29-19X-20X	1. Rock Type: similar to DR29-9						x				
DR29-21X-22X	1. Rock Type: foliated coarse-crystalline variety of DR29-8						x				

SO199 - DR30
Small NNE/SSW trending ridge segment west of main Investigator Ridge, steep westward facing slope (>45°)
Dredge on bottom UTC 17/08/08 07:11 hrs, lat 16°46,99´S, long 98°47,12´E, depth 5060m
Dredge off bottom UTC 17/08/08 08:12 hrs, lat 16°47,04´S, long 98°47,50´E, depth 4586m
total volume: 1/5 full
Comments: pillows and pillow fragments

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR30-1	1. Rock Type: single pillow with fresh glassy margin 2. Size: 30x25x20 original size 3. Shape/Angularity: intact pillow; angular to rounded 4. Encrustations: Palagonite crust on the outside face, minor Mn coating 5. Vesicularity: <2% filled vesicles in the pillow interior; < 1mm in diameter 6. Vesicle Filling: Fe-Oxyhydroxide 7. Matrix Color: yellow-orange in crystallized part of the pillow 8. Primary Minerals: fresh glass preserved in pillow margin up to 3cm thick 9. Secondary Minerals: glass partially altered to Palagonite 10. Overall Degree of Alteration: whole rock pillow interior strongly altered, but abundant fresh glass preserved on chilled margins 11. Comment: this is the largest pillow with the thickest and best glass preservation from which numerous glassy margins have been cut off. Glass quality is good enough for spot analyses but larger quantities for Sr-Nd-Pb-Hf and rare gas isotopes should be also avbailable. Sample has been saved in glass box	x				x					
DR30-2	1. Rock Type: single pillow, similar to DR30-1 2. Size: 27x20x18 original size 11. Comment:: fresh glass rim up to 1-2cm	x				x					
DR30-3	1. Rock Type: single pillow, taken as intact piece, similar to DR30-1 2. Size: 17x15x9 8. Primary Minerals: glass rim up to 1cm and with thick tachylitic margin (3 cm).	x				x					
DR30-4	1. Rock Type: massive V-shaped pillow fragment without chilled margin, fairly fresh and heavy 2. Size: 30x16x11 3. Shape/Angularity: subangular 4. Encrustations: very minor Mn spots and thin <0.2mm surface weathering 5. Vesicularity: <1% vesicle, 0.5-1mm in diameter 6. Vesicle Filling: filled with light green Smectite 7. Matrix Color: light grey where fresh 8. Primary Minerals: aphyric groundmass consists of Fsp, Px and possibly Ol. 9. Secondary Minerals: groundmass Ol altered to Fe-Oxyhydroxide 10. Overall Degree of Alteration: medium altered; a few CC veins cross-cut sample but without alteration halo. 11. Comment: could represent a more primitive (tholeiitic?) melt of the lava suite sampled by this dredge	x	x	x							
DR30-5	1. Rock Type: similar to DR30-4, in places Ol still ± fresh. Overall less altered than DR30-4 2. Size: 9x7x5 11. Comment: check TS to decide which sample is best preserved	x	x	x							
SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES

DR30-6	1. Rock Type: similar to DR30-4, Ol altered to Iddingsite but no Smectite filling of vesicles. Sample is non-vesicular 2. Size: 10x8x5 11. Comment: check TS to decide which sample is best preserved	x	x	x?							
DR30-7	1. Rock Type: Lava fragment similar to DR30-4, but more strongly altered matrix. However Fsp mircrophenocrysts are visible; possibly to to more weathered character. Nontheless it could be a more evolved sample. Need to check TS to compare with other samples 2. Size: 14x12x8 3. Shape/Angularity: subangular 4. Encrustations: minor Mn spots 5. Vesicularity: non vesicular 7. Matrix Color: light brown 8. Primary Minerals: aphyric groundmass with <1% Fsp mircrophenocrysts of <1mm diameter 9. Secondary Minerals: matrix strongly oxidized 10. Overall Degree of Alteration: strongly altered 11. Comment: sample has been saved due to Fsp microphenocrysts for dating	x	x	x?							
DR30-8	1. Rock Type: similar to DR30-7 2. Size: 20x9x89	x	x	x?							
DR30-9X	1. Rock Type: 5 pieces with glassy pillow margins						x				
DR30-10X	1. Rock Type: 1 piece of cut whole rock pillow similar to DR30-7, chilled margin preserved but without glass						x				
DR30-11X	1. Rock Type: 2 pieces of uncut pillow fragments, 10cm diameter						x				

SO199 - DR31
Southern Investigator Ridge, southwest facing slope along lower section
Dredge on bottom UTC 17/08/08 21:01hrs, lat 17°35,09´S, long 99°07,01´E, depth 5361m
Dredge off bottom UTC 17/08/08 22:24hrs, lat 17°34,93´S, long 99°08,39´E, depth 4947m
total volume: few rocks
Comments: volcanic and sedimentary rocks

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR31-1	1. Rock Type: volcanic sample, aphyric 2. Size: 9x7x6cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 7. Matrix Color: greyish-beige 9. Secondary Minerals: Mn and Fe hydroxides 10. Overall Degree of Alteration: lightly altered	x	x								
DR31-2	1. Rock Type: volcanic sample 2. Size: 10x7x6cm 3. Shape/Angularity: subrounded 4. Encrustations: minor Mn crust 7. Matrix Color: yellowish-brown 8. Primary Minerals: very alterd Ol? phenocrysts 1-2% to 1mm 9. Secondary Minerals: Mn and Fe hydroxides in subparallel banding 10. Overall Degree of Alteration: lightly altered 11. Comment: lava flow	x									
DR31-3X-4X	1. Rock Type: highly altered volcanic samples with 2mm Zeolites probably replacing phenocrysts						x				
DR31-5X	1. Rock Type: muddy sediment cemented with Mn and Fe hydroxides						x				

SO199 - DR35
"Rudolf" seamount east of the Investigator Ridge, upper northerneastern slope just below plateau rim
Dredge on bottom UTC 21/08/08 20:31hrs, lat 10°18,69'S, long 99°29,43'E, depth 3084m
Dredge off bottom UTC 21/08/08 22:26hrs, lat 10°18,69'S, long 99°29,53'E, depth 3060m
total volume: one rock
Comments: freshly broken pillow lava

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR35-1	1. Rock Type: pillow, dense, aphanitic 2. Size: 39x23x22cm 3. Shape/Angularity: angular fragment 4. Encrustations: minor Mn crust 7. Matrix Color: mostly brownish, few areas are still grey 8. Primary Minerals: very small microphenocrysts, probably Fsp 9. Secondary Minerals: Mn-Fe hydroxide overgrowth, CC filled cracks 10. Overall Degree of Alteration: mostly altered 11. Comment: glassy margins of pillows are altered, hydrated.										
DR35-1A	1. Rock Type: fragment of pillow above, freshest 2. Size: 13x11x5cm 7. Matrix Color: grey in centre, otherwise brown	x	x								

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR35-1B	1. Rock Type: fragment of pillow above, fresh 2. Size: 16x13x7cm 7. Matrix Color: grey too but less than sample 1A	x	x								
DR35-1C	1. Rock Type: like DR35-1B 2. Size: 12x8x8cm										
DR35-1D	1. Rock Type: like DR35-1B 2. Size: 17x11x9cm										
DR35-1X	1. Rock Type: ARCHIVE fragment of pillow DR35-1						x				

SO199 - DR36
"Rudolf" seamount, west facing slope of circular cone on the plateau of the guyot
Dredge on bottom UTC 22/08/08 01:24hrs, lat 10°21.10'S, long 99°29,82'E, depth 2548m
Dredge off bottom UTC 22/08/08 02:25hrs, lat 10°21,12'S, long 99°30,27'E, depth 2230m
total volume: a few rocks
Comments: lava fragments and volcanoclastics with thick Mn crust

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR36-1	1. Rock Type: lava fragment 2. Size: 18x15x8cm 3. Shape/Angularity: rounded 4. Encrustations: Mn 28mm on one side 5. Vesicularity: 10% 6. Vesicle Filling: mostly empty but some lined with CC and/or Zeolites 7. Matrix Color: dark brown with minor dark grey patches 8. Primary Minerals: altered Ol 3% to 5mm, minor Fsp needles 10. Overall Degree of Alteration: altered 11. Comment: potential for dating fresh areas, coated with sediment , which is inundated by Mn and Fe hydroxides	x	x	x?							
DR36-2	1. Rock Type: lava fragment 2. Size: 22x14x11cm 3. Shape/Angularity: subrounded 4. Encrustations: Mn 20mm 5. Vesicularity: 7-10% 6. Vesicle Filling: mostly empty but some lined with CC and/or Zeolites 7. Matrix Color: brown with minor grey 8. Primary Minerals: Ol 3% to 5mm, minor Fsp needles, both altered 10. Overall Degree of Alteration: altered 11. Comment: coated with sediment	x	x								
DR36-3	1. Rock Type: lava fragment similar to DR36-1 2. Size: 17x13x8cm 4. Encrustations: Mn up to 32mm 5. Vesicularity: 5% 6. Vesicle Filling: CC 7. Matrix Color: brown 8. Primary Minerals: altered Ol 10. Overall Degree of Alteration: pervasively altered 11. Comment: sample consists of 2 x 3cm-sized lava fragments and sediment, which is inundated by Mn and Fe hydroxides										
DR36-4M	1. Rock Type: carbonaceous sediment with thick Mn crust and volcaniclastic particles that are similar to those in DR36-5C 2. Size: 44x35x22cm 3. Shape/Angularity: subangular-irregular 4. Encrustations: Mn crust up to 3cm 10. Overall Degree of Alteration: highly altered and inundated with Mn and Fe hydroxides									x	
DR36-5C	1. Rock Type: heterolithic volcaniclastics 2. Size: 30x22x18cm 3. Shape/Angularity: angular 4. Encrustations: Mn crust up to 2cm 5. Vesicularity: variable - 0 to 50% 6. Vesicle Filling: mostly CC but some empty 7. Matrix Color: light brown and cream of pelagic ooze 8. Primary Minerals: Ol 10. Overall Degree of Alteration: highly altered and prevasive Mn and Fe hydroxide overgrowth 11. Comment: very loosely packed matrix-supported clasts. Clasts are 2-30mm, subrounded, of various basaltic composition and pumiceous with no bedding or clast orientation - epiclastic debris flow deposit							x			
DR36-6X to 9X	1. Rock Type: ARCHIVE highly altered lava fragments 11. Comment: set in sediment, inundated by Mn-Fe-hydroxides						x				

SO199 - DR37
"Scrooge" seamount south of "Rudolf", east of Investigator Ridge, cone in northern top area
Dredge on bottom UTC 22/08/08 8:30 hrs, lat 10°40,06`S, long 99°34,46`E, depth 2475m
Dredge off bottom UTC 22/08/08 9:36 hrs, lat 10°40,06`S, long 99°34,96`E, depth 2272m
total volume: few rocks
Comments: carbonate

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR37-1S	1. Rock Type: carbonate 2. Size: 27x17x10 3. Shape/Angularity: angular 4. Encrustations: minor Mn crust 5. Vesicularity: white, micritic 10. Overall Degree of Alteration: Mn-Fe-hydroxides in vade 11. Comment: diam 1cm worm barrows										

SO199 - DR38
Large cone on the lower southern flank of "Rudolf" seamount, lower eastern flank
Dredge on bottom UTC 22/08/08 19:57hrs, lat 10°31,14`S, long 99°31,70`E, depth 4381m
Dredge off bottom UTC 22/08/08 21:02hrs, lat 10°31,03`S, long 99°32,21`E, depth 3853m
total volume: empty
Comments: --

SO199 - DR39
"Rudolf" seamount, SW flank below plateau edge
Dredge on bottom UTC 22/08/08 19:57hrs, lat 10°21,95`S, long 99°29,18`E, depth 3100m
Dredge off bottom UTC 22/08/08 21:02hrs, lat 10°21,79`S, long 99°29,55`E, depth 2711m
total volume: 1 rock
Comments: carbonate crust

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR39-1S	1. Rock Type: Carbonate 2. Size: 31x28x16cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn crust, micrite with bioclasts (shells of gastropods, bivalves, corals) an Mn-clasts of 1-3mm size and few volcanic pebbles, highly altered, 1-10mm 5. Vesicularity: white-greyish 10. Overall Degree of Alteration: thin Mn-crust outside, Mn also invades, matrix dendritic								x		

SO199 - DR40
"Grinch" Ridge, west facing slope beneath small cone of this NW-SE elongated ridge
Dredge on bottom UTC 23/08/08 14.54hrs, lat 10°45,92'S, long 101°48,73'E, depth 4306m
Dredge off bottom UTC 23/08/08 16:20hrs, lat 10°45,90'S, long 101°49,26'E, depth 3791m
total volume: 1/4 full
Comments: pillow lava fragments, volcaniclastic rocks and Mn crusts

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR40-1	1. Rock Type: pillow ? Lava fragment 2. Size: 17x13x10cm 3. Shape/Angularity: rounded 4. Encrustations: minor Mn-coating <0.2mm 5. Vesicularity: 5% large vesicles 2-5mm mostly open, some filled with Fe-Oxyhydroxideor lined with Zeolites, small unfilled vesicles in groundmass up to 0.2mm , rounded to oval shaped vesicles 6. Vesicle Filling: see 5. 7. Matrix Color: light grey appears quite fresh 8. Primary Minerals: 2-3% Fsp phenocrysts, 1-2mm, +/- fresh 9. Secondary Minerals: Fe-Oxyhydroxide fillings of the vesicles 10. Overall Degree of Alteration: slightly to medium altered 11. Comment: this sample and DR40-2 are the minority lithology of this dredge but certain Fsp phenocrysts that are suitable for dating, possibly Amph	x	x	x							
DR40-2	1. Rock Type: similar to DR40-1, originally one large single piece 2. Size: 30x25x17cm 4. Encrustations: up to 1-2cm Mn-crust 5. Vesicularity: 3% vesicles <1mm, open some filled with Fe-Oxyhydroxide size distribution homogeneous in contrast to DR40-1 7. Matrix Color: dark grey where fresh, light brown when altered 10. Overall Degree of Alteration: medium altered 11. Comment: sample is the largest of the Fsp phyric rocks in this dredge. In addition to GC piece 3 more pieces have been saved for Fsp separation. On one piece breccia with yellow matrix attached	x	x	x							

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR40-3	1. Rock Type: pillow lava, single large piece 40x40x40cm 2. Size: 17x15x11cm piece for working half. Three additional pieces saved in archive 4. Encrustations: 1cm mn-crust 5. Vesicularity: 10% vesicles 2-15mm, open but lined with yellowish material (Fe-Oxyhydroxide?), rounded vesicles 7. Matrix Color: light grey 8. Primary Minerals: aphyric 9. Secondary Minerals: minor Mn lining of vesicles 10. Overall Degree of Alteration: medium altered 11. Comment: This rock type represents the major lithology of this dredge. Aphyric vesicular pillow lava.	x	x	x?							
DR40-3X	1. Rock Type: 3 pieces of sample DR40-3, backup material						x				
DR40-4	1. Rock Type: similar to DR40-3 2. Size: 18x13x13cm	x	x								
DR40-5	1. Rock Type: similar to DR40-3, but vesicles are strongly elongated, 15:2mm aspect ratio	x									
DR40-6C	1. Rock Type: heterolithic lapilli tuff 2. Size: 13x12x7cm 3. Shape/Angularity: subrounded 4. Encrustations: Mn crust up to 10mm 5. Vesicularity: variable 10-30% 6. Vesicle Filling: mostly empty 7. Matrix Color: white-light green carbonate (micrite) 9. Secondary Minerals: Mn and Fe hydroxides as rims around clasts and patches in matrix 10. Overall Degree of Alteration: altered 11. Comment: clasts blocky and angular, randomly oriented, matrix supported, few splinter-shaped smaller clasts. Clasts greenish and brown - two types <1-30mm	x						x			
DR40-7C	1. Rock Type: contact zone of pillow margin and yellow-green volcanoclastic material - pillow, similar to DR40-3 2. Size: 14x9x9cm 3. Shape/Angularity: irregular 4. Encrustations: minor Mn crust 10. Overall Degree of Alteration: altered 11. Comment: tuff is light green, very fine grained, highly altered, massive material, possibely more evolved composition and altered with Mn and Fe hydroxides. Pillow margin appears to peel off thin flakes which are incorporated in the tuff material	x						x			
DR40-8X	1. Rock Type: 3 seperate pieces, cut in half similar to DR40-3 (line 2275)						x				
DR40-9X to13X	1. Rock Type: aphanitic vesicular basalt						x				

SO199 - DR41
Mt Melchior seamount, 25km east of Grinch seamounts, West facing slope beneath south extending ridge on the south flank
Dredge on bottom UTC 23/08/08 23:20hrs, lat 10°45,52'S, long 102°10,85'E, depth 3754m
Dredge off bottom UTC 24/08/08 00:52hrs, lat 10°45,67'S, long 102°11,49'E, depth 3282m
total volume: 1/4 full
Comments: Lavas, volcaniclastic rocks, Mn crusts, carbonate

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR41-1	1. Rock Type: lava fragment 2. Size: 20x13x9cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn crust 5. Vesicularity: 15-25% 6. Vesicle Filling: mostly empty or lined with Zeolites 7. Matrix Color: greyish brown 8. Primary Minerals: altered Ol 3% up to 3mm, alterd Fsp? 3-5% 10. Overall Degree of Alteration: altered 11. Comment: increasing vesicle size beneath glass rim, possibly Amph	x	x	x?							
DR41-2	1. Rock Type: pillow fragment 2. Size: 29x38x33cm 3. Shape/Angularity: subrounded 4. Encrustations: minor Mn crust to 2mm 5. Vesicularity: 10-15% 6. Vesicle Filling: half empty otherwise Zeolite 7. Matrix Color: grey 8. Primary Minerals: alterd Ol 10-15% to 4mm 10. Overall Degree of Alteration: altered	x	x								

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR41-3	1. Rock Type: lava fragment 2. Size: 24x20x6cm 3. Shape/Angularity: subrounded 4. Encrustations: Mn crust 5. Vesicularity: 10% 6. Vesicle Filling: 70% Zeolite, 30% empty 7. Matrix Color: grey 8. Primary Minerals: altered Ol 7% up to 3mm 10. Overall Degree of Alteration: altered 11. Comment: attached small altered clasts	x	x								
DR41-4	1. Rock Type: lava fragment 2. Size: 10x8x8cm 3. Shape/Angularity: subrounded 5. Vesicularity: 20-25% 6. Vesicle Filling: mostly empty but some filled with Zeolites 7. Matrix Color: brown to dark grey 8. Primary Minerals: altered Ol 7% to 2mm 10. Overall Degree of Alteration: altered	x									
DR41-5	1. Rock Type: lava fragment 2. Size: 16x10x8cm 3. Shape/Angularity: subrounded 4. Encrustations: Mn crust to 10mm 5. Vesicularity: 10% 6. Vesicle Filling: empty except some Zeolites 7. Matrix Color: brownish-grey 8. Primary Minerals: altered Ol 7% to 2mm 10. Overall Degree of Alteration: altered 11. Comment: Zeolites concentrated along a crack	x									
DR41-6	1. Rock Type: similar to DR41-5 2. Size: 14x2x10cm 8. Primary Minerals: altered Ol 10% to 3mm 11. Comment: more cracks	x									
DR41-7	1. Rock Type: similar to DR41-1 2. Size: 16x25x20cm 6. Vesicle Filling: mostly empty, several differently filled in layers of Zeolites 8. Primary Minerals: altered Ol 15% to 2mm	x	x								
DR41-8	1. Rock Type: similar to DR41-1 2. Size: 8x7x5cm 4. Encrustations: Mn crust to 1mm 5. Vesicularity: 25% 6. Vesicle Filling: mostly empty except Zeolite	x									
DR41-9	1. Rock Type: similar to DR41-4 2. Size: 16x12x11cm 3. Shape/Angularity: subrounded 5. Vesicularity: 7% 6. Vesicle Filling: mostly empty except Zeolite 7. Matrix Color: brown-grey 8. Primary Minerals: altered Ol 5% to 2mm 10. Overall Degree of Alteration: altered 11. Comment: cracks running through filled with Zeolites										
DR41-10C	1. Rock Type: heterolithic lapilli tuff 2. Size: 65x42x14cm 3. Shape/Angularity: slab 4. Encrustations: Mn crust 2-5mm 5. Vesicularity: 10-30% 6. Vesicle Filling: Zeolites 7. Matrix Color: cream matrix non-calcareous 8. Primary Minerals: oli highly altered 1-2% in a few of the larger clasts 10. Overall Degree of Alteration: altered, espacially the smaller clasts 11. Comment: clasts blocky angular <1-25mm, closely packed, bubble wall shards possibly, faint clast orientation horizontally, z layers separated by a 5mm irregular layer of pelagic ooze, cemented with Zeolites, Palagonite and Mn-Fe-hydroxides	x						x			
DR41-11C	1. Rock Type: heterolithic coarse lapilli tuff similar to DR31-10C 2. Size: 28x16x10cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn crust 7. Matrix Color: matrix formed by very closely packed fine ash, possibly bubble wall shards, highly altered 11. Comment: clasts 5-60mm, subangular blocks of lava as in this dredge, very loosely packed matrix-supported, randomly oriented massive	x						x			
DR41-12C	1. Rock Type: similar to DR41-11C 2. Size: 17x9x6cm 11. Comment: clasts up to 25mm							x			

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR41-13S	1. Rock Type: micritic carbonate with worm burrows 2. Size: 18x15x8cm 3. Shape/Angularity: subrounded 4. Encrustations: minor Mn crust 7. Matrix Color: white-grey micrite 9. Secondary Minerals: Mn-Fe-hydroxides invade into the sediment 10. Overall Degree of Alteration: slightly altered								x		

SO199 - DR42
"Lucia", western lower slope of guyot-like seamount
Dredge on bottom UTC24/08/08 07:21 hrs, lat 11°01,78'S, long 102°18,23'E, depth 3963m
Dredge off bottom UTC 24/08/08 08:47 hrs, lat 11°01,55'S, long 102°18,74'E, depth 3441m
total volume: a few rocks
Comments: lava and volcaniclastic rocks

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR42-1	1. Rock Type: lava fragment, banded 2. Size: 9x8x4cm 3. Shape/Angularity: subrounded 4. Encrustations: almost no alteration or encrustation 5. Vesicularity: 5-25% banded layers 6. Vesicle Filling: mostly empty, some filled with CC 7. Matrix Color: dark grey to brownish 8. Primary Minerals: Ol, up to 3mm, altered Fsp or Foides (Nepheline) up to 5mm appears fresh --> dating 3% 10. Overall Degree of Alteration: fresh 11. Comment: fresh dense groundmass and empty vesicles, potential for dating, possibly Amph	x	x	x?							
DR42-2	1. Rock Type: similar to DR42-1 2. Size: 9x6x6cm 5. Vesicularity: 10-15% 6. Vesicle Filling: many filled with zeolites	x	x								
DR42-3	1. Rock Type: similar to DR42-1, homogeneous vesicularity 2. Size: 21x14x10cm 5. Vesicularity: 15% 6. Vesicle Filling: empty 8. Primary Minerals: ol 2mm altered 1-2%; Fsp/Foides up to 12mm 7-10%; Px up to 2mm ca. 1%	x	x								
DR42-4	1. Rock Type: similar to DR42-3 2. Size: 18x9x5cm	x									
DR42-5	1. Rock Type: similar to DR42-3 2. Size: 11x8x5cm 8. Primary Minerals: Fsp/Foides up to 15mm										
DR42-6	1. Rock Type: similar to DR42-3 2. Size: 11x9x4cm 5. Vesicularity: 10% 6. Vesicle Filling: empty, small vesicles										
DR42-7	1. Rock Type: similar to DR42-3 2. Size: 12x8x6cm										
DR42-8	1. Rock Type: similar to DR42-3 2. Size: 12x9x6cm										
DR42-9C	1. Rock Type: heterolithic lapilli tuff 2. Size: 22x14x8cm 3. Shape/Angularity: roundish 4. Encrustations: very minor Mn-crust 5. Vesicularity: dense to ca. 30% 6. Vesicle Filling: filled with Zeolites 7. Matrix Color: cream muddy matrix, soft 8. Primary Minerals: same lithology as DR42-1 to DR42-8 10. Overall Degree of Alteration:slightly altered 11. Comment: clasts angular, blocky, <1-25mm matrix-supported, randomly oriented							x			
DR42-10C	1. Rock Type: closely packed, monomict well sorted lapilli tuff 2. Size: 7x6x4cm 3. Shape/Angularity: subangular 5. Vesicularity: 2% 6. Vesicle Filling: empty 7. Matrix Color: open pore space Zeolite cement 9. Secondary Minerals: very little Mn-Fe-Hydroxides 10. Overall Degree of Alteration: altered reddish 11. Comment: clasts very closely packed, 1-5mm, blocky angular, well-sorted, randomly oriented	x						x			

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR42-11C	1. Rock Type: heterolithic lapilli tuff 2. Size: 8x8x3cm 3. Shape/Angularity: slab 4. Encrustations: 1cm Mn-crust on one side 7. Matrix Color: cream ooze 10. Overall Degree of Alteration: altered 11. Comment: closely packed, poorly sorted, <1-30mm, lithology of this dredge, blocky splinter shaped, angular, too small for further work							x			
DR42-12 to 20X	1. Rock Type: similar to DR42-1 to DR42-8: small and larger vesicular phenocrystic lava, vesicles partly filled.						x				

SO199 - DR44

"Attention" Seamount SW corner on W facing slope of a SW trending ridge

Dredge on bottom UTC25/08/08 00:46 hrs, lat 11°46,51'S, long 103°14,48'E, depth 2525m

Dredge off bottom UTC 25/08/08 02:09 hrs, lat 11°46,52'S, long 103°15,07'E, depth 3036m

total volume: very few rocks

Comments: 1 piece of lava, Mn and carbonate crusts

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR44-1	1. Rock Type: lava fragment 2. Size: 8x7x5cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn crust 7. Matrix Color: dark grey to brownish 8. Primary Minerals: 1% Foides, elongate up to 2 mm, Px/Amph? Up to 2mm, appear fresh, 1% altered Ol 10. Overall Degree of Alteration: fresh-ish 11. Comment: if Amphibole: potential for dating	x	x	x?							
DR44-2S	1. Rock Type: carbonate 2. Size: 17x13x16cm 3. Shape/Angularity: slab 4. Encrustations: 3mm Mn crust on one side 7. Matrix Color: white 9. Secondary Minerals: pervasive Mn-Fe hydroxide overgrowth 10. Overall Degree of Alteration: altered 11. Comment: micritic carbonate sediment with worm burrows								x		

SO199 - DR45

"Glögg" Seamount NE or DR44; small valley on westward facing slope, steepest section in this area

Dredge on bottom UTC25/08/08 08:15 hrs, lat 11°39,77'S, long 103°32,01'E, depth 3746m

Dredge off bottom UTC 25/08/08 09:47 hrs, lat 11°39,56'S, long 103°32,56'E, depth 3277m

total volume: some rocks

Comments: tuffaceous rocks or highly vesicular lava?

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR45-1	1. Rock Type: highly vesicular lava? or tuff?; very light of probably tephritic to phonolitic composition 2. Size: 30x25x18cm 3. Shape/Angularity: subangular clast 4. Encrustations: 2mm Mn crust 5. Vesicularity: 15% vesicles or pore space 6. Vesicle Filling: open 7. Matrix Color: dark grey groundmass with slight greenish touch 8. Primary Minerals: 1% Fsp or Foides, 2-4mm, fresh 10. Overall Degree of Alteration: very slightly altered 11. Comment: described as last sample, considered freshest sample after all other other rocks have been cut earlier. DR45-6 is quite similar. Both have dark grey groundmass and the largest Fsp or Foides pheoncrysts. In principle the dredge consists of tuff ? or a tuffaceous lava with a) dark grey groudmass, b) green groundmass and c) light grey groundmass which could reflect different degrees of alteration	x	x	x?							

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR45-2	1. Rock Type: overall similar to DR45-1 but with green groudmass; difficult to state whether this is a tuff or lava 2. Size: 15x12x11cm 3. Shape/Angularity: subangular to rounded 4. Encrustations: minor Mn coating 5. Vesicularity: 20-25% vesicularity, irregular shape of individual "vesicles", 0.2-0.5mm. Not clear whether these are true vesicles from degassing or pore space in between grains 6. Vesicle Filling: open, in places lined with yellowish material 7. Matrix Color: dark green groundmass 8. Primary Minerals: 1-2% Fsp or Foides, 1-2mm, appear fresh 9. Secondary Minerals: 10% black spots without mineral cleavage and through going groundmass vesicularity; probably Mn spots 10. Overall Degree of Alteration: strongly altered 11. Comment: requires TS to identify nature of this rock	x	x?	x?							
DR45-3	1. Rock Type: similar to DR45-2 2. Size: 14x10x7cm 3. Shape/Angularity: subangular clast 4. Encrustations: minor Mn coating 8. Primary Minerals: 2-3% Fsp or Foides up to 3mm 9. Secondary Minerals: less Mn spotting than DR45-2 10. Overall Degree of Alteration: medium to strongly altered	x	x	x?							
DR45-4	1. Rock Type: similar to DR45-2 2. Size: 18x10x9cm 3. Shape/Angularity: subangular clast 4. Encrustations: thin < 0.5mm Mn coating 8. Primary Minerals: 1-2% Fsp, < 2mm 9. Secondary Minerals: 7-10% Mn spots 10. Overall Degree of Alteration: medium to strongly altered	x	x	x?							
DR45-5	1. Rock Type: similar to DR45-2 but with thick Mn crust, 12mm 2. Size: 17x10x10cm 11. Comment: several pieces of this dredge have 1-2cm thick Mn crusts, reflecting longer exposure time; unlcear whether this is due to overall age or simply reflects being on top of the rubble pile	x	x	x?							
DR45-6	1. Rock Type: similar to DR45-1 but more strongly altered at rim to yellow-brown 2. Size: 16x14x11cm 10. Overall Degree of Alteration: slightly more altered than DR45-1	x	x	x?							
DR45-7	1. Rock Type: light grey vesicular lava; although similar in texture to samples with green groundmass this sample resembles closes to lava 2. Size: 11x7x6cm 3. Shape/Angularity: subangular clast 4. Encrustations: minor Mn spots and coating 5. Vesicularity: 20% open vesicles, roundish but not irregular shaped as in green groundmass samples, 0.1-0.4mm in diameter 6. Vesicle Filling: open 7. Matrix Color: light grey groundmass 8. Primary Minerals: 1% Fsp or Foides, 1-2mm, fresh 10. Overall Degree of Alteration: slightly altered 11. Comment: the main difference to the previous samples is the light grey groundmass color. Textures and vesicularity are quite similar.	x	x	x?							
DR45-8	1. Rock Type: similar to DR45-7 2. Size: 15x10x9cm 3. Shape/Angularity: angular clast 4. Encrustations: minor Mn coating 7. Matrix Color: light grey groundmass 8. Primary Minerals: 1% Fsp or Foides, 1-2mm, fresh 10. Overall Degree of Alteration: slightly altered	x	x								
DR45-9	1. Rock Type: similar to DR45-7 2. Size: 13x8x8cm 3. Shape/Angularity: subangular to rounded clast 4. Encrustations: minor Mn coating 10. Overall Degree of Alteration: slightly to medium altered	x	x								
DR45-10	1. Rock Type: similar to DR45-7 2. Size: 21x9x6cm 3. Shape/Angularity: rounded clast 4. Encrustations: 0.5-1cm Mn crust# 10. Overall Degree of Alteration: medium altered	x	x								
DR45-11	1. Rock Type: similar to DR45-7, bur most altered samples of the grey groundmass group 2. Size: 14x7x6cm	x	x								
DR45-12M	1. Rock Type: Mn crust, 3-4cm thick									x	
DR45-13X	1. Rock Type: 3 smaller pieces similar to DR45-2 to-4, 10-15cm diameter						x				
DR45-14X	1. Rock Type: 1 piece similar to DR45-5, 25cm diameter						x				
DR45-15X	1. Rock Type: 1 piece similar to DR45-6, 20cm diameter						x				
DR45-16X	1. Rock Type: 2 pieces similar to DR45-7 to-11, 10 cm diameter						x				

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR45-17X	1. Rock Type: two pieces from breccia, two individual clasts, one similar to DR45-7 (grey matrix), the other similar to DR45-2 (green matrix)						x				

SO199 - DR46
"Mt Halley" Seamount; NW corner of ridge-like seamount
Dredge on bottom UTC25/08/08 18:56 hrs, lat 10°54,91'S, long 103°37,00'E, depth 4361m
Dredge off bottom UTC 25/08/08 20:28 hrs, lat 10°55,30'S, long 103°37,44'E, depth 3769m
total volume: 1/5 full
Comments: volcaniclastica, fine grained sandstone, pillow fragments, some within sediments and volcaniclastica

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR46-1	1. Rock Type: lava fragment 2. Size: 16x12x11cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 5. Vesicularity: 15%, up to 20mm 6. Vesicle Filling: mostly empty, some big elongated with CC 7. Matrix Color: greyish-brown 8. Primary Minerals: altered Ol: 20%, up to 2mm, Fsp 10. Overall Degree of Alteration: medium altered 11. Comment: fresh Fsp, potential for dating	x	x	x?							
DR46-2	1. Rock Type: similar to DR46-1 2. Size: 19x9x7cm 5. Vesicularity: up to 15%, up to 10mm 6. Vesicle Filling: empty	x	x	x?							
DR46-3	1. Rock Type: similar to DR46-1 2. Size: 13x12x10cm 5. Vesicularity: 10%, some elongated big ones (20mm) 8. Primary Minerals: altered Ol: 20%, up to 10 mm; Fsp: 10% up to 1mm	x	x	x?			x				
DR46-4	1. Rock Type: lava fragment 2. Size: 10x10x9cm 3. Shape/Angularity: subrounded 4. Encrustations: minor Mn crust 5. Vesicularity: 5%, concentrated along the rim 6. Vesicle Filling: 50% empty, 50% filled with CC 7. Matrix Color: brownish-grey 8. Primary Minerals: altered Ol: 20%, up to 3mm; Fsp: 15%, up to 1mm; Foides?: up to 4mm 10. Overall Degree of Alteration: medium altered 11. Comment: fresh Fsp potential for dating; freshest piece of the Ol-Fsp phyric basalts; attached volcanic clastics: heterolithics; matrix supported clasts <1-20mm, matrix is white foram ooze	x	x	x?							
DR46-5	1. Rock Type: lava fragment 2. Size: 11x6x4cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 5. Vesicularity: 25% 6. Vesicle Filling: some empty, some filled with CC 7. Matrix Color: grey 8. Primary Minerals: fresh groundmass consists of mircocristalline Fsp; Px or amph?: 1-2% 10. Overall Degree of Alteration: slightly altered, groundmass rel. fresh	x									
DR46-5B	1. Rock Type: similar to DR46-5, however larger; discovered later in dredge but prior to DR48 2. Size: 11x6x4cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 5. Vesicularity: 25% 6. Vesicle Filling: some empty, some filled with CC 7. Matrix Color: grey 8. Primary Minerals: fresh groundmass consists of mircocristalline Fsp; Px or Amph?: 1-2% 10. Overall Degree of Alteration: slightly altered, groundmass rel. Fresh	x									
DR46-6	1. Rock Type: pillow? lava fragment 2. Size: 14x11x9cm 3. Shape/Angularity: subrounded 4. Encrustations: minor Mn crust 5. Vesicularity: 25% 6. Vesicle Filling: 50% empty, 50% filled with CC 7. Matrix Color: grey 8. Primary Minerals: fresh groundmass consists of mircocristalline Fsp; Px or Amph?: 1cm phenocryst 10. Overall Degree of Alteration: in general strongly altered, but groundmass appears rel. fresh in places 11. Comment: lithology similar to DR46-5	x	x?				3 pc				

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR46-7C	1. Rock Type: lapilli tuff, reddish 2. Size: 22x16x9cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 5. Vesicularity: 2-5% 6. Vesicle Filling: Zeolites 7. Matrix Color: open pore space, Zeolites, Mn-Fe-hydroxides 8. Primary Minerals: Fsp, Ol, altered 10. Overall Degree of Alteration: reddish coloration, altered 11. Comment: closely packed, poorly sorted, randomly sorted <1-5mm angular blocky clasts, outliers up to 35mm, monomict, probably basaltic, subaerial?	x						x			
DR46-8C	1. Rock Type: coarser lapilli tuff 2. Size: 12x7x7cm 3. Shape/Angularity: irregular rounded 4. Encrustations: minor Mn crust 5. Vesicularity: 2-5% 6. Vesicle Filling: mostly empty, Zeolites 8. Primary Minerals: aphanitic with minor altered Fsp laths 10. Overall Degree of Alteration: altered yellowish (palagonite) 11. Comment: open pore space, hanging calcite cement, Mn-Fe-hydroxides encrusting individual clasts; clasts <1-5mm, subangular, blocky, monomict with rare rip-up clasts of vesicular dark brown lava 15mm, faint clast orientation							x			
DR46-9C	1. Rock Type: bedded lapilli tuff 2. Size: 17x11x9cm 3. Shape/Angularity: irregular-subangular 4. Encrustations: minor Mn crust 5. Vesicularity: 2% 6. Vesicle Filling: Zeolites 8. Primary Minerals: apharitic 10. Overall Degree of Alteration: yellowish altered, Mn-Fe-patches 11. Comment: bedding 2-5cm with sharp basal contacts, normal grading, slightly wavy/oblique contacts, clasts up to 5mm, angular blocky, faintly aligned, monomict, closely packed	x					x	x			
DR46-10C	1. Rock Type: fine lapilltuff to course ash, similar to DR46-9C 2. Size: 12x10x10cm 4. Encrustations: up to 1cm on one side Mn crust 11. Comment: massive, clasts <1-3mm							x			
DR46-11C	1. Rock Type: lapilltuff, thick normally graded 2. Size: 17x11x9 11. Comment: over 12cm normally graded from 5mm to fine ash							x			
DR46-12C	1. Rock Type: large basalt clasts, similar to DR46-4 coated with volcaniclastic material 2. Size: 9x6x5cm 11. Comment: volcaniclastics consist of 8mm thick layer, coarse ash similar to DR46-10C	x	x					x			
DR46-13X	1. Rock Type: 10 pieces up to 10cm similar to DR46-1 to 4						x				
DR46-14C	1. Rock Type: massive lapilli tuff, reddish, similar to DR46-7C 2. Size: 12x9x5cm 3. Shape/Angularity: irregular 4. Encrustations: minor Mn crust 7. Matrix Color: CC or Zeolite cement, no open pore space 11. Comment: clast size <1-3mm	x						x			
DR46-15C	1. Rock Type: similar to DR46-14C 2. Size: 11x7x6 3. Shape/Angularity: round 11. Comment: bedding & interbedded pelagic ooze							x			
DR46-16	1. Rock Type: lava fragment; similar to DR46-1 to -4 2. Size: 10x6x6 3. Shape/Angularity: irregular 4. Encrustations: a few mm Mn crust 5. Vesicularity: 5% coarse vesicles 6. Vesicle Filling: lined with Zeolites 7. Matrix Color: grey-brown 8. Primary Minerals: Fsp/Foides needles & laths, 10%, fresh; Ol altered 1% 10. Overall Degree of Alteration: sligthla altered 11. Comment: potential for dating	x	x	x?							
DR46-17X to 27X	1. Rock Type: bedded volcaniclastica etc.						x				

SO199 - DR48
"Balthazar" Seamount; cone on upper SE slope of seamount, westward facing slope
Dredge on bottom UTC26/08/08 09:47 hrs, lat 11°27,41'S, long 104°29,27'E, depth 2202m
Dredge off bottom UTC 26/08/08 11:39 hrs, lat 11°27,36'S, long 104°29,39'E, depth 2098m
total volume: few rocks
Comments: lava fragments, volcaniclastic rocks and carbonate

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR48-1	1. Rock Type: lava fragment 2. Size: 8x6x2cm 3. Shape/Angularity: irregular 4. Encrustations: 5mm Mn crust on one side 5. Vesicularity: 10-15% 6. Vesicle Filling: mostly empty 7. Matrix Color: dark grey, appears fresh 8. Primary Minerals: altered Ol; Fsp needles, appear fresh, 2%, 1-2mm 10. Overall Degree of Alteration: moderately altered 11. Comment: potential for dating	x		x?							
DR48-2C	1. Rock Type: lava fragment with overlying volcaniclastics 2. Size: 20x20x8cm 3. Shape/Angularity: irregular 4. Encrustations: Mn crust up to 1mm							x			
DR48-2C-A	1. Rock Type: lava fragment with altered glassy rim 2. Size: 16x9x8cm 5. Vesicularity: 20% 6. Vesicle Filling: larger ones with CC, smaller ones empty 7. Matrix Color: dakr grey 8. Primary Minerals: Fsp needles, up to 2mm, 5%, appear fresh; Ol altered; Px <1%, 2mm 10. Overall Degree of Alteration: moderately altered 11. Comment: 4cm cavity partly filled with calcite crystal	x	x	x?							
DR48-2C-B	1. Rock Type: monomict lava fragment breccia, spalling of glassy rim of lava, 2. Size: 11x4x1cm 5. Vesicularity: open pore space, Zeolites, Mn-Fe-hydroxides, 10-20% 6. Vesicle Filling: mostly empty 11. Comment: <1-30mm angular blocky clasts appear inversely graded, yellowish Palagonite alteration, closely packed							x			
DR48-3C	1. Rock Type: coarse lapilli tuff, monomict 2. Size: 21x16x10cm 3. Shape/Angularity: irregular 4. Encrustations: Mn crust upt to 8mm on one side 5. Vesicularity: ca. 10-20% 6. Vesicle Filling: empty 7. Matrix Color: 2 generations of cement (Zeolites), minor open pore space 8. Primary Minerals: minor Fsp needles, altered 11. Comment: clasts irregular shaped, <1-30mm, closely packed, poorly sorted, randomly oriented, larger clasts appear to spall off smaller clasts (?!)	x						x			
DR48-4C	1. Rock Type: similar to DR48-3C 2. Size: 14x8x6cm 11. Comment: clasts <1-20mm							x			
DR48-5S	1. Rock Type: carbonate sediment 2. Size: 32x15x10cm 3. Shape/Angularity: angular 11. Comment: diffusely layered white-grey fine sediment, and 4cm wide pinkish area (appears to be infilling layered sediment), consists of micritic carbonate with 1-2mm sized bioclasts and rare volcanic clasts								x		
DR48-6S	1. Rock Type: carbonate sediment 2. Size: 12x10x6cm 3. Shape/Angularity: roundish 11. Comment: whitsh ooze: forams and bioclasts of corals, bivalves								x		

SO199 - DR49
"Apollo 8" Seamount; SW corner of Smt along erosional ridge, base of the structure within SE striking valley
Dredge on bottom UTC26/08/08 18:20 hrs, lat 11°30,73'S, long 104°46,99'E, depth 4582m
Dredge off bottom UTC 26/08/08 19:45 hrs, lat 11°31,03'S, long 104°47,53'E, depth 4050m
total volume: 1/3 full
Comments: pillows and pillow fragments, rounded volcaniclastic (?) pebbles

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR49-1	1. Rock Type: porphyric lava 2. Size: 12x8x6cm 3. Shape/Angularity: subangular 5. Vesicularity: ca. 20% 6. Vesicle Filling: empty 7. Matrix Color: dark grey/brown 8. Primary Minerals: altered ol, 2%, up to 2mm; translucent grey lath-like phenocrysts (Fsp or Foides up to 12x8mm, some appear beige 10. Overall Degree of Alteration: moderately altered 11. Comment: matrix grain-size becomes finer towards the altered glassy rim, which is up to 1cm along one side (see archive backup: DR49-19X,20X)	x	x								
DR49-2	1. Rock Type: similar to DR49-1 2. Size: 28x22x18cm 3. Shape/Angularity: angular 5. Vesicularity: 15% 6. Vesicle Filling: empty, except a little Mn-Fe-hydroxides 7. Matrix Color: dark grey 11. Comment: large spherical vesicles but no glass rim (see archive backup DR49-2X)	x	x								
DR49-2X	1. Rock Type: backup to DR49-2										
DR49-3	1. Rock Type: similar to DR49-1 2. Size: 26x18x9cm 3. Shape/Angularity: subangular 5. Vesicularity: 2% 6. Vesicle Filling: mostly empty, except some filled with Zeolites 7. Matrix Color: grey-brown 8. Primary Minerals: light grey lath-like Fsp?, phenocrysts, 7%, up to 10x6mm 10. Overall Degree of Alteration: light to moderate 11. Comment: matrix becoming coarser, crystals reach 1mm, brown, blacke and white	x	x								
DR49-4	1. Rock Type: similar to DR49-1 2. Size: 21x13x15cm 3. Shape/Angularity: angular 5. Vesicularity: 20% empty but a few have Zeolite and Fe-Hydroxide 7. Matrix Color: grey	x	x								
DR49-5	1. Rock Type: similar to DR49-1 2. Size: 26x25x17cm 3. Shape/Angularity: angular 5. Vesicularity: 25%, mostly empty some Zeolite and Fe-Hydroxide? 7. Matrix Color: grey 8. Primary Minerals: grey phenocrysts10% to 8x4mm plus altered Ol 2% to 4mm 10. Overall Degree of Alteration: moderate	x	x								
DR49-6	1. Rock Type: similar to DR49-1 2. Size: 12x10x9cm 3. Shape/Angularity: angular 5. Vesicularity: 25% empty 7. Matrix Color: grey-brown 8. Primary Minerals: grey lath phenocrysts 5% to 10x4mm, alteration rims occur altered Ol 5% to 3mm 10. Overall Degree of Alteration: moderate	x	x								
DR49-7	1. Rock Type: similar to DR49-1 2. Size: 12x10x7cm 3. Shape/Angularity: subangular 5. Vesicularity: 30% mostly empty 6. Vesicle Filling: few with Fe-Hydroxide 7. Matrix Color: grey-brown 8. Primary Minerals: altered Ol 8% to 6mm, grey Fsp 8% to 8mm 10. Overall Degree of Alteration: moderate	x	x								
DR49-8	1. Rock Type: lava fragment 2. Size: 23x22x17cm 3. Shape/Angularity: irregular subangular 4. Encrustations: minor Mn-crust 5. Vesicularity: 10.15%, up to 3mm, empty 7. Matrix Color: brownish-grey 8. Primary Minerals: Fsp laths, <1%, <1mm, appear fresh 10. Overall Degree of Alteration: moderately altered Mn-Fe-Hydroxides 11. Comment: potential for dating, archive backup is DR49-21X and DR49-8X	x	x	x?							

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR49-8X	1. Rock Type: backup to DR49-8						x				
DR49-9	1. Rock Type: lava fragment 2. Size:16x10x5cm 3. Shape/Angularity: subrounded 4. Encrustations: minor Mn-crust 5. Vesicularity: 15-20% up to 1mm, empty 7. Matrix Color: grey 8. Primary Minerals: Fsp laths <2mm, 1% appear fresh 10. Overall Degree of Alteration: moderately altered Mn-Fe-Hydroxides 11. Comment: archive backup is DR49-22X to DR49-27X										
DR49-10	1. Rock Type: similar to DR49-9 2. Size: 21x13x8 5. Vesicularity: 7-10%, up to 1mm 6. Vesicle Filling: mostly empty, except Zeolites 8. Primary Minerals: Fsp laths, 3%, 1-2mm 10. Overall Degree of Alteration: moderately altered	x	x	x?							
DR49-11	1. Rock Type: similar to DR49-9 2. Size: 20x12x11cm 3. Shape/Angularity: irregular subrounded 5. Vesicularity: 20%, up to 2mm 6. Vesicle Filling: mostly empty, at the top filled with CC or Zeolites 8. Primary Minerals: Fsp laths, 3%, up to 1mm 10. Overall Degree of Alteration: slightly altered, Fe-Mn-Hydroxides along the crack										
DR49-12	1. Rock Type: similar to DR49-9 2. Size: 9x8x7cm 7. Matrix Color: grey 11. Comment: potential for dating	x	x	x?							
DR49-13	1. Rock Type: lava fragment, aphanitic 2. Size: 13x13x6 3. Shape/Angularity: subrounded 5. Vesicularity: 8%, vesicles empty strongly elongated and aligned parallel to outer rim of the piece 7. Matrix Color: grey	x	x								
DR49-14	1. Rock Type: similar to DR49-10 2. Size: 14x8x5cm 3. Shape/Angularity: subrounded 7. Matrix Color: dark grey	x	x								
DR49-15	1. Rock Type: lava fragment 2. Size: 12x8x5cm 3. Shape/Angularity: subrounded 5. Vesicularity: 2%, mainly at the edges, empty except some Zeolite 7. Matrix Color: light grey-green 10. Overall Degree of Alteration: moderate										
DR49-16	1. Rock Type: lava fragment 2. Size: 11x8x7 3. Shape/Angularity: subangular 5. Vesicularity: 12% 6. Vesicle Filling: empty except some white Zeolite (no reaction to HCl) 7. Matrix Color: grey-green 10. Overall Degree of Alteration: moderate, many cracks with Mn infill 11. Comment: one side has volcanoclastic infill with small green-grey clasts (4mm) in cream-coloured matrix, some Mn-spots (no HCl reaction)										
DR49-17	1. Rock Type: similar to DR49-16 2. Size: 10x7x5cm 3. Shape/Angularity: subrounded 5. Vesicularity: 15% empty except some Zeolite 7. Matrix Color: grey-green, small white laths becoming visible										
DR49-18S	1. Rock Type: carbonate? Faint reaction to HCl - aragonite 2. Size:10x9x4cm 3. Shape/Angularity: subangular 7. Matrix Color: creamy-grey (light) 10. Overall Degree of Alteration: moderate many cracks 11. Comment: contains small green-grey clasts 3% to 4mm which are moderately altered and some darker grey clasts of the same proportions, some are over 1cm								x		
DR49-19 & 20X	1. Rock Type: similar to DR49-1 to DR49-7						x				
DR49-21X	1. Rock Type: similar to DR49-8						x				
DR49-22 to 27X	1. Rock Type: similar to DR49-9 to DR49-17						x				

SO199 - DR50
"Apollo 8" Seamount, small valley on SW facing slope between two erosional ridges; below plateau edge
Dredge on bottom UTC 27/08/08 00:52hrs, lat 11°19,85'S, long 104°47,00'E, depth 3125m
Dredge off bottom UTC 27/08/08 02:33hrs, lat 11°19,80'S, long 104°48,02'E, depth 3022m
total volume: few rocks
Comments: lava fragments and volcaniclastic rocks

SAMPLE #	SAMPLE DESCRIPTION	THOLEIITIC	CALC-ALKALINE	Ar	Rhyolite	Gabbro	Andesite	Basalt	Hydrothermal	Sediment	Manganese	NOTES
DR50-1	1. Rock Type: lava porphyritic 2. Size: 43x28x7cm 3. Shape/Angularity: subangular elongate 7. Matrix Color: dark grey 8. Primary Minerals: grey laths 20% to 4x6mm 10. Overall Degree of Alteration: moderately altered 11. Comment: cracks filled with white mineral, backup is DR49-1X	x	x	x?								
DR50-1X	1. Rock Type: similar to DR50-1											
DR50-2	1. Rock Type: lava 2. Size: 15x11x10cm 3. Shape/Angularity: subangular elongate 7. Matrix Color: dark grey 8. Primary Minerals: grey laths 5% to 4x3mm, black laths 2% to 1x0.25mm, brown Px ? <1% to 1.5mm 10. Overall Degree of Alteration: slightly altered, more towards rim	x	x									
DR50-3	1. Rock Type: porphyritic lava 2. Size: 8x6x5cm 3. Shape/Angularity: angular 7. Matrix Color: grey 8. Primary Minerals: Ol? <1% to 1.5mm altered, grey-beige laths Fsp, Px? 5% to 4x3mm 10. Overall Degree of Alteration: moderately altered 11. Comment: archive backup is DR50-12X	x	x									
DR50-4	1. Rock Type: lava 2. Size: 15x8x9cm 3. Shape/Angularity: subangular 5. Vesicularity: 30%, empty 7. Matrix Color: grey 10. Overall Degree of Alteration: moderately altered	x	x									
DR50-5	1. Rock Type: lava 2. Size: 11x11x7cm 3. Shape/Angularity: subrounded 5. Vesicularity: 5% 6. Vesicle Filling: >50% filled with Zeolites, white and beige 7. Matrix Color: grey but brown rim to vesicles 10. Overall Degree of Alteration: moderately altered	x	x									
DR50-6	1. Rock Type: lava 2. Size: 11x11x11cm 3. Shape/Angularity: subrounded 5. Vesicularity: 40% 6. Vesicle Filling: mostly Zeolite to 2cm 7. Matrix Color: grey-brown 10. Overall Degree of Alteration: high alteration, many cracks											
DR50-7	1. Rock Type: lava 2. Size: 10x8x6cm 3. Shape/Angularity: subangular 5. Vesicularity: 10% 6. Vesicle Filling: some filled with Zeolite 7. Matrix Color: grey 10. Overall Degree of Alteration: moderate alteration 11. Comment: backup is DR50-13X	x	x									
DR50-8	1. Rock Type: lava, possibly more evolved 2. Size: 9x5x5cm 3. Shape/Angularity: rounded 4. Encrustations: minor Mn-crust 5. Vesicularity: 10-15% 6. Vesicle Filling: larger ones filled with Zeolites, smaller ones are empty 7. Matrix Color: grey brown 8. Primary Minerals: Px/Amph? Up to 2mm 1%, Fsp/Foides up to 10mm < 1% appear altered 10. Overall Degree of Alteration: altered 11. Comment: lava flow fragment	x										
DR50-9C	1. Rock Type: crystal-rich lapilli tuff 2. Size: 8x7x5cm 3. Shape/Angularity: irregular 4. Encrustations: minor Mn-crust 7. Matrix Color: brown-grey 8. Primary Minerals: Foides/Fsp up to 10mm 15%, Px/Amph 1-2mm 1-2% 10. Overall Degree of Alteration: altered 11. Comment: resembles clastogenic, sintered crystal-rich lapilli tuff, clasts 1-20mm	x							x			

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR50-10C	1. Rock Type: lapilli tuff 2. Size: 9x6x5cm 3. Shape/Angularity: roundish 4. Encrustations: minor Mn-crust 7. Matrix Color: cream-beige 10. Overall Degree of Alteration: altered 11. Comment: <1-20mm clasts, closely packed, open pore space and creamy (fine ash?) matrix poorly sorted							x			
DR50-11S	1. Rock Type: sediment/tuff 2. Size: 10x7x4cm 3. Shape/Angularity: round 7. Matrix Color: greenish white 9. Secondary Minerals: Mn-Fe-hydroxide patches 10. Overall Degree of Alteration: altered 11. Comment: grainy, massive well sorted								x		
DR50-12X	1. Rock Type: similar to DR50-2 and DR50-3						x				
DR50-13X	1. Rock Type: similar to DR50-7						x				

SO199 - DR52
"Sherbakov" Seamount, western part of the seamount, little cone on lower westward facing slope
Dredge on bottom UTC 27/08/08 12:30hrs, lat 10°54,49'S, long 104°32,04'E, depth 2820m
Dredge off bottom UTC 27/08/08 14:12hrs, lat 10°54,89'S, long 104°33,56'E, depth 2229m
total volume: few rocks
Comments: pillow lava fragments, volcaniclastic rocks and carbonate crusts

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR52-1	1. Rock Type: pillow lava fragment 2. Size: 16x10x8 3. Shape/Angularity: subangular to rounded 4. Encrustations: minor Mn spotting and soft carbonate mud attached 5. Vesicularity: 10-15%, size grades from 0.2 to 1.5mm from pillow margin to core 6. Vesicle Filling: filled with CC towards pillow margin; towards core lined with CC; majority of vesicles is unfilled 7. Matrix Color: medium grey groundmass when dry 8. Primary Minerals: 3% altered Ol 0.5-2mm, ca 1% microphenocrystic Plag laths in groundmass, up to 1mm long but <0.1mm thick, fresh 9. Secondary Minerals: Fe-Oxyhydroxide replacing Ol 10. Overall Degree of Alteration: medium altered, groundmass appears fresh when vesicles are avoided 11. Comment: all lava of this dredge is quite similar: Ol-Plag phyric basalt	x	x	x?							
DR52-2	1. Rock Type: pillow lava fragment with 1cm chilled margin; no fresh glass 2. Size: 17x16x12 3. Shape/Angularity: angular 4. Encrustations: minor Mn coating 6. Vesicle Filling: 40% filled with CC 10. Overall Degree of Alteration: medium to strongly altered	x	x	x?							
DR52-3	1. Rock Type: pillow lava fragment with 1-2cm chilled margin; no fresh glass preserved, otherwise similar to DR52-1 2. Size: 21x20x11 3. Shape/Angularity: angular 8. Primary Minerals: Plag microphenocrystic smaller than in DR52-1, <0.2mm and less abundant 10. Overall Degree of Alteration: medium altered	x	x	x?							
DR52-4S	1. Rock Type: carbonate sediment 2. Size: 21x12x8 3. Shape/Angularity: irregular 10. Overall Degree of Alteration: pervasively altered with Mn-Fe hydroxides 11. Comment: burrows / bioturbation; micritic carbonate								x		
DR52-5C	1. Rock Type: coarse lapilli tuff 2. Size: 13x8x7 3. Shape/Angularity:subrounded irregular 4. Encrustations: minor Mn crust 5. Vesicularity: 10-20% 6. Vesicle Filling: mostly empty, or filled with CC 7. Matrix Color: yellowish green fine particles, open pore spaces, minor CC cement 8. Primary Minerals: Ol phenocrysts altered and minor Fsp laths 10. Overall Degree of Alteration: highly altered, Mn-Fe hydroxides, yellowish brown color 11. Comment: clasts up to 50mm subrounded, monolithic basaltic fragments similar to DR52-1							x			

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR52-6C	1. Rock Type: lapilli tuff similar DR52-5C 2. Size: 12x7x4 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 11. Comment: clasts up to 30mm, closely packed, CC cement + fine grained matrix irregular distributed							x			
DR52-7C	1. Rock Type: lapilli tuff similar DR52-6C 2. Size: 7x6x4 11. Comment: clasts up to 20mm							x			
DR52-8C	1. Rock Type: carbonate sediment with minor volcanic clasts 2. Size: 12x7x5 3. Shape/Angularity: subrounded 4. Encrustations: minor Mn crust 5. Vesicularity: 20% 6. Vesicle Filling: Zeolites 7. Matrix Color: cream micritic carbonate matrix 8. Primary Minerals: altered Ol 10. Overall Degree of Alteration: altered 11. Comment: thick layer of carbonate with foraminifera, few volcanic clasts 1-10mm, subangular, attached along one side of carbonate							x			
DR52-9C	1. Rock Type: similar to DR52-8C 2. Size: 6x6x6 10. Overall Degree of Alteration: highly altered 11. Comment: carbonate appears to be a burrow infill into the volcanic clast							x			
DR52-10X	1. Rock Type: similar to DR52-1; thin slab with chilled margin on both sides 2. Size: 25x20x8						x				
DR52-11X	1. Rock Type: similar to DR52-1 2. Size: 25x10x10						x				
DR52-12X	1. Rock Type: similar to DR52-1 2. Size: 12x12x12						x				
DR52-13X	1. Rock Type: similar to DR52-1 2. Size: 20x15x8						x				

SO199 - DR54

Christmas Island SW corner of Christmas Island, lower slope

Dredge on bottom UTC 28/08/2008 14:10hrs, lat 10° 32,39´S, long 105° 24,16´E, depth 3626m

Dredge off bottom UTC 28/08/2008 15:35hrs, lat 10° 32,39´S, long 105° 24,59´E, depth 3156m

total volume: few rocks

Comments: 1 lava, 1 volcaniclastic, 1 carbonate

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR54-1	1. Rock Type: lava fragment 2. Size:11x7x4 cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 5. Vesicularity:10-15% 6. Vesicle Filling: mostly empty, along rim filled with CC 7. Matrix Color: grey 8. Primary Minerals: Ol altered, 2 mm, 2-3%, Fsp needles in groundmass, <1 mm, appear fresh, 1% 10. Overall Degree of Alteration: slightly altered 11. Comment: potential for dating	x	x	x?							
DR54-2C	1. Rock Type: lapilli tuff, heterolithic 2. Size: 10x8x4 cm 3. Shape/Angularity: angular-irregular 4. Encrustations: minor Mn crust 5. Vesicularity: 5-10% 6. Vesicle Filling: variably filled and empty 7. Matrix Color: dark cream micritc mud 8. Primary Minerals: altered Ol 10. Overall Degree of Alteration: altered with pervasive Mn-Fe-hydroxides 11. Comment: clasts 2-20 mm subangular to subround, irregular shaped							x			
DR54-3S	1. Rock Type: carbonate 2. Size: 10x7x4 cm 3. Shape/Angularity: roundish 4. Encrustations: minor Mn crust 7. Matrix Color: white 8. Primary Minerals: Fe-hydroxides 10. Overall Degree of Alteration: altered 11. Comment: micritic carbonate with worm burrows and foraminifera								x		

SO199 - DR55
Christmas Island SW corner of Christmas Island, small canyon on upper slope
Dredge on bottom UTC 28/08/2008 18:20hrs, lat 10° 30,85´S, long 105° 28,42´E, depth 1891m
Dredge off bottom UTC 28/08/2008 19:32hrs, lat 10° 30,93´S, long 105° 28,82´E, depth 1427m
total volume: few rocks
Comments: 3 lava fragments, 1 carbonate

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR55-1	1. Rock Type: lava fragment with freshly broken face on one side 2. Size: 22x18x10 cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn crust 5. Vesicularity: 2% 6. Vesicle Filling: mostly empty and few filled with CC 7. Matrix Color: brown to olive 8. Primary Minerals: Amph laths, up to 10 mm, 5%, fresh; Fsp or Foides: up to 6 mm, 10%, appear fresh; Ol: altered, up to 20 mm 10. Overall Degree of Alteration: slightly altered 11. Comment: rock appears to be a part of an insitu sample, several, up to 5 cm holocrystalline xenoliths ranging from Fsp rich gabbroic, dark pyroxenitic and altered Ol-Px cumulate (mantle xenolith?; heterogeneity of xenoliths however argues that they are of crustal origin); volcanic rock has potential for dating but care has to be taken to distinguish phenocrysts from xenocrysts; groundmass almost glossy	x	x	x?							
DR55-2	1. Rock Type: similar to DR55-1 2. Size: 11x7x3 cm 4. Encrustations: Mn crust on one side up to 5 mm 8. Primary Minerals: Fsp/Foides up to 10 mm, 7-10% 11. Comment: holocrystalline xenoliths absent										
DR55-3	1. Rock Type: similar to DR55-2 2. Size: 15x11x4 cm 4. Encrustations: Mn crust on one site up to 5 mm 8. Primary Minerals: Amph up to 10 mm	x	x	x?							
DR55-4S	1. Rock Type: carbonate 2. Size: 23x16x9 cm 3. Shape/Angularity: irregular 4. Encrustations: Mn crust up to 12 mm 7. Matrix Color: white 9. Secondary Minerals: pervasive Mn-Fe-hydroxide 11. Comment: abundant burrows/ bioturbation, refilled with foraminifera ooze, main rock micritic carbonate								x		

SO199 - DR56
"Royal Mary" Seamount, northernmost seamount of the seamount group SE of Christmas Island, northern flank
Dredge on bottom UTC 29/08/08 6:46hrs, lat 11°15,77`S, long 106°33,28E, depth 3.997m
Dredge off bottom UTC 29/08/08 8:02hrs, lat 11°15,99`S, long 106°33,69`E, depth 3.338m
total volume: 1/3 full
Comments: porphyric lava, volcaniclastics

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR56-1	1. Rock Type: lava fragment 2. Size: 30x26x22 cm 3. Shape/Angularity: angular 5. Vesicularity: 10% 6. Vesicle Filling: half empty, half filled with CC 7. Matrix Color: grey 8. Primary Minerals: black equant crystald (Px?): 1-2%, up to 10 mm; translucent crystals equant to slightly elongate: up to 15mm, twin (Fsp/Foides?), 20-25%, appears fresh 10. Overall Degree of Alteration: fresh to slightly altered 11. Comment: porphyritic volcanic lava, potential for dating, groundmass extremly fine crystalline, archive sample DR56-1X	x	x	x?							
DR56-2	1. Rock Type: similar to DR56-1 2. Size: 25x17x12 cm 6. Vesicle Filling: mostly filled with CC 7. Matrix Color: grey to reddish brown 10. Overall Degree of Alteration: moderatly altered, several cracks, crosscut rock	x	x								
DR56-3	1. Rock Type: similar to DR56-2, but fewer vesicles 2. Size: 20x17x16 cm 5. Vesicularity: 10% 6. Vesicle Filling: mostly filled with CC 7. Matrix Color: grey to reddish brown 8. Primary Minerals: black crystal rare, 8 mm, < 1%; translucent poss. Fsp or Foides: up to 15mm, 10-15%, slightly altered 10. Overall Degree of Alteration: moderatlely altered 11. Comment: archive sample DR56-3X	x	x								

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR56-4	1. Rock Type: lava fragment 2. Size: 14x8x4 cm 5. Vesicularity: 1% 6. Vesicle Filling: empty 7. Matrix Color: grey to brown 8. Primary Minerals: brown altered ol, up to 10 mm, Fsp: 1-2mm, 1-2%, appear altered 10. Overall Degree of Alteration: moderatlely altered 11. Comment: dense lavaflow	x	x								
DR56-5	1. Rock Type: lava fragment similar to DR56-4, but more vesicular 2. Size: 11x8x5 4. Encrustations: minor Mn crust 5. Vesicularity: 5% 6. Vesicle Filling: empty 10. Overall Degree of Alteration: moderatlely altered	x	x								
DR56-6	1. Rock Type: lava fragment 2. Size: 40x35x25cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 5. Vesicularity: 15% 6. Vesicle Filling: mostly empty, except Zeolites 7. Matrix Color: greenish-grey 8. Primary Minerals: translucent, elongated crystals: Foides or Fsp?, 25%, <6mm; Px, 3%, <3mm 10. Overall Degree of Alteration: moderatlely altered 11. Comment: archive sample DR56-6X	x	x								
DR56-7	1. Rock Type: similar to DR56-6 2. Size: 15x12x8cm 5. Vesicularity: 20%	x	x								
DR56-8	1. Rock Type: similar to DR56-6 2. Size: 21x11x9cm 3. Shape/Angularity: subrounded 5. Vesicularity: 30% 7. Matrix Color: greenish-brown 8. Primary Minerals: translucent, elongated crystals: Foides or Fsp?, 25%, <6mm; Px, 3%, <3mm; brown angular porous mineral (altered Fsp?) 10. Overall Degree of Alteration: altered	x	x								
DR56-9	1. Rock Type: similar to DR56-8 2. Size: 23x18x14cm 5. Vesicularity: 30% 7. Matrix Color: brown 8. Primary Minerals: lightly altered xenolithe: 15x20mm;Fsp 15%, up to 4mm, porous, altered 10. Overall Degree of Alteration: altered	x	x								
DR56-10	1. Rock Type: similar to DR56-8 2. Size: 20x15x13cm 11. Comment: 10x4cm coarsecrystallline xenoltihe with diffuse margin (see TS)	x	x								
DR56-11C-A	1. Rock Type: volcaniclastic with cm-sized lava blocks --> lava fragment similar to DR56-4 2. Size: 10x7x6cm 3. Shape/Angularity: angular 10. Overall Degree of Alteration: moderatlely altered 11. Comment: embedded in volcaniclastic as part of debris flow	x	x								
DR56-11C-B	1. Rock Type: heterolithic coarse volcaniclastic 2. Size: 100x60x30cm 3. Shape/Angularity: subangular 7. Matrix Color: yellowish fine grained matrix and Zeolite cement 10. Overall Degree of Alteration: altered 11. Comment: variably vesicular clasts <1-60mm size, variably rounded							x			
DR56-12C	1. Rock Type: coarse ash to fine lapilli tuff 2. Size: 16x10x8cm 3. Shape/Angularity: subrounded 4. Encrustations: minor Mn crust 5. Vesicularity: 0 to 10% 6. Vesicle Filling: empty 7. Matrix Color: greenish-yellow?, finest ash or Zeolite cement 10. Overall Degree of Alteration: altered 11. Comment: very dense, closely packed, angular, moderately sorted clasts, randomly oriented							x			
DR56-1X	1. Rock Type: similar to DR56-1						x				
DR56-3X	1. Rock Type: similar to DR56-3						x				
DR56-6X	1. Rock Type: similar to DR56-6						x				
DR56-13X	1. Rock Type: similar to DR56-10						x				
DR56-14X	1. Rock Type: similar to DR56-6						x				

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR56-15X	1. Rock Type: similar to DR56-6						x				
DR56-16X	1. Rock Type: similar to DR56-10						x				
DR56-17X	1. Rock Type: similar to DR56-8						x				
DR56-18X	1. Rock Type: similar to DR56-3						x				
DR56-19X	1. Rock Type: similar to DR56-4						x				

SO199 - DR57
"Elena" Seamount (belongs to seamount group SE of Christmas Island), small valley on upper NW flank
Dredge on bottom UTC 29/08/08 14:43hrs, lat 11°42,59`S, long 106°33,24`E, depth 3501m
Dredge off bottom UTC 29/08/08 17:30hrs, lat 11°42,71`S, long 106°33,82`E, depth 3052m
total volume: 1/6 full
Comments: volaniclastics, lava fragments

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR57-1	1. Rock Type: lava fragment 2. Size: 14x14x10 cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 7. Matrix Color: darkgrey 8. Primary Minerals: Px: up to 10mm, 3%; Fsp needles: up to 2 mm, appears fresh, ca. 2% 10. Overall Degree of Alteration: slightly to moderatley altered 11. Comment: groundmass very fine crystalline (crypto crystallin) with inhomogeneously distributed domains of slightlly coarser groundmass crystallinity/dendritic?, potential for dating	x	x	x?							
DR57-2	1. Rock Type: similar to DR57-1 2. Size: 17x10x7 cm	x	x	x?							
DR57-3	1. Rock Type: similar to DR57-1 2. Size: 17x13x9 cm 11. Comment: 8 cm vug filled with secondary crystals of CC	x	x	x?							
DR57-4	1. Rock Type: similar to DR57-1 2. Size: 13x9x8 10. Overall Degree of Alteration: moderately altered										
DR57-5	1. Rock Type: similar to DR57-1 2. Size: 11x8x7 cm 8. Primary Minerals: fewer smaller phenocrysts 10. Overall Degree of Alteration: moderately altered										
DR57-6	1. Rock Type: similar to DR57-1 2. Size: 8x7x4 cm 8. Primary Minerals: fewer smaller phenocrysts 10. Overall Degree of Alteration: moderately altered										
DR57-7	1. Rock Type: lava fragment 2. Size: 7x6x4 cm 3. Shape/Angularity: irregular 4. Encrustations: minor Mn crust 5. Vesicularity: 10% 6. Vesicle Filling: mostly empty, some filled with Zeolites 7. Matrix Color: reddish brown 8. Primary Minerals: altered needles of Fsp: ca. 2% 10. Overall Degree of Alteration: altered										
DR57-8C	1. Rock Type: heterolithic lapilli tuff 2. Size: 9x7x3 cm 3. Shape/Angularity: rounded 5. Vesicularity: variably dense to ca. 10% 6. Vesicle Filling: mostly filled with Zeolites 7. Matrix Color: dark grey, very fine grained matrix 8. Primary Minerals: some clasts with needles of Fsp, highly altered 9. Secondary Minerals: Fe-Mn-hydroxides as rims around individual clasts 10. Overall Degree of Alteration: altered 11. Comment: clasts <1-30mm, angular and irregular, variably closely packed poorly sorted, randomly oriented	x						x			
DR57-9C	1. Rock Type: lapilli tuff with biogene debris 2. Size:10x7x3 cm 3. Shape/Angularity: subrounded 4. Encrustations: Mn crust on one side up to 8mm 7. Matrix Color: open pore space, cream muddy matrix 9. Secondary Minerals: pervasive Mn-Fe-hydroxides in between clasts (cement) 10. Overall Degree of Alteration: altered 11. Comment: volcanic & biogene clasts ca. 1-3 mm fairly well sorted, subangular to subround closely packed, randomly oriented, debris flow deposit							x			

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR57-10C	1. Rock Type: coarse lapilli tuff, heterolthic 2. Size: 14x8x11 cm 3. Shape/Angularity: subround 4. Encrustations: minor Mn crust 5. Vesicularity: dense to 5% variably 6. Vesicle Filling: filled with CC? 7. Matrix Color: yellowish Zeolite or muddy matrix 10. Overall Degree of Alteration: highly altrered, soft rock 11. Comment: clasts appear subrounded, <1-20mm, very closely packed, randomly oriented, debris flow deposit							x			
DR57-11C	1. Rock Type: similar to DR57-10C 2. Size: 10x8x5 cm							x			
DR 57-12X	1. Rock Type: similar to DR57-1 to -6						x				

SO199 - DR58
"Max" Seamount (belongs to seamount group SE of Christmas Island), NW facing steep slope, steepest on lower slope
Dredge on bottom UTC 29/08/08 22:14hrs, lat 11°44,20`S, long 106°52,78`E, depth 3609m
Dredge off bottom UTC 29/08/08 23:30hrs, lat 11°44,38`S, long 106°53,32`E, depth 3113m
total volume: 1/3 full
Comments: pillows, lava fragments, volcaniclastics, sediment

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR58-1	1. Rock Type: porphyric pillow lava with chilled margin; no fresh glass preserved 2. Size: 27x15x12 original size, 4 fragments saved 3. Shape/Angularity: angular to subrounded 4. Encrustations: c. 1mm thick Mn crust in places 5. Vesicularity: 3% large vesicles 0.5-1.5cm, some elongated orthogonal to pillow margin; 1 % small groundmass vesicles <0.2mm 6. Vesicle Filling: all vesicles are open, but lined with yellowish to orange material; probably Smectite or Fe-Oxyhydroxide 7. Matrix Color: medium grey groundmass under the handlense, brownish groundmass with naked eye due to vesicle lining 8. Primary Minerals: 8-10 % Fsp phenocrysts, large angular laths up to 1.5cm, mostly betweeen 3-8mm. 2% Px phenocrysts 9. Secondary Minerals: probably Smectite or Fe-Oxyhydroxide 10. Overall Degree of Alteration: medium altered, groundmass appears fresh but lots of small vesicles lined with secondary minerals. Phenocrysts are fresh. 11. Comment: this Fsp-Px phyric pillow lava is the dominant rock type of the dredge. Fsp are useful for dating but need detailed petrographic and compositional characterization (Fsp vs Foides and pheno vs xenocrysts)	x	x	x							
DR58-2	1. Rock Type: similar to DR59-1, single clast in dredge, no chilled margins 2. Size: 13x11x10 cm original size, 5 pieces saved 3. Shape/Angularity: angular 4. Encrustations: minor Mn spottting 5. Vesicularity: 3% vesicles < 1mm, open, lined with Fe-Oxyhydroxide 7. Matrix Color: brownish-grey groundmass 8. Primary Minerals: see DR58-1 but groundmass contains 1% Fsp microphenocryst laths which are most likely Plag 10. Overall Degree of Alteration: medium altered	x	x	x							
DR58-3	1. Rock Type: similar to DR59-1, without chilled margin 2. Size: 22x15x12 cm 3. Shape/Angularity: subangular to rounded 7. Matrix Color: brownish-grey groundmass 10. Overall Degree of Alteration: medium altered	x	x	x							
DR58-4	1. Rock Type: similar to DR59-1, but significantly less porphyric and with coarse grained groundmass 2. Size: 30x22x20 cm original size, 5 pieces saved 3. Shape/Angularity: angular 4. Encrustations: minor Mn coating 5. Vesicularity: 5% vesicles 1-2mm, partially filled with Fe-Oxyhydroxide 7. Matrix Color: light grey groundmass, coarse grained in contrast to previous samples 8. Primary Minerals: 4% Fsp up to 5mm, angular laths, <1% black minerals; probably Px 10. Overall Degree of Alteration: medium altered 11. Comment: although similar to DR58-1, groundmass is coarse grained	x	x	x							

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR58-5	1. Rock Type: ignimbrite? Similar to DR58-6 2. Size: 12x13x8 3. Shape/Angularity: subrounded clast 4. Encrustations: minor Mn coating 5. Vesicularity: 2-3% vesicles, strongly elongated and oval shaped, up to 1cm long and 2mm thick 6. Vesicle Filling: unfilled 7. Matrix Color: brownish-red groundmass, appears quite fresh 8. Primary Minerals: aphyric 9. Secondary Minerals: very minor filling of vesicles with CC 10. Overall Degree of Alteration: moderately altered, but groundmass is oxidized 11. Comment: Second rock type in dredge. Elongated vesicles indicate high viscosity Ignimbrite inference stems from next sample DR58-6 which has more clearly developed flow banding and flame like structures	x	x	x?							
DR58-6	1. Rock Type: ignimbrite? like rock 2. Size: 20x14x8 3. Shape/Angularity: angular 4. Encrustations: <2mm Mn crust in places 5. Vesicularity: 5% overall vesicularity, vesicles are open, 0.1-0.7mm in diameter, elongated to oval shape and bend around darker oval shaped inclusions. Indicative high viscosity while melt was still degassing 6. Vesicle Filling: unfilled 7. Matrix Color: redish-grey 8. Primary Minerals: aphyric 10. Overall Degree of Alteration: moderately altered 11. Comment: also contains xenolith as angular fragment of a Px cumulate?, 2x1cm. Care needs to be taken to separate reddish brown matrix (majority of sample) from grey matrix	x	x	x?							
DR58-7	1. Rock Type: vesicular lava fragment 2. Size: 21x14x10 3. Shape/Angularity: angular 4. Encrustations: thin Mn crust 1mm in places 5. Vesicularity: 15-20% rounded vesicles 0.5-2mm on average, 50-60% filled with CC 7. Matrix Color: light brown groundmass, coarse grained with Fsp microphenocrysts <0.2 8. Primary Minerals: 2-3% Fsp phenocrysts 0.5-1mm, fresh 9. Secondary Minerals: CC filling of vesicles as well as Fe-Oxyhydroxides filling vesicles or replacing Ol (2%, 0.5-1mm) 10. Overall Degree of Alteration: strongly altered 11. Comment: This is the third type of lava in this dredge, however strongly altered overall	x	x								
DR58-8A	1. Rock Type: altered pillow margin, pillow similar to DR58-1 2. Size: 18x15x10 10. Overall Degree of Alteration: no fresh glass preserved 11. Comment: saved to document pillow origin of DR58-1 type lava										
DR58-8B	1. Rock Type: glass rim from pillow that may contain fresh glass 2. Size: 14x11x7	x									
DR58-9C	1. Rock Type: lapilli tuff to tuff breccia 2. Size: 36x23x19cm 3. Shape/Angularity: irregular 5. Vesicularity: 5-10% 6. Vesicle Filling: Zeolite or empty 7. Matrix Color: yellowish Zeolites concentrically around clasts, as well as CC, minor open pore spaces 8. Primary Minerals: apharytic 10. Overall Degree of Alteration: lightly altered 11. Comment: clasts 1-10mm, outsized flowbanded of lavaclasts up to 70mm, clasts blocky, angular, closely packed, poorly sorted, randomly oriented (large ones appear aligned in one layer), appear monomict, lava flow breccia?							x			
DR58-10C	1. Rock Type: lapilli tuff, reddish, similar to DR58-9C 2. Size: 34x20x20cm 7. Matrix Color: white carbonate mud, minor fine grained yellowish matrix 10. Overall Degree of Alteration: altered 11. Comment: clasts are lava fragmets with glassy margins (altered), irregularly distributed muddy, matrix=variable loosely and closely packed, clast size 1-10mm, outiszed clasts up to 80mm, monomict basaltic (?)							x			

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR58-11C	1. Rock Type: greenish lapilli tuff 2. Size: 14x10x8cm 3. Shape/Angularity: round 5. Vesicularity: dense to 5% 6. Vesicle Filling: mostly filled with Zeolites 7. Matrix Color: dark grey greenish cement (Zeolites?) and open pore spaces 8. Primary Minerals: apharytic 10. Overall Degree of Alteration: lightly altered 11. Comment: angular blocky clasts, very closely packed, moderately sorted 1-5mm clasts, plus outsized clasts up to 55mm, random clast orientation							x			
DR58-12S	1. Rock Type: carbonate, bioturbated 2. Size: 17x14x10cm 3. Shape/Angularity: irregular angular 4. Encrustations: minor Mn crust 7. Matrix Color: cream micritc mud 10. Overall Degree of Alteration: fresh 11. Comment: burrows of 1cm diameter refilled with slightly lighter but sane material								x		
DR58-4x	1. Rock Type: see DR48-4						x				
DR58-13X	1. Rock Type: 3 pieces similar to DR58-1						x				
DR58-14X	1. Rock Type: volcaniclastic rock with large basalt fragment						x				
DR58-15X	1. Rock Type: yellowish-green lapillit tuff with basalt xenolith, basalt similar to DR58-7						x				
DR58-16X	1. Rock Type: volcaniclastic rock, reddish matrix, large grain size variation						x				

SO199 - DR59
"Max" Seamount, small cone in SW corner of seamount, well below plateau edge
Dredge on bottom UTC 03:10 30/08/08 hrs, lat 11° 45.66'S, long 106° 53.06'E, depth 3173m
Dredge off bottom UTC 04:54 30/08/08 hrs, lat 11° 45.72'S, long 106° 53.57'E, depth 2733m
total volume: 1/4 full
Comments: volcaniclastica, one 1m sized lapilli tuff crust with freshly broken side, a few lava fragments

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR59-1	1. Rock Type: lava fragment, highly vesicular 2. Size: 15x10x6cm 3. Shape/Angularity: subangular 5. Vesicularity: 25%, mostly 1-2mm, some up to 2 cm 6. Vesicle Filling: 60-70% of vesicles ore filled with CC 7. Matrix Color: light grey groundmass, quite fresh when vesicles are avoided 8. Primary Minerals: aphyric 10. Overall Degree of Alteration: strongly altered due to massive vesicle filling with CC, however groundmass is fresh but difficult to seperate 11. Comment: groundmass ok chemistry, no mineralphases for dating visible	x	x								
DR59-2	1. Rock Type: pillow fragment with chilled margin, no fresh glass, otherwise similar to DR59-1, but groundmass altered to brownish 2. Size: 11x8x6cm 5. Vesicularity: 10% vesicle 0.2-3mm, some filled with CC	x									
DR59-3	1. Rock Type: similar tio DR59-1 but with <1% Px phenocryst, diameter 1-2mm, fresh 2. Size: 9x7x6 10. Overall Degree of Alteration: strongly altered	x									
DR59-4	1. Rock Type: lava fragment core of Mn-Knoll 2. Size: 12x10x9cm Mn-Knoll; 5x4x4cm lava fragment 3. Shape/Angularity: rounded 5. Vesicularity: 10%, 1-2cm some filled CC, other open but lined with Fe-oxy hydroxides 7. Matrix Color: dark grey groundmass, fresh 8. Primary Minerals: aphyric, very small Fsp micriphenocrysts <0.1mm 10. Overall Degree of Alteration: medium altered groundmass 11. Comment: probably freshest sample of dredge	x	x								

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR59-5C	1. Rock Type: lapilli tuff 2. Size: 30x26x17cm 3. Shape/Angularity: irregular 4. Encrustations: minor Mn crust 5. Vesicularity: variable 0-10% 6. Vesicle Filling: mostly filled with CC or Zeolites 7. Matrix Color: sparitic CC cement, minor foram ooze yellowish 8. Primary Minerals: aphyric, few clasts with Fsp needles 10. Overall Degree of Alteration: slightly altered, well cemented 11. Comment: mostly monolithic basaltic, little altered clasts, <1-50mm, average 1-10, angular blocky, few smaller splinter-shaped clasts, poorly sorted, random clast orientation, moderately closely packed, clasts appear fresh, smaller more pervasively altered, accidental clasts of Fsp-phyric basalt and more vesicular clasts (20%)	x						x			
DR59-5C-A	1. Rock Type: CC cemented lapilli tuff 2. Size: 30x26x17cm, original size 11. Comment: Remark: after cutting slabs we realized that some clasts consist of altered glass or basalt with glassy groundmass, sample DR59-5C-A represents several slabs of a single piece of DR59-5C (see seperate description); one of the clasts has a characteristic yellow-brown core that appears to contain fresh glass	x									
DR59-5C-B	1. Rock Type: CC-cemented lapilli tuff (initially described as basalt breccia) sample B is a large clast that has been cut of from the matrix --> but these are actually two different pieces 2. Size: 5x4x4cm 3. Shape/Angularity: angular 5. Vesicularity: 2-3 vesicle filled with CC mostly 7. Matrix Color: grey-brownish 8. Primary Minerals: aphyric 11. Comment: very difficult to seperate individual clasts from breccia, overall the clasts are much less vesicle than DR59-1	x	x								
DR59-6C	1. Rock Type: highly altered lapilli tuff 2. Size: 11x8x8cm 3. Shape/Angularity: subround 4. Encrustations: very minor Mn crust 5. Vesicularity: ~ 5% 6. Vesicle Filling: mostly lined of filled with Zeolites 7. Matrix Color: CC sparitic 8. Primary Minerals: apharytic 9. Secondary Minerals: Fe-Mn-hydroxides as rims around clasts 10. Overall Degree of Alteration: highly altered yellowish Palagonite 11. Comment: very similar to DR59-5C, clast size <1-30mm							x			
DR59-7C	1. Rock Type: faintly bedded lapilli tuff 2. Size: 19x12x10cm 3. Shape/Angularity: round 4. Encrustations: very minor Mn crust 5. Vesicularity: 2% 6. Vesicle Filling: mostly empty 7. Matrix Color: white and grey sparitic CC 9. Secondary Minerals: some Mn-Fe-hydroxides rims around clasts 10. Overall Degree of Alteration: altered 11. Comment: clasts similar to DR59-6C, faintly aligned, vague grainsize changes but with clear defined bedding, <1-15mm, outsized clasts up to 50mm							x			
DR59-8C	1. Rock Type: lapilli tuff similar to DR59-6C 2. Size: 28x20x16cm, original size 3. Shape/Angularity: irregular 6. Vesicle Filling: mostly empty 7. Matrix Color: minor CC cement, open pore space, Zeolites (dark brown rims around clasts) 10. Overall Degree of Alteration: highly altered/weathered brownish rock 11. Comment: closely packed clasts, subangular to round (by alteration?),							x			
DR59-5X	1. Rock Type: 3 pieces of breccia to possibly prepare single basalt clasts, diameter 15-25cm						x				
DR59-9X	1. Rock Type: 70x50x20cm freshly broken volcaniclast slab similar to DR59-6C & 7C, saved as showpiece						x				

SO199 - DR61
"Nia" Seamount, seamount cluster SE of Christmas Island; small westward facing cone on western seamount flank
Dredge on bottom UTC 15:52 30/08/08 hrs, lat 12° 10.51'S, long 106° 46.38'E, depth 4674m
Dredge off bottom UTC 17:06 30/08/08 hrs, lat 13° 10.42'S, long 106° 46.82'E, depth 3988m
total volume: empty
Comments: difficult manouvering due to different wind, swell and current directions

SO199 - DR62
"Janne" Seamount, seamount cluster SE of Christmas Island; west facing slope of seamount
Dredge on bottom UTC 22:39 30/08/08 hrs, lat 12° 27.431'S, long 106° 38.97'E, depth 3477m
Dredge off bottom UTC 00:15 31/08/08 hrs, lat 12° 27.60'S, long 106° 39.63'E, depth 2898m
total volume: few rocks
Comments: pillows, pillow fragments, lapilli tuff and sediment

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR62-1	1. Rock Type: porphyric lava fragment with fresh core 2. Size: 12x22x14cm original size, 4 pieces saved 3. Shape/Angularity: subangular to round 4. Encrustations: minor Mn coating 5. Vesicularity: dense, non-vesicular 7. Matrix Color: most parts of the sample have brownish weathered groundmass; fresh core has dark-grey groundmass 8. Primary Minerals: 8% Fsp phenocrysts, 1-4mm long angular laths, fresh. 3% Px phenocrysts, 2-6mm fresh; <1% altered Ol, only visible in fresh core 9. Secondary Minerals: Fe-Oxyhydroxide replacing Ol 10. Overall Degree of Alteration: fresh core is slightly altered, remaining sample (vast majority) strongly altered but phenocrysts appear fresh except Ol 11. Comment: this rock contains abundant Fsp phenocrysts for dating purposes and fresh inner core is of very good quality for geochemistry. Core and altered parts saved in seperate GC bags	x	x								2x TS, fresh and altered parts to check quality of phenocrysts
DR62-2	1. Rock Type: vesicular pillow lava 2. Size: 43x31x18cm original size, 3 pieces saved 3. Shape/Angularity: subangular 4. Encrustations: minor Mn coating and weathering rind 5. Vesicularity: 15-20% vesicles, vast majority filled with CC, 0.5-1mm 7. Matrix Color: greenish grey groundmass appears relatively fresh 8. Primary Minerals: aphyric, <0.5% Px phenocrysts, 1-2mm, fresh 9. Secondary Minerals: CC filling of vesicles 10. Overall Degree of Alteration: strongly altered overall, groundmass ± fresh if vesicles are avoided 11. Comment: this rock type is the most abundant of this dredge and this is the largest piece. It may also conatin Fsp phenocrysts which are however difficult to identify due to the overabundance of filled vesicles	x	x								
DR62-3	1. Rock Type: lava fragment similar to DR62-2 but vesicles are not filled 2. Size: 8x5x4cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn spots 7. Matrix Color: light grey groundmass 10. Overall Degree of Alteration: medium altered 11. Comment: no GC due to size	x									
DR62-4	1. Rock Type: similar to DR62-3 2. Size: 8x7x7cm 3. Shape/Angularity: subangular 10. Overall Degree of Alteration: medium altered 11. Comment: no GC due to samll size	x									
DR62-5C	1. Rock Type: lapilli tuff, highly altered 2. Size: 35x25x14 3. Shape/Angularity: rounded 5. Vesicularity: 10% 6. Vesicle Filling: empty and lined with zeolithes 7. Matrix Color: CC cemented white 8. Primary Minerals: aphanitic 9. Secondary Minerals: minor Mn-Fe hydroxides as rims around some clasts 10. Overall Degree of Alteration: highly altered, softly weathered 11. Comment: clasts <1-10mm rarely up to 40mm, subangular, poorly sorted, no clast orientation, monomict, closely packed							x			
DR62-6C	1. Rock Type: lapilli tuff, similar to DR62-5C, reddish 2. Size: 12x10x6 10. Overall Degree of Alteration: altered reddish color of clasts resembles subaerial oxidation 11. Comment: irregular distribution of CC cemented areas and ash rich (matrix) areas							x			
DR62-7S	1. Rock Type: mudstone 2. Size: 9x7x4								x		
DR62-8X	1. Rock Type: similar to DR62-2 2. Size: 15x10x5cm						x				
DR62-9X	1. Rock Type: similar to DR62-2 2. Size: 27x17x16cm 11. Comment: totally altered, 60% vesicles filled with CC, some large vugs with nice CC fillings						x				

SO199 - DR63
"Helmholtz" Seamount, named after Hermann von Helmholtz born 31st Aug 1821. SW facing slope within small valley below plateau edge
Dredge on bottom UTC 04:58 31/08/08 hrs, lat 12° 39.71'S, long 106° 39.25'E, depth 3388m
Dredge off bottom UTC 06:23 31/08/08 hrs, lat 12° 39.56'S, long 106° 39.77'E, depth 2918m
total volume: 1 rock
Comments: small Mn encrusted pillow fragment

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR63-1	1. Rock Type: pervasively altered lava fragment, probably pillow lava with 1cm chilled margin 2. Size: 5x4x4cm 3. Shape/Angularity: rounded 4. Encrustations: 5mm Mn crust 5. Vesicularity: 10% in least altered part, filled with CC and Fe-Oyxhydroxides. Most of the sample is however thoroughly altered so that vesicles are no longer visible 7. Matrix Color: dark grey in fresh mini section, dark brown in remaining part 8. Primary Minerals: aphyric with Plag microphenocrysts <0.2mm, ±fresh, single large Fsp 2mm long 9. Secondary Minerals: totally oxidized groundmass 10. Overall Degree of Alteration: very strongly altered ; 1cm3 medium altered zone was seperately prepared as "GC" sample 11. Comment: the small but fresher part could be used for reconaissance geochemistry	x	x								

SO199 - DR64
"Waltrud" Seamount, NW-facing flank of seamount
Dredge on bottom UTC 31/08/08 12:53hrs, lat 12°39.26'S, long 107°12.79'E, depth 3709m
Dredge off bottom UTC 31/08/08 14:34hrs, lat 12°39.27'S, long 107°12.68'E, depth 3781m
total volume: empty
Comments: dredge got stuck at on bottom position

SO199 - DR65
"Waltrud" Seamount, little cone further along the NW facing flank of the seamount, westward facing slope
Dredge on bottom UTC 31/08/08 18:59hrs, lat 12°36.58'S, long107°14.33'E depth 3952m
Dredge off bottom UTC 31/08/08 20:03hrs, lat 12°36.77S, long 107°14.77'E, depth 3626m
total volume: three rocks
Comments:lava fragment, volcaniclastic rocks

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR65-1	1. Rock Type: lava fragment 2. Size: 20x16x15cm 3. Shape/Angularity: subrounded 4. Encrustations: minor Mn crust 5. Vesicularity: 20% 6. Vesicle Filling: half empty, half filled with CC 7. Matrix Color: grey 8. Primary Minerals: Fsp (with twins): 22mm, 7-10%; altrede Ol: up to 5mm, 2%; Px: 2mm, <1% 9. Secondary Minerals: Epidot 10. Overall Degree of Alteration: moderately altered 11. Comment: groundmass apears in parts less altered with smaller, unfilled vesicles when compared with the main part of the rock; potential for dating	x	x	x							
DR65-2	1. Rock Type: lava fragment 2. Size: 9x6x5mm 3. Shape/Angularity: rounded 4. Encrustations: minor Mn crust 5. Vesicularity: 20-25%, <1mm 6. Vesicle Filling: mostly unfilled, otherwise CC (<<1%) 7. Matrix Color: bownish-grey 8. Primary Minerals: Fsp: up to 12mm, 5%; altered Ol: up to 3mm, <1%; Px?: up to 2mm, <<1% 10. Overall Degree of Alteration: moderately altered 11. Comment: potential for dating?	x		x?							

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR65-3C	1. Rock Type: lapilli tuff, yellow-brown 2. Size: 13x7x6cm 3. Shape/Angularity: irregular subrounded 4. Encrustations: minor Mn crust 5. Vesicularity: 10-25% 6. Vesicle Filling: empty or lined with Zeolites 7. Matrix Color: light yellowish cement 8. Primary Minerals: Fsp: up to 15mm, altered ca. 10% 9. Secondary Minerals: Mn-Fe-Hydroxides as cement 10. Overall Degree of Alteration: highly altered 11. Comment: clasts <1-10mm, up to 30mm, rarely, blocky, irregular, angular, closely packed, poorly sorted, randomly oriented; lithology: similar to DR65-1, but higher vesicularity, monomict	x						x			

SO199 - DR66
"Finn" Seamount, NW corner of seamount below top
Dredge on bottom UTC 1/09/08 4:19hrs, lat 12°13.78'S, long 107°49.58'E, depth 3907m
Dredge off bottom UTC 1/09/08 5:55hrs, lat 12°14.14'S, long 107°50.08'E, depth 3381m
total volume: full
Comments: pillows, lava fragments, large volcaniclastic block, Mn crusts; probably dregded through a tulus deposit

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR66-1	1. Rock Type: porphyric lava fragment 2. Size: 15x12x11cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 5. Vesicularity: <0.5%, diam.: 0.5-1mm 6. Vesicle Filling: filled with green smectite? 7. Matrix Color: light grey groundmass along outer zone, inner core light brown 8. Primary Minerals: Fsp phenocrysts: 7%, 0.5-4mm, fresh; Ol?: <1%, altered to smectite, often not clean whether smectite occurs as vesicle filling or replacement of Ol 10. Overall Degree of Alteration: slightly to medium altered 11. Comment: most frequent rock type of this dredge, Fsp have good potential for dating. This is the largest piece with partly fresh groundmass. Sample DR66-2 and -3 are smaller but have fresher groundmass	x	x								
DR66-2	1. Rock Type: similar to DR66-1 2. Size: 14x7x7cm 7. Matrix Color: light grey 8. Primary Minerals: possibly <1% fresh? Ol, diam. <0.5mm 10. Overall Degree of Alteration: slightly altered 11. Comment: groundmass fresher than in DR66-1	x	x								
DR66-3	1. Rock Type: similar to DR66-1 2. Size: 12x9x6cm 7. Matrix Color: light grey groundmass, very fresh 8. Primary Minerals: <1% fresh Ol 10. Overall Degree of Alteration: slightly altered 11. Comment: probably freshest sample of all	x	x								
DR66-4	1. Rock Type: similar to DR66-1 2. Size: 20x14x10cm 3. Shape/Angularity: subangular 7. Matrix Color: brownsih grey 10. Overall Degree of Alteration: medium altered 11. Comment: saved as back up for Fsp separation	x	x								
DR66-5	1. Rock Type: aphyric lava fragment 2. Size: 15x11x10cm 3. Shape/Angularity: rounded 4. Encrustations: minor Mn coating 5. Vesicularity: non-vesicular 7. Matrix Color: light grey groundmass of inner core, dark grey along concentric alteration halo 8. Primary Minerals: mostly aphyric; <0.5% Fsp phenocrysts, 0.5-1mm 10. Overall Degree of Alteration: slightly to medium altered 11. Comment: second lava type of the dredge, different flow? or zoned lava flow?	x	x								
DR66-6	1. Rock Type: similar to DR66-5 2. Size: 13x8x7cm 7. Matrix Color: brownish-grey 8. Primary Minerals: 1% Fsp phenocrysts, otherwise aphyric	x	x								

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR66-7	1. Rock Type: porphyric pillow with altered chilled margin 2. Size: 13x12x12cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn coating 5. Vesicularity: < 0.5% 6. Vesicle Filling: vesicles in places open otherwise filled with Mn 7. Matrix Color: light-brown to dark brown-grey groundmass -> very strongly oxidized 8. Primary Minerals: 15-20% Fsp phenocrysts, ± fresh, 1-5mm, often with many black spots which could be Mn infiltrating through abundant cracks -> check TS before processing 10. Overall Degree of Alteration: very strongly altered groundmass, Fsp phenocrysts appear mostly fresh but need careful petrographic inspection 11. Comment: this lava type is somewhat similar to DR66-1, but significantly more porphyric	x	x								
DR66-8	1. Rock Type: similar to DR66-7, but groundmass is even more altered 2. Size: 10x10x8cm 3. Shape/Angularity: angular 10. Overall Degree of Alteration: very strongly altered	x									
DR66-9	1. Rock Type: similar to DR66-5, but texture looks like mixing of two different melts. Dark grey aphyric lava clasts are sourrounded by greenish-brown material, contacts are curved, therefore do not resemble alteration fronts but rather mixing of different materials when they where melt or at least deformed ductile 2. Size: 13x9x7cm 3. Shape/Angularity: subrounded 4. Encrustations: completly coated with Mn 5. Vesicularity: non-vesicular 7. Matrix Color: dark grey when fresh, greenish-brown where altered 8. Primary Minerals: aphyri, < 0.5% Fsp 10. Overall Degree of Alteration: fairly fresh zones 11. Comment: check TS for quality of dark grey areas	x									
DR66-10C	1. Rock Type: lapilli tuff, massive to faintly bedded hydroclastite 2. Size: 50x36x22cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn crust 5. Vesicularity: dense to ca. 5% 6. Vesicle Filling: Zeolite-lined 7. Matrix Color: translucent cement probably CC and very fine yellowish matrix 8. Primary Minerals: glassy altered, possibly fresh cores 9. Secondary Minerals: patches of Mn-Fe-hydroxides on the matrix 10. Overall Degree of Alteration: altered; possibly. fresh glass remnants in clast cores 11. Comment: clasts angular, blocky and splinter-shaped, poorly sorted, faint alignment and diffuse bedding over ca. 5cm; monomict, <1-20mm, larger clasts show flow banding, glass!	x				x?		x			
DR66-11C	1. Rock Type: highly altered coarse lapilli tuff 2. Size: 13x13x9cm 3. Shape/Angularity: irregular-subrounded 4. Encrustations: minor Mn crust 5. Vesicularity: dense 7. Matrix Color: soft pink-cream muddy matrix (pelagic ooze?) and Zeolite cement, open pore spaces 8. Primary Minerals: waxy, totally altered glass, aphanitic, large outsided clasts with white altered Fsp? (2-3mm) 9. Secondary Minerals: Mn-Fe-Hydroxides as rims around clasts 10. Overall Degree of Alteration: highly altered, yellowish Palagonite 11. Comment: <1-10mm, up to 45mm rarely subangular to subrounded massive, poorly sorted, closely packed, monomict							x			
DR66-12C	1. Rock Type: tuff 2. Size: 18x10x4cm 3. Shape/Angularity: slab 7. Matrix Color: ashy matrix, CC cement 8. Primary Minerals: aphanitic 9. Secondary Minerals: Mn-Fe-Hydroxides as patchy and dendritic overgrowth 10. Overall Degree of Alteration: highly altered 11. Comment: well sorted massive, sub-mm sized clasts closely packed, ?distal deposit of DR12-10C?							x			

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR66-13S	1. Rock Type: carbonate with few volcanic clasts 2. Size: 16x16x8cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn crust 7. Matrix Color: beige brown 11. Comment: micritic carbonate, appears brecciated & re-seated, ca. 20%, 1-30mmm volcanic clasts (altered glassy, angular)								x		
DR66-14M	1. Rock Type: Mn crust (3cm thick) on lapilli tuff 2. Size: 18x15x8cm									x	
DR66-15M	1. Rock Type: Mn crust (3cm thick), encrusting lava crust smililar to DR66-1									x	
DR66-16X	1. Rock Type: single piece broken into 6 seperate pieces, similar to DR66-1 2. Size: 24x1814cm (original size)						x				
DR66-17X	1. Rock Type: 6 seperate lava clasts similar to DR66-1, all pieces are fairly fresh						x				

SO199 - DR67
"Michael" Seamount
Dredge on bottom UTC 3/09/08 7:40hrs, lat 15°00.51'S, long 114°03.79'E, depth 3733m
Dredge off bottom UTC 3/09/08 8:45hrs, lat 15° 00.43'S, long 114°03.97'E, depth 3629m
total volume: few rocks
Comments: lava fragments and volcaniclastic rocks

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR67-1	1. Rock Type: lava fragment 2. Size: 8x7x6cm 3. Shape/Angularity: subangular 5. Vesicularity: 1% 6. Vesicle Filling: empty except a few with Mn 7. Matrix Color: light brown 8. Primary Minerals: altered Ol (amount: 15%, diameter: up to 4mm) white Fsp needles (amount: 15%, diameter: up to 1mm, appears fresh) 10. Overall Degree of Alteration: moderately altered 11. Comment: potential for dating, contains some Mn-filled cracks	x	x	x?							
DR67-2	1. Rock Type: similar to DR67-1, but with less cracks 2. Size: 7x6x5cm 5. Vesicularity: <0,5%, concentrated near one edge 6. Vesicle Filling: empty 8. Primary Minerals: altered Ol (amount: 10%, diameter: up to 10mm), wihite Fsp laths (amount: 12%, 1mm, fresh) 10. Overall Degree of Alteration: moderately altered 11. Comment: potential for dating	x		x?							
DR67-3	1. Rock Type: similar to DR67-1 2. Size: 9x6x7cm 8. Primary Minerals: altered Ol (amount: 6%, diameter: up to 6mm); white Fsp needles (amount: 6%, diameter: up to 2mm, fresh?)	x		x?							
DR67-4	1. Rock Type: similar to DR67-1 2. Size: 10x5x5cm 8. Primary Minerals: altered Ol (amount: 15%, diameter: up to 1mm), white Fsp needles (amount: 10%, diameter: up to 1mm), one black Px? (diameter: <3mm)			x?							
DR67-5	1. Rock Type: similar to DR67-1 2. Size: 10x6x6cm 8. Primary Minerals: altered Ol (amount: 4%, diameter: up to 2mm), white Fsp laths (amount: 6%, diameter: up to 1mm), single Px? crystal up to 5mm 11. Comment: lava part has been several cracks, vc are from 1 to 20mm, appear cemented to each other rather than by matrix, many have alteration			x?							
DR67-6	1. Rock Type: lava fragment, vesicular 2. Size: 12x8x6cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn coating 5. Vesicularity: 15% 6. Vesicle Filling: mostly empty, some filled with Zeolites? or lined with Zeolites? 7. Matrix Color: dark grey to brownish, some areas dark brown 8. Primary Minerals: altered Ol (amount: 3%, diameter: up to 1mm), Fsp needles (amount: 5%, diameter: up to 1mm, fresh) 10. Overall Degree of Alteration: moderately altered 11. Comment: lava fragment coated with volcaniclastic material, potential for dating, vesicles irregularly shaped, coalescent	x		x?							

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR67-7	1. Rock Type: similar to DR67-6 2. Size: 9x8x6cm 5. Vesicularity: 10% 6. Vesicle Filling: mostly filled with CC 7. Matrix Color: dark brown-greyish 10. Overall Degree of Alteration: altered 11. Comment: vesicles small, round to oval										
DR67-8	1. Rock Type: similar to DR67-6 2. Size: 10x6x7cm 7. Matrix Color: dark brown-greyish 10. Overall Degree of Alteration: altered 11. Comment: very irregularly shaped vesicles										
DR67-9C	1. Rock Type: heterolithic lapilli tuff 2. Size: 14x13x12cm 3. Shape/Angularity: irregular subrounded 5. Vesicularity: variably 0-15% 6. Vesicle Filling: mostly filled with Zeolites 7. Matrix Color: fine grainy yellowish matrix, open pore space and cementing Zeolites & Fe-Mn-hydroxides 8. Primary Minerals: variable, some clasts with Fsp needles, some with Fsp & OL, some apharitic and/or altered glass (clasts similar to DR67-1 and DR67-6) 10. Overall Degree of Alteration: highly altered 11. Comment: <1-20mm subangular blocky clasts, poorly sorted, closely packed, randomly oriented	x						x			
DR67-10C	1. Rock Type: similar to DR67-9C 2. Size: 22x16x12cm 4. Encrustations: minor Mn coating 11. Comment: clasts up to 30mm, lava fragment with glass spalling off clasts (in situ?)							x			
DR67-11CX	1. Rock Type: volcaniclastics similar to DR67-9C and -10C						x	x			

SO199 - DR68
"Michael Seamount"
Dredge on bottom UTC 03/09/08 13:54hrs, lat 14°54.512'S, long 114°01.770'E, depth 3826m
Dredge off bottom UTC 03/09/08 15:09hrs, lat 14°54.303'S, long 114°02.292'E, depth 3367m
total volume: few rocks
Comments: lava fragments and volcaniclastic rocks

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR68-1	1. Rock Type: lava fragment 2. Size: 12x9x7cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn-crust 5. Vesicularity: 3% 6. Vesicle Filling: CC 7. Matrix Color: greyish-darkbrown 8. Primary Minerals: Fsp needles <1% <1mm; Ol <1% altered <1mm 9. Secondary Minerals: black spots of probably Mn-Fe-hydroxides 10. Overall Degree of Alteration: altered 11. Comment: small round vesicles and few pipe vesicles, prob. basaltic volcanics	x	x								
DR68-2	1. Rock Type: similar to DR68-1 2. Size: 20x18x12cm 5. Vesicularity: 2% 6. Vesicle Filling: empty 7. Matrix Color: patchy yellow-brown and greyish-brown 11. Comment: microvesicular	x	x								
DR68-3	1. Rock Type: similar to DR68-1 2. Size: 8x6x5cm										
DR68-4	1. Rock Type: similar to DR68-1 2. Size: 8x7x4cm										
DR68-5C	1. Rock Type: dark, coarse lapilli tuff 2. Size: 23x15x14cm 3. Shape/Angularity: irregular 4. Encrustation: minor Mn coating 5. Vesicularity: <1% 6. Vesicle Filling: filled with Zeolites ? 7. Matrix Color: yellowish fine grained matrix 8. Primary Minerals: possibly Fsp, crystals up to 1mm, altered, 2% 10. Overall Degree of Alteration: moderately altered 11. Comment: clasts <1-50mm subangular to subrounded poorley sorted, closely packed, randomly oriented, larger clasts, grey groundmass which appears little altered. Rock heavy and solidly cemented monomict.	x						x			

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR68-6C	1. Rock Type: reddish lapilli tuff 2. Size: 10x9x9cm 3. Shape/Angularity: roundish 5. Vesicularity: variable 0-10% 6. Vesicle Filling: generally ampty or lined with Zeolites 7. Matrix Color: cream muddy matrix, CC cement 8. Primary Minerals: some clasts are Fsp-pyric, crystals <1mm, 10%, altered 10. Overall Degree of Alteration: moderately altered 11. Comment: clasts <1-40mm, subrounded, moderately closely packed, poorly sorted, randomly oriented, heterolithic	x						x			
DR68-7C	1. Rock Type: yellowish lapilli tuff 2. Size: 19x13x5cm 3. Shape/Angularity: slab 4. Encrustation: minor Mn-crust 5. Vesicularity: variably 0-10% 6. Vesicle Filling: filled with Zeolites 7. Matrix Color: CC cement 8. Primary Minerals: apharitic 10. Overall Degree of Alteration: altered 11. Comment: <1-20mm clasts, fabric structure similar to DR68-6C							x			
DR68-8C	1. Rock Type: similar to DR68-7C 2. Size: 14x10x5cm 3. Shape/Angularity: subrounded							x			
DR68-9C	1. Rock Type: similar to DR68-6C, but yellow in colour (different alteration?) 2. Size: 20x13x7cm 7. Matrix Color: muddy soft cream colour matrix							x			
DR68-10X	1. Rock Type: 3 pieces similar to DR68-1						x				
DR68-11CX	1. Rock Type: 2 pieces similar to DR68-7C						x	x			

SO199 - DR69
"Michael Seamount"
Dredge on bottom UTC03/09/08 19:48hrs, lat 15°04.447'S, long 114°05.074'E, depth 4020m
Dredge off bottom UTC 03/09/08 21:19hrs, lat 15°04.624'S, long 114°05.690'E, depth 3541m
total volume: 2 rocks
Comments: lava fragments

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR69-1	1. Rock Type: lava fragment 2. Size: 12x7x5cm 3. Shape/Angularity: angular 4. Encrustation: minor Mn coating 5. Vesicularity: ca. 1% 6. Vesicle Filling: filled with CC or empty 7. Matrix Color: brown patchy matrix 8. Primary Minerals: Ol <1mm <1% altered; Fsp needles ca. 1% appear fresh; Fsp phenocrysts ca. 1-2mm 1% prob. fresh 10. Overall Degree of Alteration: moderately altered 11. Comment: potential for dating	x	x	x?							
DR69-2	1. Rock Type: similar to DR69-1 2. Size: 7x7x5cm 4. Encrustation: and 15mm thick layer of grey soft sediment attached to one side 6. Vesicle Filling: mostly empty 8. Primary Minerals: Fsp phenocrysts 1-2mm, 2% fresh to slightly altered 10. Overall Degree of Alteration: moderately altered	x		x?							

SO199 - DR71
"Iris" Seamount
Dredge on bottom UTC 05/09/08 18:11hrs, lat 12°20.512'S, long 113°44.442'E, depth 4908m
Dredge off bottom UTC 05/09/08 19:40hrs, lat 12°21.003'S, long 113°44.786'E, depth 4321m
total volume: some rocks
Comments: lavas, Mn crusts, sedimentary rocks

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR71-1	1. Rock Type: lava fragment 2. Size: 6x6x5cm 3. Shape/Angularity: angular 4. Encrustation: minor Mn coating 5. Vesicularity: 2% 6. Vesicle Filling: Zeolites 7. Matrix Color: mostly brown, few dark grey areas 8. Primary Minerals: Ol < 1mm, altered 5% 9. Secondary Minerals: Mn-Fe-hydroxides as tiny specks 10. Overall Degree of Alteration: moderately altered 11. Comment: only samlpe with (minor) areas of potentially fresh groundmass	x									
DR71-2	1. Rock Type: lava fragment 2. Size: 8x7x6cm 3. Shape/Angularity: subangular 4. Encrustation: minor Mn coating 5. Vesicularity: ca. 1% 6. Vesicle Filling: Zeolites 7. Matrix Color: greyish-brown 8. Primary Minerals: Ol altered <1%, <1mm; Fsp laths, appear fresh, 2-3%, <1mm 10. Overall Degree of Alteration: moderately altered	x									
DR71-3	1. Rock Type: lava fragment similar to DR71-2 2. Size: 8x6x5cm 7. Matrix Color: brownish 8. Primary Minerals: Fsp needles claths 3-5% up to 2mm	x									
DR71-4	1. Rock Type: similar to DR71-1 2. Size: 6x6x4cm 4. Encrustation: 1mm Mn-crust 5. Vesicularity: <1% 6. Vesicle Filling: Zeolites 7. Matrix Color: yellowish-brown to grey 10. Overall Degree of Alteration: moderately altered 11. Comment: towards one side, fine crystalline to glassy (highly altered) rim	x									
DR71-5S	1. Rock Type: reddish sediment, bioturbated 2. Size: 16x15x14cm 3. Shape/Angularity: subrounded 4. Encrustation: minor Mn coating 7. Matrix Color: reddish pink and cream areas 9. Secondary Minerals: Mn-Fe-hydroxides patches 10. Overall Degree of Alteration: altered 11. Comment: fine grained, inhomogeneous non-calcareous sediment	x							x		
DR71-6M	1. Rock Type: Mn-crust 2. Size: 25x13x7cm 3. Shape/Angularity: slab 11. Comment: 4cm thick Mn crust on highly altered lava fragments									x	
DR71-7X	1. Rock Type: similar to DR71-2						x				
DR71-8SX	1. Rock Type: similar to DR71-5S						x		x		

SO199 - DR72
"Iris" Seamount
Dredge on bottom UTC 05/09/08 00:10hrs, lat 12° 20.71'S, long 113° 46.72"E, depth 4378m
Dredge off bottom UTC 05/09/08 01:12hrs, lat 12° 21.13'S, long 113°47.08"E, depth 3919m
total volume: 1/2 full
Comments: lava fragments and volcaniclastic rocks

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR72-1	1. Rock Type: Fsp-porphyric lava 2. Size: 24x15x19cm original size, all 3 pieces saved 3. Shape/Angularity: angular 4. Encrustations: some Mn coating no crusts 5. Vesicularity: non vesicular 7. Matrix Color: dark grey groundmass, fairly fresh 8. Primary Minerals: 10-15% Fsp phenocryst, 0.5-3mm, as laths and as circular claster fresh; <0.5% fresh Ol, 0.5-1mm, 4-5% pyroxene, fresh difficult to distinguish from Fsp except dark color 9. Secondary Minerals: minor Fe-Oxyhydorxide along cracks at the edge of the sample 10. Overall Degree of Alteration: slightly altered 11. Comment: This is the largest and freshest sample of this Fsp-Px-Ol phyric lava. Dredge exclusively consists of this lava type. All other samples are much more altered medium to very strongly altered	x	x								
DR72-2	1. Rock Type: similar to DR72-1 2. Size: 24x15x12cm 3. Shape/Angularity: angular 7. Matrix Color: greyish-brown 10. Overall Degree of Alteration: medium altered 11. Comment: second best sample with respect to freshness of matrix	x	x								
DR72-3	1. Rock Type: similar to DR72-1 but completely rounded and groundmass totally altered 2. Size: 12x10x9cm 3. Shape/Angularity: completely rounded 5. Vesicularity: vesicular inner core -> most altered zone 7. Matrix Color: brown to orange oxidized groundmass 8. Primary Minerals: possibly more Px than in DR72-1, 8% Px 1-3mm along crack rim of sample 10. Overall Degree of Alteration: very strongly altered 11. Comment: sample could be part of a small pillow type. Saved to check Px abundance	x									
DR72-4C	1. Rock Type: tuff diffusely laminated 2. Size: 10x7x5cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn-crust 7. Matrix Color: cream-yellowish 9. Secondary Minerals: Mn-Fe-hydroxide patches and dendrites 10. Overall Degree of Alteration: altered 11. Comment: very fine grained particles, probably of volcanic origin and pelagic ooze, diffusely wavy laminated	x						x			
DR72-5X	1. Rock Type: similar to DR72-1 2. Size: 30x20x10cm						x				
DR72-6X	1. Rock Type: similar to DR72-1 2. Size: 26x13x12cm						x				
DR72-7X	1. Rock Type: similar to DR72-1 2. Size: 13x11x10cm						x				

SO199 - DR73
"Annegret" Seamount, NE ward facing small nose on W ward facing slope of the seamount
Dredge on bottom UTC07/09/08 17:05hrs, lat 14°13.793'S, long 108°29.774'E, depth 4331m
Dredge off bottom UTC 07/09/08 18:23hrs, lat 14°13.504'S, long 108°30.213'E, depth 3983m
total volume: few rocks
Comments: lava fragments, carbonate

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR73-1	1. Rock Type: lava fragment 2. Size: 12x7x5cm 3. Shape/Angularity: irregular subrounded 5. Vesicularity: 10-15%, up to 5mm 6. Vesicle Filling: mostly empty, except zeolites 7. Matrix Color: darkgrey 8. Primary Minerals: Fsp needles: 20%, up to 2mm, appear fresh 10. Overall Degree of Alteration: slightly altered 11. Comment: potential for dating	x	x	x?							

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR73-2	1. Rock Type: lava fragment 2. Size:10x7x6cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn-crust 5. Vesicularity: <3%, up to 3mm 6. Vesicle Filling: mostly empty, a few Zeolites 7. Matrix Color: darkgrey 8. Primary Minerals: Fsp needles: 15%, up to 2mm, appear fresh 10. Overall Degree of Alteration: slightly altered 11. Comment: potential for dating	x	x	x?							
DR73-3	1. Rock Type: similar to DR73-2 2. Size:12x8x7cm 3. Shape/Angularity: subangular 5. Vesicularity: <1%, <1mm 6. Vesicle Filling: empty 8. Primary Minerals: Fsp needles: <15%, up to 2mm; altered Ol: layered maybe a result of shearing, 5%, up to 2mm 10. Overall Degree of Alteration: moderately altered 11. Comment: Ol appears layered as a result of shearing, potential for dating	x	x	x?							
DR73-4	1. Rock Type: similar to DR73-2 2. Size: 14x9x6cm 5. Vesicularity: <1%, up to 3mm 6. Vesicle Filling: empty 7. Matrix Color: darkgrey-brownish	x									
DR73-5	1. Rock Type: lava fragment 2. Size: 10x9x9cm 3. Shape/Angularity: regular subrounded 5. Vesicularity: in central parts <5%, up to 2mm; rest --> 0% 6. Vesicle Filling: mostly empty, except Zeolites 7. Matrix Color: darkgrey 8. Primary Minerals: Fsp needles: 10%, up to 2mm; altered Ol: <3%, up to 5mm 9. Secondary Minerals: Epidote: <1% 10. Overall Degree of Alteration: moderately altered	x									
DR73-6	1. Rock Type: lava fragment 2. Size: 9x8x6cm 3. Shape/Angularity: irregular subangular 5. Vesicularity: <5%, up to 1mm 6. Vesicle Filling: empty 7. Matrix Color: brown-greyish 8. Primary Minerals: Fsp needles: <3%, up to 1mm 10. Overall Degree of Alteration: moderately altered 11. Comment: vesicles are layered --> diameter increase from the centre to the rims										
DR73-7	1. Rock Type: similar to DR73-1 2. Size: 9x6x6cm 5. Vesicularity: 3%, up to 3mm 8. Primary Minerals: Fsp needles: 5%, up to 1mm 10. Overall Degree of Alteration: altered										
DR73-8C	1. Rock Type: lapilli tuff, monomict 2. Size: 14x7x3cm 3. Shape/Angularity: irregular- angular 4. Encrustations: minor Mn-coating 7. Matrix Color: cream fine grainy matrix and Zeolite cement 8. Primary Minerals: Fsp needles: up to 2mm, appear altered, ca. 2% variable 10. Overall Degree of Alteration: slightly altered 11. Comment: clasts <1-50mm, angular blocky and irregular, often flow-banded, massive, poorly sorted, closely packed	x						x			
DR73-9C	1. Rock Type: similar to DR73-8C, altered, heterolithic 2. Size: 8x5x3cm 3. Shape/Angularity: subrounded 5. Vesicularity: variably 0-5% 6. Vesicle Filling: opaque Zeolite (opal?) 7. Matrix Color: mostly opaque Zeolite, minor fine grained matrix 9. Secondary Minerals: Fe-Mn-Hydroxide patches 10. Overall Degree of Alteration: highly altered 11. Comment: clasts <1-40mm, angular and subrounded, in some areas small clasts floating in cement							x			

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR73-10C	1. Rock Type: tuff with crystals 2. Size: 38x24x12cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn-crust 5. Vesicularity: - but rock is porous ca. 5% 6. Vesicle Filling: empty 7. Matrix Color: greyish and cream, as patches alternating 8. Primary Minerals: Fsp up to 4mm, 5%, as equant idiomorph crystals, appear fresh 10. Overall Degree of Alteration: slightly altered 11. Comment: texture appears homogeneous, no clastic particles recognized (very fine tuff or lava flow?); potential for dating	x	x	x?				x			
DR73-10CX	1. Rock Type: Archive						x				
DR73-11C	1. Rock Type: similar to DR73-10C 2. Size: 19x14x13cm 8. Primary Minerals: Fsp, up to 4mm, ca. 7%, irregularly disturbed 9. Secondary Minerals: Mn-Fe-hydroxide as mm-sized patches on groundmass 10. Overall Degree of Alteration: altered slightly to moderately 11. Comment: potential for dating	x	x	x?				x			
DR73-11CX	1. Rock Type: Archive						x				
DR73-12C	1. Rock Type: similar to DR73-10C 2. Size: 9x6x4cm 3. Shape/Angularity: round 5. Vesicularity: - dense 7. Matrix Color: yellowish-greenish 8. Primary Minerals: Fsp laths and more equant crystals ca. 5%, appear fresh 9. Secondary Minerals: Mn-Fe-hydroxide as dendritic and patchy overgrowth 10. Overall Degree of Alteration: moderately altered 11. Comment: potential for dating	x		x?				x			
DR73-13C	1. Rock Type: similar to DR73-12C 2. Size: 10x6x4cm 8. Primary Minerals: ca. 2% 10. Overall Degree of Alteration: altered 11. Comment: groundmass looks very dense, coherent and shows ghost-like round 2mm lighter coloured areas which appear perlitic, or else, highly compacted tuff	x		x?				x			
DR73-14S	1. Rock Type: carbonate 2. Size: 33x21x16cm 3. Shape/Angularity: angular-irregular 7. Matrix Color: cream micrite 9. Secondary Minerals: light green, soft areas of something highly weathered 11. Comment: inhomogeneous, clean micritic carbonate and carbonate with abund ant mm-sized clasts (volcanic and biogene), rounded pebbles --->beach!								x		
DR73-14SX	1. Rock Type: Archive						x		x		

SO199 - DR75
"Kirk" Seamount, E ridge of SSW sticking canyon
Dredge on bottom UTC 08/09/08 05:10hrs, lat 13°23.30'S, long 108°00.19'E, depth 3639m
Dredge off bottom UTC 08/09/08 07:43hrs, lat 13°23.01'S, long 108°00.62'E, depth 3260m
total volume: 2 rocks
Comments: lava fragments

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR75-1	1. Rock Type: lava fragment, Fsp-phyric 2. Size: 11x9x8cm 3. Shape/Angularity: angular 4. Encrustations: Mn-coating 5. Vesicularity: non vesicular 7. Matrix Color: brown thoroughly oxidized, very few greyish spots <1% 8. Primary Minerals: Fsp-microphenocryst laths, <0.5mm, +/- fresh, 1% Fsp glomerocrysts, 0.5-3mm, slightly altered 9. Secondary Minerals: oxidized groundmass 10. Overall Degree of Alteration: strongly altered 11. Comment: Fsp microphenocryst may be used for dating only reconaussance chenistry possible	x									

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR75-2	1. Rock Type: lava fragment, Px-phyric 2. Size: 7x8x4cm 3. Shape/Angularity: angular 4. Encrustations: Mn-coating 5. Vesicularity: non vesicular 7. Matrix Color: greenish-brown groundmass for the most part 10% grey spots with relatively fresh groundmass 8. Primary Minerals: Px, 1-10mm, some quite large, 5%, +/- fresh 9. Secondary Minerals: oxidized groundmass 10. Overall Degree of Alteration: strongly altered	x									

SO199 - DR76
"Günter" seamount, SW-facing slope of the seamount, steepest part of upper slope, small KUM dredge
Dredge on bottom UTC 08/09/08 17:49hrs, lat 13°28.023'S, long 107°02.161'E, depth 3564m
Dredge off bottom UTC 08/09/08 20:28hrs, lat 13°28.144'S, long 107°01.809'E, depth 3807m
total volume: empty
Comments: dredge got stuck

SO199 - DR77
"Isabel" Seamount, SW-upper flank just beneath the top
Dredge on bottom UTC 09/09/08 05:40hrs, lat 14°05.98'S, long 106°22.47'E, depth 4257m
Dredge off bottom UTC 09/09/08 07:04hrs, lat 14°05.89'S, long 106°23.00'E, depth 3730m
total volume: 3/4 full
Comments: vesicular lava fragments and large blocks of volcaniclastic rock

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR77-1	1. Rock Type: highly vesicular pillow lava fragment 2. Size: 12x9x8cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn-coating and weathered chilled margin 5. Vesicularity: 50% vesicles 0.1-1mm, zoned distribution, only piece with unfilled vesicles, some lined with yellow-green material 7. Matrix Color: dark grey groundmass, quite fresh 8. Primary Minerals: 2% Fsp phenocrysts, 1-3mm angular laths, fresh often idiomorph 10. Overall Degree of Alteration: slightly altered 11. Comment: Best piece for geochemistry due to unfilled vesicles. Volcaniclastic sediment attached on pillow margin	x	x								
DR77-2	1. Rock Type: similar to DR77-1 2. Size: 8x8x7cm 6. Vesicle Filling: at the edge of the sample filled with yellowish-brown material 10. Overall Degree of Alteration: medium altered 11. Comment: saved for Fsp separation	x									
DR77-3	1. Rock Type: similar to DR77-2 6. Vesicle Filling: more filled vesicles	x									
DR77-4	1. Rock Type: similar to DR77-1, but much less vesicular 2. Size: 10x9x5cm 5. Vesicularity: 30% vesicles 6. Vesicle Filling: filled with Fe-Oxyhydroxide 7. Matrix Color: dark grey groundmass, with dense areas 10. Overall Degree of Alteration: medium altered 11. Comment: dense area could be used for geochemistry	x									
DR77-5	1. Rock Type: similar to DR77-1 2. Size: 7x6x4cm 11. Comment: nice chilled margin 1cm thick	x									
DR77-6	1. Rock Type: 12x lava fragments similar to DR77-1 recoverd from large 73x53x30cm volcanoclastic bloc sitting on top of dredge 2. Size: avrg sample size 5-9cm 11. Comment: saved for fsp seperation							(x)			
DR7-7C	1. Rock Type: heterolithic massive lapilli tuff 2. Size: 19x14x10cm 3. Shape/Angularity: subround 4. Encrustations:minor Mn coating 5. Vesicularity: variably 2-30% 6. Vesicle Filling: empty, lined and filled with zeolites 7. Matrix Color: clear sparitic cc and minor finegrained cream-yellowish matrix 8. Primary Minerals: <1% fsp idiomorph, altered, in some clasts 10. Overall Degree of Alteration: altered, overall rock colour Yellowish-brown 11. Comment: clasts <1-40mm, poorly sorted, closely packed, randomly oriented, clasts blocky angular to abraded, of different vesicularity & colour & alteration -> rockfall (debris flow. Some of the smaller clasts apparently resemble clasts of DR77-8C	x						x			

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR77-8C	1. Rock Type: monomict lapilli tuff 2. Size: 18x14x9cm 3. Shape/Angularity: subrounded 4. Encrustations: minor Mn-coating 5. Vesicularity: variably 0-20 (30) % 6. Vesicle Filling: mostly filled with zeolites, often highly stretched and clasts broken across vesicles 7. Matrix Color: pink soft pelagic ooze and very fine grained greenish matrix 10. Overall Degree of Alteration: altered, yellowish-greenish coloured clasts 11. Comment: clasts <1-10mm and up to 50mm occaionsally, closely	x						x			
DR77-9C	1. Rock Type: similar to DR77-7C 2. Size: 12x10x6cm 7. Matrix Color: dark olivine matrix, muddy 10. Overall Degree of Alteration: altered 11. Comment: clasts subrounded, smaller ones resemble bubble wall shards							x			
DR77-10X	1. Rock Type: ca 5 pices similar to DR77-1						x				

SO199 - DR78
"Helga" Seamount, W facing lower slope of seamount, steepest part in this area
Dredge on bottom UTC 09/09/08 15:14hrs, lat 14°31.95'S, long 106°05.45'E, depth 5120m
Dredge off bottom UTC 09/09/08 16:47hrs, lat 14°32.10'S, long 106°05.99'E, depth 4592m
total volume: 1/3 full
Comments: lava fragments, volcaniclastic rocks and carbonate

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR78-1	1. Rock Type: lava fragment with flow banding 2. Size: 14x11x8cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn coating 5. Vesicularity: 1-5% variable in flowbands 6. Vesicle Filling: empty 7. Matrix Color: darkcgrey 10. Overall Degree of Alteration: slightly altered 11. Comment: areas in groundmass almost devoid of vesicles, fresh, aphanitic	x	x								
DR78-2	1. Rock Type: similar to DR78-1 2. Size: 14x13x11 7. Matrix Color:darkgrey and some brown altered flow bands 10. Overall Degree of Alteration: fresh to altered	x	x								
DR78-3	1. Rock Type: lava fragment 2. Size: 13x9x7cm 3. Shape/Angularity: subangular 4. Encrustations: one side Mn-crust up to 10mm 5. Vesicularity: 5-10% 6. Vesicle Filling: small are empty, bigger ones are filled with cream soft filling 7. Matrix Color: grey, partly brownish 10. Overall Degree of Alteration: moderatly altered 11. Comment: presumably second lava type in this dredge	x	x								
DR78-4	1. Rock Type: similar to DR78-3 2. Size: 14x13x10 4. Encrustations: no Mn-crust 6. Vesicle Filling: bigger vesicles filled with greenish soft filling	x	x								
DR78-5	1. Rock Type: similar to DR78-3 2. Size: 8x10x6cm 4. Encrustations: minor Mn-crust 5. Vesicularity: 5%	x	x								
DR78-6	1. Rock Type: similar to DR78-3 2. Size: 15x15x11	x	x								
DR78-7	1. Rock Type: similar to DR78-3 3. Shape/Angularity: 4. Encrustations: minor Mn-crust 5. Vesicularity: 10-15% 11. Comment: pipe vesicles up to 3cm										
DR78-8	1. Rock Type: similar to DR78-3 2. Size: 15x10x12cm 4. Encrustations: minor Mn-crust 5. Vesicularity: 10-15% 6. Vesicle Filling: small ones, empty, bigger ones yellowish filling 8. Primary Minerals: Fsp needles, <1mm, <1%, altered										
DR78-9	1. Rock Type: similar to DR78-8 2. Size: 15x12x8cm										

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR78-10	1. Rock Type: similar to DR78-3 2. Size: 13x6x6cm 4. Encrustations: minor Mn-crust 5. Vesicularity: 5% 8. Primary Minerals: Fsp needles less than 1mm and less than 1% 11. Comment: potential for dating???	x	x	x?							
DR78-11C	1. Rock Type: lapilli tuff 2. Size: 27x17x17cm 3. Shape/Angularity: subrounded 4. Encrustations: minor Mn coating 5. Vesicularity: variably 0-10% (rarely up to 20%) 6. Vesicle Filling: empty or filled with Zeolites 7. Matrix Color:yellowish fine grained matrix, with cement 9. Secondary Minerals: Mn-Fe-hydroxide as rims around clasts 10. Overall Degree of Alteration: altered brownish-yellow 11. Comment: clasts <1-15mm, rarely up to 40mm, subangular and angular, monomict, poorly sorted, closly packed, randomly orientated, clasts often with flow banding and stretched vesicles, hanging cements	x						x			
DR78-12S	1. Rock Type: carbonate, bioturbated 2. Size: 16x9x7cm 3. Shape/Angularity: subrounded 4. Encrustations: irregular Mn coating up to 1cm 7. Matrix Color: cream-pink micrite 11. Comment: network of ca. 5mm diameter, burrows filled with lighter coloured compacted rock (?cherty)								x		
DR78-4X	1. Rock Type: see DR78-4						x				
DR78-9X	1. Rock Type: see DR78-9						x				
DR78-13 to 16X	1. Rock Type: similar to DR78-3 to -9						x				

SO199 - DR79
"Bente" seamount, seamount with conical shape, SW-facing slope, middle of slope
Dredge on bottom UTC 09/09/08 22:26hrs, lat 14°14.96'S, long 106°05.40'E, depth 3787m
Dredge off bottom UTC 10/09/08 00:30hrs, lat 14°15.00'S, long 106°05.44'E, depth 3828m
total volume: 1/4
Comments: dredge got stuck near on bottom contact

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR79-1	1. Rock Type: crystal rich tuff or lava with flow banding of crystals 2. Size: 32x28x22 original size, 4 pcs saved for working 3. Shape/Angularity: angular 4. Encrustations: thin <0.2mm Mn coating covering entire sample 5. Vesicularity: 4% vesicles, 0.1-2mm, zoned distribution of vesicle size, mostly unfilled, irregular and angular in shape. Vesicles are not elongated and not aligned like the Fsp / Foide crystals. 6. Vesicle Filling: filled in places with white and yellowish brown material; presumably CC 7. Matrix Color: dark to light grey groundmass with slight brownish discoloration where altered 8. Primary Minerals: 10%, fresh Fsp or Foide phenocrysts aligned in a parallel curved texture. In orthogonal view to the flow banding, the crystals are platy and have hexagonal shape, 3-20mm size in plain view and 1-3mm thick. Could be Nepheline or Leucite? 10. Overall Degree of Alteration: slightly to medium altered 11. Comment: this is a crystal rich evolved melt. Not clear whether erupted as lava or welded? Tuff. The alignment of the crystals indicates sorting and bending during deposition. The vesicles appear to have formed later during final cooling when most of the rock was already solid	2pc	x	x			5 pc				TS perpendicular to each other

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR79-2	1. Rock Type: crystal rich tuff or lava, somewhat similar to DR79-1 but with brownish groundmass and without flow bending 2. Size: 14x12x11cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn coating covering entire sample 5. Vesicularity: 5%, <0.1mm, mostly unfilled, a few vesicles are up to 10mm but resemble unfilled cracks 6. Vesicle Filling: open 7. Matrix Color: light brown 8. Primary Minerals: 10-15% Fsp or Foides, 1-10mm, fresh, irregularily distributed, no flow banding visible; possibly 1-2% Px, 1-2mm, fresh, appears as black phenocryst 9. Secondary Minerals: oxidized groundmass 10. Overall Degree of Alteration: medium altered judging from groundmass color, phenocrysts are fresh 11. Comment: Although somewhat similar to to DR79-1, there are differences in groundmass color and crystal distribution										
DR79-3	1. Rock Type: crystal rich tuff or lava with light green groundmass. This is the second lithological unit of the dredge 2. Size: 27x23x17 3. Shape/Angularity: angular 4. Encrustations: minor Mn-spotting 5. Vesicularity: 10% vesicles, 0.2-2mm, very irregular shape, angular contacts with groundmas 6. Vesicle Filling: unfilled 7. Matrix Color: light green; somewhat similar to phonolite 8. Primary Minerals: 8% Fsp or Foides, 1-4mm, fresh 10. Overall Degree of Alteration: slightly to medium altered 11. Comment: not clear whether this is lava or tuff. The absence of crystal or vesicle alignment favor a lava origin										
DR79-4	1. Rock Type: similar to DR79-3 2. Size: 13x11x9 10. Overall Degree of Alteration: 1-2cm thick weathering halo 11. Comment: saved as back up										
DR79-5	1. Rock Type: pillow lava 2. Size: 23x19x16cm original size, 3pcs saved 3. Shape/Angularity: subangular 4. Encrustations: very minor Mn-coating 5. Vesicularity: 6% rounded vesicles, 0.5-2mm, filled with CC or lined with Zeolites 7. Matrix Color: greyish-brown groundmass 8. Primary Minerals: 2-3% Fsp phenocrysts, 1-2mm, ±fresh 10. Overall Degree of Alteration: medium to strongly altered 11. Comment: large piece saved for Fsp separation. Other smaller samples of the pilloow lithology are fresher and saved in the following samples. This is the third lithology of the dredge										
DR79-6	1. Rock Type: pillow lava with 2cm chilled margin, no fresh glass 2. Size: 15x10x10cm original size, 3pcs saved 5. Vesicularity: 10% vesicles, 0.2-0.5mm, large areas with open vesicles 7. Matrix Color: greyish-brown groundmass 8. Primary Minerals: 4-5% Fsp phenocrysts, 2-5mm, fresh 10. Overall Degree of Alteration: medium altered 11. Comment: sample has more abundant phenocryst phases and areas of unfilled vesicles. More useful for geochemistry than DR79-5										
DR79-7	1. Rock Type: vesicular pillow lava, quite aphyric with 0,5-1cm thick Mn-crust 2. Size: 23x13x9cm 3. Shape/Angularity: rounded 4. Encrustations: 0.5-1cm Mn-crust covering entire sample 5. Vesicularity: 10% rounded vesicles, 0.5-3mm, often butr areas with open vesicles are also present 7. Matrix Color: greyish-brown groundmass 8. Primary Minerals: mostly aphyric, a single Fsp phenocryst 3mm long is observed 9. Secondary Minerals: partially oxidized groundmass 10. Overall Degree of Alteration: medium altered 11. Comment: this is a second pillow variety that is aphyric in contrast to DR79-5 and -6										
DR79-8	1. Rock Type: similar to DR79-7 2. Size: 11x8x6cm 11. Comment: initially saved because vesicle filling seemed least abundant, but after cutting vesicles appear filled with CC										

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR79-9C	1. Rock Type: lapilli tuff faintly bedded 2. Size: 28x25x17cm 3. Shape/Angularity: subrounded 4. Encrustations: minor Mn coating 5. Vesicularity: most clasts ~5-10%, some 20-30%, some 0%t 6. Vesicle Filling: generally lined or filled with Zeolites or CC 7. Matrix Color: yellowish-greenish very fine grained matrix consisting of platy and cuspate shards, minor white cement 8. Primary Minerals: aphanitic 9. Secondary Minerals: minor Fe-Mn-Hydroxide patches on matrix 10. Overall Degree of Alteration: very strongly altered, clasts thoroughly hydrated, palagonitized 11. Comment: Clasts <1-15mm, irregular angular shaped, fine fraction some bubble wall shards. Mostly monomict, rare accidential non-vesicular, Fsp-phyric lithics. Poorly sorted, moderately cloesely packed to loosely packed, in places faint clast alignment, bedding poorly defined, resembles shear horizons of debris flow.							x			
DR79-10X	1. Rock Type: 2 pieces similar to DR79-3, 10-15cm						x				
DR79-11X	1. Rock Type: 4 pieces of Fsp phyric pillow lava similar to DR79-6						x				
DR79-12X	1. Rock Type: 2 piecesof ±aphyric pillow lava similar to DR79-7						x				
DR79-13	1. Rock Type: lava fragment with coarse grained relatively fresh groundmass. Discovered when dried and other samples had been already described, therfore listed as last sample after archive samples 2. Size: 14x11x8cm 3. Shape/Angularity: angular 4. Encrustations: Mn-coating 5. Vesicularity: 10% rounded vesicles, 1-3mm, mostly open but lined with dark green material; possibly smectite 7. Matrix Color: light grey 8. Primary Minerals: <1% Fsp, 1-2mm, ±fresh, coarse grained groundmass consists of Fsp and Px 10. Overall Degree of Alteration: medium altered but groundmass is quite fresh when vesicles are avoided 11. Comment: represents a thrid typ of pillow?										

SO199 - DR80
"Clara-Marie" Seamount
Dredge on bottom UTC 10/09/08 12:20hrs, lat 13°16.46'S, long 105°13.52'E, depth 3220m
Dredge off bottom UTC 10/09/08 13:41hrs, lat 13°16.74'S, long 105°13.95'E, depth 2686m
total volume: 3 rocks
Comments: lava fragment, epiclastic conglomerates/volcaniclastic-rich

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR80-1	1. Rock Type: lava fragment, flow banded 2. Size: 10x9x5cm 3. Shape/Angularity: rounded 4. Encrustations: minor Mn couting 5. Vesicularity: <1%, <1mm 6. Vesicle Filling: empty 8. Primary Minerals: fsp or foides equant and highly elongate crystals lath-shaped, 1-2mm and up to 2mm, appear fresh, 2-3%; brown altered ca. 1mm crystals, prob. Ol? 10. Overall Degree of Alteration: slightly altered 11. Comment: potential for dating, based on groundmass color, prob. More evolved rock	x	x	x?							
DR80-2C	1. Rock Type: epiclastic sedimentary rock 2. Size: 11x10x8cm 3. Shape/Angularity: subangular 7. Matrix Color: grey fine grained matrix, minor CC cement 11. Comment: clasts consist of tuff fragments, biogene debris, lava of different types and carbonate; rock fall; matrix-supported conglomerate	x						x			
DR80-3C	1. Rock Type: similar to -2C 2. Size: 9x8x6cm							x			

SO199 - DR81
"Clara-Marie" Seamount, N-S elongated guyot-like seamount, westward facing lower slope
Dredge on bottom UTC 10/09/08 18:18hrs, lat 13°21.59'S, long 105°10.09'E, depth 4400m
Dredge off bottom UTC 10/09/08 19:50hrs, lat 13°21.604'S, long 105°10.66E, depth 3970m
total volume: few rocks
Comments: columnar jointed, flow banded lava fragment/s, volcaniclastics, carbonate; all lava from same lithology, progessively altered from -1 to -6

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR81-1	1. Rock Type: colmunar jointed lava fragment 2. Size: 25x11x11cm 3. Shape/Angularity: regular angular column 4. Encrustations: minor Mn crust, on one side thicker (up to 5mm) 5. Vesicularity: 15%, 2 sets of vesicles: sub-mm empty irregular shaped, 1-5mm empty ones 7. Matrix Color: brown to browngreyish, slightly inhomogeneous (flow banding) 8. Primary Minerals: aphyric 10. Overall Degree of Alteration: moderately altered 11. Comment: nice pillar, 5-sided column, groundmass surprisingly non-crystalline	x	x								
DR81-2	1. Rock Type: similar to DR81-1 2. Size: 27x12x10 5. Vesicularity: some of the large vesicles are elongated pipe-vesicles	x	x								
DR81-3	1. Rock Type: similar to DR81-1 2. Size: 18x13x8 3. Shape/Angularity: irregular shaped angular fragment	x	x								
DR81-4	1. Rock Type: similar to DR81-3 2. Size: 18x8x8 6. Vesicle Filling: minor lining of vesicles with Zeolites	x	x								
DR81-5	1. Rock Type: similar to DR81-3 2. Size: 10x9x4 5. Vesicularity: 15-20%, large rounded oval vesicles up to 7mm, abundant <1mm vesicles 6. Vesicle Filling: empty, some of thelarger ones occassionally filled with CC 7. Matrix Color: brown										
DR81-6	1. Rock Type: similar to DR81-3 2. Size: 16x8x7 5. Vesicularity: coalescent and collapsing vesicles (irregular shapes) 6. Vesicle Filling: some filled with CC 7. Matrix Color: brown										
DR81-7C	1. Rock Type: monomict lapilli tuff 2. Size: 30x20x20 3. Shape/Angularity: irregular angular 4. Encrustations: up to 5mm Mn crust on one side 5. Vesicularity: 20% 6. Vesicle Filling: mostly filled with zeolites, few empty, size 0.1-1mm 7. Matrix Color: dark amorphous cement 9. Secondary Minerals: Mn-Fe Hydroxides as patchy overgrowth on cement 10. Overall Degree of Alteration: highly altered yellowish brown 11. Comment: clasts <1-40mm, poorly sorted,massive, rare dense grey brown lava fragments 10-20mm, clasts angular, irregular blocky shapes, smaller ones often platy	x						x			
DR81-8S	1. Rock Type: carbonate 2. Size: 9x7x5 3. Shape/Angularity: subrounded 11. Comment: greenish-yellowish fine grained carbonate with parallel banding and bioturbation burrows, secondary Mn-Fe Hydroxide dentrites								x		
DR81-8S	1. Rock Type: several pieces of lava similar to DR80-1								x		

SO199 - DR82
"Clara-Marie" Seamount
Dredge on bottom UTC 11/09/08 01:25hrs, lat 13°36.40'S, long 105°11.22'E, depth 3835m
Dredge off bottom UTC 11/09/08 03:17hrs, lat 13°36.43'S, long 105°11.37E, depth 3755m
total volume: few rocks
Comments: small fragments of pillow margins; dredge got stuck near on bottom position

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR82-1	1. Rock Type: pillow fragment with 2cm thick chilled margin 2. Size: 9x5x4 3. Shape/Angularity: angular, bottom freshly broken 4. Encrustations: minor patchy Mn-coating 5. Vesicularity: 5% vesicles, 0.2-1mm, some filled with CC, majority is open or lined with Fe-Hydroxide. 7. Matrix Color: dark grey where fresh, chilled margin oxidized to light brown 8. Primary Minerals: aphyric, 2% Plag microphenocryst laths, 1mm long and 0.1mm thick 10. Overall Degree of Alteration: moderately to medium altered in freshest part, very strongly altered along oxidized chilled margin 11. Comment: fresh groundmass ok for geochemistry, Ar-Ar dating questionable	x	x								
DR82-2	1. Rock Type: similar to DR82-1; oxidized chilled margin only 2. Size: 8x4x2 10. Overall Degree of Alteration: very strongly altered										

SO199 - DR84
"Ulrike" Seamount, large seamount (tilted block?) NW of DR83
Dredge on bottom UTC 12/09/08 11:17hrs, lat 13°02.17'S, long 103°52.49'E, depth 3542m
Dredge off bottom UTC 12/09/08 12:41hrs, lat 13°01.89'S, long 103°52.92'E, depth 3239m
total volume: few rocks
Comments: lava fragments (1 lithology)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR84-1	1. Rock Type: lava fragment 2. Size: 11x10x9cm 3. Shape/Angularity: angular 4. Encrustations: minor Mn-coating 7. Matrix Color: greydark 8. Primary Minerals: Fsp needles ca. 1mm, <1% appear fresh 9. Secondary Minerals: very few Fe-Mn-hydroxide dendritic growth along cracks 10. Overall Degree of Alteration: slightly altered 11. Comment: potential for dating, groundmass appears fresh	x	x	x?							
DR84-2	1. Rock Type: similar to DR84-1 2. Size: 12x8x5cm	x	x	x?							
DR84-3	1. Rock Type: similar to DR84-1 2. Size: 4x8x6cm	x	x	x?							
DR84-4	1. Rock Type: similar to DR84-1 2. Size:6x7x4cm 7. Matrix Color: grey and areas of greyish-brown 10. Overall Degree of Alteration: slightly to moderately altered	x									
DR84-5	1. Rock Type: similar to DR84-4 2. Size: 12x7x6cm	x									
DR84-6	1. Rock Type: similar to DR84-4 2. Size: 10x8x6cm	x									
DR84-7X	1. Rock Type: similar to DR84-1, 4 pieces						x				

SO199 - DR 87
"Ronja" Seamount
Dredge on bottom UTC 13/09/08 13:00 hrs, lat 14°07.19´S, long 102° 10.29´E, depth 3377m
Dredge off bottom UTC 13/09/08 14:22hrs, lat 14° 07.57´S, long 102° 10.65E, depth 2960m
total volume: 1/3 full
Comments: lava fragments and volcaniclastic rocks

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR87-1	1. Rock Type: lava fragment 2. Size: 15x12x7cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn-coating 5. Vesicularity: 3% <1-1mm irregular shaped, empty up to 2mm oval, filled commonly with CC 7. Matrix Color: dark grey to slightly dark brown 8. Primary Minerals: fsp laths and equant crystals, opalescent, altered, up to 5mm 10-15% 10. Overall Degree of Alteration: moderately altered 11. Comment: dating perhaps possible, massive lava with faintly aligmed crystals	x	x	x?							
DR87-2	1. Rock Type: lava similar to DR87-1 2. Size: 18x13x10 5. Vesicularity: vesicles concentrated in layers irregular shaped 6. Vesicle Filling: empty 8. Primary Minerals: fsp laths up to 6mm and complex-shaped crystals up to 7mm, both altered	x	x								
DR87-3	1. Rock Type: lava similar to DR87-1 2. Size: 9x6x5cm 5. Vesicularity: mostly oval shaped, 1-2mm 6. Vesicle Filling: filled with green ?zeolites?, 1/2 empty 7. Matrix Color: brown-grey dark 8. Primary Minerals: fsp lath equant altered 10% up to 4mm; very rare 2-3mm elongate black crystals (px?)	x	x								
DR87-4	1. Rock Type: lava similar to DR87-1, but with less fsp and more vesicles 2. Size: 6x6x4cm 5. Vesicularity: 5-8% 6. Vesicle Filling: mostly empty 7. Matrix Color: dark grey 8. Primary Minerals: fsp as complex shaped, equant crystals up to 6mm and few needles up to 2mm ~5%, altered	x									
DR87-5	1. Rock Type: similar to DR87-4 2. Size: 7x6x3cm	x									
DR87-6	1. Rock Type: lava fragment similar to DR87-4 2. Size: 23x12x7 7. Matrix Color: grey to brownish 8. Primary Minerals: fsp up to 3mm, altered, 5% 11. Comment: faint flow alignment of vesicles and phenocrysts	x	x								
DR87-7	1. Rock Type: lava fragment 2. Size: 24x14x10cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn-crust 5. Vesicularity: 20%, up to 4mm 6. Vesicle Filling: 1/3 of the vesicles are filled. Zeolites? 7. Matrix Color: dark grey 8. Primary Minerals: Fsp, <5% altered, up to 3mm 10. Overall Degree of Alteration: moderately altered	x	x								
DR87-8	1. Rock Type: lava fragment, part of a larger piece 2. Size: 37x27x25cm (large piece), 19x11x10cm (part of the large piece) 3. Shape/Angularity: subangular 5. Vesicularity: 20% 6. Vesicle Filling: 2% empty, rest are filled with yellowish filling (Zeolites), vesicles: 1-5mm large 7. Matrix Color: dark grey 8. Primary Minerals: Fsp: 5-7% up to 5mm, altered 10. Overall Degree of Alteration: moderately altered	x	x				x				
DR87-9	1. Rock Type: lava fragment 2. Size: 9x6x3cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn-crust 5. Vesicularity: 5-7%, inhomogeneous distributed, 1-5mm at size 6. Vesicle Filling: <1% with yellowish filling (Zeolites ?), vesicles mostly empty 7. Matrix Color: grey 8. Primary Minerals: Fsp: <1% up to 2mm, very altered 10. Overall Degree of Alteration: moderately altered	x	x								

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR87-10	1. Rock Type: lava fragment 2. Size: 16x12x11cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn-crust 5. Vesicularity: 15-20%, vesicles on one side ca. 1mm big, getting bigger to the other side up to 3mm 6. Vesicle Filling: 1/3 are filled, mainly along the cracks filled with CC, few filled with yellowish (Zeolites?) or brownish filling, 2/3 are empty 7. Matrix Color: grey 8. Primary Minerals: Fsp: <1%, up to 1mm, altered 10. Overall Degree of Alteration: moderately altered	x					x				
DR87-11	1. Rock Type: lava fragment 2. Size: 9x8x7cm 3. Shape/Angularity: subangular 5. Vesicularity: 5-7%, <1mm up to 3mm, bandered distribution of the vesicles 6. Vesicle Filling: mostly empty, few filled with yellowish and brownish filling 7. Matrix Color: grey 8. Primary Minerals: Fsp: <1%, up to 1.5mm, altered 10. Overall Degree of Alteration: moderately altered	x	x								
DR87-12	1. Rock Type: similar to DR87-11 2. Size: 10x7x6cm 7. Matrix Color: light grey 8. Primary Minerals: Fsp: 1%, up to 5mm, altered	x	x								
DR87-13C	1. Rock Type: lapilli tuff, massive monomict 2. Size: 28x25x10 3. Shape/Angularity: thick slab 5. Vesicularity: 2-10%, <1-2mm 6. Vesicle Filling: empty or lined with Zeolites 7. Matrix Color: CC cement 8. Primary Minerals: one side of slab (lower side?) reddish clasts, other side greenish-yellowish 10. Overall Degree of Alteration: highly altered, soft 11. Comment: clasts angular, <1-10, rarely up to 50mm, larger ones often irregularly shaped, closely packed, massive, poorly sorted. Some larger clasts appear to spall off smaller clasts = in situ fragmentation	x						x			
DR87-14C	1. Rock Type: loosely lapilli tuff, heterolithic 2. Size: 14x10x9 3. Shape/Angularity: subrounded 5. Vesicularity: 2-30% 6. Vesicle Filling: empty and filled with Zeolites 7. Matrix Color: homogeneously highly altered, yellowish green matrix, brown clasts and reddish scoriaceous clasts 9. Secondary Minerals: Mn-Fe hydroxide patches on matrix 10. Overall Degree of Alteration: altered 11. Comment: very widelyspaced clasts of 2-25mm, irregularily-delicately shaped in very fine, waxy matrix probably altered ash, heterolithic probably massive, poorly sorted - short transport / fall of clasts into ash / mud							x			
DR87-15C	1. Rock Type: massive lapilli tuff 2. Size: 10x8x5 3. Shape/Angularity: subrounded 5. Vesicularity: 5-30% 6. Vesicle Filling: mostly filled with Zeolites? 7. Matrix Color: reddish matrix and green yellow matrix 10. Overall Degree of Alteration: altered 11. Comment: clasts equant - irregularily shaped, abraded slightly, 1-5mm moderately sorted, massive closely packed clasts appear to be of one dominant lithology (scoriaceous) and a few dense dark and highly vesicular accidental lithics. Water settled tuff?, slightly reworked?							x			
DR87-16C	1. Rock Type: lapilli tuff 2. Size: 8x8x5 3. Shape/Angularity: subrounded 5. Vesicularity: 5-30% 6. Vesicle Filling: mostly filled 7. Matrix Color: greenish fine matrix 10. Overall Degree of Alteration: altered 11. Comment: clasts <1-3mm angular greenish highly vesicular tuff, well sorted with a few reddish scoriaceous, highly irregular shaped clasts up to 30mm, which are faintly aligned. Deposit closely packed, too weathered and too soft for TS							x			

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR87-17C	1. Rock Type: tuff 2. Size: 9x9x7 3. Shape/Angularity: round 7. Matrix Color: yellowish-beige matrix 10. Overall Degree of Alteration: altered cream colored 11. Comment: extremely fine clasts , no further details discernibe, random							x			
DR87-18C	1. Rock Type: similar to -17C 2. Size: 11x8x4 4. Encrustations: 1mm Mn crust on one side 7. Matrix Color: reddish matrix (secondary?) 10. Overall Degree of Alteration: altered soft rock 11. Comment: faint bedding / parallel clast alignment							x			
DR87-19C	1. Rock Type: tuffaceous lava 2. Size: 8x8x3 3. Shape/Angularity: irregular angular 4. Encrustations: minor Mn coating 5. Vesicularity: 2% 6. Vesicle Filling: empty, <1mm 7. Matrix Color: greenish-grey groundmass 8. Primary Minerals: 2%, 1-2mm clear equant square crystals probably fesh Fsp 9. Secondary Minerals: rust stains on groundmass of 2-3mm, often elongate 10. Overall Degree of Alteration: slightly altered 11. Comment: vesicles very irregular shaped and oriented, groundmass appears homogeneous	x		x?				x			
DR87-20C	1. Rock Type: dense tuff 2. Size: 15x11x8 3. Shape/Angularity: subrounded 4. Encrustations: minor Mn coating 7. Matrix Color: light grey and cream, very fine 8. Primary Minerals: angular 1-2 holes, probably of former crystals 9. Secondary Minerals: Fe-Mn hydroxide patches 10. Overall Degree of Alteration: altered 11. Comment: 5-10mm thick banding cream grey, irregular wavy = flow banding? Or deformed tuff layers. Very dense groundmass, no further details dicernible	x		x?				x			
DR87-21X	1. Rock Type: similar to DR87-3, 6 pieces						x				
DR87-22X	1. Rock Type: aphanitic, altered basalt with cm sized cc filled cavities						x				
DR87-23X	1. Rock Type: similar to DR87-7						x				
DR87-24X	1. Rock Type: similar to DR87-11, 5 pieces						x				

SO199 - DR88
"Giana"Seamount, upper western flank
Dredge on bottom UTC 14/09/08 11:24hrs, lat 11°55.04'S, long 101°38.68'E, depth 3626m
Dredge off bottom UTC 14/09/08 12:52hrs, lat 11°55.13'S, long 101°39.27'E, depth 3141m
total volume: few rocks
Comments: manganese crusts & sediments, lava fragments and 1 volcaniclastic rock

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR88-1	1. Rock Type: lava fragments 2. Size: 11x10x6cm 3. Shape/Angularity: subrounded 4. Encrustations: uo to 5mm Mn crust 5. Vesicularity: 20%, 2-5mm 6. Vesicle Filling: 2/3 filled with cc an zeolites 7. Matrix Color: light brown-beige 8. Primary Minerals: highly altered phenocrysts of ca. 1-2mm, poss. Fsp, a few %; and <1mm rustbrown cystals poss Ol 9. Secondary Minerals: Mn-Fe-hydroxides 10. Overall Degree of Alteration: highly altered 11. Comment: large clast with pelagic ooze attached along margin, and a sliver of a micro-vesicular, highly altered fragment	x	x								
DR88-2	1. Rock Type: similar to -1 2. Size: 7x6x5cm 5. Vesicularity: 1-2mm, 20% 6. Vesicle Filling: mostly empty and lined with zeolites	x									
DR88-3	1. Rock Type: similar to -1 2. Size: 7x4x4cm 5. Vesicularity: up to 6mm 6. Vesicle Filling: mostly filled with cc & zeolites 8. Primary Minerals: 1-2mm rust brown crystals poss. Ol										

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR88-4C	1. Rock Type: lapillituff 2. Size: 13x10x7cm 3. Shape/Angularity: subangular 4. Encrustations: minor Mn coating 5. Vesicularity: 15-20%, <1mm 6. Vesicle Filling: most lined & filled with zeolites 7. Matrix Color: greybeige fine grained matrix & white cc cement 9. Secondary Minerals: Mn-Fe-hydroxides as patches om matrix & rims around clasts 10. Overall Degree of Alteration: altered reddish brown 11. Comment: clasts 2-20mm, rarely up to 50mm, subangular, poorly sorted, monomict	x						x			
DR88-5S	1. Rock Type: maganese-rich sediment 2. Size: 4x7x5cm 3. Shape/Angularity: irregular 4. Encrustations: 5-10mm coating on one side 11. Comment: porous with 5-10mm white muddy areas & peroasive Mn-growth in between mud								x		
DR88-6S	1. Rock Type: similar to -5S 2. Size: 13x7x5cm								x		
DR88-7S	1. Rock Type: carbonate 2. Size: 13x8x3cm 3. Shape/Angularity: slab 4. Encrustations: 1mm Mn crust 11. Comment: cream micritic carbonate mud with sub-mm bioturbation traces, Fe-Mn-hydroxide patches, 1-2mm round-oval microfossils								x		

SO199 - DR89
"Giana" Seamount, some 2,5 miles further to the SW of DR88
Dredge on bottom UTC 14/09/08 16:26, lat 11°55,96'S, long 101°36,96'E, depth 4290m
Dredge off bottom UTC 14/09/08 18:07, lat 11°56,06'S, long 101°37,55'E, depth 3847m
total volume: few rocks
Comments: lava fragments, coated with volcaniclastic material

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR 89-1	1. Rock Type: lava fragment, fine-vesicular 2. Size: 25x18x17 3. Shape/Angularity: irregular piece 4. Encrustations: Mn crust up to 10mm on one side 5. Vesicularity: up to 2mm irregular shaped, 5% 6. Vesicle Filling: empty, along fragment margin lined filles with white cc or zeolite 7. Matrix Color: centre dark grey, towards margins progressively more brown altered 8. Primary Minerals: brown altered crystals Ol, <1-3mm, 2-3%, black mineral: 2mm <1% maybe px, 1mm light crystals, elongate poss. Fsp, best seen in areas with dark grey groundmass 10. Overall Degree of Alteration: slightly altered 11. Comment: centre of fragment potential for clating, coated with pelagic ooze 1cm and some volcaniclastic particles <1-5mm	x	x	x							
DR 89-2	1. Rock Type: very large rock , with consists of several large lava fragments cemented by Mn-crust up to 30mm thick and volcaniclastics & pelagic sediments, further described are the individual lava fragments and 1VC: 2. Size: 47x37x24										
DR 89-2-A	1. Rock Type: coarse vesicular lava fragment 2. Size: 18x18x14 3. Shape/Angularity: lightly irregular 5. Vesicularity: up to 10mm, oval and irregularly shaped 6. Vesicle Filling: smaller ones partly filled with zeolites 7. Matrix Color: dark grey to slightly brown 8. Primary Minerals: brown altered Ol up to 5mm 2-3%, black poss. Px 1% 2-3mm equant to slightly elongated 10. Overall Degree of Alteration: slightly to moderately altered	x	x								
DR 89-2-B	1. Rock Type: lava, similar to DR 89-1 2. Size: 21x17x15 3. Shape/Angularity: angular 5. Vesicularity: <1-2mm 6. Vesicle Filling: mostly empty, some zeolites 7. Matrix Color: dark grey with hint of brown 8. Primary Minerals: Ol altered up to 3mm 2-3%, Px 2% 2-4mm 10. Overall Degree of Alteration: slightly altered										

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR 89-2-C	1. Rock Type: volcaniclastic with lava fragments up to 10cm 2. Size: 18x16x13 3. Shape/Angularity: 5. Vesicularity: 5-20% 6. Vesicle Filling: mostly filled with zeolites 7. Matrix Color: reddish fine grained matrix 8. Primary Minerals: altered up to 2mm variably abundant 9. Secondary Minerals: Mn-Fe-hydroxide patches 10. Overall Degree of Alteration: highly altered 11. Comment: VC <1-3mm fairly well sorted and closely ?, as a matrix supporting the large lava fragments (which correspond to coarse and fine vesicular lithologies described above)	x						x			
DR 89-2-D	1. Rock Type: lava fragment 2. Size: 29x20x21										
DR 89-2M	1. Rock Type: several pieces of the thick manganese crust									x	
DR 89-3	1. Rock Type: lava fragment, similar to DR 89-2-B 2. Size: 15x11x5 3. Shape/Angularity: angular 4. Encrustations: 10mm Mn crust and 10mm pelagic ooze coating 7. Matrix Color: dark grey brown 8. Primary Minerals: abundant <1mm altered Ol 10. Overall Degree of Alteration: moderately altered	x									

SO199 - DR90
"Leibniz" Seamount, small cone c. 50km WSW of Giana
Dredge on bottom UTC 15/09/08 04:42, lat 12°09,67'S, long 101°24,42'E, depth 4722m
Dredge off bottom UTC 15/09/08 06:21, lat 12°09,28S, long 101°25,06'E, depth 4255m
total volume: few ı 1/6 full
Comments: Mn-crusts and Mn encrusted pillow lava fragments

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR 90-1	1. Rock Type: Ol-Px phyric basalt 2. Size: 15x12x10 3. Shape/Angularity: rounded 4. Encrustations: 5mm Mn crust 5. Vesicularity: 10-15%, 1-3mm, 50% unfilled, others filled with CC or lined with Zeolites 7. Matrix Color: drark grey with brownish discoloration 8. Primary Minerals: 3% altered Ol 0.5-2mm, 5-8% Px phenocrysts, fresh, 1-4mm 9. Secondary Minerals: Fe-Oxyhydroxide replacing Ol 10. Overall Degree of Alteration: medium altered 11. Comment: this is the freshest and most porphyric sample of the dredge. The other basalts are also Ol-Px phyric but have fewer phenocrysts and are more altered	x	x								
DR 90-2	1. Rock Type: Ol-Px phyric basalt similar to DR90-1 but less phyric; probably pillow basalt 2. Size: 17x16x8, original size, 3 pieces saved 3. Shape/Angularity: subrounded 4. Encrustations: 0.5-1cm Mn crust 5. Vesicularity: 20%, 0.5-2mm, 30% filled with CC, otherwise open or lined with Zeolites 7. Matrix Color: drark grey where fresh, brownish oxidized in latered zones 8. Primary Minerals: 1-2% altered Ol microphenocrysts, 0.2-0.5mm, <1% Px 9. Secondary Minerals: Fe-Oxyhydroxide replacing Ol 10. Overall Degree of Alteration: medium altered 11. Comment: except for phenocryst content similar to DR90-1	x	x								
DR 90-3	1. Rock Type: pillow basalt similar to DR90-1 but lesser amounts of Ol and Px 2. Size: 22x21x20, original size, 5 pieces saved 3. Shape/Angularity: subrounded 4. Encrustations: 1cm Mn crust 5. Vesicularity: 20%, 0.5-2mm, open and filled with CC 7. Matrix Color: drark grey to brownish 8. Primary Minerals: 1% altered Ol, 0.5-1mm, 1% Px phenocrysts, 1-3mm, fresh 9. Secondary Minerals: Fe-Oxyhydroxide replacing Ol 10. Overall Degree of Alteration: medium to strongly altered 11. Comment: very similar to DR90-2	x	x								
DR 90-4M	1. Rock Type: Mn encrusted sediment, probably carbonate 2. Size: 15x12x8, original size, 5 pieces saved 11. Comment: Mn-crust 0.5-2cm thick									x	

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar	Rest	GL/MIN	ARCH	VULC	SED	MN	NOTES
DR 90-5S	1. Rock Type: mud overlying tuff 2. Size: 27x14x11 3. Shape/Angularity: subrounded 4. Encrustations: Mn encrusting sample up to 10mm 9. Secondary Minerals: Fe-Mn Oxyhydroxide patches on tuff 10. Overall Degree of Alteration: altered soft rock 11. Comment: mud ca 5cm thick, light grey, biotrurbated, soft mud, sharp contact. Burrows (5-10mm) filled with white-cream colored mud. Tuff: beige faintly layered, well sorted material, subangular clasts c. 0.5mm	x	x						x		

Appendix III (Volcaniclastic Rocks)

Dredge	Sample	Rock type / Interpretation	P/R/E	Sample (cm)	Componentry	Clast size (mm)	Clast shape	Vesicles	Fabric	Structure	Matrix/ Cement	Alteration	TS	Notes
DR1	8C	LT of lava rim fragments; gravity flow deposit	P?	13x8x7, subrounded	mainly glass, larger clasts of aphyric basalt	<1-22	angular blocky, splinter	-	closely packed, poorly sorted	faint bedding & clast alignment	Mn & zeolite	highly altered		
DR2	19C	hyaloclastitic pillow breccia; 2 pillow fragments (DR2-15) with glassy rim spalling off & jig saw fit texture	P	12x8x6, irregular angular	micro xx to glass juv	1-4	angular	-	very poorly sorted	no bedding	zeolite	palagonite	x	
DR5	12C	reddish heterolithic LT; lithologies of DR5	E	9x7x7 subangular	micro-, crypto xx basalt, glass juv	<1-15	subrounded	some 1%, cc or empty	poorly sorted, closely packed	faintly bedded	whitish and reddish zeolites	altered, reddish	x	colour diagnostic? unlikely to have been subaerial
DR5	13C	yellowish heterolithic LT similar to DR5-12C	E	19x10x10 irregular subangular	micro-, crypto xx basalt, glass juv	<1-30	subrounded	some 1%, cc or empty	poorly sorted, closely packed	no bedding or grading	zeolites, palagonite	highly altered		
DR6	10	heterolithic LT with glassy and xx clasts - 1 plutonic cL clast with margin of VC	E	16x12x10 subround	plutonitic lith, basaltic lith/juv	<1-15mm	angular, subangular	some poorly vesicular	-	-	matrix beige-greyish	moderately altered	2	the large plutonitic clast GC&TS
DR6	17C	heterolithic, matrix-rich LT; short transport, fall into mud	E	9x7x2 subangular	plutonitic lith, basaltic lith/juv	<1-10	blocky angular	-		no bedding	dark grey matrix			
DR6	18C	monolithic, matrix-rich LT; short transport, fall into mud	P?	10x8x5 subangular	micro xx juv	<1-10	blocky angular	-	closely packed	no bedding	red mud radiolarian?			
DR6	19C	LT, highly altered; lithology similar DR6-8, appears to be coherent rock	-	11x7x6 angular	grey juv	L			closely packed			highly altered		
DR6	20C	heterolithic LT, low vesicular basaltic clasts	E	9x7x5 irregular	micro xx basalt lith; plutonic lith (DR6-8), fsp xx	<1-40	subangular	poorly vesicular basalt	poor sorting	no bedding	grey, grainy		x	
DR6	21C	heterolithic LT, inhomogeneous muddy matrix, debris flow or low-turbulent sliding	E	8x6x5 subrounded	all lithologies of DR6, poss basalt, lithics	<1-15	subangular - subround			faint clast alignment and bedding and grading	beige inhomog mud, poss zeol		x	
DR6	22C	heterolithic LT, similar to DR6-10	E	6x5x2 irregular		up to 30	subangular							too small for further interpretation

Appendix III (Volcaniclastic Rocks)

Dredge	Sample	Rock type / Interpretation	P/R/E	Sample (cm)	Componentry	Clast size (mm)	Clast shape	Vesicles	Fabric	Structure	Matrix/ Cement	Alteration	TS	Notes
DR6	23C	heterolithic LT, similar to DR6-21C	E	9x8x6 subround		up to 55					cream mud or cement & grainy matrix		x	
DR8	15C	bedded LT, monolithic, micro xx basalt, poorly vesicular	P?	20x20x11 subangular	basaltic Ol-Fsp phyric juv	<1-40mm	angular & slightly rounded	0,01	moderate sorting, matrix supported	clast aligment, bedding diffuse, beds 1-3cm thick, slightly curved	grainy beige mud & cc geopedal strutures	slightly altered		
DR8	16C	heterolithic LT	E	14x9x7 irregular	variable basaltic lith of this dredge, glass & 1mm biogene detritus	<1-50	subrounded	variably non- to poorly	poor sorting, matrix supported	random	grainy yellowish grey ooze	slightly altered		
DR8	17C	LT, monolithic, appears thermally fused	P	21x16x13 irregular	fsp phyric glassy to micro xx juv	<1mm-30	angular blocky	poorly vesicular	very closely packed	random	dark grey	fresh		
DR8	18C	LT, monolithic, appears clasts included in coherent lava	P	23x20x8 subangular	fsp phyric glassy to micro xx juv	<1-40	angular blocky & irregular	poorly vesicular	clast-to-matrix supported	random	dark grey, appears micro xx	fresh	x	
DR10	21C	brecciated lava flow top, jig saw fit textures	P	14x12x6 irregular	micro xx to glass juv	<1-50	angular blocky & splinter	poorly vesicular	very closely packed	random & jig saw fit textures	zeolite cement	hydrated glass	x	
DR10	22C	hyaloclastite, jig saw fit textures	P	10x7x5 roundish	glassy juv	<1-10	angular (alteration rounding)	-	closely packed, poorly sorted	random & jig saw fit textures	zeolite cement	highly altered, palagonite	x	irregular glassy lava fragment spalling off clasts
DR10	23C	hyaloclastite, jig saw fit textures	P	12x7x6 roundish	glassy juv	<1-11	angular (alteration rounding)	-	closely packed, poorly sorted	random & jig saw fit textures	zeolite cement	highly altered, palagonite		
DR10	24C	highly altered hyaloclastite	-	11x8x5 roundish	glassy juv	<1-15	angular (alteration rounding)	-	closely packed	random	zeolite cement	highly altered, palagonite		
DR10	25C	highly altered hyaloclastite	-	11x9x6 roundish	glassy juv	<1-16	angular (alteration rounding)	-	closely packed	random	zeolite cement	highly altered, palagonite		
DR11	15C	slab of basaltic VC	E	58x40x18 slab	variably glassy-micro xx basalt juv/lith	<1-10mm	subangular blocky & splinter	some up to 30%	matrix supported, moderately sorted	faint clast alignment, very faint curved bedding	pelagic ooze	slightly altered	x	1x5cm pocket of pelagic ooze, thick knobbly Mn crust
DR11	16C	hyaloclastitic breccia	-	8x7x5 rounded	glass juv	up to 30	blocky	-				highly altered, palagonite		

Appendix III (Volcaniclastic Rocks)

Dredge	Sample	Rock type / Interpretation	P/R/E	Sample (cm)	Componentry	Clast size (mm)	Clast shape	Vesicles	Fabric	Structure	Matrix/ Cement	Alteration	TS	Notes
DR11	17C	hyaloclastitic breccia	-	7x6x6 roundish	glass juv	up to 50	blocky	-				highly altered, palagonite		
DR13	11C	10cm thick VC layer associated with 15cm lava blocks, flow base breccia	P	19x15x13 subangular	glassy juv (poss evolved)	<1-30mm	angular	-	poorly sorted, very loosely packed , matrix-supported	no bedding, random orientation	dark brown pelagic ooze	altered glass greenish	x	
DR13	12C	wavy banded VC; either streaks of lava incorporating blocky clasts or fluidal clasts interbedded with blocky clasts	P	15x13x6 subrounded	basaltic reddish micro xx juv, dark grey crypto xx juv	cA - fL	blocky & ?fluidal elongate	blocky poorly vesicular		subparallel banding defined by ?fluidal clasts alternating with blocky clasts			x	
DR13	13C	LT	P	24x20x20 irregular	basaltic reddish & grey crypto xx juv	mA & fL	angular	poorly to moderately vesicular	bimodal, very closely packed	random	cc	fresh-ish	x	
DR16	1C	10cm irregular lava fragment spalling overlying fine hyaloclastitic breccia	P	17x16x11 irregular subangular	micro-xx to glassy lava & blocky angular juv	ashy	angular blocky	0,05	closely packed and jig saw fitting, low grain size range	random	cc	olive greenish	x	composition prob nephelinitic, lava fragment used for GC, TS
DR16	2C	coarse VC with 6cm lava fragment		8x6x5 irregular	-	-	-	-	-	-	-	-	x	lava fragm used for GC, TS, no recording of VC details
DR16	5C	monolithic, matrix-rich LT	P?	7x6x5 rounded	micro xx juv	<1-50	blocky angular, irregular	3-5%	very loosely packed matrix supported	random	white calc ooze	fresh to slightly greenish alteration	x	DR16-1 to -7 greenish-more evolved, -8 to -10 reddish-basaltic
DR16	6C	similar to -5C	P?	11x9x7 rounded	micro xx juv	<1-50	blocky angular, irregular	3-5%	very loosely packed matrix supported	random	white calc ooze	fresh to slightly greenish alteration	x	
DR16	7C	coarse monolithic lava breccia	P?	15x9x7	micro xx juv	1-50	subangular	3-5%	clast supported poorly sorted	random	cavities, beige matrix, cc cement	greenish alteration	x	
DR16	8C	scoariaceous heterolithic coarse VC with geopedal texture	E	19x17x10 irregular angular	grey and reddish micro xx juv	<1-50	subangular	3-50%, mostly cc filled	poorly sorted, moderately closely packed,	random	prob very fine VC matrix & hanging cc cement	variably altered	x	

Appendix III (Volcaniclastic Rocks)

Dredge	Sample	Rock type / Interpretation	P/R/E	Sample (cm)	Componentry	Clast size (mm)	Clast shape	Vesicles	Fabric	Structure	Matrix/ Cement	Alteration	TS	Notes
DR16	9C	similar to -8C	E	14x14x7	grey and reddish micro xx juv	<1-50	subangular	3-50%, mostly cc filled	poorly sorted, moderately closely packed,	random	prob very fine VC matrix & hanging cc cement	variably altered		
DR16	10C	similar to -8C	E	11x10x7	grey and reddish micro xx juv	<1-50	subangular	3-50%, mostly cc filled	poorly sorted, moderately closely packed,	random	prob very fine VC matrix & hanging cc cement	variably altered		
DR16	11CX-14CX	simiarl to -8C to -10C	E											
DR17C	1B	monomict reddish fine LT	P	15x15x10 4x3x3	reddish basaltic juv & glass juv	<1-30	blocky irregular subangular	non- to poorly vesicular	moderately sorted, closely packed	random	cc cement	glass appears fresh, micro xx clasts altered	x	large sample cut for GC; small sample left for VC details
DR17C	2	heterolithic VC	R/E	20x20x10 irregular slab	micro xx basaltic, glass, biogene debris, a recycled VC of 3x1cm with closely packed 0.5mm clasts	<1-30	subangular, mostly blocky, minor splinter	poorly vesicular	poorly sorted, matrix supported	very faint clast orientation at low angle oblique to Mn-encrusted surface	light grey pelagic ooze & cc cement, in places hanging	fairly altered	x	
DR17C	3	bedded LT, monolithic, micro xx basalt, poorly vesicular	P	30x30x30 7x7x4	aphyric micro xx basaltic juv	<1-10	blocky angular to subangular, few splinter	poorly vesicular, half filled with cc	fairly well sorted, closely to very closely packed	bedded, normal grading, bed at least 5cm thick, sharp basal contact, bedding appears wavy-irregular	very little yellowish matrix in finer parts, coarse parts cc cemented	slightly altered	x	sample cut for GC
DR17C	4	LT	P?	11x7x6 subangular	micro xx basaltic juv & glass juv	<1-20	blocky subangular	non- to poorly vesicular	closely packed, poorly sorted	random	cc cement	mostly fresh		
DR17C	5	Lapillistone	P	13x9x8 subangular	aphyric juv	2-12	blocky irregular angular	0 to 20-25%, vesilces lined with dark substance	well sorted, very closely packed	random	very little beige grainy matrix & cc cement	highly altered	x	probably evolved composition

Appendix III (Volcaniclastic Rocks)

Dredge	Sample	Rock type / Interpretation	P/R/E	Sample (cm)	Componentry	Clast size (mm)	Clast shape	Vesicles	Fabric	Structure	Matrix/ Cement	Alteration	TS	Notes
DR17C	6	heterolithic LT, appears bedded (variations in cc cement vs. matrix)	E	15x12x8 subangular	glassy to micro xx basaltic lith, evolved lith	<1-20	blocky and splinter, subangular	variably 0 to 20%, vesicles cc filled	poorly sorted, moderately closely packed,	random clast orientation, 3cm thick bedding appears to be related to variations in cc cement vs. matrix, perhaps cc-layers fewer very fine clasts	beige matrix, cc	fresh-ish, some clasts highly altered	x	
DR17C	7	monomict fine, bedded tuff with erosional scour; primary flow or early remobilized	P/E	12x8x8 roundish	light yellowish, aphyric juv	<1-5	blocky angular rugged	coarser clasts vesicular, cc filled	well sorted, very closely packed	well bedded, 1cm interval of laminated very fine ash, 6cm coarse ash bed internally homogeneous, scouring mark eroding into fine ash layers	coarse ash with cc cement	highly altered		poss evolved tuff
DR17C	8	heterolithic LT	E	9x6x5	micro xx lith/juv (basaltic?)	<1-15	subangular	non- to poorly vesicular	moderately closely packed	random	minor matrix and cc cement	slightly altered		sample too small for further study
DR17C	9	heterolithic LT similar to -8	E	9x6x6	micro xx lith/juv (basaltic?) & common fresh glass	<1-20	subangular	0-15%	moderately closely packed	random	minor matrix and cc cement	slightly altered		sample too small for further study
DR17C	10	heterolithic LT similar to -9	E	8x5x4	micro xx lith/juv (basaltic?)	<1-15	subangular	non- to poorly vesicular	moderately closely packed	random	minor matrix and cc cement	slightly altered		sample too small for further study
DR19	3C	monomict LT, faintly bedded	P	11x8x6	basaltic juv	<1-10	subangular		variably sorted	faintly bedded	pelagic ooze	altered	x	
DR20	9C	fine tuff, highly altered	P?	12x12x7 rounded	greenish yellow substance with few sub-mm fsp crystals	very fine ash	-	-	-	-	-	highly altered	x	poss evolved tuff

Appendix III (Volcaniclastic Rocks)

Dredge	Sample	Rock type / Interpretation	P/R/E	Sample (cm)	Componentry	Clast size (mm)	Clast shape	Vesicles	Fabric	Structure	Matrix/ Cement	Alteration	TS	Notes
DR20	10C	very coarse, heterolithic LS	E	18x10x10 irregular angular	differently coloured aphyric and micro xx lith, biogene debris	10-50	angular irregular shaped, often elongate	some clasts 5%	clast-to-matrix supported, domains with more abundant finer clasts (poorly sorted) and coarse-only domains (moderately sorted)	faint clast orientation	yellow cream pelagic ooze, calcareous	slightly altered		
DR20	11C	very coarse, heterolithic LT similar to -10C	E	15x9x8	differently coloured aphyric and micro xx lith, biogene debris	<1-30	angular irregular shaped, often elongate	some clasts 5%	more closely packed clasts	faint clast orientation	yellow cream pelagic ooze, calcareous	slightly altered		
DR20	12C	very coarse, heterolithic LT similar to -10C	E	19x14x10	differently coloured aphyric and micro xx lith, biogene debris	<1-50	angular irregular shaped, often elongate	some clasts 5%	clast-to-matrix supported, domains with more abundant finer clasts (poorly sorted) and coarse-only domains (moderately sorted)	faint clast orientation	yellow cream pelagic ooze, calcareous	slightly altered		
DR21	4C	heterolithic, biogene LT	E	15x9x8 irregular	micro xx and glassy basaltic lith, biogene debris (corals up to 40mm, bivalve fragments)	1-2 and a few up to 40	blocky rounded, few platy and splinter shaped	variably 0-10%	moderately sorted, matrix supported	random	light grey find calcareous, biogenic sand	clasts variably altered, rock general fresh-ish		
DR21	5C	heterolithic, biogene LT similar to -4C	E	9x6x4	large coral debris absent	1-30	blocky rounded, few platy and splinter shaped	variably 0-10%	moderately sorted, matrix supported	random	light grey find calcareous, biogenic sand	clasts variably altered, rock general fresh-ish	x	
DR21	6C	heterolithic, biogene LT similar to -4C	E	12x7x4	micro xx and glassy basaltic lith, biogene debris	1-30	blocky rounded, few platy and splinter shaped	variably 0-10%	moderately sorted, matrix supported	random	light grey find calcareous, biogenic sand	clasts variably altered, rock general fresh-ish		

Appendix III (Volcaniclastic Rocks)

Dredge	Sample	Rock type / Interpretation	P/R/E	Sample (cm)	Componentry	Clast size (mm)	Clast shape	Vesicles	Fabric	Structure	Matrix/ Cement	Alteration	TS	Notes
DR21	7C	heterolithic, biogene LT similar to -4C	E	12x7x4	micro xx and glassy basaltic lith, biogene debris	1-30	blocky rounded, few platy and splinter shaped	variably 0-10%	moderately sorted, matrix supported	faint clast alignment	light grey find calcareous, biogenic sand	clasts variably altered, rock general fresh-ish		
DR21	8C	bedded, graded fine LT	P?	9x6x5 irregular	monomict basaltic juv	<1-3	blocky angular to subangular, minor splinter shaped	non- to poorly vesicular	clast supported, moderately sorted	bedded, normal grading, bed thickness at least 30mm	light brown ooze matrix, white cc	altered		sample too small for further analysis
DR30		several samples of coarse hyaloclastitic breccia derived from (mini-) pillows	P				angular blocky and minor splinter	non-vesicular	clast supported mostly, often with jig saw textures	random	palagonite, zeolite cement	fresh glass		samples dismissed
DR36	5C	heterolithic, carbonaceous matrix-rich VC, debris flow deposit	E	30x22x18 angular	polymict volcanic lith	2-30	subrounded	varibably 10-50%	very loosely packed - 20% clasts only, matrix supported	random	light brown and cream micritic carbonate	highly altered and Mn invaded		
DR40	6C	heterolithic LT	E	13x12x7 subrounded	1: light green, poss more evolved juv/lith; 2: brown basaltic lith 2-30mm	1: up to 8mm; 2: 2-30mm	1: blocky & splinter & elongate, angular; 2: blocky subrounded	1: up to 30%, highly stretched; 2: ~10%, oval round	matrix supported, poorly sorted	random	whitish to light green micrite, inhomogeneous (intraclasts)	highly altered, Mn-Fe patches and rims around clasts	x	
DR40	7C	pillow rim with overlying tuff	P	14x9x9 irregular	light green very fine grained, homogeneous	sub-mm	-	-	closely packed	random	-	highly altered and hydrated, Mn overgrowth	x	pillow margin appears to spall off thin flakes which are incorporated into tuff
DR41	10C	heterolithic LT	E	65x42x14 slab	1: basaltic lith; 2: very fine ash	1: <1-25; 2: very fine	1: blocky angular; 2: irregular, poss bubble wall shards	1: 10-30%	closely packed	faint horizontal clast orientation, two layers separated by 5mm irregular layer of pelagic ooze	very little cream mud or zeolite, non-calcareous	highly altered	x	

Appendix III (Volcaniclastic Rocks)

Dredge	Sample	Rock type / Interpretation	P/R/E	Sample (cm)	Componentry	Clast size (mm)	Clast shape	Vesicles	Fabric	Structure	Matrix/ Cement	Alteration	TS	Notes
DR41	11C	heterolithic coarse LT	E?	28x16x10 angular	1: basaltic lith as of this dredge; 2: very fine ash	1: 5-60; 2: very fine	1: blocky subangular; 2: irregular, poss bubble wall shards	1: 10-30%	very closely packed fine ash with large lith floating in it	random massive	light greenish-cream very fine ash	highly altered ash, lith slightly altered	x	
DR41	12C	similar to DR41-11C	E?	17x9x6 subround	1: basaltic lith as of this dredge; 2: very fine ash	1: up to 25mm; 2: very fine	1: blocky subangular; 2: irregular, poss bubble wall shards	1: 10-30%	very closely packed fine ash with larger lith floating in it	random massive	light greenish-cream very fine ash	highly altered ash, lith slightly altered		
DR42	9C	heterolithic LT very loosely packed in soft pelagic ooze	E	22x14x8 roundish	various mafic lithologies of this dredge	<1-25	angular, blocky and irregular	variable 0-30%, filled with zeolites	widely spaced clasts matrix-supported	randomly oriented	cream muddy pelagic ooze	highly altered		
DR42	10C	reddish closely packed LT, monomict	P	7x6x4 subangular	aphanitic basaltic juv	1-5mm	blocky angular	2%, empty	moderately well sorted, closely packed	massive	open pore space, zeolites, Mn-Fe-hydroxides	reddish coloration, altered	x	
DR42	11C	heterolithic coarse LT	E	8x8x3 slab	various mafic lava lith	<1-30	blocky, splinter shaped, irrgular	variably 2-30%	poorly sorted, clast-to-matrix supported	randomly oriented	cream muddy pelagic ooze	altered		
DR46	7C	reddish closely packed LT, monomict	P	22x16x9 subangular	aphanitic basaltic juv	<1-5, rare outliers up to 35	angular blocky	2-5%, tiny	moderately well sorted, closely packed	randomly oriented	open pore space, zeolites, Mn-Fe-hydroxides	reddish coloration, altered	x	subaerial due to reddish ox? colour?
DR46	8C	LT	P?	12x7x7 irregular rounded	1: aphanic basaltic juv wth few fsp lath; 2: very minor basaltic dark grey vesicular lith (rip ups?)	1: <1-15, 2: 10-15	subangular, blocky	2-5%, mostly empty vesicles	closely packed, poorly sorted	faint clast orientation	oen pore space, hanging cements of zeolites, Mn-Fe-hydroxides encrusts clasts individually	yellowish, palagonite		
DR46	9C	well-bedded, graded, monomict T and LT	P	17x11x9 irregular subangular	aphanitic basaltic juv	fine ash to 5mm	blocky angular, less common irregular and splinter	2%, tiny	closely packed	normal grading, bed thickness 2-5cm, bed contacts basal sharp and diffuse, slightly wavy/oblique, clasts faintly aligned	zeolites, patches of Mn-Fe-hydroxides	yellowish, palagonite	x	for fallout bedding contacts too irregular, poss. primary density current deposit; large archive sample

Appendix III (Volcaniclastic Rocks)

Dredge	Sample	Rock type / Interpretation	P/R/E	Sample (cm)	Componentry	Clast size (mm)	Clast shape	Vesicles	Fabric	Structure	Matrix/ Cement	Alteration	TS	Notes
DR46	10C	coarse T to fine LT, similar componentry to -9C	P	12x10x10	aphanitic basaltic juv	fine ash to 3mm	blocky angular, less common irregular	2%, tiny	closely packed	massive, moderately sorted	zeolites, patches of Mn-Fe-hydroxides	yellowish, palagonite		
DR46	11C	thick normally graded T-LT	P	17x11x9	aphanitic basaltic juv	fine ash to 5mm	blocky angular, less common irregular	2%, tiny	closely packed	internally massive, moderately sorted	zeolites, patches of Mn-Fe-hydroxides	yellowish, palagonite		
DR46	12C	8mm thick coating of VC around large basaltic lith, VC similar to -10C												not further described, TS & GC of basaltic lith
DR46	14C	massive reddish LT, similar to -7C	P	12x9x5 irregular	aphanitic basaltic juv	<1-5	angular blocky	2-5%, tiny	moderately well sorted, closely packed	randomly oriented	white zeolite cement	reddish coloration, altered		
DR46	15C	reddish LT, similar componentry to -7C, flow over obstacle	P?	11x7x6 round	1: aphanitic basaltic juv; 2: one 3cm basaltic lith	<1-5	angular blocky	2-5%, tiny	moderately well sorted, closely packed	clasts randomly oriented, appears as 3 layers draped over lith, with pelagic ooze interspersed	minor matrix	reddish coloration, altered		
DR48	2C	lava fragment with glassy rim and overlying hyaloclastitic LT, probably in situ	P	20x20x8 irregular	glassy and aphanitic basaltic juv	<1-30	angular blocky and irregular	10-20%	poorly sorted, closely packed	appear inversely graded	open pore space, zeolites, Mn-Fe-hydroxides	yellowish, palagonite	x	spalling glassy margin of lava flow
DR48	3C	coarse monomict LT, "scoriaceous" irregular shaped clasts	P	21x16x10 irregular	basaltic juv with fsp needles	<1-30	irregular shaped	20-30%	closely packed, poorly sorted	randomly oriented	2 generations of zeolites, minor open pore space	light brown yellowish alteration	x	larger clasts appear to spall off smaller clasts - alteration artefact?
DR48	4C	similar to -3C	P	14x8x6	basaltic juv with fsp needles	<1-20	irregular shaped	20-30%	closely packed, poorly sorted	randomly oriented	zeolite cement	light brown yellowish alteration		

Appendix III (Volcaniclastic Rocks)

Dredge	Sample	Rock type / Interpretation	P/R/E	Sample (cm)	Componentry	Clast size (mm)	Clast shape	Vesicles	Fabric	Structure	Matrix/ Cement	Alteration	TS	Notes
DR50	9C	crystal-rich lapilli tuff, resembles clastogenic accumulate	P?	8x7x5 irregular	greyish and brownish slightly differently coloured magmatic particles with fsp needles; 10-15% 10mm phenocrysts of fsp/foide	1-20	equant with smooth outline	0	absolutely densly packed, inhomogeneous distribution of large xx	random orientation	-	slightly altered	x	
DR50	10C	LT	P?	9x6x5 roundish	monomict basaltic juv	<1-20		0	closely packed, poorly sorted	randomly oriented	open pore space, cream beige matrix of ?fine ash	altered		
DR52	5C	coarse basaltic monolithic LT	E	13x8x7, subrounded irregular	basalt blocks lith	10-50, minor ash	subrounded	10-20%	variably closely packed, poorly sorted	randomly oriented	yellowish green altered particles, open pore space, minor cc cement	highly altered		slope debris, too small for further study
DR52	6C	similar to -5C	E	12x7x4	basalt blocks lith	up to 30	subrounded	10-20%	closely packed, poorly sorted	randomly oriented	yellowish green altered particles and cc cement irregularly distributed	highly altered		
DR52	7C	similar to -6C	E	7x6x4	basalt blocks lith	up to 20	subrounded	10-20%	closely packed, poorly sorted	randomly oriented	yellowish green altered particles and cc cement	highly altered		
DR52	8C, 9C	carbonate sediment with minor volcanic clasts												
DR54	2C	coarse heterolithic LT	E	10x8x4 angular irregular	various volc lith	2-20	subangular to subround, irregular shaped	5-10%, variably filled	clast-to-matrix supported		dark cream micritic mud	altered		sample too small for further study
DR56	11C	heterolithic LT, debris flow deposit	E	100x60x30 subangular	various volc lith	<1-60	variably rounded	variable 0-30%, filled with zeolites	closely packed, poorly sorted	faint clast orientation	yellowish very fine particles and zeolite cement	altered		TS of large lava clast

Appendix III (Volcaniclastic Rocks)

Dredge	Sample	Rock type / Interpretation	P/R/E	Sample (cm)	Componentry	Clast size (mm)	Clast shape	Vesicles	Fabric	Structure	Matrix/ Cement	Alteration	TS	Notes
DR56	12C	monomict coarse ash to fine lapilli tuff	P?	16x10x8 subround	volc	<1-4	angular	0-10%, empty	closely packed, moderately sorted	random clast orientation	greenish-yellow ?finest ash or zeolite cement	altered		
DR57	8C	LT, heterolithic or just variably dense/altered?	E?	9x7x3 rounded	aphanitic juv/lith	<1-30	angular and irregular	variably 0-10%, mostly filled with zeolites	variably closely packed, poorly sorted	randomly oriented clasts	dark grey fined grained matrix	highly altered, Mn-Fe rims around clasts	x	
DR57	9C	LT with biogene debris	E	10x7x3 subrounded	volcanic lith, biogene debris	1-3	subrounded	0%	closely packed, fairly well sorted	randomly oriented clasts	open pore space, cream muddy matrix	altered		
DR57	10C	yelllowish coarse LT, heterolithic	E	14x11x8 subrounded	aphanitic	<1-20	subround, due to alteration?	0-5%, filled with ?cc	very closely packed	randomly oriented clasts	yellowish zeolites? or muddy matrix	highly altered		
DR57	11C	similar to -10C	E	10x8x5	aphanitic	<1-21	subround, due to alteration?	0-5%, filled with ?cc	very closely packed	randomly oriented clasts	yellowish zeolites? or muddy matrix	highly altered		
DR58	9C	yellowish LT to TB, lava flow breccia	P	36x23x19 irregular	aphanitic basaltic juv, outsized flow banded lava fragments	1-10, up to 70	blocky angular	5-10%, zeolite-filled or empty	closely packed, poorly sorted	randomly oriented, large clasts appear to be aligned within a layer and parallel-oriented	yellowish zeolites concentrically around clasts as well as cc, minor open pore space	highly altered		
DR58	10C	reddish LT to TB, similar to -9C	P	34x20x20	aphanitic basaltic juv with altered glassy margin, outsized lava fragments	1-10, up to 80	blocky angular	5-10%, zeolite-filled or empty	variably loosely and closely packed, poorly sorted	irregularly distributed matrix, randomly oriented clasts	white carbonate mud, minor fine grained yellowish matrix	altered		
DR58	11C	greenish LT	P?	14x10x8 round	aphanitic juv, outsized lava fragments	1-5, up to 55	angular blocky	0-5%, mostly filled with zeolites	very closely packed, moderately sorted	random clast orientation	dark grey greenish cement (zeolites?) and open pore space	highly altered		more evolved composition?
DR59	5C	LT, relatively fresh, solidly cemented	P?	30x26x17 irregular	aphanitic basaltic juv, rare accidental lith: fsp-phyric & more vesicular	<1-10, up to 50	angular blocky, few smaller splinter shaped	0-10%, mostly filled with cc or zeolites	poorly sorted, moderately closely packed	randomly oriented	sparitic cc, minor foraminifera ooze yellowish	most clasts relatively fresh, smaller ones pervasively altered	x	larger clasts taken for TS & GC separately

Appendix III (Volcaniclastic Rocks)

Dredge	Sample	Rock type / Interpretation	P/R/E	Sample (cm)	Componentry	Clast size (mm)	Clast shape	Vesicles	Fabric	Structure	Matrix/ Cement	Alteration	TS	Notes
DR59	6C	highly altered yellowish LT, faintly bedded, componentry similar to -5C	P?	11x8x8 subround	aphanitic basaltic juv, rare accidental fsp-phyric lith	<1-10, up to 30	angular blocky, few smaller splinter shaped	5%, mostly lined or filled with zeolites	poorly sorted, variably loosely and closely packed	very faintly aligned clasts	sparitic cc, irregular patchy distribution, minor very fine ashy matrix	yellowish pervasively altered, Mn-Fe-hydroxide rims around clasts		
DR59	7C	similar to -6C	P?	19x12x10 round	aphanitic basaltic juv	<1-15, up to 50	angular blocky, few smaller splinter shaped	5%, mostly lined or filled with zeolites	poorly sorted, closely packed	very faintly aligned clasts, vague grain size changes but no clear bedding	white and grey sparitic cc	yellowish pervasively altered, Mn-Fe-hydroxide rims around clasts		
DR59	8C	brown LT, similar to -6C	P?	28x20x16 irregular	aphanitic basaltic juv, appears monomict	<1-25	subangular to round - due to alteration?	5%, mostly empty	poorly sorted, closely packed	random clast orientation	minor cc cement, open pore space, dark brown zeolite rims around clasts (alteration?)	highly altered/weathered		
DR62	5C	yellowish highly altered, monomict LT	P?	35x25x14 rounded	aphanitic volc juv	<1-10, rarely up to 40	subangular (?due to alteration)	10% empty and lined with zeolites	poorly sorted, closely packed	random clast orientation	cc	yellowish, soft, highly altered		
DR62	6C	reddish monomict LT with inhomogeneous patchy matrix/cement distribution	P?	12x10x6 rounded	aphanitic volc juv	<1-10	angular blocky clasts, irregular shaped clasts	10% mostly empty	poorly sorted, moderately loosely packed either matrix-supported or floating in cc cement	randomly oriented clasts	white sparitic cc and/or yellow-brown fine ashy matrix	reddish coloration resembling subaerial oxidation, altered		
DR65	3C	yellow-brown LT	P?	13x7x6 irregular subangular	fsp-ol-px phyric juv (same lith as -1 but more vesicular)	<1-10, rarely up to 30mm	blocky and irregular shaped	10-25%, empty or lined with zeolites	closely packed, poorly sorted	randomly oriented clasts	light yellowish cement	highly altered yellowish	x	

Appendix III (Volcaniclastic Rocks)

Dredge	Sample	Rock type / Interpretation	P/R/E	Sample (cm)	Componentry	Clast size (mm)	Clast shape	Vesicles	Fabric	Structure	Matrix/ Cement	Alteration	TS	Notes
DR66	10C	massive to faintly bedded monomict LT, hyaloclastite	P	50x36x22 subangular	glassy aphanitic juv, some with "wrinkled" flow banding	<1-20	angular blocky and splinter-shaped	0-5% lined with zeolites	poorly sorted, closely packed	faintly aligned clasts, diffuse bedding over ~5cm thickness with normal grading	translucent cement prob cc, very fine grained yellowish matrix, Fe-Mn-hydroxide patches on matrix	altered, fresh glass remnants in cores of larger clasts	x	
DR66	11C	highly altered monomict coarse LT	P?	13x13x9 irregular subrounded	glassy highly palagonized juv, some with fsp needles	<1-10, rarely up to 45mm	subangular to subrounded blocky	0%	poorly sorted, closely packed	massive, random clast orientation	pinkish soft muddy matrix and zeolite cement, open pore space	highly altered yellowish palagonite		
DR66	12C	well sorted tuff	P?	18x10x4 slab	glassy altered juv	<1mm		0%	well sorted, closely packed	massive	ashy matrix, cc cement, Mn-Fe hydroxides as patchy and dentritic overgrowth	yellowish palagonite alteration		distal deposit of -10C?
DR67	9C	heterolithic LT	E	14x13x12 irregular subrounded	variably dense to vesicular, glassy basaltic juv, variably phenocrystic (Fsp needles, Ol) clasts as of this dredge	<1-20	subangular blocky	0-15%, mostly filled with zeolites	poorly sorted, closely packed	randomly oriented clasts, massive	fine grainy yellowish matrix, open pore space, zeolite cement	Mn-Fe hydroxide patches on matrix	x	
DR67	10C	similar to -9C	E	22x16x12		<1-30								1 lava fragment with glassy crust spalling off clasts after transport
DR67	11CX	similar to -9C, 3 archive samples												

Appendix III (Volcaniclastic Rocks)

Dredge	Sample	Rock type / Interpretation	P/R/E	Sample (cm)	Componentry	Clast size (mm)	Clast shape	Vesicles	Fabric	Structure	Matrix/ Cement	Alteration	TS	Notes
DR68	5C	dark coarse LT, monomict, strongly cemented, heavy	P?	23x15x14 irregular	fsp-phyric juv, larger clasts with dark grey fresh? groundmass; lithologies different to DR68-1 to-4	<1-50	subangular to subrounded	<1%, filled with zeolites	poorly sorted, closely packed	randomly oriented, massive	yellowish fine grained matrix	reddish-brown alteration of smaller clasts, strongly cemented	x	clasts vaguely resemble fluidal shaped clasts/alteration?
DR68	6C	reddish LT, heterolithic	E	10x9x9 roundish	aphanitic & fsp-phyric lith variably vesicular; lithologies different to DR68-1 to-4	<1-40	subrounded	variably 0-10%, generally empty or filled with zeolites	moderately closely packed, poorly sorted	randomly oriented clasts	cream muddy matrix	reddish and yellowish alteration	x	
DR68	7C	yellowish LT, heterolithic similar to -6C	E	19x13x5 slab	aphanitic & fsp-phyric lith variably vesicular; lithologies different to DR68-1 to-5	<1-20	subrounded	variably 0-10%, generally empty or filled with zeolites	moderately closely packed, poorly sorted	randomly oriented clasts	sparitic cc cement	yellowish alteration, clasts brown		
DR68	8C	yellowish LT, heterolithic similar to -7C	E	14x10x5 subround	aphanitic & fsp-phyric lith variably vesicular; lithologies different to DR68-1 to-6	<1-21	subrounded	variably 0-10%, generally empty or filled with zeolites	moderately closely packed, poorly sorted	randomly oriented clasts	sparitic cc cement and yellowish matrix/zeolite cement?	yellowish alteration, clasts brown		
DR68	9C	heterolithic LT similar to -6C but with yellowish alteration	E	20x13x7	aphanitic & fsp-phyric lith variably vesicular; lithologies different to DR68-1 to-7	<1-40	subrounded	variably 0-10%, generally empty or filled with zeolites	moderately closely packed, poorly sorted	randomly oriented clasts	soft muddy matrix	yellowish alteration, clasts brown		
DR68	11CX	2 small archive samples similar to -7C												

Appendix III (Volcaniclastic Rocks)

Dredge	Sample	Rock type / Interpretation	P/R/E	Sample (cm)	Componentry	Clast size (mm)	Clast shape	Vesicles	Fabric	Structure	Matrix/ Cement	Alteration	TS	Notes
DR72	4C	diffusely laminated tuff	?	10x7x5 subangular	very fine grained particles, probably of volcanic origin and/or pelagic ooze				very closely packed	diffusely laminated, wavy	cream-yellowish	altered, Mn-Fe-hydroxides		
DR73	8C	monomict LT		14x7x3 irregular angular	basaltic juv, often flow banded, with Fsp needles	<1-50	blocky angular	0%	closely packed, poorly sorted	randomly oriented	cream fine grained matrix and zeolite cement	altered	x	
DR73	9C	similar to 8C, heterolithic	E	8x5x3 subrounded		<1-40	angular blocky and subrounded	variably 0-5%	poorly sorted, moderately closely packed, in some areas small clasts floating in cement	randomly oriented	opaque zeolite cement, minor fine grained matrix	Mn-Fe hydroxide patches on matrix		
DR73	10C	crystal-rich tuff, texture appears homogeneous, no clastic particles recognized; very fine tuff or lava flow? - "tuffaceous lava"	P	38x24x17 angular	Fsp up to 4mm, idiomorph equant crystals			rock is porous 5%			alternating greyish and cream mottled patches		x	
DR73	11C	similar to -10C	P	19x14x13	Fsp up to 4mm, idiomorph equant crystals			rock is porous 5%			alternating greyish and cream mottled patches	Mn-Fe hydroxide patches on matrix	x	
DR73	12C	similar to -10C	P	9x6x4 round	Fsp lath and equant crystals							Mn-Fe hydroxide patches on matrix	x	

Appendix III (Volcaniclastic Rocks)

Dredge	Sample	Rock type / Interpretation	P/R/E	Sample (cm)	Componentry	Clast size (mm)	Clast shape	Vesicles	Fabric	Structure	Matrix/ Cement	Alteration	TS	Notes
DR73	13C	similar to -12C; groundmass looks very dense, coherent and shows ghost-like round 2mm lighter coloured areas which resemble perlitic textures, or larger clasts in highly compacted tuff	P	10x6x4	Fsp lath and equant crystals							Mn-Fe hydroxide patches on matrix	x	
DR77	6	massive LT to TB, probably similar to -8C; no further observation here		73x53x30										disintegrated for clast picking
DR77	7C	heterolithic LT, massive, rock fall/debris flow	E	19x14x10 subround	several types of basaltic lith, some of the smaller clasts resemble those of -8C	<1-40	blocky angular to abraded	variably 2-30%, empty, lined and filled with zeolites	poorly sorted, closely packed	randomly oriented	sparitic cc, minor fine grained cream-yellowish matrix	altered yellowish brown	x	several larger samples, no detailed observations
DR77	8C	monomict LT; magmatic fragmentation with chilling/quenching superimposed?	P	18x14x9 subround	basaltic or more evolved, often flow banded and two margins chilled juv; rare brown poorly vesicular lith	<1-10, rarely up to 50mm, lined or filled with zeolites	angular irregular shaped, cuspate shards	0-20% often highly stretched, clasts broken across vesicles	closely packed, moderately sorted	randomly oriented clasts	pinkish soft muddy matrix, very fine grained greenish matrix	altered greenish-yellow clasts	x	
DR77	9C	similar to -7C	E	12x10x6	several types of basaltic lith	<1-30	smaller clasts resemble bubble wall shards	variably 2-30%, empty, lined and filled with zeolites	poorly sorted, closely packed	randomly oriented	dark olive very fine matrix	altered yellowish brown		
DR78	11C	LT hyaloclastitic	P	27x17x17 subrounded	monomict glassy juv; clasts often with flow banding and stretched vesicles	<1-15, rarely up to 40	angular ad subangular	0-10%, rarely up to 20%, empty and filled with zeolites	poorly sorted, closely packed	randomly oriented	yellowish fine grained matrix, some cement	altered, brownish yellow; Mn-Fe hydroxide as rims around clasts	x	

Appendix III (Volcaniclastic Rocks)

Dredge	Sample	Rock type / Interpretation	P/R/E	Sample (cm)	Componentry	Clast size (mm)	Clast shape	Vesicles	Fabric	Structure	Matrix/ Cement	Alteration	TS	Notes
DR79	9C	faintly bedded LT; monomict with accidental lithics; sample 79-1 to -4: crystal-rich tuff or lava…..	P	28x25x17	basaltic aphanitic juv, rare fsp-phyric non-vesicular lithics	<1-15	irregular shaped; smaller curved chips (bubble wall shards)	most 5-10%, some 20-30%, some 0%; generally lined or filled with zeolites	poorly sorted, inhomogeneously moderately closely packed to loosely packed	faint clast alignment, bedding poorly defined, resembles shear planes of high-concentration debris flow	yellow-greenish very fined grained matrix, consisting of platy & cuspate shards, minor white cement	altered, clasts hydrated and palagonized, minor patchy Mn-Fe-hydroxide overgrowth on matrix	x	
DR80	2C	Polymict volcanigenic and biogenic matrix-supported conglomerate	E	11x10x8	basaltic lith, tuff fragments, biogene debris (shells, corals), micrites, mudstones	<1-5 matrix, clasts up to 50mm	rounded, subrounded		loosely packed matrix supported	faintly aligned clasts	grey fine grained matrix and white cc cement		x	
DR80	3C	similar to -2C	E	9x8x6										
DR81	7C	monomict LT	P	30x20x20 irregular angular	aphanitic basaltic vesicular juv; rare dense lava lithics	<1-40, lava lith 10-20	angular irregular and blocky shapes, smaller ones often platy	20%, <1-1mm; mostly filled with zeolites, few empty	poorly sorted	massive	dark amorph cement (zeolite?)	highly altered yellowish-brown, Fe-Mn-hydroxide patches on matrix	x	
DR87	13C	massive monomict LT; insitu spalling of clasts	P	28x25x10 thick slab	aphanitic basaltic vesicular juv	1: <1-10; 2: rarely up to 50mm	1: angular; 2: irregularly shaped, apear to spall off smaller particles	2-10%, <1-2mm, empy or lined with zeolites	poorly sorted, closely packed	massive	white cc cement	one half of slab reddish alteration of clasts (lower side?), other side greenish-yellowish alteration, soft with less (obvious) cc cement	x	
DR87	14C	heterolithic loosely packed LT	E	14x10x9 subrounded	aphanitic basaltic juv (lith?) of variable colour (brown, reddish) and wide range of vesicularity	2-25	irregularly delicately shaped	2-30%, empty and filled with zeolites	widely spaced clasts, very matrix-supported, poorly sorted	massive	yellowish greenish fine grained matrix	altered, Mn-Fe-hydroxides		

Appendix III (Volcaniclastic Rocks)

Dredge	Sample	Rock type / Interpretation	P/R/E	Sample (cm)	Componentry	Clast size (mm)	Clast shape	Vesicles	Fabric	Structure	Matrix/ Cement	Alteration	TS	Notes
DR87	15C	massive fine grained LT	P?	10x8x5 subrounded	scoriaceous juv, rare dense lith, rare coarse vesicular lith	1-5	equant delicate shaped, slightly abraded	5-30%, mostly filled with zeolites	moderately sorted, closely packed	massive	greenish-yellow grainy matrix, some of it with reddish secondary staining	altered, soft rock		en masse vertical debris fall or water-settled tuff slightly reworked?
DR87	16C	well sorted LT with outsized, faintly aligned clasts	P?	8x8x5 subrounded	1: angular highly vesicular tuff; 2: highly irregularly shaped scoriaceous clasts	1: <1-3; 2: up to 30		5-30%, mostly filled with zeolites	well sorted, closely packed tuff, outsized clasts floating widely spaced in tuff	outsized clasts faintly aligned	greenish-yellow fine grained matrix	altered, soft rock		some lateral transport, however angular tuff and delicate large clasts indicate proximity to source
DR87	17C	massive tuff	P	9x9x7 round	extremely fine, altered ash	<1	angular-subangular	-	closely packed, well sorted	massive	yellowish matrix	altered, soft rock		
DR87	18C	massive to faintly bedded tuff simiilar to -17C	P	11x8x4 round	extremely fine, altered ash	<2	angular-subangular	-	closely packed, well sorted	massive to faintly parallel aligned clasts	reddish matrix ?secondary alteration	altered, soft rock		
DR87	19C	"tuffaceous lava" similar to DR73-10C to 13C	?	8x8x3 irregular angular	extremely fine, vesicular light grey mass; 1-2mm clear equant square crystals ?Fsp			2%, <1mm, empty, irregular shaped	homogeneous coherent appearance	variably oriented vesicles	greenish grey	rusty stains of 2-3mm on groundmass overgrowing vesicles	x	crystal tuff or evolved lava flow?
DR87	20C	dense ?tuff or flow banded lava?	?	15x11x8 subrounded	dense, aphanitic grey mass				very homogeneous, dense	cream and grey 5-10mm thick softly-wavy banding ?flow banding/disturbed tuff layers?	light grey and cream	Fe-Mn-hydroxide patches	x	
DR88	4C	monomict massive LT	P	13x10x7 subangular	reddish basaltic juv	2-20, rarely up to 50	subangular blocky	15-20%, <1mm mostly lined and filled with zeolites	poorly sorted, matrix supported	massive	grey beige fine grained matrix and white cc cement	altered reddish brown rock	x	

Appendix III (Volcaniclastic Rocks)

Dredge	Sample	Rock type / Interpretation	P/R/E	Sample (cm)	Componentry	Clast size (mm)	Clast shape	Vesicles	Fabric	Structure	Matrix/ Cement	Alteration	TS	Notes
DR89	2C	large lava fragments set in fine LT (description refers to LT only)	P	47x37x24 irregular	reddish juv	<1-3	-	5-20%, mostly filled with zeolites	fairly well sorted, closely packed	as a matrix supporting the lava fragments (up to 10cm)	reddish fine grained matrix	Mn-Fe hydroxide patches on matrix	x	

Abbreviations

LT	lapilli tuff
juv	juvenile particles
lith	lithic particles

SO199 Biological Samples

Abbreviations: n = number of collected specimens, FIX = fixation, F = Formalin, EtOH = 100% pure Ethanol, Glu = 2.5% Glutaraldehyde/PB-buffered, RNA=RNALater. gDr = geological dredge, zD r = zoological dredge, TVG = TV grab, MUC = multicorer
The numbers 2, 5, 50, 100, 200, 500 and 1000 give the size of the vials in ml, WP= Whirl Pack, OT=Orange Tube, LC=Large Cryotube
Fixation of meiofauna from sediment traps as 1 vol sediment : 1 vol 6% formalin

SO199 - DR1
Seamount W of Investigator Ridge at its N termination; +/- circular morphology; track along steepest part of W-facing slope
Dredge on bottom UTC 05/08/08 00:05hrs, lat 6°13.59'S, long 97°22.35'E, depth 4036m
Dredge of bottom UTC 05/08/08 01:32hrs, lat 6°13.75'S, long 97°22.79'E, depth 3546m
total volume: full
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera	1	x								EtOH	flat, elevated in the centre, "fried-egg-like"
	Cnidaria	5	x								F	Octocorallia
	Cnidaria	1	x								EtOH	Octocorallia
	Cnidaria	3	x								F	Coronata
	Polychaeta	1	x								EtOH	Amphinomida, with bristle whorls
	Polychaeta	1	x								EtOH	Sabelariid, two pieces,
	Polychaeta	>5	x								F	Sabelariid, several pieces,
	Bryozoa	1	x								EtOH	Ctenostome, tree-like
	Bryozoa	1	x								F	creeping, rarely branched, same as in DR2
Meiofauna	Nematoda	57	x								F	
	Kinorhyncha	1								slide	F	*Echinoderes*: 1x adult
	Polychaeta	1	x								F	
	Oligochaeta	2	x								F	
	Copepoda	15	x								F	
	Tanaidacea	1	x								F	

SO199 - DR2
Investigator Ridge, Northern End, west facing slope of N-S trenching ridge
Dredge on bottom UTC 06/08/08 16:07hrs, lat 7°0.76'S, long 98°06.40'E, depth 4602m
Dredge off bottom UTC 06/08/08 17:17hrs, lat 7°0.80'S, long 98°06.40'E, depth 4135m
total volume: 2/3 full
gDr, no sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera	3	x								EtOH	small, flat, one central opening
	Porifera	1	x								EtOH	Asbestopluma?
	Porifera	1	x								F	Hexactinellida
	Porifera	1	x								F	small, flat, one central opening
	Cnidaria	1	x								EtOH	Coronate polyp, semi-transparent tube
	Polychaeta	5	x								F	two species of sabellariids
	Bryozoa	1	x								EtOH	branched, rather soft, upright
	Bryozoa	3	x								EtOH	creeping, rarely branched
	Bryozoa	5	x								EtOH	2 species
	Tunicata	1	x								EtOH	flat, with a knobly surface

SO199 - DR3
Investigator Ridge
Dredge on bottom UTC 07/08/08 00:39hrs, lat 7°20.71'S, long 98°05.24'E, depth 4789m
Dredge off bottom UTC 07/08/08 02:00hrs, lat 7°20.80'S, long 98°05.74'E, depth 4125m
dredge lost

SO199 - TVG4
Deep sea plain 2nm west of Investigator Ridge
UTC 07/08/08 05:58 hrs lat 7°36.16' S long 98°03.06' E, depth 4604m
TVG, signal loss at 1200 m, cancelled

SO199 - DR5
Investigator Ridge Northern End, west facing slope of N-S trenching ridge
Dredge on bottom UTC 07/08/08 12:58hrs, lat 8°09.41'S, long 98°03.58'E, depth 4357m
Dredge off bottom UTC 07/08/08 14:35hrs, lat 8°09.40'S, long 98°04.20'E, depth 4357m
total volume: few rocks, pillow lava fragments, very few small volcanoclastics
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	Nematoda	56	x								F	
	Plathelminthes?	1	x								F	
	Copepoda	5	x								F	

SO199 - DR6
Investigator Ridge ca 60 nm S of DR5, West-facing slop below circular shaped volcanic structure
Dredge on bottom UTC 08/08/08 22:53hrs, lat 9°02,44'S, long 98°4,45'E, depth 4135m
Dredge off bottom UTC 09/08/08 01:30hrs, lat 9°02,42'S, long 98°4,98'E, depth 3704m
total volume: several rocks, intrusiva and volcanic rocks, probably slope debris
gDr, no sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	unsorted											
Meiofauna	Nematoda	65	x								F	
	Copepoda	3	x								F	
	Polychaeta	1	x								F	
	Tanaidacea	2	x								F	
	Loricifera	1								slide	F	

SO199 - TVG7
Top of Investigator Ridge
TVG on bottom UTC 16/08/08 05:24 hrs, lat 9°06.76' S, long 98°05.54' E, depth 3500m
TVG off bottom UTC 16/08/08 06:10 hrs, lat 9°06.76' S, long 98°05.70' E, depth 3588m
TVG, signal loss after 40 min transect and video recording, cancelled

SO199 - DR8
Investigator Ridge, steep W-facing slope of ridge in this area
Dredge on bottom UTC 08/08/08 15:18 hrs, lat 9°57.19'S long 98°04.03'E, depth 4925m
Dredge off bottom UTC 08/08/08 16:51 hrs, lat 9°57.19'S long 98°04.55'E, depth 4350m
total volume: dredge filled to top. Pillows and pillow fragments, very minor glass crusts, few pillow breccias
gDr, no sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera	2	x								EtOH	Hexactinellida
	Cnidaria	1	x								EtOH	Coronata
	Polychaeta	4	x								EtOH	Sabellariid

SO199 - DR9
Investigator Ridge at 10°53S, S of E-ward kink on Smith & Sandwell map
Dredge on bottom UTC 09/08/08 01:30hrs, lat 10°53.20'S, long 98°04.72'E, depth 4420m
Dredge off bottom UTC 09/08/08 04:45hrs, lat 10°53.19'S, long 98°04.40'E, depth 4259m
total volume: few rocks
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera	1	x								EtOH	same as DR2-Por1
Meiofauna	Nematoda	21	x								F	
	Copepoda	4	x								F	

SO199 - DR10
Central Investigator Ridge , Northern End of tilted block
Dredge on bottom UTC 09/08/08 10:51hrs, lat 10°59.25'S, long 98°07.82'E, depth 4060m
Dredge off bottom UTC 09/08/08 12:12hrs, lat 10°59.24'S, long 98°08.30'E, depth 3515m
total volume: few rocks
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Polychaeta	1	x								EtOH	*Spirorbis*?
Meiofauna	Nematoda	89	x								F	
	Copepoda	7	x								F	
	Tardigrada	1	x								F	

SO199 - DR11
Investigator Ridge Central Section within Seamount Province
Dredge on bottom UTC 09/08/08 22:09hrs, lat 11°56.26'S, long 98°11.50'E, depth 3953m
Dredge off bottom UTC 10/08/08 01:00hrs, lat 11°56.20'S, long 98°11.72'E, depth 3701m
total volume:1/4 full
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera	1	x								EtOH	Hexactinellida
	Polychaeta	2	x								EtOH	2 species, one tube with serrated edge
	Bryozoa	2	x								EtOH	unusual, vibracularia on long stalks, holdfasts
Meiofauna	Nematoda	66	x								F	
	Copepoda	10	x								F	
	Ostracoda	1	x								F	

SO199 - DR12
Central Investigator Ridge
Dredge on bottom UTC 10/08/08 11:44hrs, lat 13°00.91'S, long 98°16.10'E, depth 3994m
Dredge off bottom UTC 10/08/08 13:07hrs, lat 13°00.70'S, long 98°16.60'E, depth 3504m
total volume:very few rocks, breccia with rounded serpentinit clasts
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera	3	x								EtOH	3 pieces, anastomosing, red-brownish, common
	Polychaeta	1										empty foram-tube, rather large, not preserved
Meiofauna	Nematoda	100	x								F	
	Copepoda	5	x								F	
	Tardigrada	3	x								F	
	Nemertini?	1	x								F	

SO199 - DR13
Southwest facing slope of northern Keeling Island
Dredge on bottom UTC 11/08/08 17:05 hrs, lat 11°54.38'S, long 96°39.06'E, depth 2402m
Dredge off bottom UTC 11/08/08 19:13 hrs, lat 11°54.04'S, long 96°39.52'E, depth 1880m
total volume: about 10%, few volcanoclastic rocks, lava fragments
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera	1	x								EtOH	Hexactinellida
	Cnidaria	1	x								EtOH	Coronata
	Polychaeta	>5	x								EtOH	tubes on matrix
Meiofauna	Nematoda	54	x								F	
	Copepoda	3	x								F	
	Tardigrada	1	x								F	
	Oligochaeta	1	x								F	
	Polychaeta	1	x								F	

SO199 - TVG14
Abyssal plain west of Keeling Island
UTC 11/08/08 1016hrs lat 12°02.68'S, long 96°30.61'E depth 4934 m
TVG, signal loss at 1200 m, cancelled

SO199 - MUC15
Abyssal plain ca. 10nm W of Keeling Island
MUC on bottom UTC 11/08/08 14:39 hrs, lat 12°04.31'S, long 96°21.10'E depth 5231m
MUC off bottom UTC 11/08/08 14:44 hrs, lat 12°04.31'S, long 96°21,10'E depth 5231m
total volume: two tubes with ca. 15 cm sediment, remaining tubes empty, sediment sample rinsed with unfiltered seawater before fixation
MUC, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	Nematoda	310	x								F	
	Copepoda	82	x								F	
	Tardigrada	1	x								F	
	Kinorhyncha	1								slide	F	*Echinoderes*: 1x juvenile
	Polychaeta	1	x								F	
	Ostracoda	1	x								F	

SO199 - DR16
"Noel" Seamount; SW of Keeling Island. This is the NW most seamount of the Muirfield seamount cluster
Dredge on bottom UTC 12/08/08 01:23 hrs, lat 12°23.489'S, long 95°17.292'E, depth 2883m
Dredge off bottom UTC 12/08/08 03:25 hrs, lat 12°23.626'S, long 95°17.377'E, depth 2676m
total volume: few rocks
qDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	Nematoda	177	x								F	
	Copepoda	16	x								F	
	Tardigrada	2	x								F	
	Polychaeta	2	x								F	
	Tanaidacea	1	x								F	
	Acari	1	x								F	

SO199 - DR17
Seamount chain west of Keeling Island (Muir Field Seamount), NW summit at end of chain (Noel, some 14 km SSE of DR16), SW facing slope
Dredge on bottom UTC 12/08/08 07:03 hrs, lat 12°29.908'S, long 95°21.158'E, depth 2247m
Dredge off bottom UTC 12/08/08 09:07 hrs, lat 12°29.666'S, long 95°21.503'E, depth 1839m
total volume: few rocks, volcaniclastic rocks with 3-4 basaltic clasts
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera	1	x								EtOH	Hexactinellid?
	Porifera	1	x								EtOH	Hexactinellid
	Porifera	1	x								EtOH	Hexactinellid
	Cnidaria	2	x								EtOH	Coronata
	Sipuncula	2	x								EtOH	*Golfingia*-like
Meiofauna	Nematoda	110	x								F	
	Copepoda	10	x								F	
	Cnidaria	29	x								F	
	Tanaidacea	1	x								F	
	Tardigrada	1	x								F	
	Sipunculida	1	x								F	

SO199 - DR18
Muir Field Seamount Cluster: small Seamount SE of NOEL Smnt.
Dredge on bottom UTC 12/08/08 13:20 hrs, lat 12°48.31'S, long 95 22.64'E, depth 3549m
Dredge off bottom UTC 12/08/09 15:56 hrs, lat 12°49.05'S, long 95°23.23'E, depth 3053m
total volume: 1 rock
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	Nematoda	86	x								F	
	Copepoda	6	x								F	
	Polychaeta	2	x								F	
	Tardigrada	4	x								F	
	Ostracoda	1	x								F	

SO199 - DR19
Muir Field Seamount: Western Slope
Dredge on bottom UTC 12/08/08 23:26 hrs, lat 13°05.34'S, long 96°00.34'E, depth 3002 m
Dredge off bottom UTC 12/08/08 00:42 hrs, lat 13°05.43'S, long 96°1.177'E, depth 2607 m
total volume: few rocks
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Polychaeta	3	x								EtOH	2 species, pieces of tubes and 1 complete animal
	Tunicata	1	x								EtOH	Ascidian
Meiofauna	Nematoda	139	x								F	
	Copepoda	24	x								F	
	Plathelminthes?	3	x								F	
	Polychaeta	3	x								F	
	Ostracoda	1	x								F	

SO199 - DR20
KLAUS Seamount: southward trending rift (?) structure
Dredge on bottom UTC 13/08/08 10:08 hrs, lat 13°36.36'S, long 96°23.36'E, depth 3140 m
Dredge off bottom UTC 13/08/08 11:28 hrs, lat 13°36.19'S, long 96°23.84'E, depth 2819 m
total volume: few rocks
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera	1								LC	RNA	small hexactinellid
	Polychaeta	3	x								EtOH	tiny white tubes, one complete animal
	Tunicata	1	x								EtOH	Ascidian
Meiofauna	Nematoda	103	x								F	
	Copepoda	5	x								F	
	Tardigrada	1	x								F	
	Bivalvia	1	x								F	
	Acari	1	x								F	

SO199 - DR21
SANTA Seamount: SE of Muirfield Smnt. SW slope near a NE-SW striking valley
Dredge on bottom UTC 13/08/08 15:42 hrs, lat 13°43.27'S, long 96°25.85'E, depth 2783 m
Dredge off bottom UTC 13/08/08 17:31 hrs, lat 13°43.10'S, long 96°26.40'E, depth 2295 m
total volume: very few rocks ca 7 pieces
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	Nematoda	102	x								F	
	Copepoda	18	x								F	
	Tardigrada	1	x								F	
	Ostracoda	1	x								F	

SO199 - DR22
Central Investigator Ridge
Dredge on bottom UTC 14/08/08 11:14 hrs, lat 13°14.17'S, long 98°14.17'E, depth 4287m
Dredge off bottom UTC 14/08/08 12:18 hrs, lat 13°14.09'S, long 98°14,76'E, depth 4287m
total volume: few angular rock fragments, single pillow that broke into 6 pieces
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera	1	x								EtOH	Hexactinellida
	Polychaeta	2	x								EtOH	soft chitinous tubes
Meiofauna	Nematoda	14	x								F	
	Copepoda	4	x								F	
	fish larva	1	x								F	

SO199 - DR23
Central Investigator Ridge, WNW facing slope beneath upper part of the ridge
Dredge on bottom UTC 14/08/08 20:54 hrs, lat 13°54.16'S, long 98°22.24'E, depth 4203m
Dredge off bottom UTC 14/08/08 22:15 hrs, lat 13°54.40'S, long 98°22.72'E, depth 3796m
total volume: one third full of very large pieces, intrusive rocks and Mn crusts
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	Nematoda	18	x								F	
	Copepoda	2	x								F	

SO199 - TVG24
West of Investigator Ridge, abyssal plain
UTC 15/08/08 02:08 hrs, lat 14°05.03' S, long 98°17.48' E, depth 5407m
TVG, signal loss at 1800m, cancelled

SO199 - MUC25
West of Investigator Ridge, abyssal plain
MUC on bottom UTC 15/08/08 06:10 hrs, lat 14°05.01' S, long 98°17.47' E, depth 5406m
MUC off bottom UTC 15/08/08 06:15 hrs, lat 14°05.04' S, long 98°17.48' E, depth 5400m
total volume: 3 tubes with ca 25 cm sediment, remaining tubes empty, some bottom lids in an akward position, needs checking
MUC, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	Nematoda	355	x								F	
	Copepoda	49	x								F	
	Oligochaeta	1	x								F	
	Ostracoda	5	x								F	
	Isopoda	2	x								F	
	Plathelminthes	2	x								F	
	Kinorhyncha	1								slide	F	*Echinoderes*: 1x adult
	Tardigrada	1	x								F	

SO199 - DR26
Southern Investigator Ridge
Dredge on bottom UTC 15/08/08 16:28hrs, lat 14°55.18'S, long 98°29.54'E, depth 4938m
Dredge off bottom UTC 15/08/08 17:33hrs, lat 14°55.09'S, long 98°30.07E, depth 4575m
total volume: 1/4 full
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	Nematoda	24	x								F	
	Copepoda	2	x								F	
	Cnidaria	1	x								F	

SO199 - TVG27
Southern Investigator Ridge, Eastern slope below top of the ridge
TVG on bottom UTC 16/08/08 03:09 hrs, lat 15°52.83' S, long 98°44.23' E, depth 3830m
TVG on bottom UTC 16/08/08 03:49 hrs, lat 15°52.80' S, long 98°44.56' E, depth 3883m
total volume: 1/3 full, sediment mainly consisting of foram tests
TVG, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted											

SO199 - DR28
Southern Investigator Ridge
Dredge on bottom UTC 16/08/08 08:40hrs, lat 16°00.09'S, long 98°44.32'E, depth 4649m
Dredge off bottom UTC 16/08/08 10:06hrs, lat 16°00.08'S, long 98°29.89'E, depth 4290m
total volume: 1/3 full
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	fossil shark teeth	2								WP	dry	embedded in manganese crust
Meiofauna	Nematoda	26	x								F	
	Copepoda	5	x								F	
	Isopoda	1	x								F	
	Loricifera	1								slide	F	

SO199 - DR29
Seamount west of southern Investigator Ridge
Dredge on bottom UTC 16/08/08 19:46 hrs, lat 16°33.87'S, long 98°50.31'E, depth 5262m
Dredge off bottom UTC 16/08/08 21:12 hrs, lat 16°34,17'S, long 98°50.86'E, depth 4813m
total volume: few rocks, range from plutonic to volcanic
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	Nematoda	4										

SO199 - DR30
Snamm NNE/SSW trending ridge segment West of main Investigator Ridge, steep westward facing slope (>45°)
Dredge on bottom UTC 17/08/08 07:11 hrs, lat 16°46.99'S, long 98°47.12'E, depth 5060m
Dredge off bottom UTC 17/08/08 08:12 hrs, lat 16°47.04'S, long 98°47.50'E, depth 4586m
total volume: 1/5 full, pillows and pillow fragments
gDr, no sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera	1	x								EtOH	hair-like, only stem of specimen?

SO199 - DR31
Southern Investigator Ridge, Southwest facing slope along lower section
Dredge on bottom UTC 17/08/08 21:01 hrs, lat 17°35.09' S, long 99°07.01' E, depth 5361m
Dredge off bottom UTC 17/08/08 22:24 hrs, lat 17°34.93' S, long 99°08.39' E, depth 4947m
total volume: few rocks
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	Nematoda	6	x								F	

SO199 - TVG32
Southern Investigator Ridge, central eastern slope
UTC 18/08/08 hrs, lat 17°29,99'S, long 99°14,13'E, depth 5699m
TVG, signal loss at 4400m, camera signal loss at 5200 m, cancelled

SO199 - MUC33
East of southern Investigator Ridge, abyssal plain
MUC on bottom UTC 18/08/08 08:08 hrs, lat 17°27.89'S, long 99°19.18'E, depth 6259m
MUC off bottom UTC 18/08/08 08:12 hrs, lat 17°27.89'S, long 99°19.18'E, depth 6259m
total volume: 1 tube full, remaining 11 tubes only with some 5 cm of sediment, if not empty
MUC, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	Nematoda	70	x								F	
	Copepoda	9	x								F	
	Plathelminthes?	1	x								F	
	Isopoda	1	x								F	
	Ostracoda	1	x								F	
	Oligochaeta	1	x								F	
	?	1	x								F	

SO199 - MUC34
West of northern end of Investigator Ridge, small basin south of seamount structure
MUC on bottom UTC 20/08/08 22:15 hrs, lat 8°01.68'S, long 98°24.03'E, depth 5226m
MUC off bottom UTC 21/08/08 00:06 hrs, lat 8°01.68'S, long 98°24.03'E, depth 5226m
total volume: 2 tubes full, remaining tubes mainly empty, 5 lower lids twisted (all in the same direction)
MUC, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera	>5	x								F	three species, entangled with large radiolarians
	Polychaeta	1	x								F	amphinomid?
Meiofauna	Nematoda	806	x								F	
	Copepoda	207	x								F	
	Tardigrada	13	x								F	
	Oligochaeta	2	x								F	
	Polychaeta	20	x								F	
	Ostracoda	20	x								F	
	Plathelminthes	10	x								F	
	Loricifera	3								slides	F	
	Kinorhyncha	3								slides	F	"*Antygomonas*": 1x adult, *Echinoderes:* 2x adult
	Isopoda	1	x								F	
	Holothuroidea?	1	x								F	
	Bivalvia	2	x								F	
	Egg case?	1								slide		
	Sipunculida?	1								slide		
	?	1	x								F	not Priapulida, Sipunculida?
	?	2	x								F	

SO199 - DR35
"Rudolf" seamount east of the Investigator Ridge, upper northerneastern slope just below plateau rim
Dredge on bottom UTC 21/08/08 20:31 hrs, lat 10°18.69'S, long 99°29.43'E, depth 3084m
Dredge off bottom UTC 21/08/08 22:26 hrs, lat 10°18.69'S, long 99°29.53'E, depth 3060m
total volume: one rock, freshly broken pillow lava
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera	1	x								EtOH	Hexactinellida
Meiofauna	unsorted											

SO199 - DR36
"Rudolph" seamount, west facing slope of circular cone on the plateau of the guyot
Dredge on bottom UTC 22/08/08 01:24 hrs, lat 10°21.10'S, long 99°29.82'E, depth 2548m
Dredge off bottom UTC 22/08/08 02:25 hrs, lat 10°21.12'S, long 99°30.27'E, depth 2230m
total volume: a few rocks, lava fragments and volcanoclastics with thick Mn crust
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera	6	x								EtOH	Asbestopluma, one with head
	Porifera	4	x								EtOH	Hexactinellid, same as in 35
	Cnidaria	5	x								EtOH	Coronata
	Polychaeta	>5	x								EtOH	tube pieces, 3 species
	Bryozoa	2	x								EtOH	Ctenostomata
Meiofauna	Nematoda	154	x								F	
	Copepoda	26	x								F	
	Tardigrada	2	x								F	
	Ostracoda	5	x								F	
	Gastrotricha?	1	x								F	
	Plathelminthes?	1	x								F	
	Kinorhyncha	1								slide	F	*Echinoderes*: 1x juvenile
	Oligochaeta	1	x								F	
	?	1	x								F	

SO199 - DR37
Seamount just south of "Ruprecht" seamount, east of Investigator Ridge
Dredge on bottom UTC 22/08/08 8:30 hrs, lat 10°40.06'S, long 99°34.46'E, depth 2475m
Dredge off bottom UTC 22/08/08 9:36 hrs, lat 10°40.06'S, long 99°34.96'E, depth 2272m
total volume: few rocks, carbonate
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera	4	x								EtOH	2 species
	Polychaeta	1	x								EtOH	Maldanidae
	Polychaeta	>5	x								EtOH	pieces of tubes, several species
	Mollusca	3	x								F	2 species of Pteropoda, shells
Meiofauna	Nematoda	240	x								F	
	Copepoda	61	x								F	
	Acari	3	x								F	
	Oligochaeta	1	x								F	
	Sipunculida	1	x								F	
	Tardigrada	7	x								F	
	Bivalvia	2	x								F	
	Isopoda	7	x								F	
	Plathelminthes?	3	x								F	
	Ostracoda	3	x								F	
	Polychaeta	2	x								F	

SO199 - DR38
Large cone on the lower southern flank of "Rudolf" seamount, lower eastern flank
Dredge on bottom UTC 22/08/08 19:57hrs, lat 10°31.14'S, long 99°31.70'E, depth 4381m
Dredge off bottom UTC 22/08/08 21:02hrs, lat 10°31.03'S, long 99°32.21'E, depth 3853m
total volume: empty
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	Nematoda	53	x								F	
	Copepoda	6	x								F	
	Sipunculida	1	x								F	
	Tardigrada	2	x								F	

SO199 - DR39
"Rudolf" seamount, SW flank below plateau edge
Dredge on bottom UTC 22/08/08 19:57hrs, lat 10°21.95'S, long 99°29.18'E, depth 3100m
Dredge off bottom UTC 22/08/08 21:02hrs, lat 10°21.79'S, long 99°29.55'E, depth 2711m
total volume: 1 rock, carbonate crust
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Polychaeta	2	x								EtOH	Serpulidae
Meiofauna	Nematoda	37	x								F	
	Copepoda	3	x								F	
	Cnidaria	1	x								F	Coronata
	Tardigrada	1	x								F	

SO199 - DR40
"Grinch" Ridge, west facing slope beneath small cone of this NW-SE elongated ridge
Dredge on bottom UTC 23/08/08 14.54hrs, lat 10°45.92'S, long 101°48.73'E, depth 4306m
Dredge off bottom UTC 23/08/08 16:20hrs, lat 10°45.90'S, long 101°49.26'E, depth 3791m
total volume: 1/4 full, pillow lava fragments, volcaniclastic rocks and Mn crusts
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Cnidaria	1	x								EtOH	Coronata
	Polychaeta	>5	x								EtOH	Serpulidae
Meiofauna	Nematoda	90	x								F	
	Copepoda	24	x								F	
	Tardigrada	2	x								F	
	Kinorhyncha	2								slides	F	"*Antygomonas*": 1x adult, *Echinoderes*: 1x juvenile
	Loricifera	4								slides	F	
	Plathelminthes	1	x								F	
	Polychaeta	2	x								F	

SO199 - DR41
Mt Melchior seamount, 25km east of Grinch seamounts, West facing slope beneath south extending ridge on the south flank
Dredge on bottom UTC 23/08/08 23:20hrs, lat 10°45.52'S, long 102°10.85'E, depth 3754m
Dredge off bottom UTC 24/08/08 00:52hrs, lat 10°45.67'S, long 102°11.49'E, depth 3282m
total volume: 1/4 full, lavas, volcanoclastic rocks, Mn crusts, carbonate
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera	1	x								EtOH	Asbestopluma?
	Bryozoa	>5	x								EtOH	stalked, only one with "head"
Meiofauna	Nematoda	127	x								F	
	Copepoda	38	x								F	
	Polychaeta	5	x								F	
	Sipunculida	1	x								F	
	Bryozoa	1	x								F	
	Tardigrada	2	x								F	

SO199 - DR42
Lucia seamount, western lower slope of guyot-like seamount, small KUM Dredge
Dredge on bottom UTC24/08/08 07:21 hrs, lat 11°01.78'S, long 102°18.23'E, depth 3963m
Dredge off bottom UTC 24/08/08 08:47 hrs, lat 11°01.55'S, long 102°18.74'E, depth 3441m
total volume: a few rocks, lava and volcaniclastic rocks
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Polychaeta	3	x								EtOH	pieces of tubes, several species
Meiofauna	Nematoda	44	x								F	
	Copepoda	9	x								F	

SO199 - MUC43
MUC on bottom UTC 24/08/08 14:46 hrs, lat 11°12.66'S, long 102°33.11'E, depth 5484m
MUC off bottom UTC 24/08/08 14:47 hrs, lat 11°12.66'S, long 102°33.11'E, depth 5484m
total volume: only 1 tube with 20 cm sediment, remaining tubes only filled with water
MUC, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	Nematoda	153	x								F	
	Copepoda	50	x								F	
	Ostracoda	3	x								F	
	Plathelminthes?	2	x								F	
	Kinorhyncha	1								slide	F	*Echinoderes*: 1x juvenile
	Polychaeta	5	x								F	
	Tardigrada	3	x								F	
	Oligochaeta	2	x								F	

SO199 - DR44
"Attention" Seamount SW corner on W facing slope of a SW trending ridge
Dredge on bottom UTC25/08/08 00:46 hrs, lat 11°46.51'S, long 103°14.48'E, depth 2525m
Dredge off bottom UTC 25/08/08 02:09 hrs, lat 11°46.52'S, long 103°15.07'E, depth 3036m
total volume: very few rocks, 1 piece of lava, Mn and carbontae crusts
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera		x									Asbestopluma?
	Cnidaria				x					OT	EtOH	Hydrozoans on dead gorgonian stem
	Cnidaria	1	x								EtOH	Hydrozoa, single animal on long stem
	Bryozoa	1	x								EtOH	ctenostome, tree-like
Meiofauna	Nematoda	214	x								F	
	Copepoda	61	x								F	
	Polychaeta	7	x								F	
	Tardigrada	3	x								F	
	Ostracoda	7	x								F	
	Plathelminthes	2	x								F	
	Loricifera	2								slides	F	
	Acari	2	x								F	
	Kinorhyncha	2								slides	F	*Echinoderes*: 1x adult, Homalorhagida: 1x juvenile
	Priapulida?	1	x								F	
	Oligochaeta	1	x								F	
	Bivalvia	1	x								F	
	Bryozoa	3	x								F	

SO199 - DR45
"Glögg" Seamount NE of DR44; small valley on westward facing slope, steepest setzion in this area
Dredge on bottom UTC25/08/08 08:15 hrs, lat 11°39.77'S, long 103°32.01'E, depth 3746m
Dredge off bottom UTC 25/08/08 09:47 hrs, lat 11°39.56'S, long 103°32.56'E, depth 3277m
total volume: some rocks, tuffaceous or highly vesicular lava
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Cnidaria	3			x					OT	F	Isididae, pieces of large colony
	Cnidaria	1			x						EtOH	Isididae, soft tissue of the colony
	Polychaeta	>5	x								EtOH	Tubes, several species
Meiofauna	Nematoda	107	x								F	
	Copepoda	21	x								F	
	Isopoda	2	x								F	
	Loricifera	2								slides	F	
	Kinorhyncha	2								slides	F	*Echinoderes*: 1x adult + 1x juvenile
	Tardigrada	3	x								F	
	Sipunculida	1	x								F	

SO199 - DR46
"Mt Halley" Seamount; NW corner of ridge-like seamount - NW facing slope of N trending "erosional" ridge
Dredge on bottom UTC25/08/08 18:56 hrs, lat 10°54.91'S, long 103°37.00'E, depth 4361m
Dredge off bottom UTC 25/08/08 20:28 hrs, lat 10°55.30'S, long 103°37.44'E, depth 3769m
total volume: 1/5 full, volcaniclastica, fine grained sandstone, pillow fragments, some within sediments and volcaniclastica
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera	1	x								EtOH	encrusting sponge, tube-like
Meiofauna	Nematoda	34	x								F	
	Copepoda	16	x								F	
	Ostracoda	2	x								F	
	Kinorhyncha	1								slides	F	*Echinoderes*: 1x juvenile
	Plathelminthes	1	x								F	

SO199 - TVG47
"Balthasar" Seamount, cone on upper SE slope, top
TVG on bottom UTC 26/08/08 07:02 hrs lat 11°27.29'S, long 104°29.63'E, depth 1922m
TVG off bottom UTC 26/08/08 07:44 hrs lat 11°27.34'S, long 104°29.73'E, depth 2018m
total volume: empty
TVG, 4 tries to get gorgonian corals or crinoids, unsuccessful
Macrofauna: many gorgonian corals, at least 50 stalked crinoids during the 300m camera transect (2 species), on video

SO199 - DR48
"Balthazar" Seamount; cone on upper SE slope of seamount, westward facing slope
Dredge on bottom UTC26/08/08 09:47 hrs, lat 11°27.41'S, long 104°29.27'E, depth 2202m
Dredge off bottom UTC 26/08/08 11:39 hrs, lat 11°27.36'S, long 104°29.39'E, depth 2098m
total volume: few rocks, lava fragments, volcaniclastic rocks and carbonate
gDr, no sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Cnidaria	1										
	Cnidaria	1			x						EtOH	gorgonian coral, piece of large specimen
	Cnidaria	1	x								EtOH	Hydrozoa
	Polychaeta	2	x								EtOH	Serpulidae
	Bryozoa	1	x								EtOH	stalked, branched, calcified

SO199 - DR49
"Apollo 8" Seamount; SW corner of Smnt along erosional ridge, base of the structure within SE striking valley
Dredge on bottom UTC26/08/08 18:20 hrs, lat 11°30.73'S, long 104°46.99'E, depth 4582m
Dredge off bottom UTC 26/08/08 19:45 hrs, lat 11°31.03'S, long 104°47.53'E, depth 4050m
total volume: 1/3 full, pillows and pillow fragments, rounded volcaniclastic (?) pebbles
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	Nematoda	30	x								F	
	Copepoda	22	x								F	
	Loricifera	2								slides	F	
	Ostracoda	1	x								F	
	Isopoda	1	x								F	

SO199 - DR50
"Apollo 8" Seamount, small valley on SW facing slope between two erosional ridges; below plateau edge
Dredge on bottom UTC 27/08/08 00:52hrs, lat 11°19.85'S, long 104°47.00'E, depth 3125m
Dredge off bottom UTC 27/08/08 02:33hrs, lat 11°19.80'S, long 104°48.02'E, depth 3022m
total volume: few rocks, lava fragments and volcaniclastic rocks
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	Nematoda	29	x								F	
	Copepoda	8	x								F	
	Isopoda	1	x								F	

SO199 - TVG51
"Sherbakov" Seamount, SW corner of seamount, just beneath edge of plateau
TVG on bottom UTC 27/08/08 08:03 hrs lat 10°55.32'S, long 104°34.67'E, depth 1787m
TVG off bottom UTC 27/08/08 09:49 hrs lat 10°55.49'S, long 104°34.95'E, depth 1832m
total volume: empty
TVG, 3 unsuccessful tries, cancelled
Macrofauna: Swimming *Enypniastes eximia* sea cucumber and few stalked crinoids on video

SO199 - DR52
"Sherbakov" Seamount, western part of the seamount, littel cone on lower westward facing slope
Dredge on bottom UTC 27/08/08 12:30hrs, lat 10°54.49'S, long 104°32.04'E, depth 2820m
Dredge off bottom UTC 27/08/08 14:12hrs, lat 10°54.89'S, long 104°33.56'E, depth 2229m
total volume: few rocks, pillow lava fragments, volcaniclastic rocks and carbonate crusts
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Cnidaria	2	x								EtOH	Coronata
	Mollusca/Echinodermata	1									F	Cephalopod or *Enypniastes*, heavily damaged
	Mollusca/Echinodermata	1					x				EtOH	Cephalopod or *Enypniastes*, heavily damaged, piece of larger specimen
	Polychaeta	5	x								EtOH	2 species of serpulids/sabellids
	Bryozoa	1	x								EtOH	very small piece of calcified, encrusting species
Meiofauna	Nematoda	46	x								F	
	Copepoda	20	x								F	
	Tardigrada	2	x								F	
	Ostracoda	2	x								F	
	Isopoda	2	x								F	

SO199 - MUC53
Abyssal plain off SW corner of Christmas Island
MUC on bottom UTC 28/08/08 10:03 hrs, lat 10°37.21'S, long 105°17.63'E, depth 4688m
MUC off bottom UTC 28/08/08 10:04 hrs, lat 10°37.21'S, long 105°17.63'E, depth 4688m
total volume: 7 tubes with ~20 cm sediment, tubes with silver lids empty, 1 white lid didn't close
MUC, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Foraminifera	>5	x								Glu	*Leptohalysis*-like
	Porifera	4	x								Glu	
	Sipuncula	1	x								Glu	in orange cone-shaped foram?-tube, with eggs
Meiofauna	Nematoda	307	x								Glu	
	Nematoda	521	x								F	
	Copepoda	155	x								Glu	
	Copepoda	270	x								F	
	Loricifera	4								slides	Glu	
	Kinorhyncha	1								slide	Glu	Echinoderes juvenile
	Kinorhyncha	8								slides	F	"*Antygomonas*": 2x adult, *Echinoderes*: 2x adult + 4x juvenile
	Ostracoda	5	x								Glu	
	Ostracoda	21	x								F	
	Polychaeta	10	x								Glu	
	Polychaeta	31	x								F	
	Oligochaeta	1	x								Glu	
	Oligochaeta	2	x								F	
	Plathelminthes	7	x								Glu	
	Plathelminthes	6	x								F	
	Tardigrada	1	x								Glu	
	Tardigrada	4	x								F	
	Tanaidacea	1	x								Glu	
	Bivalvia	1	x								Glu	
	Bivalvia	3	x								F	
	Gastrotricha?	2	x								F	
	Isopoda	2	x								F	
	Cumacea	1	x								F	with crustacean parasite

SO199 - DR54
Christmas Island SW corner of Christmas Island, lower slope
Dredge on bottom UTC 28/08/2008 14:10hrs, lat 10°32.39'S, long 105°24.16'E, depth 3626m
Dredge off bottom UTC 28/08/2008 15:35hrs, lat 10°32.39'S, long 105°24.59'E, depth 3156m
total volume: few rocks, 1 lava, 1 volcaniclastic, 1 carbonate
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	Nematoda	142	x								F	
	Copepoda	115	x								F	
	Poychaeta	8	x								F	
	Kinorhyncha	5								slides	F	*Echinoderes*: 3x adult + 2x juvenile
	Loricifera	2								slides	F	
	Ostracoda	9	x								F	
	Tardigrada	12	x								F	
	Isopoda	2	x								F	
	Plathelminthes	3	x								F	
	Acari	4	x								F	

SO199 - DR55
Christmas Island SW corner of Christmas Island, small canyon on upper slope
Dredge on bottom UTC 28/08/2008 18:20hrs, lat 10°30.85'S, long 105°28.42'E, depth 1891m
Dredge off bottom UTC 28/08/2008 19:32hrs, lat 10°30.93'S, long 105°28.82'E, depth 1427m
total volume: few rocks, 3 lava fragments, 1 carbonate
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera/Cnidaria	1	x								EtOH	heavily spiculated, either Calcarea or soft coral
	Porifera	1	x								F	Hexactinellida
	Cnidaria	5	x								EtOH	branched, tree-like hydrozoans
	Mollusca	1	x								dry	shell, like *Retusa obtusa*
	Mollusca	1	x								dry	shell of a pteropod
	Crustacea	1	x								EtOH	caprellid Amphipoda on hydrozoan stem
	Bryozoa	2	x								EtOH	light brownish ctenostome
Meiofauna	Nematoda	123	x								F	
	Copepoda	61	x								F	
	Ostracoda	2	x								F	
	Tardigrada	10	x								F	
	Kinorhyncha	2								slides	F	*Campyloderes*: 1x adult, *Echinoderes*: 1x adult
	Loricifera	1								slide	F	
	Polychaeta	5	x								F	
	Acari	2	x								F	
	Plathelminthes	2	x								F	
	Tanaidacea	1	x								F	with nematode parasite

SO199 - DR56
"Royal Mary" Seamount, northernmost seamount of the seamount group SE of Christmas Island, northern flank
Dredge on bottom UTC 29/08/08 6:46hrs, lat 11°15.77'S, long 106°33.28'E, depth 3997m
Dredge off bottom UTC 29/08/08 8:02hrs, lat 11°15.99'S, long 106°33.69'E, depth 3338m
total volume: 1/3 full, porphyric lava, volcaniclastics
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera	1								LC	RNA	piece of hexactinellid
	Porifera	2	x								EtOH	two pieces of the same hexactinellid
Meiofauna	Nematoda	106	x								F	
	Copepoda	76	x								F	
	Polychaeta	6	x								F	
	Ostracoda	1	x								F	
	Acari	1	x								F	
	Tardigrada	5	x								F	
	Plathelminthes	3	x								F	
	Bivalvia	1	x								F	
	Kinorhyncha	2								slides	F	*Echinoderes*: 2x adult

SO199 - DR57
"Elena" Seamount (belongs to seamount group SE of Christmas Island), small valley on upper NW flank
Dredge on bottom UTC 29/08/08 14:43hrs, lat 11°42.59'S, long 106°33.24'E, depth 3501m
Dredge off bottom UTC 29/08/08 17:30hrs, lat 11°42.71'S, long 106°33.82'E, depth 3052m
total volume: 1/6 full, volaniclastics, lava fragments
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Sipuncula	1	x								EtOH	only head
Meiofauna	Nematoda	65	x								F	
	Copepoda	27	x								F	
	Tardigrada	1	x								F	
	Polychaeta	2	x								F	

SO199 - DR58
"Max" Seamount (belongs to seamount group SE of Christmas Island), NW facing steep slope, steepest on lower slope
Dredge on bottom UTC 29/08/08 22:14hrs, lat 11°44.20'S, long 106°52.78'E, depth 3609m
Dredge off bottom UTC 29/08/08 23:30hrs, lat 11°44.38'S, long 106°53.32'E, depth 3113m
total volume: 1/3 full, pillows, lava fragments, volcaniclastics, sediment
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Cnidaria	1	x								EtOH	Octocorallia
	Polychaeta	1	x								EtOH	2 pieces, Maldanidae
Meiofauna	Nematoda	121	x								F	
	Copepoda	48	x								F	
	Kinorhyncha	3								slides	F	"*Antygomonas*": 1x adult, *Echinoderes*: 1x adult + 1x juvenile
	Loricifera	2								slides	F	
	Acari	1	x								F	
	Tardigrada	13	x								F	
	Ostracoda	2	x								F	
	Isopoda	2	x								F	

SO199 - DR59
"Max" Seamount, small cone in SW corner of seamount, well below plateau edge
Dredge on bottom UTC 30/08/08 03:10 hrs, lat 11°45.66'S, long 106°53.06'E, depth 3173m
Dredge off bottom UTC 30/08/08 04:54 hrs, lat 11°45.72'S, long 106°53.57'E, depth 2733m
total volume: 1/4 full, volcaniclastica, one 1m sized luipilltuff crust with freshly broken side, a few lava fragments
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Polychaeta	3	x								EtOH	Sabellariidae, tubes strong, with forams
Meiofauna	Nematoda	126										
	Copepoda	65										
	Cnidaria	5										
	Polychaeta	2										
	Kinorhyncha	4								slides		*Echinoderes*: 2x adult + 2 x juvenile
	Loricifera	1								slide		
	Solenogastres?	2										
	Plathelminthes	3										
	Oligochaeta	1										
	Ostracoda	1										
	Acari	1										

SO199 - TVG60
"Max" Seamount, just beneath southern plateau edge
TVG on bottom UTC 30/08/08 08:28 hrs, lat 11° 48.80'S, long 107° 02.26'E, depth 2739m
TVG off bottom UTC 30/08/08 08:41 hrs, lat 11° 48.79'S, long 107° 02.29'E, depth 2728m
total volume: 1/2 full with sediment
TVG, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Polychaeta	1									EtOH	in soft tube, very long, group?
	Polychaeta	1		x							F	Polynoida, head missing
	Polychaeta	1	x								F	in soft tube, very long, Syllidae?
	Polychaeta	1	x								F	Syllidae?
Meiofauna	Nematoda	590	x								F	
	Copepoda	50	x								F	one with crustacean parasite
	Tadigrada	12	x								F	
	Loricifera	5								slides	F	
	Kinorhyncha	2								slides	F	*Echinoderes*: 1x adult + 1x juvenile
	Polychaeta	10	x								F	
	Gastrotricha	3	x								F	
	Sipunculida	1	x								F	
	Acari	1	x								F	
	Isopoda	1	x								F	

SO199 - DR61
"Nia" Seamount, seamount cluster SE of Christmas Island; small westward facing cone on western seamount flank
Dredge on bottom UTC 30/08/08 15:52 hrs, lat 12°10.51'S, long 106°46.38'E, depth 4674m
Dredge off bottom UTC 30/08/08 17:06 hrs, lat 13°10.42'S, long 106°46.82'E, depth 3988m
total volume: empty
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	Nematoda	17	x								F	
	Copepoda	13	x								F	
	Gastropoda	1	x								F	

SO199 - DR62
"Janne" Seamount, seamount cluster SE of Christmas Island; west facing slope of seamount
Dredge on bottom UTC 30/08/08 22:39 hrs, lat 12°27.431'S, long 106°38.97'E, depth 3477m
Dredge off bottom UTC 31/08/08 00:15 hrs, lat 12°27.60'S, long 106°39.63'E, depth 2898m
total volume: few rocks, pillows, pillow fragments, lapilli tuff and sediment
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera	1	x								EtOH	Hexactinellidae
Meiofauna	Nematoda	53	x								F	
	Copepoda	12	x								F	
	Ostracoda	2	x								F	
	Polychaeta	1	x								F	
	Kinorhyncha	1								slide	F	*Echinoderes:* 1x juvenile
	Plathelminthes	1	x								F	

SO199 - DR63
"Helmholtz" Seamount, named after Hermann von Helmholtz born 31st Aug 1821. SW facing slope within small valley below plateau edge
Dredge on bottom UTC 31/08/08 04:58 hrs, lat 12°39.71'S, long 106°39.25'E, depth 3388m
Dredge off bottom UTC 31/08/08 06:23 hrs, lat 12°39.56'S, long 106°39.77'E, depth 2918m
total volume: 1 rock, small Mn encrusted pillow fragment
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	Nematoda	98	x								F	
	Copepoda	32	x								F	
	Loricifera?	1								slide	F	
	Polychaeta	1	x								F	
	Plathelminthes	3	x								F	
	Bivalvia	1	x								F	
	Cnidaria	1	x								F	
	Ostracoda	1	x								F	
	Tardigrada	1	x								F	

SO199 - DR64
"Waltrud" Seamount, NW-facing flank of seamount
Dredge on bottom UTC 31/08/08 12:53hrs, lat 12°39.26'S, long 107°12.79'E, depth 3709m
Dredge off bottom UTC 31/08/08 14:34hrs, lat 12°39.27'S, long 107°12.68'E, depth 3781m
total volume: empty
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	Nematoda	29	x								F	
	Copepoda	18	x								F	
	Tardigrada	1	x								F	
	Kinorhyncha	1								slide	F	*Echinoderes*: 1x adult

SO199 - DR65
"Waltrud" Seamount, little cone further along the NW facing flank of the seamount, westward facing slope
Dredge on bottom UTC 31/08/08 18:59hrs, lat 12°36.58'S, long107°14.33'E depth 3952m
Dredge off bottom UTC 31/08/08 20:03hrs, lat 12°36.77S, long 107°14.77'E, depth 3626m
total volume: three rocks, lava fragment, volcaniclastic rocks)
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera	1	x									encrusting sponge, tube-like
Meiofauna	unsorted											

SO199 - DR66
"Finn" Seamount, NW corner of seamount below top
Dredge on bottom UTC 01/09/08 4:19hrs, lat 12°13.78'S, long 107°49.58'E, depth 3907m
Dredge off bottom UTC 01/09/08 5:55hrs, lat 12°14.14'S, long 107°50.08'E, depth 3381m
total volume: full, pillows, lava fragments, large volcaniclastic bloc, Mn crusts)
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Polychaeta	1	x								EtOH	Amphinomidae, same as in DR1
	Polychaeta	3	x								EtOH	Maldanidae
	Polychaeta	1	x								EtOH	Eunicidae?
	Polychaeta	1	x								EtOH	Serpulidae?
Meiofauna	unsorted											

SO199 - DR67
"Michael" Seamount
Dredge on bottom UTC 3/09/08 7:40hrs, lat 15°00.51'S, long 114°03.79'E, depth 3733m
Dredge off bottom UTC 3/09/08 8:45hrs, lat 15°00.43'S, long 114°03.97'E, depth 3629m
total volume: few rocks
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Makrofauna	Porifera?	1	x								F	redish-brown sediment-tube, black tissue inside
Meiofauna	unsorted											

SO199 - DR68
"Michael" seamount
Dredge on bottom UTC 03/09/08 13:54hrs, lat 14°54.512'S, long 114°01.770'E, depth 3826m
Dredge off bottom UTC 03/09/08 15:09hrs, lat 14°54.303'S, long 114°02.292'E, depth 3367m
total volume: few rocks
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera?	1	x								F	three-lobed foram tube
	Cnidaria	1	x								EtOH	Coronata
	Bryozoa	1	x								EtOH	branching colony on chitinous stalk
Meiofauna	unsorted											

SO199 - DR69
"Michael" seamount
Dredge on bottom UTC03/09/08 19:48hrs, lat 15°04.447'S, long 114°05.074'E, depth 4020m
Dredge off bottom UTC 03/09/08 21:19hrs, lat 15°04.624'S, long 114°05.690'E, depth 3541m
total volume: 2 rocks
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted											

SO199 - MUC70
Argo Basin, abyssal plain
MUC on bottom UTC 4/09/08 11:06hrs, lat 15°30.82'S, long 115°25.10'E, depth 5698m
MUC on bottom UTC 4/09/08 11:08hrs, lat 15°30.82'S, long 115°25.10'E, depth 5698m
total volume: 6 tubes with ~30 cm sediment, tubes with silver lids empty, 2 white lids didn't close
MUC, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted											

SO199 - DR71
"Iris" seamount
Dredge on bottom UTC 05/09/08 18:11hrs, lat 12°20.512'S, long 113°44.442'E, depth 4908m
Dredge off bottom UTC 05/09/08 19:40hrs, lat 12°21.003'S, long 113°44.786'E, depth 4321m
total volume: some rocks
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Makrofauna	Cnidaria	1	x								EtOH	Coronata
	Polychaeta	1	x								EtOH	Terebellidae?
	Polychaeta	1	x								EtOH	Maldanidae
Meiofauna	Nematoda	101	x								F	
	Copepoda	62	x								F	
	Acari	1	x								F	
	Entoprocta?	12	x								F	
	Tardigrada	3	x								F	
	Polychaeta	4	x								F	
	Kinorhyncha	2								slides	F	*Echinoderes*: 2x juvenile
	Loricifera	1								slide	F	
	Ostracoda	1	x								F	

SO199 - DR72
"Iris" seamount
Dredge on bottom UTC 05/09/08 00:10hrs, lat 12° 20.71'S, long 113° 46.72'E, depth 4378m
Dredge off bottom UTC 05/09/08 01:12hrs, lat 12° 21.13'S, long 113°47.08'E, depth 3919m
total volume: 1/2 full
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Makrofauna	Polychaeta	>5		x							EtOH	Maldanidae
	Tunicata	1	x								EtOH	
Meiofauna	unsorted											

SO199 - DR73
"Annegret" Seamount, NE ward facing small nose on W ward facing slope of the seamount
Dredge on bottom UTC07/09/08 17:05hrs, lat 14°13.793'S, long 108°29.774'E, depth 4331m
Dredge off bottom UTC 07/09/08 18:23hrs, lat 14°13.504'S, long 108°30.213'E, depth 3983m
total volume: few rocks
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Makrofauna	Polychaeta	1	x								EtOH	2 pieces, family?
Meiofauna	unsorted											

SO199 - TVG74
Top of small cone
UTC 08/09/08 02:40 hrs, lat 13°21.43' S, long108°05.27' E, depth 2879m
TVG, signal loss at 1600m, cancelled

SO199 - DR75
"Kirk" Seamount, E ridge of SSW sticking canyon
Dredge on bottom UTC 08/09/08 05:10hrs, lat 13°23.30'S, long 108°00.19'E, depth 3639m
Dredge off bottom UTC 08/09/08 07:43hrs, lat 13°23.01'S, long 108°00.62'E, depth 3260m
total volume: 2 rocks, lava fragments
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted											

SO199 - DR76
"Günter" seamount, SW-facing slope of the seamount, steepest part of upper slope
Dredge on bottom UTC 08/09/08 17:49hrs, lat 13°28.023'S, long 107°02.161'E, depth 3564m
Dredge off bottom UTC 08/09/08 20:28hrs, lat 13°28.144'S, long 107°01.809'E, depth 3807m
total volume: empty
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Makrofauna	Porifera	2	x								F	branched, additional worm tubes
Meiofauna	unsorted											

SO199 - DR77
"Isabel" Seamount, SW-upper flank just beneath the top
Dredge on bottom UTC 09/09/08 05:40hrs, lat 14°05.98'S, long 106°22.47'E, depth 4257m
Dredge off bottom UTC 09/09/08 07:04hrs, lat 14°05.89'S, long 106°23.00'E, depth 3730m
total volume: 3/4 full, vesicular lava fragments and large blocks of volcaniclastic rock
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted											

SO199 - DR78
"Helga" Seamount, W facing lower slope of seamount, steepest part in this area
Dredge on bottom UTC 09/09/08 15:14hrs, lat 14°31.95'S, long 106°05.45'E, depth 5120m
Dredge off bottom UTC 09/09/08 16:47hrs, lat 14°32.10'S, long 106°05.99'E, depth 4592m
total volume: 1/3 full
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Makrofauna	Porifera	1	x								EtOH	Hexactinellidae
Meiofauna	unsorted											

SO199 - DR79
"Bente" seamount, seamount with conical shape, SW-facing slope, middle of slope
Dredge on bottom UTC 09/09/08 22:26hrs, lat 14°14.96'S, long 106°05.40'E, depth 3787m
Dredge off bottom UTC 10/09/08 00:30hrs, lat 14°15.00'S, long 106°05.44'E, depth 3828m
total volume: 1/4
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Makrofauna	Porifera?	1	x								F	three lobed foram tube, see DR68
	Polychaeta	1	x								EtOH	Serpulidae
	?	3	x								EtOH	green "trumpet-shaped" tubes
Meiofauna	unsorted											

SO199 - DR80
"Clara-Marie" Seamount
Dredge on bottom UTC 10/09/08 12:20hrs, lat 13°16.46'S, long 105°13.52'E, depth 3220m
Dredge off bottom UTC 10/09/08 13:41hrs, lat 13°16.74'S, long 105°13.95'E, depth 2686m
total volume: 3 rocks (lava fragment, epiclastic conglomerates/volcaniclastic-rich)
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Makrofauna	Porifera?	1	x								F	
Meiofauna	unsorted											

SO199 - DR81
"Clara-Marie" Seamount, N-S elongated guyot-like seamount, westward facing lower slope
Dredge on bottom UTC 10/09/08 18:18hrs, lat 13°21.59'S, long 105°10'E, depth 4400m
Dredge off bottom UTC 10/09/08 19:50hrs, lat 13°21.604'S, long 105°10.66E, depth 3970m
total volume: few rocks (columnar jointed, flow banded lava fragment/same lithology, volcaniclastics, carbonate)
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Makrofauna	Porifera?	1	x								F	
Meiofauna	unsorted											

SO199 - DR82
"Clara-Marie" Seamount
Dredge on bottom UTC 11/09/08 01:25hrs, lat 13°36.40'S, long 105°11.22'E, depth 3835m
Dredge off bottom UTC 11/09/08 03:17hrs, lat 13°36.43'S, long 105°11.37'E, depth 3755m
total volume: two small fragments of pillow margins
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted											

SO199 - TVG83
Small nose of upper SE slope
UTC 12/09/08 05:15 hrs, lat 12°58.64' S, long 103°59.80' E, depth 3184 m
TVG, signal loss at 1900m, cancelled

SO199 - DR84
"Ulrike" Seamount, large seamount (tilted block?) NW of DR83, small KUM dredge
Dredge on bottom UTC 12/09/08 11:17hrs, lat 13°02.17'S, long 103°52.49'E, depth 3542m
Dredge off bottom UTC 12/09/08 12:41hrs, lat 13°01.89'S, long 103°52.92'E, depth 3239m
total volume: few rocks, 1 lava fragment (1 lithology)
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted											

SO199 - MUC85
Abyssal plain NE of "Ronja" seamount
MUC on bottom UTC 13/09/08 03:44hrs, lat 13°57.58'S, long 102°20.00'E, depth 5032m
MUC on bottom UTC 13/09/08 03:46hrs, lat 13°57.58'S, long 102°20.00'E, depth 5032m
total volume: empty

SO199 - TVG86
"Ronja" Seamount, small nose of upper SE slope
UTC 13/09/08 07:37 hrs, lat 14°09.55' S, long 102°10.22' E, depth 2657 m
TVG, 1st try: signal loss at 1750m, cancelled; 2nd try: signal loss at 2609m (40m above seafloor!), cancelled

SO199 - DR87
"Ronja" Seamount
Dredge on bottom UTC 13/09/08 13:00 hrs, lat 14°07.19'S, long 102°10.29'E, depth 3377m
Dredge off bottom UTC 13/09/08 14:22hrs, lat 14°07.57'S, long 102°10.65'E, depth 2960m
total volume: 1/3 full
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Makrofauna	Polychaeta	1	x								EtOH	Serpulidae, in several pieces
Meiofauna	unsorted											

SO199 - DR88
"Giana"Seamount, upper western flank
Dredge on bottom UTC 14/09/08 11:24hrs, lat 11°55.04'S, long 101°38.68'E, depth 3626m
Dredge off bottom UTC 14/09/08 12:52hrs, lat 11°55.13'S, long 101°39.27'E, depth 3141m
total volume: few rocks (manganese crusts & sediments, lava fragments and 1 volcaniclastics)
gDr, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Makrofauna	Tunicata	1	x								EtOH	
Meiofauna	unsorted											

SO199 - DR89
"Giana" Seamount, some 2,5 miles further to the SW of DR88
Dredge on bottom UTC 14/09/08 16:26, lat 11°55.96'S, long 101°36.96'E, depth 4290m
Dredge off bottom UTC 14/09/08 18:07, lat 11°56.06'S, long 101°37.55'E, depth 3847m
total volume: few rocks, lava fragments, coated with volcaniclastic material
gDr, sediment, macrofauna

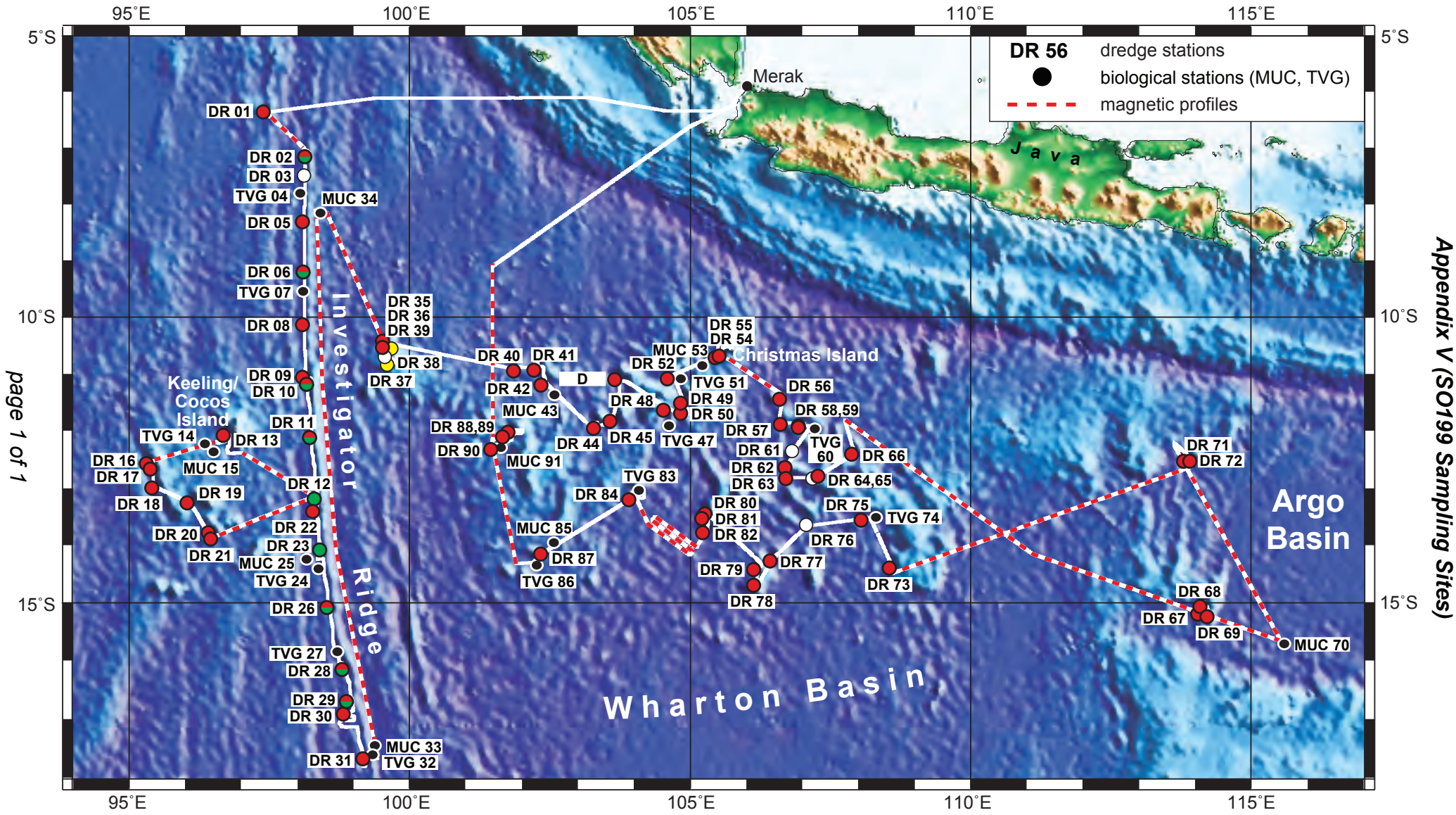
	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Makrofauna	Porifera	1	x								EtOH	
	Polychaeta	1	x								EtOH	Maldanidae
Meiofauna	unsorted											

SO199 - DR90
"Leibniz" Seamount, small cone c. 50km WSW of "Giana" Seamount
Dredge on bottom UTC 15/09/08 04:42, lat 12°09.67'S, long 101°24.42'E, depth 4722m
Dredge off bottom UTC 15/09/08 06:21, lat 12°09.28S, long 101°25.06'E, depth 4255m
total volume: few rocks, Mn-crusts and Mn encrusted pillow lava fragments
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted											

SO199 - MUC91
Abyssal plain East of "Leibniz" Seamount,
MUC on bottom UTC 15/09/08 10:36hrs, lat 12°05.92'S, long 101°30.09'E, depth 4917m
MUC off bottom UTC 15/09/08 10:38hrs, lat 12°05.92'S, long 101°30.09'E, depth 4917m
total volume: 3 tubes with ~25 cm sediment, remaining tubes only filled with water
gDr, sediment, no macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted											


95˚E
100˚E
105˚E
110˚E
115˚E
5˚S
10˚S
15˚S
DR 56 dredge stations
biological stations (MUC, TVG)
magnetic profiles
Merak
Java
Christmas Island
Keeling/ Cocos Island
Investigator Ridge
Wharton Basin
Argo Basin
DR 01
DR 02
DR 03
TVG 04
MUC 34
DR 05
DR 06
TVG 07
DR 08
DR 09
DR 10
DR 11
TVG 14
DR 13
DR 16
DR 17
MUC 15
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MUC 25
TVG 24
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MUC 91
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TVG 83
MUC 85
DR 87
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MUC 53
DR 52
TVG 51
DR 49
DR 50
TVG 47
DR 56
DR 58,59
DR 57
DR 61
TVG 60
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DR 63
DR 64,65
DR 80
DR 81
DR 82
DR 79
DR 78
DR 77
DR 76
DR 75
TVG 74
DR 73
DR 71
DR 72
DR 68
DR 67
DR 69
MUC 70
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Appendix V (SO199 Sampling Sites)
R/V SONNE cruise SO199 rock sampling yielded....
mainly volcanic rocks
mainly intrusive rocks
mainly carbonates
no hard rocks...

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No.	Title
1	RV Sonne Fahrtbericht / Cruise Report SO 176 & 179 MERAMEX I & II (Merapi Amphibious Experiment) 18.05.-01.06.04 & 16.09.-07.10.04. Ed. by Heidrun Kopp & Ernst R. Flueh, 2004, 206 pp. In English
2	RV Sonne Fahrtbericht / Cruise Report SO 181 TIPTEQ (from The Incoming Plate to mega Thrust EarthQuakes) 06.12.2004.-26.02.2005. Ed. by Ernst R. Flueh & Ingo Grevemeyer, 2005, 533 pp. In English
3	RV Poseidon Fahrtbericht / Cruise Report POS 316 Carbonate Mounds and Aphotic Corals in the NE-Atlantic 03.08.–17.08.2004. Ed. by Olaf Pfannkuche & Christine Utecht, 2005, 64 pp. In English
4	RV Sonne Fahrtbericht / Cruise Report SO 177 - (Sino-German Cooperative Project, South China Sea: Distribution, Formation and Effect of Methane & Gas Hydrate on the Environment) 02.06.-20.07.2004. Ed. by Erwin Suess, Yongyang Huang, Nengyou Wu, Xiqiu Han & Xin Su, 2005, 154 pp. In English and Chinese
5	RV Sonne Fahrtbericht / Cruise Report SO 186 – GITEWS (German Indonesian Tsunami Early Warning System 28.10.-13.1.2005 & 15.11.-28.11.2005 & 07.01.-20.01.2006. Ed. by Ernst R. Flueh, Tilo Schoene & Wilhelm Weinrebe, 2006, 169 pp. In English
6	RV Sonne Fahrtbericht / Cruise Report SO 186 -3 – SeaCause II, 26.02.-16.03.2006. Ed. by Heidrun Kopp & Ernst R. Flueh, 2006, 174 pp. In English
7	RV Meteor, Fahrtbericht / Cruise Report M67/1 CHILE-MARGIN-SURVEY 20.02.-13.03.2006. Ed. by Wilhelm Weinrebe und Silke Schenk, 2006, 112 pp. In English
8	RV Sonne Fahrtbericht / Cruise Report SO 190 - SINDBAD (Seismic and Geoacoustic Investigations Along The Sunda-Banda Arc Transition) 10.11.2006 - 24.12.2006. Ed. by Heidrun Kopp & Ernst R. Flueh, 2006, 193 pp. In English
9	RV Sonne Fahrtbericht / Cruise Report SO 191 - New Vents "Puaretanga Hou" 11.01. - 23.03.2007. Ed. by Jörg Bialas, Jens Greinert, Peter Linke, Olaf Pfannkuche, 2007, 190 pp. In English

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12	FS Maria S. Merian / Fahrtbericht / Cruise Report MSM 04-2: Seismic Wide-Angle Profiles, Fort-de-France – Fort-de-France, 03.01. - 19.01.2007, Ed.: Ernst Flüh, 45 pp. In English
13	FS Sonne / Fahrtbericht / Cruise Report SO 193: MANIHIKI Temporal, Spatial, and Tectonic Evolution of Oceanic Plateaus, Suva/Fiji – Apia/Samoa 19.05. - 30.06.2007, Eds.: Reinhard Werner and Folkmar Hauff, 201 pp. In English
14	FS Sonne / Fahrtbericht / Cruise Report SO195: TOTAL TOnga Thrust earthquake Asperity at Louisville Ridge, Suva/Fiji – Suva/Fiji 07.01. - 16.02.2008, Eds.: Ingo Grevemeyer & Ernst R. Flüh, 106 pp. In English
15	RV Poseidon Fahrtbericht / Cruise Report P362-2: West Nile Delta Mud Volcanoes**,** Piräus – Heraklion 09.02. - 25.02.2008, Ed.: Thomas Feseker, 63 pp. In English
16	RV Poseidon Fahrtbericht / Cruise Report P347: Mauritanian Upwelling and Mixing Process Study (MUMP), Las-Palmas - Las Palmas, 18.01. - 05.02.2007, Ed.: Marcus Dengler et al., 34 pp. In English
17	FS Maria S. Merian Fahrtbericht / Cruise Report MSM 04-1: Meridional Overturning Variability Experiment (MOVE 2006), Fort de France – Fort de France, 02.12. – 21.12.2006, Ed.: Thomas J. Müller, 41 pp. In English
18	FS Poseidon Fahrtbericht /Cruise Report P348: SOPRAN: Mauritanian Upwelling Study 2007**,** Las Palmas - Las Palmas**,** 08.02. - 26.02.2007, Ed.: Hermann W. Bange, 42 pp. In English
19	R/V L'ATALANTE Fahrtbericht / Cruise Report IFM-GEOMAR-4: Circulation and Oxygen Distribution in the Tropical Atlantic, Mindelo/Cape Verde - Mindelo/Cape Verde, 23.02. - 15. 03.2008, Ed.: Peter Brandt, 65 pp. In English
20	RRS JAMES COOK Fahrtbericht / Cruise Report JC23-A & B: CHILE-MARGIN-SURVEY, OFEG Barter Cruise with SFB 574, 03.03.-25.03. 2008 Valparaiso – Valparaiso, 26.03.-18.04.2008 Valparaiso - Valparaiso, Eds.: Ernst Flüh & Jörg Bialas, 242 pp. In English

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21	FS Poseidon Fahrtbericht / Cruise Report P340 – TYMAS "Tyrrhenische Massivsulfide", Messina – Messina, 06.07.-17.07.2006, Eds.: Sven Petersen and Thomas Monecke, 77 pp. In English
22	RV Atalante Fahrtbericht / Cruise Report HYDROMAR V (replacement of cruise MSM06/2), Toulon, France - Recife, Brazil, 04.12.2007 - 02.01.2008, Ed.: Sven Petersen, 103 pp. In English
23	RV Atalante Fahrtbericht / Cruise Report MARSUED IV (replacement of MSM06/3), Recife, Brazil - Dakar, Senegal, 07.01. - 31.01.2008, Ed.: Colin Devey, 126 pp. In English
24	RV Poseidon Fahrtbericht / Cruise Report POS376 ABYSS Test, Las Palmas - Las Palmas, 10.11. - 03.12.2008, Eds.: Colin Devey and Sven Petersen, 36 pp, In English

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