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In Cretaceous time, rifting of the New Zealand subcontinents from the Ross Sea Sector of Antarctica resulted in the formation of passive margins and widespread extension throughout the Ross Sea Embayment. This rifting event is thought to have produced widespread basin and range topography throughout the Ross Sea. More specifically, Cretaceous extension has been interpreted with confidence in the Eastern Basin of the Ross Sea but not in the western Ross Sea. In January of 2003, new geophysical data were collected on board RVIB Nathaniel B. Palmer cruise NBP03-01 along the Ross Ice Shelf front, Antarctica. The primary goal was to collect detailed grids of seismic data to select potential drill sites to further understand the glacial and tectonic history of the Ross Embayment. The survey sites were located in regions where large sections of the ice shelf have recently broken off, thus exposing previously covered and unexplored seafloor. Because the ice shelf is advancing at 1 km/yr, drilling from the ice shelf into the survey area will be possible in 2 to 3 years. The C-19 survey site in the western Ross Sea was uncovered by the breaking off of the C-19 iceberg in March of 2002, and includes approximately 3600 km2. It spans from the Victoria Land Basin (VLB) immediately west of the survey site to the Coulman High, over the Central Trough and west onto the Central High. The multichannel seismic reflection data have been processed, for attenuation of multiples. The resulting stacks have been loaded and interpreted in 3D interactive software. The data collected from the survey site shows well-defined N-S trending normal separation faults. Regional correlation along several different paths from coreholes near Cape Roberts in the western Victoria Land Basin, have been made to the C-19 survey site. Although this correlation crosses many faults, it suggests that a 23 Ma horizon is within a few hundred meters of the seafloor at the C-19 survey area. We interpret two unconformities below the 23 Ma horizon. The first unconformity overlies gently tilted and faulted strata, which we interpret as early Oligocene in age. The second and deeper unconformity overlies tilted and highly disrupted or discontinuous strata, which we interpret as Cretaceous syn-rift deposits. Given the fact that we have correlated a Miocene horizon to the survey site, our interpretation of Cretaceous syn-rift strata and early to mid Cenozoic extension is permissible. Similar interpretations have been made in the Eastern Basin of the Ross Sea and are widely accepted. We propose these interpretations are not unique to either the Eastern Basin or the C-19 region. We suggest that highly disrupted Cretaceous syn-rift deposits overlain by gently tilted and faulted strata are characteristic of and occur across the entire Ross Sea.

T12A-0448 1330h POSTER

TECTONIC FEATURES OF THE BARGUZIN DEPRESSION OF THE BAIKAL RIFT ZONE USING COMPUTER INTERPRETATION OF ELECTRICAL SOUNDINGS DATA

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In 1950s of the twentieth century, extensive geophysical prospecting was carried out in the region of Baikal Rift Zone with the aim to investigate the deep depression structure. The basic method of geophysical exploration was vertical electrical sounding (VES). At that time, the sufficiently complicated structure of the section gave no way of determining the main parameters of separate depositional sequences. With the development of computer techniques it has become the possibility to interpret these complicated data of electrical exploration at the new qualitative level by using programs of mathematical modelling and inversion. At the first stage, interpretation of electrical prospecting data was executed based on solution of the inverse problem within the limit of the horizontally-layered model using the SONET program complex. Moreover, by using both 2D modelling and inversion, it is possible to refine geoelectrical parameters and to conclude that entirely acceptable results can be obtained using 1D inversion. The final results reflect the detailed deep depression structure and it tectonic features. Tectonically active zone with multiple ruptures, which form complicated block structures as in the sedimentary cover so in the base, are under investigation.The sedimentary cover is as thick as 2.5 km according to results of computer interpretation. Fractured zones exhibit the areas with decreased rock resistivity. Reconstruction of a detailed tectonic structure of Barguzin depressions allow better understanding peculiarities of geodynamic processes for the Baikal rift zone in general and for depression in particular.

T12A-0449 1330h POSTER

The structure and evolution of Baffin Bay and its implication on the development of the continental margins of northwest Greenland, the Nares Strait, and Baffin Island, Canada

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Baffin Bay, located between northern Greenland and North America, is an ocean basin with a poorly understood seafloor spreading history. Magnetic anomalies identified in the North Atlantic, Norwegian-Greenland Sea and Labrador Sea have defined the independent motion of the Greenland Plate during the Cretaceous and Tertiary. However, defining the age and geometry of the crustal rocks of Baffin Bay remains key to understanding the plate tectonic history of the North Atlantic and Arctic Ocean. Satellite derived gravity data over Baffin Bay have revealed an axial low with large offsets that has been interpreted as an extinct spreading ridge and transform fault system, and this geometry has been used to improve the rotation pole for Greenland relative to North America. Based on the timing of a change in the direction of plate motions in the Labrador Sea, the latest phase of the spreading system in Baffin Bay is assumed to have been active between chron 24R (55Ma) and 13N (35Ma). Since no recent magnetic data exist in the Baffin Bay area, and older surveys suffer from the extremely large diurnal effects, observed in the auroral zone, the independent dating of the rift system remains enigmatic. However, Jackson et al. (Can. J. Earth Sci., 1979) report a magnetic survey corrected with independent diurnal observations from a moored magnetometer. A re-evaluation of this data, in context with the identified spreading system, reveals the existence of linear magnetic anomalies consistent with patterns of seafloor spreading, proving an oceanic character of the basin. The identified anomalies are tentatively interpreted as magnetic chrons 25N and 26N, and provide the first definitive ages of the plate geometry within Baffin Bay. Modern aeromagnetic data collected in the Nares Strait region in 2001 and 2003, in collaboration between the German Federal Institute of for Geosciences and Natural Resources (BGR) and the Geological Survey of Canada (GSC) have revealed new insights into the geometry of the plate boundaries between Canada and Greenland, implying that a simple linear Wegener fault along Nares Strait is likely not valid. Questions that remain unsolved, and for which a variety of hypotheses have been proposed include: Did Greenland behave as one plate during the Cenozoic or was it acting as at least two distinct plates; How much displacement took place along Nares Strait; How is the opening of Baffin Bay related to the development of the Sverdrup Basin? We present reconstructions of compiled magnetic, gravity, and bathymetric data between Canada and Greenland (Oakey et. al, 2001) to show how the evolution of Baffin Bay relates to the opening of the North Atlantic as a whole, and speculate on how the early opening history affected the evolution of the conjugate continental margins of northwest Greenland, Nares Strait, and Baffin Island, Canada.

T12A-0450 1330h POSTER

Differing Forms of Continental Rifting on the Eurasian and Amerasian Margins of the Lomonosov Ridge, Arctic Ocean

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The Lomonosov Ridge is a high-standing ridge of continental crust extending across the Arctic Ocean, separating the Amerasian and Eurasian Basins, and forming a continental margin to both basins. Geophysical data collected from U.S. Navy submarines during the SCICEX program shows that the Lomonosov Ridge has a different structural relationship to each of the flanking basins. These variations appear to reflect two very different types of rifting and resulting continental margins. The western Lomonosov Ridge is steep, blocky and less than 100 km wide for 450 km from the North American margin past the pole. This portion of the ridge is made up of sets of tilted fault blocks forming sediment-filled half grabens. South of 88°N on the Eurasian side, the ridge broadens to about 200 km width. The Eurasian side of the ridge remains steep and relatively straight to the Siberian slope. The majority of the broadening occurs on the Amerasian side which consists of a series of en echelon ridges oriented at about 30° to the overall trend of the ridge. The Lomonosov Ridge is flanked on the Eurasian side by a 40-60 mGal free-water gravity low relative to the level in the Eurasian Basin, generally with a steep gradient on the basinward side of the low. The gravity gradient parallels and is located just ridgeward of the termination of the Cenozoic seafloor magnetic anomaly sequence in the Eurasian Basin and is interpreted as the ocean-continent boundary. The parallelism between the Lomonosov Ridge, the magnetic anomaly trend and the present Gakkel Ridge axis along much of the length of the Eurasian Basin implies nearly orthogonal rifting. The blocky Greenland end of the Lomonosov Ridge is paralleled on the Amerasian side by Marvin Spur, which can be traced as a narrow, linear ridge or as a gravity high across the Makarov Basin to about 88°N on the Siberian side, where the Lomonosov Ridge broadens and becomes more complex. Marvin Spur may then merge with the basinward edge of the ridge. A gravity low is situated between Marvin Spur and the Lomonosov Ridge. Further south, toward Siberia, the en echelon ridges making up the Lomonosov Ridge trend obliquely into the Amerasian Basin and die out basinward. This structure is interpreted as defining a complex sheared margin that is compatible with the rotational model for the development of the Amerasian Basin. This model predicts a pure shear margin at the Greenland end of the Lomonosov Ridge with motion becoming more oblique to the trend of the Lomonosov Ridge toward Siberia. We suggest that Marvin Spur marks the ocean-continent boundary in the shear portion of the margin and that the oblique ridges and basins at the Siberian end or the ridge consist of extended continental crust affected by trans-tensional rifting.

T12B MCC: Level 1 Monday 1330h

Drilling at the Hawaii-2 Observatory and the Nuuanu Landslide Posters

(joint with B, S, V)

Presiding: **R A Stephen,** Woods Hole Oceanographic Institution**; J Kasahara,** Earthquake Research Institute, University of Tokyo

T12B-0451 1330h INVITED POSTER

Petrogenesis of the Crystal Vitric Tuffs recovered 300 km Northeast of Oahu, from ODP Leg 200: Pyroclastic or Landslide Deposit?

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Hawaiian volcanoes frequently experience flank failure that generate landslides, debris flows, and turbidity currents. The largest landslide known to have occurred on the Hawaiian islands is the Nuuanu landslide. The Nuuanu landslide resulted from the collapse of Koolau volcano on the island of Oahu, Hawaii approximately 2 million years ago where 40% of the Koolau volcano was removed. An ancillary objective of ODP Leg 200 was to

drill the distal facies of the deposits emplaced during the Nuuanu landslide. The actual date and the mechanics of this landslide had not been well constrained. It is not known whether the landslide occurred as a single catastrophic event or as a series of collapses. One of the justifications for drilling the Nuuanu landslide deposit was thus to better understand how this and other similar landslides occur. Because they are relatively common events on volcanic islands such an understanding is highly desirable. In addition, there are major potential hazards associated with landslides, e.g., tsunami generation and as in the case of Mt. St. Helens, explosive eruptions. The location of site 1223a is 300 km northeast of Oahu on the crest of the Hawaiian arch. The depth of the hole reaches 41 meters below the seafloor (mbsf) and 23.5 m of core was recovered (61% recovery). Three main types of lithologies were recovered: unconsolidated clays and volcaniclastic turbidites, consolidated volcaniclastic siltstones and claystones, and lithified crystal vitric tuffs. Only 12.7 mbsf was drilled before encountering an ~ 3 m thick bed of lithified crystal vitric tuff. A second 4 m thick crystal vitric tuff was recovered at 33 mbsf. The main components of both of the crystal vitric tuffs, in order of abundance, are volcanic glass, mineral fragments (the majority are olivine and plagioclase with minor amounts of pyroxene) clay and zeolites, predominantly phillopsite. The volcaniclastic siltstones and claystones contain the same components. Chlorite is found in all lithologies in minor amounts. Both of the tuffs have an average particle size of 2 mm, the upper tuff is normally graded. The major element chemistry of individual glass fragments from the upper crystal vitric tuff is heterogeneous. All of the glass fragments are tholeiitic basalts and have sulfur abdunances below 0.04 wt% indicating they were erupted subaerially or under very shallow marine conditions. The majority of the samples have MgO concentrations between 6 and 8 wt%. The major element chemistry of the crystal vitric tuffs have affinities with Koolau and have SiO_2 abduances up to 55 wt%. The two crystal vitric tuffs may be related to the giant Nuuanu landslide deposit. However, it is not known if the tuffs are the result of a pyroclastic eruption or if they are simply a product of the landslide.

T12B-0452 1330h INVITED POSTER

Frequent Landslides from Ko'olau Volcano: Results from Cores 1 & 2 at ODP Site 1223

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Landslides associated with the collapse of oceanic islands are an infrequent but potentially devastating natural hazard. The Hawaiian Islands are known to produce some of the largest landslides on Earth. The Nu'uanu slide largest of the Hawaiian slides; it removed 40% of the Ko'olau volcano from the island of O'ahu. The purpose for drilling Site 1223 was to determine the depositional history, timing, thickness and hazards associated with the Nu'uanu landslide. Site 1223 was drilled 300 km northeast of the island of O'ahu on the axis of the Hawaiian Ridge, a topographic high 500 m high, to a depth of 41 m. Soft sediments were recovered to a depth of 11 mbsf in cores 1 and 2 at this site before hard rock (tuffs) was encountered. Six prominent dark gray, sandy layers are preserved in these cores. The basal contact of each sand layer is sharp and in some cases, irregular. In contrast, the upper contact of these layers is gradational with overlying yellowish-brown clay. The sandy layers range in thickness from 11 to 232 cm and are normally graded. The thickest sand unit is internally complex with numerous thin (0.5 to 2 cm thick) light and dark bands of varying grain size overlying a basal carbonate gravel. The sand layers contain abundant volcanic material including fresh glass, olivine, and plagioclase fragments. The composition of the glass grains are all tholeiitic and typical of Hawaiian shield volcanoes. However, the compositional range at any level of fractionation (i.e., MgO) is greater than observed for any Hawaiian shield. Most of the compositions are typical of Ko'olau, including the high SiO2-type. A few glasses have unusually high MgO (up to 12 wt%) indicating primitive magma compositions and very high quenching temperatures. A few others have high SiO2 (up to 60 wt%), which are very rare in Hawai'i. The vast majority of the glasses (>90%) are degassed (>0.03 wt% S) indicating that they were erupted subaerially. The sand layers are probably turbidites, the distal remnants of landslides derived primarily from the flanks of Ko'olau volcano. Timing of these landslides and whether any of the sand layers are related to the Nu'uanu slide remains uncertain. Preliminary work on radiolarian tests yield ages ranging from Quaternary to Early Eocene. The Eocene ages may represent reworking of older sediments. It is clear from the Site 1223 results that Hawaiian volcanoes can collapse repeatedly and that the debris from these slides can travel great distances across the ocean floor and over significant bathymetric highs.

T12B-0453 1330h INVITED POSTER

Massive Pyroclastic Eruptions Accompanied the Sector Collapse of Oahu and the Nu'uanu Landslide: Petrological Evidence for a Submarine Directed Blast

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During ODP Leg 200 in December, 2002, a series of thinly bedded volcaniclastic turbidites and silty muds interbedded with two thicker and strongly indurated vitric tuffs was drilled at Site 1223 on the crest of the Hawaiian arch east of the island of Oahu. The massive Nu'uanu landslide debris field, derived from a massive collapse of the eastern half of Oahu at about 2 Ma, lies in the flexural moat between the site and the island. The shipboard interpretation (1) was that the muds and silts are typical turbidites derived by redeposition from beaches and nearshore benches, but that the tuffs represent the distal portions of large submarine pyroclastic eruptions that may have attended the landslide. We report electron probe microanalyses of basaltic glass, olivine, Cr-spinel, palagonite and secondary minerals in the tuffs supporting the shipboard interpretation. In particular, the glass compositions from individual thin sections match precisely the range of compositions obtained from numerous samples of coarse volcaniclastic breccia sampled from the steep flanks of landslide blocks in the moat (2). This includes somewhat higher SiO_2 and lower total iron as FeO(T) at given MgO than similar basaltic glasses from other Hawaiian volcanoes, a distinctive attribute of tholeiitic basalt from Oahu's Ko'olau volcano. Key attributes of the glasses in the tuffs and the minerals in them are that they are poly-compositional and they are strongly differentiated, with a range of compositions typical of those erupted from modern Hawaiian volcanic rift systems supplied by lateral diking from central conduits. The finer-grained tuffs at Site 1223 thus are indeed a distal pyroclastic facies that seemingly tapped much of the suddenly exposed, magma-inflated, deep flanking rift system of Ko'olau volcano. Over-steepening of the NE flank of the volcano coupled with internal weakening provided by near saturation of its rift system with magma may have triggered the landslide. This was almost immediately followed by massive submarine pyroclastic eruptions of magma mainly at submarine levels in the rift that, accelerated by steep downslope descent, were directed all the way to the ENE in rapidly-moving debris flows. These sorted themselves by size (mass) with the coarsest material plastering the sides of the landslide blocks, and the finer grained material, mainly glass and olivine grains, reaching the crest of the Hawaiian arch. The palagonite is compositionally-modified glass that probably formed by leaching in response to lateral migration of warm hydrothermal fluids from beneath thicker and still hot proximal pyroclastic material that was abruptly deposited in the moat to the west following the landslide. (1)Shipboard Scientific Party, 2003. Site 1223. In Stephen, R.A., Kasahara, J., Acton, G.D., et al., Proc. ODP, Init. Rept. 200 [CD-ROM], College Station, TX (Ocean Drill. Prog), 1-159. (2)Clague, D.A., Moore, J.G., and Davis, A.S., 2002. In Takahashi, E.,Lipman, P., Garcia, M.O., and Aramaki, S., (Eds.), Geophys. Monog. 128: Washington (AGU), 279-296.

T12B-0454 1330h POSTER

The Age of Large Landslides From the Koolau Volcano, Oahu, From Coring on the Northern Hawaiian Arch

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Large landslides, although infrequent on human time scales, occur off the flanks of most oceanic islands and have the potential to cause considerable devastation. To understand future hazards related to large landslides, we need to know the number, age, and size of past landslide events as well as their geologic setting. With this in mind, Ocean Drilling Program (ODP) Leg 200 cored Site 1223 on the northern Hawaiian Arch with the goal of recovering a record of the distal portion of the giant Nuuanu Landslide. This catastrophic event or series of events removed ~40% (3000 to 4000 km^3) of the Koolau Volcano on the Island of Oahu. The distal landslide deposits cored at Site 1223 (4235 m water depth) must have traveled over 100 km, traversing the Hawaiian Moat (4800-5500 m water depth) and then over 0.5 km uphill before reaching the arch. Leg 200 results showed that multiple landslide events have occurred. The landslide-related deposits recovered include at least 8 turbidites >10-cm thick in the upper 7 m of sediments, an unconsolidated black sand unit >2-m thick at 7.9-10.8 meters below seafloor (mbsf), and two lithified vitric tuff units at 12.7-15.1 and 32.0-37.0 mbsf. The timing of these events, particularly those in the upper 7 m, can be constrained well from a detailed magnetostratigraphy, with the aid of independent age constraints. In particular, 40Ar-39Ar dates indicate that both the unconsolidated black sand unit and the upper vitric tuff have estimated ages of ~3 Ma or <4 Ma including 95% uncertainties, which is consistent with these units being derived from the Koolau Volcanic series. Furthermore, this agrees with petrological and geochemical observations, which indicate that the source was subaerial and has Koolau affinities. The biostratigraphy analyses indicated that reworked Eocene radiolaria were most abundant, although some Neogene species have been identified. Given these constraints, the sequence of normal and reversed polarity intervals from the upper 7.2 m of core most likely span the middle to upper portion of the Brunhes Chron (0-0.78 Ma) to the old end of the Olduvai Chron (Chron C2n; 1.77-1.95 Ma). The units below 7.2 mbsf are interpreted to have reversed polarity and to have been deposited during Chron 2r (1.95-2.581 Ma).

T12B-0455 1330h INVITED POSTER

Ancient Fungal Life in North Pacific Eocene Oceanic Crust

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Little is known about the manifold life forms of the deep biosphere although there is increasing scientific evidence that an extensive biosphere does exist in extreme environments such as the rocks below the seafloor. The ODP Leg 200 was devoted to the study of Eocene oceanic crust of the North Pacific Ocean. Within a massive tholeiitic lava flow unit, at depth of 51 mbsf underneath a water column of about 5000 m, we found unique filamentous structures. Based on morphological traits like branching, septa and central pores the filaments are interpreted as fungi. These filaments were found within carbonate-filled vesicles ranging in size from 0.5 to 3 mm in diameter. The net of fungal hyphae completely fills the whole pore space from the basalt-carbonate boundary towards the center of the pores. The cross section dimension of these filaments is about 5-10 micrometer and the length differ from 50 to several hundreds micrometer. Thereby the cell septa of the hyphae are clearly visible. The number of hyphae ranges from some tenth to some hundreds per particular pore. The presence of pyrite within the carbonate cements points out anaerobic conditions in this habitat. After removing the carbonate by etching the vesicles with diluted formic acid, the 3-dimensional structure of the fungus could be clearly visualized. Fine structure analysis of the hyphae obtained by field emission scanning electron microscopy (FE-SEM) revealed a network of tiny small fibers coating the surface of the hyphae. Semi-quantitative chemical analyses of the etched hyphae were conducted with an energy dispersive spectrometer system (EDS) coupled with the FE-SEM. The results evidence a chemical composition of the hyphae different from the surrounding carbonate matrix. Undisturbed filamentous growth through different calcite crystals within the vesicles and small open space between the fungi and matrix indicate endolithic fungal growth after the calcium carbonate filling of the vesicles. To the best of our knowledge, this is the first finding of eukaryotic life signs within deep

ocean basaltic rocks with few signs of alteration. Moreover, these microorganisms are associated with relatively ancient, and therefore cold, volcanic rocks.

T12B-0456 1330h POSTER

Microbial Life of North Pacific Oceanic Crust

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Information on the microbiology of the deep subsurface is necessary in order to understand the factors controlling the rate and extent of the microbially catalyzed reactions that influence the geophysical properties of these environments. Drilling into 45-Ma oceanic basaltic crust in a deepwater environment during ODP Leg 200 provided a promising opportunity to explore the abundance, diversity and activity of microorganisms. The combined use of culture-independent molecular phylogenetic analyses and enrichment culture techniques is an advantageous approach in investigating subsurface microbial ecosystems. Enrichment culture methods allow the evaluation of potential activities and functions. Microbiological investigations revealed few aerobic cultivable, in part hitherto unknown, micro-organisms in deep submarine sediments and basaltic lava flows. 16S rDNA sequencing of isolates from sediment revealed the next relatives to be members of the genera Halomonas, Pseudomonas, and Lactobacillus. Within the Pseudomonadaceae the closest relative is Acinetobacter sp., which was isolated from a deep subsurface environment. The next phylogenetical relatives within the Halomonadaceae are bacteria typically isolated from Soda lakes, which are considered as model of early life conditions. Interestingly, not only sediment bacteria could be obtained in pure culture. Aerobic strains could also be successfully isolated from the massive tholeiitic basalt layer at a depth of 76.16 mbsf (46 m below the sediment/basement contact). These particular isolates are gram-positive with low G+C content of DNA, phylogenetically affiliated to the phylum Firmicutes. The closest neighbors are e.g. a marine Bacillus isolated from the Gulf of Mexico and a low G+C gram-positive bacterium, which belongs to the microbial flora in the deepest sea mud of the Mariana Trench, isolated from a depth of 10,897 m. Based on the similarity values, the isolates represent hitherto undescribed species of the deep biosphere. Molecular microbial diversity is currently determined by cloning und comparative 16S rRNA gene analyses. The first results will also be presented. In summary, the low number of isolates, cultivated under aerobic conditions, is in good agreement with the common opinion that most of the bacteria within the deep biosphere are anaerobic. Thus, studies of microbial community structure in solid geological materials are feasible and constitute further evidence that continuing microbiological activity in the challenging exploration of the deep sub-seafloor biosphere environment is absolutely promising.

T12B-0457 1330h POSTER

The Origin and Propagation of Microseisms: ODP Leg 200 at the Hawaii-2 Observatory

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The Hawaii-2 Observatory (H2O), located about half way between Hawaii and California, is an excellent site for study of the origin and propagation of microseisms, because it is far from shorelines and shallow water where most microseism energy is thought to be generated. H2O collected seismic data during Leg 200 of the Ocean Drilling program, when the Joides Resolution was drilling near the observatory between Dec 26, 2001 and January 24, 2002. During this period, the bridge crew took environmental measurements (wind speed and direction, wave height, etc.) for comparison with the microseismic data collected by the H2O seismic system, consisting of buried geophones and Guralp CMG-3 sensors, and a broad-band hydrophone. Comparison of the ship weather log with the seismic data at frequencies from about 0.2 to 0.5 Hz shows a strong correlation of seismic amplitude with wind speed and sea height, implying that the energy reaching the ocean floor (4977 m below) is generated locally by ocean gravity waves at the sea surface. The energy is believed to be generated by non-linear wave-wave interaction of opposing wave trains, transmitting a non-attenuating pressure wave to the ocean floor at twice the frequency of the source gravity waves. This is the double-frequency microseism source mechanism in the deep ocean. Near-shore seismic stations on the U.S. west coast see similar spectra generated by waves at nearby shorelines. Correlation of local environmental data above H2O with microseisms at lower frequencies, 0.1- 0.2 Hz, is poor, implying that these signals have their origin at distant locations. Correlation of the H2O seismic data with NOAA buoy data and with seismic data from mainland and island stations does not clearly define source areas of these 0.1 - 0.2 Hz signals. There is some indication that only a small number of sources is involved, since the spectra from all of the seismic stations are very similar at these low frequencies.

T12B-0458 1330h POSTER

Broadband Seismic Observations at the Hawaii-2 Observatory During ODP Leg 200

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Ocean Drilling Project Leg 200 was the first leg in deep sea and ocean drilling history to conduct operations in the vicinity of a continuously operating broadband seafloor seismometer. In 1998 investigators from the University of Hawaii, Woods Hole Oceanographic Institution, and Incorporated Institutions for Seismology had installed a broadband, shallow buried seismometer at the site [Duennebier et al., 2002] and data has been acquired in real time in Oahu over the Hawaii-2 transoceanic cable. Hole 1224D was drilled, cased and cemented at the site so that a broadband borehole seismometer can be emplaced in the future. The noise from the JOIDES Resolution as it approached and left the site as well as during all on-site operations was observed. In addition we recorded shots with 80 cubic inch water guns during single channel seismic tests as well as whale songs and earthquake activity. The behavior of ambient noise levels near the microseism peak was also compared with local wind speed and sea state conditions as observed from the drill ship. This work was supported by a grant from JOI-USSAC. We would like to thank the Earthquake Research Institute at the University of Tokyo for a Visiting Professorship for RAS during which much of this work was carried out. [Duennebier , F.K., D.W. Harris, J. Jolly, J. Babinec, D. Copson, and K. Stiffel, The Hawaii-2 observatory seismic system, IEEE Journal of Oceanic Engineering, 27, 212-217, 2002.]

URL: http://www-odp.tamu.edu/publications

T12B-0459 1330h POSTER

3.5kHz Profiling with Vertically Separated Source and Receiver

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The spatial resolution of hull mounted 3.5kHz echo sounding systems is often limited in deep water by the large footptint (Fresnel zone) of the insonifying energy on the seafloor. On ODP Leg 200 at Site 1224, we tested a system that could be used from the drillship while on station to improve resolution. In 4970 m water depth, a 3.5 kHz pinger was mounted on the video camera frame and lowered down the drill string to a few meters above the seafloor. The ship's 3.5 kHz receiver recorded the returns. Having the source and receiver at differing distances above the seafloor provides two advantages: 1) the area returning reflections is greatly reduced, 2) the amplitudes of the sub-seafloor reflections are less affected by the spreading effect. Reflections were observed to 38 ms beneath the seafloor on lowerings at three closely spaced holes. The heave of the ship and camera frame shifted the travel times of the reflection sequences. A level-discriminator and correlation MatLab routine was used to align the traces and to stack them to enhance signal. The reflections showed good correlation with the limited geotechnical data obtained from the sediment cores. Although tested from the drill ship this system could be used to provide a low cost, shallow penetration profiling system from ROV's and AUV's. This work was supported by a grant from JOI-USSAC.

URL: http://www-odp.tamu.edu/publications

T12B-0460 1330h POSTER

Absolute Paleointensity Determinations of Oceanic Basalts Using the Thellier-Coe and Microwave Techniques

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A selection of 43 oceanic basalts from cores recovered from ODP Leg 200 off Oahu, Hawaii (ca. 45 Ma old) have been analysed using the Thellier-Coe method to determine the absolute palaeointensity of the geomagnetic field. A very low success rate (less than 10 percent) was observed due to the onset of low-temperature alteration of the samples. Low-field susceptibility vs. temperature (k-T) analyses show this is due to the presence of a low Curie temperature magnetic mineral phase (about 150-200^{o}C). A higher temperature phase (about 580^{o}) was also observed. Magnetisation (SIRM) experiments have also been carried out to further characterize the magnetic mineralogy. The magnetic experiments indicate that the carriers of magnetisation are small grains of titanomagnetites with average volume content of 1 percent. These titanomagnetites are oxidised gradually under sub-oceanic conditions and thereby form cation deficient spinels (titanomaghaemites). This oxidation proceeds at low temperatures, most likely at bottom water temperatures. The microwave technique was then applied to six 5mm diameter samples, with five samples yielding palaeointensity results. Where comparison between Thellier-Coe and microwave results was possible, the obtained palaeointensity values were similar. A range of palaeointensity values from 23-58 micro Tesla were obtained, with a mean value of 36.8 micro Tesla, which corresponds to a mean VADM of 7.48 x 10^{22} Am^{2} for a latitude of 27^{o} North. This study demonstrates the potential of using ODP oceanic basalts as a source of palaeointensity data for a period extending back 160 My. The reduced thermochemical alteration of the samples and use of small sample sizes makes the microwave technique a powerful tool in this area of study.

T12B-0461 1330h POSTER

Constraining the Extent and Duration of Low Temperature Alteration in Pacific Ocean Crust

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The generation, alteration, and subduction of oceanic lithosphere is one of the primary chemical cycles that occur on Earth. The circulation of seawater through ocean crust facilitates the exchange of elements and chemical compounds between the hydrosphere and lithosphere, ultimately having a profound effect on both the chemical composition of seawater and ocean crust. Our understanding of the chemical cycles that result from ocean crustal alteration and subsequent subduction is largely based on core recovered by the Deep Sea Drilling Project (DSDP) and Ocean Drilling Program (ODP). Basement holes drilled in the Pacific Ocean basin however, poorly represent the span of crustal ages that exist in fast-spreading Pacific Ocean crust. Thus, several pressing questions concerning the evolution of seawater-rock interactions and the extent of chemical exchange remain unanswered. The 46 Ma igneous basement that was drilled during ODP Leg 200 at Hole 1224F fills a key age gap in the drill core collection that falls between Holes 597C ($\sim$29 Ma) and 843B ($\sim$110 Ma) enabling a better understanding of how ocean crustal alteration proceeds. The secondary mineral assemblages identified in Hole 1224 cores are typical of low temperature alteration, consisting of Fe-oxyhydroxides, saponite, celadonite, carbonate, minor pyrite and quartz, and rare phillipsite. When compared to adjacent fresh rock, haloed rock samples have increases in Si, Fe and Cr and minor increases in Ca, CO_2, K, Mg, Mn, P, Na and Al. A significant finding thus far is that the extent of primary mineral replacement and quantity of secondary minerals filling voids is surprisingly low; much less than that found in younger crust (e.g. 6.9 Ma, Sites 504, 896). This suggests that crustal age may not be a controlling factor in the extent of crustal alteration. Hole 1224F also provides a critical constraint for understanding the controls on carbonate uptake in the Pacific upper ocean crust through time. Preliminary calculations show that the carbon content of Hole 1224F cores is less than that contained in younger crust, suggesting that age is not a dominant factor in regulating carbon uptake by the ocean crust.

T12B-0462 1330h POSTER

The Hawaii-2 Observatory: New Capabilities and Instrumentation

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The Hawaii-2 Observatory (H2O) is a permanent deep ocean research facility located about halfway between California and Hawaii. The H2O infrastructure consists of a submarine cable termination and junction box which provides two-way digital data communications and power for seafloor instruments. Prior to 2003, H2O instrumentation consisted of a buried broadband seismic sensor. In September 2003, a major upgrade to the H2O junction box was completed which changed the communications architecture to TCP/IP, making reconstruction of data streams on shore a system rather than a user task. A new biological experiment, two seafloor geomagnetic observatories (SGO; one US and one French), a high frequency hydrophone, and a Small Experiment Module (SEM) were also installed at the H2O site. The goal of the biological experiment is determination of the short and long-term responses of benthic fauna to a temporally-variable food supply in a very food-limited environment. An instrument platform was installed which includes cameras to photograph the activities of animals near the seafloor and a sedimentation sensor to monitor the seafloor flux of particulates and phytoplankton pigments. The SGOs each incorporate vector and scalar sensors for the relative geomagnetic field and its absolute magnitude, along with a gyrocompass-based method to measure the instantaneous absolute direction of the field. In addition, the SGOs measure the vector electric field, including removal of electrode drift. The hydrophone is suitable for high frequency seismic studies and whale monitoring. The SEM was installed to supply a secondary interface to experiments. It provides data interfaces and power for the H2O seismic system and up to eight additional low-data rate and low-power sensors

T12C MCC: Level 1 Monday 1330h

Earthquake Geology and Hazards of East Asia III Posters *(joint with S)*

Presiding: **Y Chen,** National Taiwan University**; K Mueller,** University of Colorado**; Y Sugiyama,** National Institute of Advanced Industrial Science and Technology

T12C-0463 1330h POSTER

Slip-rate Estimation of Active Fault by Luminescence Dating on Deformed River Terraces at Tsaotun, Central Taiwan

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This study carried out luminescence ages of the deformed terraces located at Tsaotun in central Taiwan. These terraces are considered as a result of crustal deformation caused by recent activity of the Chelungpu fault, 1999 surface rupture. Since this active fault runs through urban area, it is urgently needed to figure out its neotectonic behavior, including slip-rate and recurrence interval. Based on new ages, we also discuss the terrace correlation and its related structures. The study terraces are all strath terraces with only a few meters of veneered fluvial deposits on top. Due to the strong stream-power, nearly all the outcrops are dominated by fluvial cobbles, which is worst condition to preserve the syndepositional carbonaceous materials. Alternatively, optical stimulated luminescence (OSL) dating uses sandy quartz as the material and even has longer dating upper limit (up to several hundreds of years). Fortunately, sandy layer are found intercalated within the fluvial cobbles in studying terraces. We adopted the Single-Aliquot Regenerative (SAR) dose protocol on large aliquots of 90-150μm quartz, which were cleaned using HCL, H_2O_2 and HF in the usual way. In case of incomplete bleaching during quick deposition, the OSL/TL ratio was adopted to approach the true De. Dosimetry is derived by ICP-MS and XRF analyses. For ascertainment of the initial bleaching of fluvial sediment, the modern samples collected in river bed of Wuhsi were also measured. Based on the results of modern samples, we believe that the residuals are inevitable in younger sediments, especially along the upper stream. On the contrary, the samples older than 10 kyr are little influenced due to the larger age error than the younger ones. The OSL age of the terrace samples in the hanging wall is dated ca. 13 kyr, which has been corrected for poorly-bleaching problem. Comparing to the ages collected down hole in the footwalls, we found out vertical displacements of ca. 67 and 37 m, has been cumulated by the slips of main and back thrust. Thus, the long-term slip rates of the main and back thrust are 3.8-6.5 m/kyr and 2.0-3.8 m/kyr, respectively. If we consider that the 1999 Chi-Chi earthquake is a characteristic event, a recurrence interval of 300-600 years is derived.

T12C-0464 1330h POSTER

Using optical dating to assess the recent activity of active faults in Hsinchu Area, northwestern Taiwan

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The aim of this study is to evaluate the recent activity of active fault systems mapped in Hsinchu area, northwestern Taiwan. Since it is the largest site of industrial park and highly populated, it is essential to assess potential of earthquake hazards. As a result of previous work, two active fault systems (Hsinchu and Hsincheng) were identified as active. However, they have not been included in dangerous active faults on published map because Holocene offset has not been confirmed yet. Relationship between five river terraces and faults were discussed by mapping on geomorphic features; both of these thrust faults contain active anticlines in their hanging walls based on folded terraces that are composed of young alluvial deposits. Neither long-term nor short-term slip rate has been reported due to lack of age control on development timing of the terraces mentioned above. We collected samples from these terraces and open-pit trench on the highest terrace, where intercalated sandy layers are found within cobbles. As literatures optically stimulated luminescence (OSL) dating method can directly measure the burial ages of sedimentary deposits that underwent a short period of sunlight bleaching. Therefore, OSL dating is applied via single aliquot regeneration method on sand size quartz extract from our study terraces. OSL ages about 46ka and 68-75ka are obtained from 4 fluvial deposits at trenching site. We tentatively suggest that the terrace was abandoned by the main channel after 68ka and then upper strata were subsequently deposited by local small creeks. The vertical displacements cross these Hsinchu and Hsincheng active faults are ca. 90m and 70m, respectively since 68ka. Consequently, the derived long-term rates of vertical slip are 1.3 and 1.0 m/ka respectively for both of them. The details of the other age results and discussion on recent structural behavior will be presented.

T12C-0465 1330h POSTER

Natural Occurrences of Surface Melting in the Slickensides of the Fault Zone in Miaoli Area, Western Taiwan

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Slickensides are non-penetrative smoothed or polished surface normally developed on movement planes of fault zone, or between rock layers folded by flexural slip. Experimental evidence suggests that naturally silckenside formation may be widely originated by surface melting in the relatively dry faulting (Spray, JSG, 1989). However, due to the modification by fluid alteration or via various co-seismic and interseismic events, evidence of melting has not yet been unequivocally found in natural slickensides. This research reports an unambiguous pseudotachylyte occurred in the slickensides formed by surface melting in the fault zone of Miaoli area, west Taiwan. Taiwan is located in the young orogenic belt, which the fault-related earthquakes were very common and severe in last few million years. The faults, especially for the thrust faults, thus, are widely distributed in the Island. The pseudotachylyte occurred in the slickenside surface of the fault zone have been found in the drilled core, about 500 meters in depth below the surface in the western foothill sedimentary sequences of Miaoli area, west Taiwan. Two types of surface feature, well-polished shiny surface as mirror and scrape furrow or striated coatings can be found in the surface of slickensides. The former mostly occurred in the fine sandstones to siltstones, while the later mainly found in the coarse sandstones. It clearly suggests that the surface features may be originated by the asperity during the comminution in the slickenside formation. Petrographically, the slickensides are dominantly composed of fault gouge and cataclasites with or without preferred orientated micas. The pseudotachylytes are thin, submillimeter to millimeter in thickness and dominantly occur on the surface of slickenside of fault zone. Optical and scanning and transmission electron microscopies reveal that the pseudotachylytes are very fresh and dominantly consist of black or dark brown, fine-grained to glassy aphanitic matrix with microlites, rounded or embayed clasts and numerous rock and mineral fragments. The presences of well fresh pseudotachylyte and surface melting in the slickensides strongly indicate that the fault zone in the Miaoli area, west Taiwan is very dry condition during or after rapid seismic faulting.

URL: http://www.gl.ntu.edu.tw/