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Black Peak is a 1,032m stratovolcano on the Alaska Peninsula located at 56.53 N, 158.80 W. It is one of approximately 80 historically active volcanic centers along the 2,500km long Aleutian Arc that stretches from southern Alaska to Russia's Kamchatka Peninsula. Ash-flow tuffs from the >10km^3 caldera forming eruption ∼4,600 years ago filled the valleys to the west and north. The ice-free caldera floor of Black Peak volcano is occupied by a complex of approximately one dozen overlapping dacitic lava domes. During emplacement, additional domes breeched the eastern caldera wall depositing avalanches partway down the drainages in this area. We sampled each of the domes outcropping in and around the flanks of the caldera. Initial examination of these samples reveals a possible range in bulk composition within the dome field, with differences in amphibole content and matrix glass alteration. Several of the domes contain dark, mafic enclaves with chilled margins, whereas others are enclave free. The purpose of this study is to investigate how these apparent differences in dome mineralogy and bulk composition are detected in the satellite imagery (ASTER, Landsat ETM+, Ikonos) collected for Black Peak volcano, and apply the results to the ground based field observations in order to map changes in the physical and chemical properties of the domes. To compare with the satellite data results, the bulk rock compositions of collected samples will be analyzed using both laboratory thermal emission spectroscopy and XRF. Electron microprobe and standard light microscopic petrographic techniques will also be used to determine specific details about the changes in mineralogy and chemistry within and between each dome. The results of these analyses will be used to construct a satellite based map of the physical and chemical properties of the dome field, augmented by careful ground validation and laboratory analyses. This combined with other studies of Black Peak will lead to a more complete understanding of the volcanic processes that followed the caldera formation. Further, given the significant amount of unstudied and unmapped volcanic regions in Alaska, the use of high resolution satellite data for preliminary investigation of remote volcanoes may be a cost effective and efficient way to assess eruption deposits along the Aleutian Arc, which might otherwise be unstudied for a number of years.

V31G-08 1205h

External Triggering of the Superexplosive Volcanism

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Explosive eruptions of silicic magma are generally thought to be internally triggered by pressure build-up during second boiling that results in the production of a separate gas phase. Resulting overpressures of 20 to 25 MPa are thought to be sufficient to fracture the magma chamber roof and trigger eruption. However, this may not be the trigger for the most catastrophic "superexplosive" eruptions that result in thousands of cubic kilometers of silicic magma being erupted as massive low aspect ratio ignimbrites of the "monotonous intermediate" genre. Exemplified by the Fish Canyon Tuff (San Juan Mountains, Co, USA), the Cerro Galan Ignimbrite (Argentina), or the Atana ignimbrite (Chile), these are typically regionally- extensive, simple cooling units that are crystal-rich (45 vol%), fine-grained, lithic and pumice-poor units, and rarely show evidence for multiple flow units. These features coupled with the lack of basal or intercalated fall deposits suggest that the eruptions developed very quickly to catastrophic proportions without a low discharge rate convective column phase. Typical eruptive conditions that would account for such eruptions are high mass eruption rate, large vents, low gas content and eruption velocity. A further complication is that pre-eruptive viscosities of the magmas (10^6 to 10^8 Pa s) are close to the eruptibility barrier for such magmas. A catastrophic mechanism is thus required to trigger these eruptions. Clues to the mechanism include: 1) Intra- vs extracaldera tuff volume - intra-caldera tuff is the dominant volume of erupted material. 2) Paucity of lithics and pumice in the ignimbrites 3) Nature of the eruption sites - complex often trap-door like collapses, faults, fissures These observations suggests that "caldera collapse" occurred very early on in the eruptions, that vent erosion and reaming was not significant and is unlikely to be the cause of the inferred high mass eruption rates, that dense pyroclastic flows resulted in efficient crushing of pumice, and that the roof of the magma chamber may have foundered into the magma chamber along outward dipping faults. The eruption trigger is external and is suggested to be mechanical failure of the thermally weakened low aspect ratio roof. The roof fails as its tensile strength is exceeded and founders into the magma due to a density inversion produced by concentration of the gas phase into the uppermost part of the magma chamber. Large vents open quickly and catastrophic mass eruption rates are achieved immediately. Fissures and ring faults may progressively unzip allowing dense eruptive curtains or fountains to collapse quickly to generate dense pyroclastic flows with high energy. This type of mechanism may help explain the paucity of classic Valles-type caldera structures and the growing evidence for eruption of large ignimbrites along faults or fissures.

V32A MCC: Level 2 Wednesday 1330h

The Origins of Hot Spots, LIPs, Seamount Chains, and Volcanic Ridges VI Posters *(joint with OS, T)*

Presiding: **D C Presnall,** Carnegie Institution of Washington**; J H Natland,** Rosenstiel School of Marine and Atmospheric Science, University of Miami

V32A-0988 1330h POSTER

Rejuvenation of the Lithosphere by the Hawaiian Plume

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Thickness of oceanic lithosphere increases with distance from the ocean ridge due to cooling. If the lithosphere overrides a mantle plume, it will be modified. There exist several models describing the interaction of a plume with the lithosphere. However, existing seismic imaging techniques did not have sufficient resolution to decide for one of the models. We applied the S receiver function technique to data of three permanent seismic broadband stations on the Hawaiian islands to map the thickness of the lithosphere in so far unequaled detail. Under Big Island the lithosphere is 100-110 km thick, as expected for a 90-100 Myr old oceanic plate not modified by a plume. From there it is thinning gradually along the island chain to about 50-60 km below Kauai. The lithosphere retains its normal thickness in the region about 150 km to the north and to the south of the island chain, still well within the region of the topographic swell. Our data favour the rejuvenation model, in which the plume returns the lithosphere into conditions close to its origin at the mid ocean ridge. The maximum observed rejuvenation of the lithosphere at Kauai is delayed by about 3-4 Myr (the approximate age difference between Big Island and Kauai) and its thickness is nearly cut in half within that time.

V32A-0989 1330h POSTER

A critical examination of the Emperor and Hawaiian volcanic chains

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The Emperor and Hawaiian volcanic chains are usually assumed to represent a single entity, and to be an exemplary fit to the plume model. However, many features do not conform to this hypothesis. These include: 1) the great "bend" does not result from a change in direction of motion of the Pacific plate, since no such change occurred, 2) southerly motion of 800 km of the melt locus occurred during formation of the Emperor chain, and stopped at the time of the great bend, 3) the chain apparently commenced near a ridge, 4) there is no Hawaiian "plume head", 5) the melt volume flux varies greatly along the chains and has increased by an order of magnitude during the last 5 Myr, 6) there is no significant heatflow anomaly around the bathymetric swell, 7) there is no measurable thermal rejuvenation near Hawaii, 8) low temperatures relative to those required for a plume are estimated from geothermometry, 9) there is no petrological or geochemical evidence that requires a deep melt source, and 10) seismic evidence indicates relatively normal wave speeds throughout the mantle beneath Hawaii. A large number of seamounts unaffiliated with volcanic chains have similar geochemistry to Hawaii. A fully quantified hypothesis for Hawaii that can explain these features is long overdue.

URL: http://www.mantleplumes.org/Hawaii.html

V32A-0990 1330h POSTER

The Hawaii-Emperor Bend: Clearly a Record of Pacific Plate Motion Change

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As most introductory textbooks will point out, the conventional explanation for the ∼120° change in the trends of the Hawaiian and Emperor chains is a ∼60° change in plate motion over a fixed plume in the mantle. Recently, however, new paleomagnetic and radiometric age data from the Emperor Seamounts have led some scientists to reject the conventional view of the origin of the Hawaii-Emperor bend in favor of a mobile plume. Yet, at the brink of being explained away as the mere consequence of a drifting plume, the fixed hotspot hypothesis now gains support from newly reported radiometric dates of rock samples from seamounts at the bend which reveal an age much older than expected. Unlike the previous younger age (∼43 Ma), the older age (∼47 Ma) allows the bend to be directly correlated with a period of pronounced, global tectonic reorganizations around Chron 21. Here we present a new Pacific absolute plate motion model, derived from 15 hotspot chains, which does not require hotspot drift in order to satisfy geometric and chronological constraints. By considering this absolute plate motion model with available Pacific paleomagnetic poles we find support for the notion that the spin axis was closer to the Hawaiian hotspot during the formation of the Emperor chain, and this interpretation (polar wander, not hotspot drift) also explains the paleomagnetic latitudes from the Emperor seamounts as well as the lack of coral reefs materials in the drill holes north of Koko Guyot. However, this interpretation is not unique, and drift cannot be summarily ruled out. Yet, if Pacific plumes are drifting then they appear to be moving in unison. Careful examination of the Pacific seafloor reveals additional Pacific trails with bends that appear to be contemporaneous with the Hawaii-Emperor Bend, although conclusive radiometric age data are lacking. Our plate motion model predicts hotspot tracks that fit these bends. Considering all these lines of evidence the fixed hotspot hypothesis is granted a new lease on life.

V32A-0991 1330h POSTER

Pb Isotopic Evolution of Koolau Volcano (Oahu, Hawaii)

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High precision Pb isotopes in Hawaiian shield lavas have revealed the existence of source heterogeneities

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between volcanoes, as well as within a single volcano during its temporal evolution, e.g. Mauna Kea [1, 2]. The Koolau Scientific Drilling Project (KSDP) was initiated in order to evaluate the long-term evolution of Koolau volcano (Oahu), whose subaerial Makapuu stage lavas define the isotopically enriched endmember of Hawaiian shield lavas. We report Pb triple spike data on KSDP main shield-stage lavas (depth range: 304-632 mbsl) and post-erosional Honolulu volcanics. KSDP lavas show a small range of Pb isotopic compositions ($^{206}Pb/^{204}Pb$=18.02-18.15; $^{207}Pb/^{204}Pb$=15.44-15.46; $^{208}Pb/^{204}Pb$=37.82-37.87). Pb isotope ratios increase with depth until $\sim$450 m and then decrease again to a depth of 616 m. Superimposed on this "bell" trend, $^{206}Pb/^{204}Pb$ ratios oscillate at depth intervals of $\sim$10m. The Honolulu volcanics display, at a given $^{206}Pb/^{204}Pb$ ratio, similar $^{207}Pb/^{204}Pb$ but lower $^{208}Pb/^{204}Pb$ ratios than KSDP lavas. In $^{208}Pb/^{204}Pb$-$^{206}Pb/^{204}Pb$ space, KSDP and Honolulu lavas define two distinct linear arrays which converge at the radiogenic end. However, in $^{207}Pb/^{204}Pb$-$^{206}Pb/^{204}Pb$ space, KSDP and Honolulu lavas form a single array, with Honolulu lying at the radiogenic end of the array. While KSDP lavas have more radiogenic Pb isotopic compositions than Makapuu stage lavas [1], they show close resemblance to Nuuanu 1 and Nuuanu 2 landslide blocks [3]. The distinct Pb isotopic features of subaerial, main-shield and post-erosional lavas reflect compositional source changes during the growth of Koolau volcano. The mixing lines defined by KSDP and Honolulu lavas in ^{208}Pb-^{206}Pb space require the presence of three distinct Pb isotopic components. While the enriched "Koolau" component is predominantly sampled during the subaerial stage, its contribution during the main shield building stage has been waxing and waning. The radiogenic Pb endmember common to Honolulu and KSDP lavas samples a plume component which apparently persisted during the post-erosional stage. The unradiogenic Pb component present in Honolulu lavas has Pb isotope characteristics that are clearly distinct from those of East Pacific Rise MORB [4], suggesting that it may not be derived from the underlying Hawaiian lithosphere. Available isotopic data on the oceanic crust basement near Hawaii [5] are unreliable, making a direct comparison difficult. While the Hawaiian lithosphere hypothesis cannot be entirely ruled out, we suggest that the unradiogenic Honolulu Pb component reflects material thermally entrained by the upwelling plume during its ascent and is essentially sampled during the post-erosional stage of Hawaiian volcanism. 1.Abouchami, W. et al., Eos Trans. AGU, 81 (48), Fall Meet. Suppl., Abstract V21D-03, 2000b 2.Eisele, J. et al., Geochem. Geophys. Geosyst., 4(2), 8710, doi:10.1029/2002GC000339, 2003 3.Tanaka, R. and Nakamura, E., Geophys. Monograph Ser., vol. 128, 311-332, 2002 4.Galer, S.J.G. et al., Eos Trans. AGU, 80 (46), Fall Meet. Suppl., Abstract V11E-08, 1999 5.King et al., Proc. ODP, Sci. Results., 136, 1993, 107-118

V32A-0992 1330h POSTER

Two Forms of Hawaiian Volcanism Generated by Mantle Decompression Beneath Flexural Uplift of the Lithosphere

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Two forms of Hawaiian volcanism are poorly understood: post-erosional eruptions and the Hawaiian Arch flows. Various hypotheses have been forwarded to explain these magmatic events; one such mechanism that is relatively undeveloped associates volcanism with the topographic uplift caused by lithospheric flexure. We propose a model in which melt is generated as a direct consequence of the flexural uplift, which surrounds new volcanic shields as they grow. This uplift causes upward flow and decompression of the underlying asthenosphere. We assume that a thick ($\sim$50 km) layer of asthenosphere is near its solidus, a condition resulting from mantle plume material that first melted partially beneath the shield, but has since flowed laterally away from the shield. One prediction of our model is similar geochemical characteristics between the two types of volcanism, and this is consistent with results of recent geochemical studies. Another prediction is volcanism occurs where the lithosphere is actively rising, during the loading of a volcanic shield. Using age estimates of the post-erosional and arch volcanics, we find that they occurred $\sim$200-400 km away from the volcanic shield(s) active at the same time. This range of distance is consistent with the zone of flexural uplift predicted by loading a lithosphere with an effective elastic plate thickness of 30 km. To evaluate the volume and composition of melts generated, we calculate the flow of asthenosphere driven by the rate of lithospheric flexure. We simplify volcano loading as a growing point load and calculate the axisymmetric flexure of the lithosphere, which is the surface boundary condition on an isoviscous (asthenospheric) half-space. Two analytical methods are used to compute asthenospheric flow. The first method uses Fourier transforms, and the second used Hankel transforms. The two methods show good agreement, and both predict uplift beneath the arch, which decays with depth, but is present throughout the zone of near-solidus asthenosphere. From these calculations we evaluate the melting conditions required to generate the observed eruption volumes and many key aspects of the magma geochemistry.

V32A-0993 1330h POSTER

Platinum Group Element (PGE) Abundances in Lava Flows Generated by the Hawaiian Plume: Insights into Plume Evolution

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Picritic and high-MgO (7.7-24 wt.%) basalt samples from Detroit (/sim81-76 Ma) and Koko (/sim48 Ma) Seamounts along the ESC have been analyzed for PGEs (Ru, Rh, Pd, Ir, and Pt) allowing an examination of how the PGEs in lavas from the Hawaiian plume have changed over time. Major and trace element (including the PGEs) concentrations were quantified by ICP methods at the University of Notre Dame. See Ely et al. (1999, Chem. Geol. 157:219) for the PGE analytical method. Bennett et al. (2000) analyzed Hawaiian picrites and found PGE abundances slightly greater than average MORB and comparable to the low-PGE basaltic komatiites. These authors modeled the PGE abundances of these picrites by using variable amounts of residual sulfide during melting, such that Koolau (low PGE contents) formed from a relatively sulfide-rich source and Loihi (high PGEs) from a sulfide-poor source. Our PGE data from Detroit Seamount show slightly higher PGE abundances than Loihi and Kilauea, suggesting these picrites formed from a source lacking residual sulfide. These results suggest that, if the model of Bennett et al. (2000) is correct, the dilution of plume lava with MORB source, as hypothesized on the basis of depleted isotope ratios and lower trace element abundances than modern Hawaii (Keller et al., 2000, Nature 405:603; Kinman & Neal, 2002, Eos 83:F1282; Regelous et al., 2003, JPet 44:113), was not the controlling factor in PGE abundances. However, since MORB PGE concentrations are not substantially different than low-PGE Hawaiian picrites, incorporation of MORB material within the Hawaiian plume at Detroit Seamount would not have drastically reduced the PGE abundances. Koko Seamount has relatively high PGE concentrations (/sim3-12 times greater than those from Detroit lavas). This may be the result of a lack of residual sulfide facilitated by higher degrees of partial melting. Although our initial data are consistent with variable degrees of partial melting and/or source heterogeneity over the life of the Hawaiian plume, the data from Detroit Seamount can be modeled by, for example, magma mixing between Koko-type "PGE-rich" plume and MORB end members (cf. Kinman & Neal, 2002). The Pt/Ir ratios and PGE abundances of picrites from Detroit and Koko Seamounts and from Hawaii (as analyzed by Bennett et al., 2000) increase in the order: Hawaii (4.8), Detroit (5.8), Koko (8.1). Bennett et al. argued that if more sulfide was retained in the source the PGE profile would be more fractionated and abundances would be lower. Our data suggest the opposite is true. For Koko Seamount to have PGE abundances approximately 3-12 times greater than the high-PGE picrites from Hawaii and yet have a more fractionated profile, the source of the Hawaiian plume must have been relatively PGE-enriched at 48 Ma than it is currently. In addition, the more fractionated profile of Detroit Seamount is consistent with the incorporation of MORB material (Pt/Ir /sim 25.9), thereby raising its Pt/Ir ratio.

V32A-0994 1330h POSTER

East Molokai Volcano, Hawaii: Petrogenesis of Shield-, Postshield- and Rejuvenated Stage Lavas

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The results of the Hawaii Scientific Drilling Project have led to renewed interest in the existence of Kea and Loa trends defined by recent Hawaiian volcanoes, that is correlations between geochemical characteristics and volcano location along the recent hotspot track (Lassiter et al., 1996). Mauna Kea and Haleakala are well studied, relatively young but inactive Hawaiian volcanoes belonging to the Kea trend. East Molokai is an older Kea-trend volcano (shield and postshield volcanism from $\sim$1.5 to 1.75 Ma). We have analyzed major and trace element abundances and isotopic ratios of Sr, Nd and Pb in lavas from the 305 m Kalaupapa section that exposes lavas erupted at the end of shield building and during the transition to the alkalic post-shield stage at East Molokai volcano (Beeson, 1976). In addition, our study includes older shield-stage lavas from below the Kalaupapa section and samples from the overlying rejuvenated-stage basalt, including submarine rejuvenated-stage lavas recovered by submersible (Clague et al., 2002). The major and trace element abundances and trends of East Molokai lavas are similar to lavas from Haleakala. At both volcanoes there is a long-term trend for $^{87}Sr/^{86}Sr$ to decrease and $^{143}Nd/^{144}Nd$ to increase with decreasing eruption age. However, over short time intervals these trends show scatter and, especially at East Molokai, there is considerable range in $^{87}Sr/^{86}Sr$ at a given $^{143}Nd/^{144}Nd$, even after acid leaching. The late shield and early post-shield lavas of East Molokai also define a positive $^{87}Sr/^{86}Sr$ vs $^{206}Pb/^{204}Pb$ trend, a distinctive feature of postshield Hawaiian lavas. The rejuvenated-stage East Molokai lavas are not as silica-undersaturated as the well known rejuvenated lavas forming the Honolulu Volcanics and Koloa Volcanics, and they range to higher $^{143}Nd/^{144}Nd$. We evaluate the relative importance of source heterogeneity, which is clearly indicated by temporal changes in isotopic ratios and correlated abundance ratios and processes, such as the extent and depth of melting which control the change from tholeiitic to alkalic volcanism.

V32A-0995 1330h POSTER

Koolau Scientific Drilling Project: A transition from typical Koolau to Mauna Loa-like compositions at $\sim$325 mbsl

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The well established geochemical differences between adjacent Hawaiian shields provide important constraints on the sources and processes involved in Hawaiian hotspot volcanism. Recent studies of lavas forming the Kilauea, Mauna Loa and Mauna Kea shields show that there are important geochemical variations during the growth of individual Hawaiian shields. Koolau volcano is significant because the surficially exposed shield lavas define endmember geochemical characteristics for major and trace elements, radiogenic and oxygen isotopic ratios in Hawaiian shield lavas. There is strong evidence that these extreme geochemical characteristics reflect a source component derived from recycled oceanic crust including abyssal sediment. Is this endmember composition characteristic of the entire Koolau shield? Studies of lavas and glasses exposed in the Nuuanu landslide block suggest that older Koolau lavas were unlike the subaerially exposed Koolau lavas; however, stratigraphy of blocks within the landslide is complex. With the objective of directly defining temporal geochemical variations during growth of the Koolau shield, the Koolau Scientific Drilling Project (KSDP) penetrated the shield to a depth of 679m. Only chips are available from the upper part of the hole that was rotary drilled, but coring of the lower 328m recovered 103 lava flows. Based on petrography and major element compositions, Haskins and Garcia (submitted) argue that the distinctive Koolau lavas defining endmember geochemical characteristics "form only a veneer with maximum thickness of $\sim$400m in the volcano's summit region." We have determined trace element abundances in cored KSDP lavas from 304m to 625m and find that a gradual transition from Koolau-like to Mauna Loa-like lavas occurs at 325m in the core. For example, Frey et al. (1994) showed that among Hawaiian shield lavas, subaerially exposed Koolau lavas have the highest La/Nb and Sr/Nb. In the KSDP core with decreasing age these ratios show a long-term increase with significant scatter. Most of these KSDP lavas have La/Nb and Sr/Nb within the field of Mauna Loa lavas and ratios typical of uppermost Koolau lavas occur only in the depth interval of $\sim$304 to 336m; although a few samples deeper in the core, $\sim$525m, also have some geochemical characteristics similar to the uppermost Koolau shield lavas. We concur with Haskins and Garcia that the endmember

Koolau composition forms a thin, several hundred meter, veneer of the Koolau shield. Consequently, the source component with a recycled slab geochemical signature was not a long-lived characteristic of hotspot volcanism.

V32A-0996 1330h POSTER

The Loa-Kea trend revisited

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The existence of two parallel chains of volcanoes in the Hawaiian Islands was first described by Dana [1]. The consistency between the locus of the shields and the age progression along the chain was used to define the so-called "Loa" and "Kea" trends. The two chains do indeed show some systematic geochemical and isotopic differences. New high precision Pb isotope data on several Hawaiian volcanoes along the two chains and detailed Pb isotope stratigraphy on Mauna Kea (HSDP) [2] provide new insights into the length scale of isotopic heterogeneities within the Hawaiian plume. Using these data and published isotope data from submarine landslide blocks from Nuanuu [3], we show that the two trends have systematically different Pb isotopic compositions, showing that they sample two compositionally different sides of the Hawaiian plume. However, the extension of the Loa trends to Oahu and Kauai is inconsistent with the observed Pb isotope systematics. In particular, main shield-stage lavas from these two volcanoes do not have the high 208Pb*/206Pb* ratio typical of Loa trend volcanoes. Although Koolau subaerial lavas Pb isotope data are consistent with Loa-trend compositions, stratigraphically deeper Koolau shield-stage lavas have isotopic characteristics similar to those of Kea trend volcanoes. Similarly, lavas from Kauai, the most remote island on the Loa trend, share more similarities with Kea trend than with Loa trend volcanoes. On the basis of these observations, we suggest that the Loa and Kea trends developed about 2 to 3 Ma ago, following a change in the Pacific plate motion reflected by a bend in the Hawaiian chain near the Molokai Fracture Zone. This inference is consistent with that obtained by geometric relocation of the Hawaiian hotspot track in the Pacific [4] and models calling upon lithospheric flexure to explain the creation of a dual chain of volcanoes [5, 6]. The large-scale left-right asymmetry, evident in the spatial distribution of the volcanoes along the Loa-Kea trend is also present in the temporal evolution of a single volcano (e.g. Koolau and Mauna). This may be explained if the azimuth of the compositional boundary between Loa and Kea type chemistry is at a slight angle to the azimuth of the plate motion. It is quite possible that the change in the direction of plate motion, 2 to 3 Ma ago, also caused a change in the position of Koolau volcano in such a way that its magma supply switched from one side of the plume to the other. [1] J.D. Dana, Geology, Volume 10 of United States Exploring Expedition, during the years 1838-1839, 1840, 1841, 1842, C. Sherman, Philadelphia, 1849. [2] J. Eisele, W. Abouchami, S.J.G. Galer, A.W. Hofmann, Geochem. Geophys. Geosyst., 4(2), 8710, doi:10.1029/2002GC000339, 2003 [3] R. Tanaka, E. Nakamura, Geophys. Monograph Ser., vol. 128, 311-332, 2002 [4] P. Wessel, L. Kroenke, Nature 387, 365-369, 1997. [5] C.F. Hieronymus, D. Bercovici, Nature 397, 604-607, 1999. [6] U. ten Brink, Geology, 19, 397-400, 1991.

V32A-0997 1330h POSTER

Isotopic Study of the Mauna Loa Southwest Rift Mile High Section: Hawaiian Mantle Plume Components

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The new JASON2 ROV was employed to collect 51 samples from a 1.8 km thick submarine landslide scarp along the crest of the southwest rift zone of the Mauna Loa volcano to investigate the nature and history of Hawaiian mantle plume components. The rift zone section records about 400,000 years of eruptive activity, 50% of the volcano's total lifetime, which is comparable to the time-period sampled by the Hawaiian Scientific Drilling Project (HSPD2). Sr, Nd, Pb and Hf isotopes have been analyzed on 14 samples from the "Mile High" section. The range of variation observed falls typically within literature data for the Mauna Loa volcano with $^{87}Sr/^{86}Sr$ from 0.70368 to 0.70378 and $^{206}Pb/^{204}Pb$ from 18.16 to 18.26, and is somewhat more radiogenic than most Mauna Loa prehistoric (<31 ka) lavas. In the section, there is a distinct increase in Pb and Sr isotopes, which is also recorded by major and trace element data, at a depth of 1353 m. Isotope ratios continue to increase to the bottom of the section at 2290 m. High precision Pb-Pb isotopic systematics for Mauna Loa lavas do not show the binary mixing trends as also observed in the upper part of the HSDPI pilot hole and contrary to Mauna Kea lavas (Abouchami et al., Chemical Geology 2000). This might imply that the Mauna Loa plume source is more thoroughly mixed than the Mauna Kea source. Most of Mauna Loa isotopic compositions cluster at 18.15-18.20 for $^{206}Pb/^{204}Pb$ and $\sim$0.70370 for $^{87}Sr/^{86}Sr$, which could be a ubiquitous refractory component in the Hawaiian mantle plume (Rhodes and Weis, Fall AGU 2001). Nevertheless, a more radiogenic plume component with higher $^{208}Pb/^{204}Pb$ and $^{208}Pb^*/^{206}Pb^*$ is clearly present in the lower part of the Mile High section and might be comparable to the Kilauea-like component observed in Mauna Kea lavas in HSDP2 (Blichert-Toft et al., G3 2003). Team members also include: D. Wanless and K. Kolysko, University of Hawaii; H. Guillou, CEA/CNRS, France; M. Kurz and D. Fornari, WHOI; M. Norman and V. Bennett, ANU, Australia; F. Trusdell and S. Schilling, USGS; M. Chapman, Morehead State University; M. Vollinger, University of Massachusetts.

V32A-0998 1330h POSTER

Sampling the Cape Verde Mantle Plume: Evolution of Santo Antão, Cape Verde Islands

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The 7.5 - 0.1 Ma old volcanics of the northwesternmost Cape Verde Island of Santo Antão show a change from early incompatible element enriched basanite-phonolite series to more enriched nephelinite/melilite nephelinite-phonolite series volcanics all of HIMU OIB type. Mantle melts were derived by 1-4 % melting and had around 12 wt.% MgO. Olivine Fo88-91 is found in many primitive volcanics. Incompatible element modelling shows that the geochemical change of the composition of the primary magmas requires source enrichment by silicate melts of mainly two compositional types. One of these is MORB. Isotopically the > 2 Ma Old Volcanics group can largely be explained by mixing of two components both with relatively radiogenic Sr and unradiogenic Nd of which one is a young HIMU type source (Δ 8/4 $\sim$ 0 and Δ 7/4 $\sim$ -5). The period 2 - 0.7 Ma saw two component mixing of two other end members of which one is a young HIMU source with less radiogenic Sr, more radiogenic Nd, Δ 8/4 $\sim$ -38 and Δ 7/4 $\sim$ -5, which isotopically is identical to an end member of carbonatites from the neighbouring island of São Vicente and the southern island Santiago. The youngest volcanics show stronger source enrichment, the most silica undersaturated magmas and an old HIMU-type component (Δ 7/4 > 2). The characteristic EM1-type enrichment of the southern Cape Verde Island is not detected on Santo Antão. We argue that the main components of Santo Antão volcanism are plume derived and reflect vertical variation in composition of rising plume material. The inter island variation of the Cape Verdes may reflect a lateral variation of the plume or lithosphere derived components in the southern island volcanics

V32A-0999 1330h POSTER

Faults, Post-1720 Explosion Craters, and the Remains of a Lava Lake at Castro Bank Seamount (E Azores)

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During 25-28 July 2003 the US Navy submarine NR-1 dove on the seamount D. Joao de Castro Bank, compiling reconnaissance sonar and visual data. Castro Bank sits along strike and between the eastern Azorian islands of Terceira and S. Miguel, occupying a seismically active region $\sim$60 km from each of these islands and apparently controlled by the same underlying tectonics as other islands found along the Azores' northern margin. Castro Bank's last recorded eruptions built a $\sim$1 km diameter ephemeral island in the 1720s. The bathimetry of the uppermost 40 m or so of the Bank is rather well known via single beam sonar, scuba diving and AUV surveys (IH, DOP/UA and ISR/IST, unpublished work). Our dives compiled data in concentric rings along contours, collecting side- and forward-looking sonar along an overall track length of $\sim$20 km, with the deepest ring approaching $\sim$200 m depth. To document key features we came near the sea floor and took videos in water with typical visibility of $\sim$10-15 m. This is the first progress report on our work, which found the edifice morphologically complex and irregular. We noted that the seamount was often covered by aerially extensive yellow-brown hyaloclastic tuffs that were presumably products of the 1720s eruption, but also cut by faults and fissures (with offsets of ten's of meters) exposing abundant areas of older edifice. The faults typically lacked sediment cover, and in one case a very fresh, sediment-free fault trended along the base of a steep cliff. This suggested the faults were much younger than the 1720 eruption, an observation in accord with intense seismicity recorded in this area. The faults provided exposures of older rocks, which included abundant breccia and lesser clearly identified pillows or thick lava flows. The NW quadrant contains two small, shallow, elliptical craters. These lie side-by-side and crosscut inferred 1720s-age tuffs. One crater held a lava lake, the body of which apparently withdrew or subsided slightly, stranding the lake's chilled upper surface ($\sim$20 cm thick). Unsupported from below, that fragile surface has largely broken and dropped on the order of a meter or two. Much of it lies strewn across the crater floor in a pattern of broken, interlocking plates. The lava lake's upper surface appeared surprisingly clean–devoid of sediments or colonizing organisms. This, taken together with the craters cutting across the inferred 1720s tuffs, suggests the craters are post-1720s, and were perhaps deposited in the past few decades(?). In conclusion, we suggest that Castro Bank underwent post-1720s faulting and volcanism. The complexity and difficulty of mapping the seamount suggests multiple studies and techniques will be required to portray its morphology and history.

V32A-1000 1330h POSTER

Age and Geochemical Data From the Madeira-Tore Rise and Surrounding Seamounts: New Insights Into East Atlantic Volcanism

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Located off the NW African continental margin is a >3000 km long belt of volcanic archipelagoes (e.g.

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Canary, Madeira Islands) and large seamounts including the 900 km long Madeira-Tore Rise (MTR). The cause of the East Atlantic volcanism, and in particular the origin and age of the MTR, which is composed of a widespread plateau with several seamount groups, is controversial. Proposed models include an origin of the MTR at the Mid Atlantic Ridge, formation over a hotspot, or as a product of diffuse small-scale mantle convection. All recently dredged volcanic samples (RV Meteor cruise M51/1) from the MTR and nearby off-rise seamounts exhibit enriched Ocean Island Basalt-like incompatible trace element signatures similar to HIMU (high time integrated $^{238}U/^{204}Pb$) ocean islands. Their isotope compositions are similar to those from Madeira with $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ overlapping Atlantic N-MORB to a large extent, but Pb isotope ratios plotting well below the Northern Hemisphere Reference Line and extending to $^{206}Pb/^{204}Pb$ values of 19.90. Our preliminary data confirm the existence of at least two distinct isotopic domains in the eastern North Atlantic: 1) a Madeira-like domain (as characterized above) stretching from Madeira Island along the MTR to the NE as far as the Azores Gibraltar fracture zone, and 2) a Canary-like domain with Sr, Nd, Pb isotope ratios intermediate between N-MORB and HIMU ($^{206}Pb/^{204}Pb$ = 19.0-20.2; $^{207}Pb/^{204}Pb$ = 15.54-15.66) but with lower $^{143}Nd/^{144}Nd$ ratios (<0.5130) than the Madeira domain. We interpret the distinct compositions of these domains to reflect spatial zonation in the deeper sources of the mantle upwellings. The domains include zones influenced by Enriched Mantle (EM) I and II, which appear to be orientated along the extension of the Oceanographer (at $\sim 34^{\circ}$N) and the Azores-Gibraltar fracture zones (at $\sim 37^{\circ}$N), respectively. The first zone includes a hitherto unknown seamount that exhibits the most extreme EM I composition yet discovered in the North Atlantic ($^{206}Pb/^{204}Pb$ = 17.72, $^{143}Nd/^{144}Nd$ = 0.5124). If the association with the fracture zones can be confirmed, a shallow source for the EM I and II signatures can be assumed. One explanation would be that splinters of subcontinental lithosphere or continental crust have been incorporated into the oceanic upper mantle during the break up of Pangaea and subsequently trapped along the fracture zones. $^{40}Ar/^{39}Ar$ age determinations on MTR lavas and off-rise seamounts (currently underway) will help in constructing a geodynamic model for the East Atlantic volcanism.

V32A-1001 1330h POSTER

Geochemistry of Foundation Seamount Chain Eruptives: Effects of Lithospheric Thickness and Ridge-Hotspot Distance on Magma Generation.

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From experiments and theory, the thickness of the lithosphere overlying a melting column in the mantle should control many of the characteristics of the erupted magmas. Thick lithosphere should lead to eruption of low-degree melts with a relatively large average depth of melting, silica undersaturation and strong incompatible-element enrichment. Hotspots migrating towards or away from spreading axes could provide a natural laboratory to test this model, as the oceanic lithosphere thickens progressively with age. Most examples of hotspot-ridge interaction are characterised, however, by a monotonic increase or decrease in hotspot-ridge separation (and hence age of the plate overlying the active hotspot) through time, making it impossible to separate the influences of melt column capping and hotspot-ridge magma mixing on magma chemistry. In the case of the Foundation Chain, which lies on the Pacific plate west of the Pacific-Antarctic spreading axis, an easterly, 380 km ridge jump at ca. 11Ma lead to the creation of the Selkirk Microplate and subsequently a situation where, for ca. 5Ma, the hotspot approached the spreading axis but lay under progressively thicker lithosphere. We present major and trace element compositions of lavas collected along the whole length of the Foundation chain. Combined with published information on the age of the seamounts and the underlying plate, we can examine the magma compositions in terms of ridge-hotspot separation and thickness of lithosphere over the last 21Ma. MgO and distance to spreading axis are negatively correlated for all samples. Lithospheric thickness, on the other hand, is positively correlated with MgO for the magmas erupted on the Selkirk microplate, but negatively for the other Foundation seamounts. This suggests that distance to axis rather than lithospheric thickness is controlling the MgO contents of the hotspot magmas. Exactly the opposite effect is seen when examining Dy/Yb (theoretically high when residual garnet is left after melting, low in ridge basalts) - the Selkirk samples show similar behaviour to the rest of the chain when plotted against lithospheric thickness (a positive correlation) but behave differently when distance to the spreading axis is considered (Selkirk negatively correlated, rest of chain positive). These results suggest that, over hotspot-ridge distances of up to 700km, the effects of the spreading axis dominate the MgO contents of the hotspot magmas. Lithospheric thickness on the other hand plays a major role in controlling trace element patterns.

V32A-1002 1330h POSTER

Cobb Hotspot Volcanism Prior to 7 Million Years ago

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From where the Cobb hotspot currently resides beneath Axial Seamount on the Juan de Fuca Ridge, a discontinuous trail of seamounts of increasing age extends 1800 km to the northwest, all the way to the Alaskan Trench off of the southern tip of Kodiak Island. These seamounts record the evolution of mantle melting and volcanism at the Cobb hotspot over the past 30+ million years, including how the approach of the Juan de Fuca Ridge from the east affected the hotspot. We conducted multibeam mapping and stratigraphically-controlled rock sampling of several of the seamounts created by the Cobb hotspot up until 7 Ma. Using the Alvin submersible to do depth transects for geological observations and rock sampling allowed us to establish the volcanic style and setting represented by each sample, and to avoid the thick ferro-manganese oxide coatings and abundant ice-rafted debris common in the Gulf of Alaska. Our goal is to understand the volcanic histories and morphologies of these seamounts with an eye to how volcanism at the hotspot was affected by the approaching ridge. Our targeted seamounts included, from SE to NW, Warwick (~7 Ma on 9 Ma crust), Murray (~28 Ma on 39 Ma crust), Patton (~30 Ma on 42 Ma crust), and Marchand (30+? Ma on 43 Ma crust). Marchand Seamount, though small compared to the others, appears to be the oldest unsubducted volcanic product of the Cobb hotspot. So far, we have XRF data for our samples, and argon dating and trace element analyses are underway. Warwick Seamount yielded only tholeiitic basalts, while most of the samples from the other seamounts are evolved alkalic rocks. Murray samples are entirely alkalic, being dominantly trachytes and trachydacites, with a few mugearites. Rocks from Patton are mainly hawaiites and mugearites, with rare tholeiitic to transitional basalts and a single trachyte. Marchand samples are trachydacites and trachytes similar to the differentiated Patton and Murray samples. Basement drilling at ODP Hole 887D in a saddle near Murray Seamount did recover tholeiites beneath about 40m of alkalic basalt flows interbedded with sediments, so apparently tholeiites, while poorly exposed today, did play some role in the construction of the 28+ Ma seamounts. The lack of alkalic rocks on Warwick may be related to the fact that it formed near the Juan de Fuca Ridge (on 2 m.y. old crust), while the other seamounts formed on 11+ m.y. old crust.

V32A-1003 1330h POSTER

Helium and Neon Isotopic Systematics in Kerguelen Archipelago High-MgO Basalts and Picrites

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The Pb-Hf-Nd-Sr compositions of the mildly alkalic basalts (< 25 Ma) erupted in the southeastern Kerguelen Archipelago are inferred to represent the enriched Kerguelen plume end-member (Weis et al. G3 2002). We present new helium (He) and neon (Ne) isotopic compositions for olivines of eight high-MgO basalts and picrites (6-17 wt.% MgO) from this part of the archipelago to better characterize the mantle sources involved in the genesis of Kerguelen plume-related basalts. Crushing experiments were performed on a ARESIBO mass spectrometer, which is connected to a new fully automated extraction/purification line. The studied olivines have extremely variable $^{4}He/^{3}He$ compositions ($\sim$ 90000 to 40000). This covers a range from the limited field of radiogenic MORB to primitive values observed in OIB ($^{4}He/^{3}He \sim 90000$, and down to $\sim$ 15000, respectively). These olivines are characterized by primitive Ne isotopic compositions (lower $^{21}Ne/^{22}Ne$ for a given $^{20}Ne/^{22}Ne$ relative to MORB). Ne and He isotopic results are apparently decoupled, which could be related to He loss during magmatic evolution or secondary processes occurring during exposure time. The $^{20}Ne/^{22}Ne$-$^{21}Ne/^{22}Ne$ compositions define a linear trend, which completes the trend formed by previously analyzed Kerguelen Archipelago xenoliths (Valbracht et al. EPSL 1996). This well-defined trend ($r^2 > 0.95$) suggests that the Ne isotopic compositions of these basalts result from mixing between an air-like component and a primitive material characterized by $^{21}Ne/^{22}Ne$ of 0.056 (calculated for a solar $^{20}Ne/^{22}Ne$ = 13.8). This ratio appears to be a characteristic of the enriched source of the Kerguelen mantle plume. Alternatively, the Ne isotopic ratios of the studied samples may result from different amount of mixing between a MORB-like source end-member and a primitive source end-member subsequently contaminated by the air, an hypothesis that is apparently inconsistent with Sr-Nd isotopic systematics in these basalts (Doucet et al., EGS 2003).

V32A-1004 1330h POSTER

Preliminary Experimental Results on a Volcanic Meimechite Composition From Meymecha, Siberia

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Ultramafic lavas, predominantly meimechites, form an approximately 1400 m stack at the top of the Siberian flood basalt section in the Maymecha-Kotuy region (see in particular Fedorenko and Czamanske, 1997). The meimechite stratigraphy correlates with an area above the top of the Siberian flood basalt stratigraphic sections in Noril'sk, Tunguska, and Putorana. Meimechites are exceptionally high in magnesium and iron (up to 38 wt% and 17 wt% respectively), low in silica (40 to 42 wt%). Although the major element compositions of the meimechite melt inclusions measured by Sobolev et al. (1991) plot on the same trends as the bulk rocks, the alkali contents of the melt inclusions are systematically higher than the lava compositions, suggesting that the lavas have lost alkalis. The majority of whole rock compositions have sodium to potassium ratios below one, while the majority of melt inclusions have ratios above one, indicating loss of sodium. With the higher alkali content, up to 5 wt% sodium plus potassium in the melt inclusions, the melt inclusion liquids no longer qualify as meimechites under the new IUGS definition, but rather as foidites. Further analysis of major element trends indicates that, in agreement with Arndt et al. (1995) and others, compositions with MgO contents of approximately 25% represent liquid compositions, and we conclude that lower magnesium compositions are the results of olivine fractionation, while higher magnesium composition have accumulated olivine. Preliminary one-atmosphere and piston-cylinder experiments have been performed on a synthetic analog of a meimechite composition obtained from an olivine melt inclusion, with 26.9 wt% MgO, 8.2 wt% CaO, and 40.2 wt% silica. The experimental composition, with an Mg# of 78.3, has a nearly identical major element composition as whole rock compositions, except that the melt inclusion has higher alkali content, at about 3 wt% sodium oxide plus potassium oxide. The preliminary experiments show that the composition's liquidus at one atmosphere is at about 1450 degrees C, and at 1 GPa the liquidus lies at about 1550 degrees C. Olivine and spinel are stable at the liquidus from one atmosphere to 1 GPa, and pyroxene appears at one atmosphere at about 1250 degrees C, after approximately 200 degrees of olivine crystallization. While the roles of hydrous fluids and magma mixing have yet to be determined, it can be shown that a number of the lavas erupted within their olivine stability fields, with pyroxene only in the groundmass, and from our preliminary experimental results this constrains the eruption temperature to between 1250 and 1450 degrees C. The high magnesium content of these lavas have lead some workers to conclude that they are the definitive plume signature, arguing that they could only have

been formed by very deep and hot melting. Others have suggested that they are olivine cumulates, supported by the large, abundant olivine grains in the lavas, because the linear compositional trends in major elements of all the meimechite bulk compositions are consistent with an accumulation or loss of olivine. The high concentration of incompatible elements of the lavas also may suggest either a lithospheric component, a very small degree of mantle melting, or possibly magma mixing. The very high liquidus temperature for this composition is a strong contraint on processes of formation for the Siberian flood basalts, and as experiments are performed at higher temperatures, suggestions for the mantle source lithology will be discovered.

V32A-1005 1330h POSTER

Link Between Volcanism and Mantle Exhumation at the Axial Zone of a Fossil Slow Spreading Ocean

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Within an axial zone of a slow spreading ocean, the mechanisms checking together volcano emplacement, mantle exhumation and ocean enlargement are poorly known. In order to better assess how they are linked, a detailed study of a fossil ocean-floor structure, preserved from alpine tectonic and metamorphism, was performed in the Chenaillet unit (Franco-Italian Alps)(Chalot-Prat et al, submit.). The 3D geometry of the ophiolite evidences that from its dimensions, topography, morphology and the architecture of the basaltic cover, the Chenaillet unit is a witness of an axial zone of Atlantic type. The basement (serpentinized peridotites; gabbros), below and on both sides of the volcanic cover, is capped by cataclasite horizons underlining detachment faults responsible for its exhumation at the seafloor. Clasts of basalt found within the cataclasite indicate an active exhumation during and after volcano emplacement. Stair- and Comb-type volcanic systems check the distribution of individual volcanoes. The higher the edifice, the younger it is relative to the others. In a S-type, each step is formed with a pillow and tube tongue stacking fed from fissures located at the root of each step. The system formed by uplift, step by step fracturation of an already exhumed basement, and magma injection along the fissures. A C-type consists in alignments of pillow and tube conic edifices. Their central feeder dykes are located at the crossing of fractures oblique and parallel (line) to the main branch of the comb. Along a same line, eruptions are coeval. The comb formation needed initial basement fracturation, then uplift and exhumation of a new basement along a detachment fault which also controlled magma injection. Once formed, volcanoes were dragged away and down on the travelator to give place to new volcanoes. The pseudo-symmetry of the C-type evidences that the exhumation process occurred synchronously, but not at the same rate, in opposite directions, as observed at any mid-oceanic ridge axis. In both systems, fast alternation between partial melts and their differentiates suggest that the main magma conduits were rooted within frequently fed small reservoirs. The regular recurrence of partial basaltic melts also suggests that the main conduits were rooted within the mantle source. Lithospheric stretching could control both magma ascent and mantle melting.

V32A-1006 1330h POSTER

Origin Of Extreme $^3He/^4He$ Signatures In Icelandic Lavas: Insights From Melt Inclusion Studies

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Helium isotopes are considered a powerful tool for tracking different mantle domains. Yet, the origin of He isotope variations in many basaltic suites remains enigmatic and often difficult to link with more lithophile chemical and isotopic tracers. One problem is that He isotope ratios are measured from crushed olivines and thus reflect prior fluid and melt fluxes trapped in inclusions within the olivine grains, whereas the lithophile elements mainly reflect the host lava. In an attempt to link He and lithophile element variations, we have characterized the major and trace element composition including volatile elements, of olivine-hosted melt inclusions from three ankaramitic lavas from Vestfirdir, NW-Iceland. Previous studies have reported extreme $^3He/^4He$ ratios from NW-Iceland and one ankaramite (SEL97) has been suggested to provide the most precise estimate of the radiogenic (Sr-Nd-Pb) isotopic composition of a relatively undegassed (high $^3He/^4He$) mantle component (C or FOZO) common to several ocean islands (Hilton et al. 1999, EPSL 173, 53-60). The samples investigated here exhibit amongst the highest $^3He/^4He$ ratios observed in terrestrial rocks (42.9 and 34.8 R/R_a). A detailed account of the trace element signature of melt inclusions in these samples may thus help explain the origin of FOZO. One sample of similar composition to these, has a lower He content and a relatively poorly defined He isotope composition of 8.15 $\pm$ 5.1 R/R_a (Breddam & Kurz, 2001, EOS, 82, F1315). In terms of major elements, the whole rock data reflect olivine accumulation, whereas the melt inclusion data reflect ol + cpx fractionation. The melt inclusions are generally basaltic (Mg#: 52-62), with primitive mantle normalised trace element concentrations that are broadly parallel the host lavas. There is little compositional difference between melt inclusion populations from high and low $^3He/^4He$ lavas, although inclusions of the low $^3He/^4He$ lava have lower S and moderately lower Cl. The observed range of trace element ratios: $[La/Sm]_N$ 1-4, $[La/Yb]_N$ 1-5, Sr/Nd 14-24, Ba/Rb 9-23, and Ce/Pb 5-46, covers much of the range observed in Icelandic alkali basalts. The compositional similarities between inclusions and host lavas suggests that bulk rock compositions are petrogenetically related to the melts sampled by melt inclusions. If He predominantly resides in these inclusions, it suggests that the whole rock composition is an aggregate derived from the same melts that contain the measured He.

V32A-1007 1330h POSTER

He-Ne systematics in OIB and the nature of the source of mantle plumes

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We have designed a new extraction and purification line, fully automated, coupled with our glass mass spectrometer ARESIBO I, equipped with a faraday cup and an ion counting system. The very low CO2 and 40Ar levels of the machine allow us to analyze the neon isotopic composition in very small samples. We have performed helium and neon analyses on olivine phenocrysts from different oceanic island basalts (St Helena, Gough, Tristan, Azores, Kerguelen, Hawaii). Most of the samples present anomalies compared to air for neon (with ratio 20Ne/22Ne up to 11.67) and all the data plot between the MORB line (e.g. Sarda et al. 1988) and the Iceland line (e.g. Moreira et al., 2001). Corrected for air 21Ne/22Ne ratios (assuming a solar 20Ne/22Ne) are between 0.036 and 0.081. In a diagram 21Ne/22Nec versus 4He/3He, all the OIB plot between a mean MORB composition and a solar like composition, and can be interpreted as a binary mixing with a r=(3He/22Ne)MORB/(3He/22Ne)solar parameter for the hyperbolae around 10 suggesting that mixing between the plume material and the MORB material occur in liquid condition. Another interpretation is that the 3He/22Ne of the MORB source is higher from the solar 3He/22Ne which appears in contradiction with previous estimates. Nevertheless, our conclusion is that the neon is a better tracer of primordial material than helium.

V32A-1008 1330h POSTER

State of mantle (re-)mixing and large igneous provinces

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Large igneous provinces are the largest expression of magmatism on the Earth, and they are usually associated with hypothetical mantle plumes, thereby playing a fundamental role in forming a currently prevailing view of mantle dynamics; mantle convection is characterized by large-scale plate-tectonic circulation and small-scale plume upwelling. The actual origins of large igneous provinces are, however, still poorly understood. In this contribution, I review geophysical and geochemical constraints on the origin of the North Atlantic igneous province, which is one of the best-studied provinces. By combining various constraints ranging from mantle and crustal tomography to igneous petrology and geochemistry, I suggest that this igneous province has most likely resulted from strong chemical heterogeneity in source mantle without notable thermal anomaly. A long-standing dynamical problem regarding the upwelling of fertile (thus dense) mantle is also shown to be resolved by considering the physics of a self-contained whole-mantle convection system. The significance of chemical heterogeneity in the genesis of large igneous provinces may not be limited to the North Atlantic province. The efficiency of convective remixing is not expected to be globally uniform, which implies that spatially variable mantle composition is a natural outcome. The distribution of large igneous provinces may simply reflect the pattern and intensity of such inherent chemical heterogeneity in convecting mantle.

V32B MCC: Level 2 Wednesday 1330h

The First Historical Eruption of Anatahan Volcano, Mariana Islands Posters *(joint with T)*

Presiding: **D Wiens,** Washington University**; T Fischer,** University of New Mexico**; D Hilton,** Scripps Institution of Oceanography**; J T Camacho,** Emergency Management Office, Capitol Hill

V32B-1009 1330h POSTER

The First Historical Eruption of Anatahan Volcano, Mariana Islands

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The first historical eruption of Anatahan volcano occurred on May 10, 2003. The MARGINS office responded by authorizing helicopter surveillance and ship deployment to visit the volcano. The helicopter flight on May 19 allowed visual observations and identification of the east crater as the source of the eruption. The top of the plume was estimated to be at 10,000 ft - significantly less than the 30,000 ft of the initial blast. No bombs were ejected out of the east crater at this time but were falling back into the crater. The bombs looked irregular in shape, massive and were estimated to be a few m in diameter. Bombs and tephra samples were collected from the eastern side of the island when blasts were occurring at a rate of approx. 1 per 5min. The ship visit followed on May 21 to the western side of the island for collection of samples and SO_2 flux measurements, along with maintenance of a previously deployed seismometer.

Volcanic samples collected on Anatahan consisted of bombs, ash and scoria from the present eruption and old lavas (age unknown). The ash section on the western shore was 25 cm thick and consisted of the following sequence (bottom to top): 0-5 cm: grey/tan layer fine ash coarsening upward to sand size, 5-8 cm: well sorted accretionary lapilli (2-3 mm), 8-20cm: inversely? graded dark ash with scoria and pumice clasts (1-2 cm), 20-25 cm: well sorted clast-supported scoria (max 2 cm) with some fine ash. The maximum total thickness measured at a site 6 km from the east crater was approximately 45 cm. The sequence is interpreted as 1) initial blast 2) interaction of magma with water (from pre-existing hydrothermal system) as evidenced by accretionary lapilli 3) magmatic phase of the eruption producing juvenile material. Electron microprobe analyses of the pumice and scoria show uniform compositions of 60wt% SiO_2 in the glass; zoned plagioclase with average composition of 61% An, 37.7% Ab, 1.2% Or; pyroxenes (19.4% Wo, 53.4% En, 26.7% Fs) and Fe-Ti oxides. Sulfur and Cl contents are approx. 100 and 1500 ppm, respectively. Water content of the glass may be several wt% based on analytical totals.

Volatile emissions from the volcano were measured by traversing under the plume with a ship-based COSPEC.