2003 2. D.L. Anderson, Proc. Natl. Acad. Sci. USA 95, 4822-4827. 1998 3. J.H. Natland, J. Pet. 44, 421-456. 2003

V31F-04 1120h

Motion of Hotspots Relative to the Paleomagnetic Axis

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Southward motion of the Hawaiian hotspot plume relative to the paleomagnetic axis has been observed (Tarduno et al.,2003), and this can be explained by either motion of the Hawaiian hotspot relative to other Pacific hotspots, or motion of the group of hotspots relative to the paleomagnetic axis. First, we examined whether inter-hotspot motion is essential or not for the explanation of observed data of seamounts in the Pacific basin. We found that both the Polygonal Finite Rotation Method (Harada and Hamano, 2000) and the Hotspotting Method (Wessel and Kroenke, 1997) can successfully be used to develop models of the Pacific and the Nazca plate motion relative to hotspots. This indicates that no inter-hotspot motion is needed to explain ages and positions of hotspot tracks in the Pacific basin. Second, combining the Pacific plate motion relative to hotspots and Pacific paleomagnetic poles (Acton and Gordon, 1994, Johnson, 2000), we calculated the motion of Pacific hotspots relative to the paleomagnetic axis (Pac-PWP). Based on this analysis, southward drift of the Hawaiian hotspot is predicted and it is quite in harmony with the newly observed southward motion of paleolatitude for the Emperor seamount chain. Similarly, we constructed a model of the African plate motion relative to African hotspots, and calculated the motion of African hotspots relative to the paleomagnetic axis (Af-PWP). Pac-PWP and Af-PWP are quite similar and we conclude that there is no significant relative motion between Pacific hotspots and African hotspots since 70 Ma.

V31F-05 1135h

Transform Control on Ridge Propagation and Hotspot Formation

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Large extensional stresses at ridge-transform intersections provide a mechanism for both the propagation of mid-ocean ridge segments and the formation of hotspot seamounts at ridge-transform intersections (RTIs). I propose that extensional stress is increased at ridge-transform intersections when slip along transforms is impeded. Thus, the inability of transforms to slip may cause either ridge-propagation and/or the formation of hotspot seamounts at RTIs. Extensional stress at the ridge-transform intersection may result in decompression melting and a change in the physiographic and thermal gradient in the upper mantle. Under these conditions excess magma at or near the ridge would result in the formation of a hotspot seamount at the ridge-transform intersection rather than in the segment center. Conversely, ridge propation may occur when the magma supply is lower and the stress concentration is high enough. Because transform slip can be impeded by a number of factors ranging from hydrothermal alteration to plate motion changes, the coupling of ridge-propagations to transform slip does not decouple the propagation of ridges from changes in plate motion. Rather, in addition to providing an alternative means of propagation during plate motion changes, the coupling of ridge-propagation to transform slip provides a mechanism for ridge-propagation during steady-state plate motions. Thus, a simple lithospheric mechanism is proposed, under certain conditions, to be responsible for the propagation of mid-ocean ridge segments and the location of hotspot seamounts at RTIs. To test the viability of this proposal a three-dimensional finite element grid of a series of three ridges and 2 transforms was constructed. Slip along the transforms was impeded by changing the strength of the transform and by varying plate motions. Large extensional stresses were concentrated at ridge-transform intersections when slip along the transform was impeded. Changes in the stress of the mantle were also observed when slip along the transform was impeded. Large concentrations of extensional stress at transforms may result in either the propagation of the ridge or, when magma supply is high, the formation of a hotspot. Thus, a lithospheric element is suggested as a mechanism for ridge propagation and hotspot formation.

V31F-06 1150h

Mantle Dynamics beneath the western United States

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Much uncertainty still exists with respect to the state of the mantle beneath the western United States and the dynamical activity that created this current state. Three end-member dynamical agents may be at work. First, input of heat from below is often used to explain: the Yellowstone Hotspot track (a plume), the high standing elevation of the northern Basin and Range (a plume head), the petrology and geochemistry of southern Nevada young basalts (a plume), and the late-Cenozoic uplift and rifting of the southern Rockies (unspecified source of heat). Second, many publications note the correspondence between the volcano-tectonic activity of the western US and pre-existing lithospheric structures (sutures). For example, the low velocity body imaged beneath the Jemez volcanic lineament (from the CD-ROM project) shows clear mantle velocity layering within the low velocity body suggesting that this velocity anomaly is lithospheric, not asthenospheric in origin. Third, both lithospheric and asthenospheric modes of small-scale convection may be ongoing today. If our understanding of the dynamical parameter space for small-scale convection is correct, then the low upper mantle viscosity ($<10^{19}$ Pa-s) and thin Basin and Range lithosphere demands that small-scale convection is occurring. Yet, the abundance of seismic imaging beneath this region cannot presently constrain the planform and modes of small-scale convection. In particular, the magnitude of the thermal anomalies are poorly constrained due to uncertainties in the Q operator and hence the magnitude of the anelastic velocity-temperature derivative. Also, the numerous short term (<1-2 year) PASSCAL deployments in the western US, while providing unparallel spatial coverage, generally lacks a sufficient distribution of SKS events to constrain dipping anisotropy. This undersampling problem is unfortunate because dipping anisotropy is probably our best proxy for small-scale convective flow beneath this region Comments on the seismic imaging challenges, that will face the deployment of the USarray component of Earthscope, will conclude this talk.

V31F-07 1205h

Post-Laramide Volcanism and Upper Mantle Dynamics in the Western US: Role of Small-Scale Convection

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Seismic tomography in the Western U.S. reveals ubiquitous small-scale (200-600 km wavelength) seismic velocity variations at 100 km depth. Many slow anomalies lie beneath recent volcanic fields and exhibit a magnitude that is difficult to explain on the basis of temperature variations alone, implying the presence of partial melt in the asthenosphere. Two- and three-dimensional numerical convection simulations, including the effects of melt and residual composition changes, show that these effects add buoyancy to the system and increase both the vigor and temperature contrast in the resulting small-scale convection relative to cases in which no melting occurs. In our models, the viscosity contrast between lithosphere and asthenosphere is regulated by the activation energy for temperature-dependent viscosity. A high viscosity contrast results in small horizontal temperature anomalies and involves only small portions of the lithosphere (the “compact mode”). A lower viscosity contrast gives rise to larger temperature anomalies by involving a greater portion of lithosphere in the convection, resulting in substantial thinning of the lid by erosion in the form of detached drips (the “drippy mode”). Because the drippy mode occurs for small viscosity contrasts, it is consistent with a weak lithosphere that might arise due to the presence of volatiles. A temporal transition from a “wet” drippy mode (resulting in substantial lithospheric thinning and melt production) to a “dry” compact mode (following volatile removal in melts) may provide an explanation for the observed diachronous character of tectonic and volcanic events in the Western U.S. geologic record. This process would have initiated with the mid-Tertiary ignimbrite flare-up following removal of the flat (and presumably volatile-rich) Farallon slab, and continued through the Miocene when much of the volcanism became basaltic and effusive in character. Such a model is consistent with numerous observations, and perhaps importantly involves only basic small-scale convection processes without requiring the presence of deep-seated mantle plumes. In addition, by experimenting with various imposed strain rates in a moving lithosphere, we have also been able to produce time-progressive volcanism generated by small-scale convection in the form of Richter rolls that presents a viable alternative to the hot spot idea.

URL: http://geodyn.ess.ucla.edu/~hernlund

V31G MCC: 3008 Wednesday 1020h

Eruptive Behavior of Hazardous Volcanoes I

Presiding: **S L de Silva,** University of North Dakota**; A Clarke,** Arizona State University

V31G-01 1020h

Eruption Dynamics and Conduit Processes of the Circa 240 A.D. KS1 Eruption of Ksudach Volcano, Kamchatka, Russia

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The 240 A.D. KS1 eruption of Ksudach volcano formed a 6-7 km3 caldera and dispersed 18-19 km3 of material over much of the Kamchatka peninsula. Previous workers have shown that the deposit consists of 15 km3 of tephra falls and 3-4 km3 of pyroclastic flows. Current studies of deposit stratigraphy and componentry, rock textures, compositions, and volatile contents give insight into dynamics and conduit processes of the eruption. KS1 deposits consist of interbedded white pumice falls and ash layers overlain by gray pumice fall and flow deposits. Two lithic-rich fall layers are present at the transition from white to gray pumice and ash. We interpret the changing character of the deposits with distance and height as a reflection of changing eruptive conditions. Early stages of eruption were dominated by buoyant (fall) behavior. During the main stage, falls and flows (non-buoyant behavior) were simultaneously erupted. The final stage involved caldera collapse followed by buoyant eruption of gray material. Column heights calculated from lithic distributions show that the column was highest and eruption most vigorous during the main stage of eruption, just prior to caldera collapse. Occurring just after collapse and at the shift from fall and flow to fall-dominated deposition, the white to gray transition provides an important timeline in the eruption. Whole-rock and microprobe analyses show the two pumice types to be nearly identical. Similarly, magnetite-ilmenite geothermometry shows that both types were erupted at 895 degrees C. FTIR analyses of melt inclusions in phenocrysts indicate that both white and gray pumices had water contents of 4 wt% prior to eruption and completely degassed during eruption. These data indicate that the difference between the white and gray pumices may be solely textural. Ongoing studies of textural differences between white and gray pumices, particularly with regard to bubble sizes, shapes and distributions, may reveal important differences between pre- and post-collapse eruptive processes.

V

V31G-02 1035h

Pre-eruptive volatile contents of the 26.5 ka Oruanui magma, Taupo Volcanic Zone, New Zealand

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The Taupo Volcanic Zone (TVZ) in New Zealand is exceptional worldwide for its large-scale Quaternary silicic magmatism. The 26.5 ka, ~530 km^3 (magma) Oruanui event is the largest young TVZ eruption. Although showing geochemical variability, Oruanui rhyolite compositions show no systematic strata-bound variations. Our study of the Oruanui deposits can test the hypothesis that a magma body with a stable density stratification exists before eruption and, for this, we determined the volatile contents in Oruanui melt inclusions. Quartz phenocrysts from both pumice fall deposits and ignimbrite were doubly polished to expose melt inclusions, reentrants, and hourglass inclusions. In total, 69 melt inclusions and 32 reentrants were analyzed using FTIR spectroscopy. Average dissolved H_2O and CO_2 ($\pm 1\sigma$) in melt inclusions are: 4.9±0.3 wt% H_2O and 100±42 ppm CO_2 (Fall Unit 1), 5.0±0.1 wt% H_2O and 100±10 ppm CO_2 (Fall Unit 2), 5.0±0.1 wt% H_2O and 110±40 ppm CO_2 (middle ignimbrite), and 5.2±0.3 wt% H_2O and 200±70 ppm CO_2 (upper most ignimbrite or late-erupted ignimbrite). Minimum pre-eruptive pressures of each melt inclusion, derived from the solubility model for mixed H_2O-CO_2 fluid (Liu et al. 2003), vary from ~110 to 220 MPa. The H_2O and CO_2 contents of melt inclusions from late-erupted ignimbrite are generally >4.9 wt% and 200 ppm, greater than those from other samples. The higher volatile contents in the late-erupted samples are consistent with a deeper origin of these samples in the magma chamber, supporting gas-saturation crystallization. However, there is an increase in both CO_2 and H_2O contents from early- (Fall Unit 1 and 2, middle ignimbrite) to late-erupted samples. Although the correlation is weak, the positive trend may indicate gas-undersaturated crystallization. The H_2O and CO_2 contents of reentrants from single pumices vary widely, but are generally lower than in melt inclusions from the same pumice, reflecting late stage pre-eruptive/eruptive degassing.

V31G-03 1050h

Magma evolution model for the post-caldera volcanism of Aso volcano: constraints from geochemistry and mineralogy

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After the 90-thousand-year old caldera forming plinian eruptions, Aso volcano has produced a wide range of magma compositions from basaltic to rhyolitic (Ono and Watanabe, 1985), indicating a change in the structure of the magma plumbing system. Including this Aso-4 pyroclastic flow, Aso volcano produced four gigantic caldera-forming pyroc,astic flows, all of which probably represent an existence of a single zoned magma chamber, as suggested by the geochemical study of Hunter (1998). It is difficult to create a wide range of post-caldera magma compositions from a single magma chamber model, when the following observations are considered. (1) Basaltic group and silicic group of lavas show distinct trends in FeO*/MgO-SiO2 plot. (2) Two lavas with wide compositional variation commonly show mingling texture. (3) Basaltic lavas have plagioclase with dusty zones, whereas silicic lavas do not. Corroded form of plagioclase is observed in all types of lavas. (4) Orthopyroxene phenocrysts (mg#: 64-69) in basalt always have reaction-rims of clinopyroxene (mg#:68-74) having reverse zoning rim. (5) Estimated temperature from two-pyroxene parallel growth in glomeroporphyritic texture in most lavas show 950-1050 deg. irrespective of their composition. (6) Trace element ratios indicate that the source material for caldera-forming products and post-caldera products are identical. For example, Ba/Zr ratio ranges 2.2-3.0, K2O/Rb, 0.028-0.035. Combining all these observations, we established a dual-magma chamber model: one is fractionated, the other is supplying basaltic magma. A wide range of lava composition probably reflects different degree of magma mixing between the two end member compositions.

V31G-04 1105h

Episodes II and III of the 1912 Novarupta Eruption : Understanding Pauses and Shifts in Intensity Using Pyroclast Textures

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The eruption of Novarupta in June 1912 produced 11 km^3 of ignimbrite and 17 km^3 of Plinian fall deposits in 60 hrs. The fall deposits are divided into eight layers (A through H) formed during three episodes (I through III) of sustained eruptive activity interrupted by two short breaks of up to several hours in duration. The initial fallout belonging to Episode I was rhyolitic, but as the eruption progressed (Episodes II and III), erupted material became dominantly dacitic. The Plinian activity ended with the emplacement of a dacite dome, subsequently destroyed by Vulcanian activity which created the post-H block bed. Emplacement of the rhyolitic dome seen today marked the final stage of the eruption. Density data show pumices from Episode II have a very similar narrow range of vesicularity, but during Episode III the density values increase and the range between high and low values steadily widens. Selected clasts from each layer were used to obtain quantitative evidence for textures indicative of syneruptive degassing. The clasts have very similar vesicle volume distributions in which coalescence signatures are superimposed on prolonged nucleation and free growth of bubbles. Clasts from Layers F and C, both representing the start of an episode, are the most similar whereas a comparison between Layers D and G deposited during the close of Episodes II and III reveals dissimilarities. Layer D has thinner glass walls resembling Layers C and F, or episode initiation, but its bubble population is more coarsely skewed. For both medial and proximal fall deposits of Episode III, Layer G has the lowest vesicularity and thicker glass walls, and the shapes of the larger bubbles are complex. The contrast between clasts erupted at the start of an episode (Layers C and F) and the end of Plinian activity (Layer G) reflects a shift in the degassing process from coupled magma ascent-gas exsolution to open-system degassing necessary for effusive dome growth. While the transition to effusive activity is evident in the pyroclasts, external changes involving the conduit more likely effected the break in explosive activity at the end of Episode II.

V31G-05 1120h

An Experimental Contribution to the Dynamics of Explosive Volcanism. A Case Study of Unzen Volcano and Soufrière Hills Volcano, Montserrat.

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Knowledge of the dynamics of magma fragmentation is necessary for a better understanding of the explosive behavior of silicic volcanoes. Here we have measured the fragmentation speed and the fragmentation threshold of five dacitic field samples (6.7 vol.% to 53.5 vol.% open porosity) from Unzen volcano, Kyushu, Japan and four andesitic-dacitic field samples of Soufrière Hills Volcano, Montserrat, West Indies (2.5 vol.% to 70 vol.%). The measurements were carried out using a shock-tube based fragmentation apparatus modified after Alidibirov & Dingwell (1996a, b). The results of the experimental work confirm the dominant influence of porosity on fragmentation dynamics. The velocity of the fragmentation front increases, and the value of the fragmentation threshold decreases, with increasing porosity. Further, we observe that the fragmentation speed is strongly influenced by the initial pressure difference and the texture of the dacite. E.g. at the Unzen samples the fragmentation speed varies at an initial pressure difference of 30 MPa from 34 m/s for the least porous sample (6.7 vol.%) to 100 m/s at 53.5 vol.% porosity. During field work at Unzen we observed porosity layering in single large blocks within the pyroclastic flow deposits as well as in dome material of Mt. Unzen. The existence of layered structures may be the sites for the initiation of the explosive events at Unzen. Here we address the influence of the layered structure on the fragmentation behavior and deduce a speed propagation model for fragmentation in a layered medium. These results are evaluated in terms of their application to the 1990 - 1995 eruptive activity of Unzen Volcano, Japan and the 1997 eruption activity of Soufrière Hills Volcano, Montserrat. The different explosivity and eruption style of these both volcanoes can be analyzed by means of the fragmentation behavior. Hereby we highlight the influence of the fragmentation dynamics on dome collapse and vulcanian events. In order to explain long lasting collapse events which occurred on Montserrat as well as on Unzen, we propose a fragmentation-induced collapse scenario.

V31G-06 1135h

Petrological Constraints on the Decompression History of Magma Prior to Vulcanian Explosions at the Soufrière Hills Volcano, Montserrat

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A series of 75 Vulcanian explosions occurred at the Soufrière Hills volcano from September 21st to October 22nd 1997. The densities, textures and compositions of plagioclase microlites have been documented for 15 pumice samples. Pre-explosion conduit conditions have been inferred from these data by comparison with experimental decompression experiments of Couch et al. (Journal of Petrology 44, 1477-1502, 2003) on a representative groundmass composition for Montserrat, which established empirically-based relationships between the decompression history and plagioclase composition, plagioclase proportions, crystal size distributions and crystal shape. The natural samples all show very high number densities of microlites (2 x 10^3 to >5 x 10^5 crystals per mm^2) and >90% of microlites have areas less than 20 square microns. Only the most rapidly decompressed experimental samples even approached reproducing these features of nucleation-dominated crystallization observed in the pumices, although none of the experimental samples yielded number densities that exceeded 10^3 per mm^2. Most experiments were confined to pressures of above 30 MPa with a trend from growth-dominated to nucleation-dominated crystallization for fast decompression rates and lower final pressures. Comparison of natural samples to experimental results suggest quench pressures in the range of 20 to 40 MPa. Surface observations indicate a cylindrical conduit with radius of 15 m. Estimated time-averaged flow rates associated with the period of Vulcanian explosions give values of 9 to 13 m^3/s. If the conduit cross-sectional area were constant with depth and magma flow was steady, then the corresponding ascent rates should produce growth-dominated textures with a much higher proportion of coarse-grained (>20 square microns) crystals produced during decompression from 130 to 20 MPa. The following model reconciles pumice sample data with experiments and field observation. We propose that the conduit is not of uniform cross-sectional area. Instead, it is likely that at depths of greater than 1 to 1.5 km the conduit is a narrow dyke which then merges into a wider cylindrical conduit. Each Vulcanian explosion evacuates much of the shallow conduit system. Then, due to the sudden evacuation of the upper conduit and the narrow dyke at depth, magma ascends rapidly (more rapidly than the time-averaged flux rates suggest) to fill up the shallow conduit. The quickly decompressed magma is therefore strongly undercooled and gas supersaturated, conditions which lead to nucleation-dominated microlite crystallization, to subsequent gas pressure increase and ultimately to the next explosive eruption.

V31G-07 1150h

Analysis of Composition and Chronology of Dome Emplacement at Black Peak, Alaska Utilizing ASTER Remote Sensing Data and Field-Based Studies

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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 "super-explosive" 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) there 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

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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.

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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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