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Two-dimensional numerical modelling of the HP-UHP Maksyutov Complex in the south Urals answers questions about thermal conditions during eclogite-facies metamorphism, exhumation rates, and whether UHP metamorphism is thermally possible within existing time constraints. Thermal boundary conditions used for modelling are based on the P-T-t evolution of the eclogitic unit of the Maksyutov Complex from previous thermobarometric and geochronologic data. Best fit models are obtained with initial surface heat flow of 70 mWm-2, not the low present-day values. Onset of subduction in the south Urals probably occurred between 410 and 393 Ma. High-pressure eclogite-facies metamorphism was modelled at 380 Ma. Exhumation rates for the eclogites to mid-crustal levels are up to 7 mm/a if blueschist-/greenschist-facies metamorphism occurred at 375 Ma; if younger ages for this metamorphism are assumed (360 Ma), rates drop to about 1.7 mm/a. Final exhumation rates from mid- to shallow-crustal levels range from 0.2 to 0.3 mm/a. Previous work has shown there is a possibility of UHP metamorphism pre-dating the HP metamorphic event; modelling shows that a UHP event at 385 Ma fits well within the time frame of arc-continent collision in the south Urals as constrained by geological and isotopic data. Exhumation from UHP to HP conditions would have been faster initially (9.2 mm/a) and followed by a long relaxation period (25 m.y.) at eclogite-facies conditions; this relaxation period would have provided the time and heat required to transform any UHP index minerals to their low-pressure pseudomorphs.

T32B-0901 1330h POSTER

Wavelet transform mapping of effective elastic thickness and plate loading

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We present a new wavelet transform method to map spatial variations in effective elastic thickness T_e and plate loading ratio f. The method assumes a model of thin plate flexural isostasy to describe the mechanical response of the lithosphere to vertical loading. In this model, the rheological properties of the lithosphere are aggregated into the effective elastic thickness T_e of an equivalent thin plate overlying an inviscid fluid. A number of methods have been developed to map spatial variations in T_e in an attempt to assess regional patterns of flexural strength. Our new method first obtains local coherence and local admittance through wavelet cross-spectral analysis of surface topography and Bouguer gravity anomaly. Wavelet coherence is used to obtain the local characteristic wavelength, which is a function of both T_e and the degree of relative loading f of the plate by sub-surface loads and surface loads (loading is the combined effect of erosion, sedimentation, intrusion, faulting and metamorphism). Wavelet admittance is converted into local pseudo-coherence and is used to resolve this f-T_e ambiguity. We carry out extensive tests of the wavelet method on simulated topography and Bouguer gravity anomaly data, that we generate through finite difference simulations of flexural isostasy with spectrally realistic loads and simple spatial variations in T_e. These tests demonstrate that the wavelet inversion method is reasonably robust to uncertainties in loading and in crustal thickness, and is able to recover the correct values and patterns of T_e to within $\pm5\,\mathrm{km}$. We apply the wavelet method to southern Africa and recover estimates of T_e principally in the range $25-50\,\mathrm{km}$, in good agreement with existing estimates from forward modeling and Fourier coherence analyses. The relationship of the apparent variations in T_e and plate loading to regional tectonics are discussed.

URL: http://geomorph.ldeo.columbia.edu

T32B-0902 1330h POSTER

Relationships Between the Kern Canyon Fault (KCF) and the Prot-Kern Canyon Fault (PKCF), Southern Sierra Nevada, CA.

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The PKCF is an intra-arc shear zone which accommodated several tens of kilometers of Late Cretaceous dextral displacement during oblique convergence between the North American and Farallon plates. It is expressed for ca. 90% of its ca. 130 km length as a 1-2 km wide zone of mylonitization centered along a transposed intrusive contact with pendant rocks both as a function of distance from the contact and rock type: Marbles and pelites are pervasively deformed with crystal plastic fabrics, while impure and pure quartzites and amphibolites are domainally sheared with vestigial lenses preserving earlier deformation, metamorphism, and primary features. The east-bounding granitic intrusives are pervasively mylonitic for up to .51 km, with the youngest phases (85-80 Ma) exhibiting syn-magmatic shear fabrics. Much of the batholithic rock to the west of the shear zone-hosting pendant is Early Cretaceous in age and shows localized brittle-ductile shear bands related to the PKCF. We interpret these relations to indicate that Late Cretaceous ductile shearing was localized along a high ductility contrast zone between older far subsolidus batholithic rocks to the west and solidus to near subsolidus intrusions to the east. The northen half of the PKCF also exhibits a brittle phase of dextral shear localized primarily along the pendant - Late Cretaceous batholith contact zone. In the Kernville area this brittle shear zone/fault is shunted southwestward into the KCF. Timing of this brittle phase of dextral shear is poorly constrained, but is thought to be latest Crtetaceous - Paleocene(?). Busby-Spera and Saleeby (1990) suggested a minor component of East side up motion of the PKCF. Recent field investigations indicate West side up normal faulting remobilization of the KCF and its northward extension into the PKCF has occurred in Quaternary time. The down-dip projection of the normal fault structures intersects the Durrwood Meadows hypocenter swarm of extensional earthquakes (Jones and Dollar, 1986).

T32B-0903 1330h POSTER

Provenance of Cambrian Sandstone in Southern Israel: SHRIMP Dating of Detrital Zircons

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Phanerozoic silisiclastic detrital sequences cover large parts of NE Africa and Arabia. East of the Nile, including in southern Israel, thick Phanerozoic siliciclastic sequences (often referred to as Nubian sandstones) rest upon the Pan-African crystalline basement of the Arabian-Nubian Shield (ANS) that was deeply eroded at the end of the Neoproterozoic. This late to post Pan-African unroofing is a logical source for the thick Phanerozoic sequence that was deposited over the northern Gondwana margin, but previous U-Pb geochronology of detrital zircons in northern Africa yielded Middle Proterozoic ages (pre-Pan-African).

In southern Israel, Middle to Late Cambrian sandstone unconformably overlies the Late Precambrian crystalline basement of the ANS. U-Pb SHRIMP measurements were performed on 230 zircon grains from 4 samples taken from different startigraphic levels of the Cambrian of southern Israel.

In contrast with previous studies, our data reveal ubiquitous Pan-African detritus in these rocks. The Cambrian section contains an important contribution (more than 80%) of individual zircons that yield concordant 206Pb/238U ages between 530-950 Ma. These grains are idiomorphic to slightly rounded, typically showing oscillatory, euhedral concentric Cl zoning. They were derived from a Pan-African terrain, most probably from the ANS. Our analyses also revealed the presence of a small proportion of pre-Pan-African zircons, Early and Middle Proterozoic ages: 1.8-1.9 and 2.65-2.7 Ga. in the same Cambrian section. Because the Arabian-Nubian Shield is generally considered to be juvenile Pan-African crust, the provenance of pre-Pan-African zircons should a priori lie at the shield's margins or outside it. However, the shape of these ancient zircon grains does not differ significantly from the Pan-African zircons we dated, suggesting that a distal provenance outside the ANS may not be indicated. Pre-Pan-African crust has been reported in isolated parts of the ANS and it is thus possible that the pre-Pan-African zircons were derived from terrenes similar to these.

Our work has shown that the Cambrian section in Israel contains abundant Pan-African detritus, whereas previous studies showed that Ordovician and younger siliciclastic sequences in northern Africa were derived from a Middle Proterozoic source. Previous preliminary data suggest that it is reasonable to assume that the post-Cambrian section in Israel is also dominated by pre-Pan-African detritus. If this is correct, the end of the Cambrian marks the end of erosion of the Pan-African orogen in NE Africa.

T32C MC: 309 Wednesday 1330h

Hotspot-Ridge Interactions II *(joint with OS, S, V)*

Presiding: **J Lin,** Woods Hole Oceanographic Institution**; J Dyment,** Universit de Bretagne Occidentale

T32C-01 1330h

Jan Mayen, related to ridge-transform-plume or ridge-transform interactions?

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Jan Mayen, an active volcanic island in the North Atlantic (71N), is located at the Jan Mayen fracture zone that separates the ultra-slow spreading Kolbeinsey and Mohns ridges. The volcanic island has been interpreted to form above a mantle plume, to be related to the Icelandic plume, to result from leaky transform volcanism, or to have formed by southward propagation of the Mohns ridge into a microcontinent situated south of the Jan Mayen fracture zone. The location of the southernmost segment of the Mohns ridge has been poorly defined, and the relation between the ridge and volcanic island volcanisms has therefore been unclear. Dredge sampling and ROV survey followed multibeam mapping of the Jan Mayen region and the Mohns ridge during two cruises in the summer of 2001. These surveys demonstrated that the neovolcanic zone of the Mohns ridge intersects the Jan Mayen fracture zone about 60 km east of Jan Mayen. Mapping and dredge sampling demonstrated also that Jan Mayen does not extend north of the Jan Mayen fracture zone. The volcanic island does therefore not define the southernmost tip of the Mohns ridge, and is not related to propagation of this ridge across the fracture zone and into the margin of a micro-continent located south of the fracture zone. Bathymetry and lineament analyses suggest that the northern, and highly active part of the volcanic island may represent a very short spreading segment within the fracture zone. Submarine lava flows from the northern part of Jan Mayen, and the southern segments of the Mohns ridge were systematically dredge sampled. Elemental and isotopic compositions of these basalts will be reported and discussed in terms of Jan Mayen being related to ridge-transform-plume or just ridge-transform interactions, and the influence of the Iceland plume on the Arctic ridges.

T32C-02 1345h INVITED

Mantle Discontinuity Structure Beneath Iceland

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Receiver functions derived from teleseismic body waves recorded in two broadband seismic experiments in Iceland reveal shear waves converted from compressional waves at mantle discontinuities near 660-, 410-, 330-, and 200-kilometer depth. The transition zone

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between the 410- and 660-km discontinuities is anomalously thin beneath central and southern Iceland. The center of the transition-zone anomaly lies at least 100 km south of the upper-mantle low velocity anomaly imaged tomographically. This offset is evidence for a tilted plume conduit in the upper mantle. Together with shear-wave-splitting measurements at seismic stations in Iceland and the north-south elongation of the low-velocity anomaly at 300-400 km depth, tilting of the plume suggests a generally northward flow of the upper mantle beneath the North Atlantic region near Iceland.

The depth to the 330-km discontinuity increases from northeastern Iceland to southwestern Iceland. This is probably a consequence of the differences in the history of the interactions between the plume and the Eurasian and North American plates. It may also be related to the apparently more pronounced geochemical and geophysical anomalies along the spreading center south of Iceland than to the north. Possible explanations for the 330-km discontinuity include the onset of (wet) melting, the base of the horizontally deflected plume mantle, and the transition between coecite and stishovite.

The topography of the 200-km discontinuity is relatively flat and therefore does not follow the pressure-temperature relationship for melting beneath the hotspot. Stacking of receiver functions from northeastern Iceland, where shear-wave-splitting measurements show a similar pattern of anisotropy, reveals two points of transverse energy - about 180 degrees apart in azimuth and with the same polarity - originating from the 200-km discontinuity. Little transverse energy is seen in phases generated at any of the discontinuities below this depth. This observation suggests that the 200-km discontinuity beneath Iceland is associated with a transition between isotropic and anisotropic mantle layers.

T32C-03 1405h

Rayleigh Wave Constraints on Shear Wave Velocities Beneath Iceland

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A plume conduit beneath Iceland has been imaged using body wave tomography, however, the morphology of the plume head, a key indication of plume-ridge interaction, is not yet well resolved. We investigate upper mantle structure beneath Iceland by imaging shear wave velocity structure using Rayleigh wave phase and amplitude data recorded during both the HOTSPOT and the ICEMELT experiments. We have applied the two-plane wave technique and used events with epicentral distance from 30° to 120° and Mb > 6.0. The average phase velocity varies from 3.58 km/s at period 20 s to 3.83 km/s at 100 s, ∼0.1 km/s lower than for Pacific sea floor of age less than 4 Ma, indicating the presence of melt in the crust and shallow upper mantle beneath Iceland. The generally low phase velocities at periods less than 33 s are confined in the Icelandic rift zones and the lowest phase velocity is imaged near the plume center, corresponding to the thickest crust in Iceland. At longer periods (> 50 s), two slow regions appear in southwestern and north-central Iceland, near the western and northern rift zones, respectively. The slow anomalies are connected to the plume at different periods, suggesting that they may be fed by the plume at different depths. The connection is deeper in southern Iceland. We do not observe a plume head which spreads out evenly from the plume center. Surprisingly, phase velocities at periods greater than 50 s beneath the plume center are close to or slightly higher than the average in Iceland. To better understand the 3-D dynamics of the plume-ridge interaction, we will invert for 3-D shear-wave structure from the phase velocities and take into account effects of anisotropy as well.

T32C-04 1420h INVITED

Plume-Ridge Interaction in Iceland: Expression in Crustal Deformation Fields and Volcanic Activity

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Plume-ridge interaction greatly influences the geology of Iceland and is responsible for the island's existence. A number of anomalies of this hotspot-ridge system are well known and have been used for modeling, such as anomalous topography, excessive crustal thickness, geochemical signatures, and V-shaped ridges along the Reykjanes Ridge. We give overview of two other types of data that hold the potential to constrain models of plume-ridge interaction. These data are observed crustal deformation fields in Iceland, and knowledge about volcanic activity. Repeated geodetic observations have been extensively used in Iceland to measure deformation associated with rifting and volcanism. Electronic distance measurements and precise leveling were initiated in the 1960s. Several hundred geodetic benchmarks have been repeatedly measured in GPS campaigns since 1986, and a network of continuously recording GPS stations is being installed. Large areas of the plate boundary have as well been studied with InSAR, interferometric analysis of Synthetic Aperture Radar images acquired by satellites. The regional measurements provide constraints on rheological properties of the crust, and show that the lower crust behaves viscoelastically. The geodetic data provide some information on conditions in the mantle, as Iceland holds the unique possibility of allowing studies of response to ice-load removal and post-glacial uplift at a plume-ridge system. Previous modeling of glacio-isostatic uplift in Iceland has suggested a maximum viscosity value of 10^{19} Pa s for the mantle under Iceland. On a more local scale, deformation at a number of volcanic systems in Iceland is consistent with pressure sources at depths of 3-8 km, relating to magma accumulation. Transport of magma from below to these magma accumulation areas is clearly episodic. Episodic behavior is also characteristic for the volcanic activity in Iceland. After a quiet period during the middle part of the 20th century, activity increased during its last quarter. In a 200-km-wide area in South and Central Iceland activity has been unusually high since 1994, with three confirmed eruptions, intrusive activity in two other volcanoes, a number of unconfirmed eruptions, and large earthquakes. Different tectonic setting of the volcanoes involved, suggest it is unlikely that the activity pulse is solely triggered by plate movements, as these would affect the involved volcanoes differently. An explanation for such a pulsating activity over wide areas may be pulsating delivery of magma from the Iceland mantle plume, or contemporaneous episodic transport of magma through the lower crust at a number of Iceland's volcanic systems at intermittent times. Our suggestion is that plume-ridge interaction is not only responsible for generation of thicker crust in Iceland, but also for anomalously high amount of magma inside the crust (compared to slow spreading ridges), fed by pulsating delivery of magma from the Iceland plume. Any plume-ridge model that yields displacements on the surface of the Earth or predicts flow of magma from the mantle towards the surface can be compared to the observed deformation fields and behavior of volcanic activity in Iceland.

T32C-05 1440h

Summary of Geothermal Data Around the Iceland Hot Spot

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A total of 90 publicly available heat flow measurements on and around Iceland between 60-70 deg N latitude and 5-30 deg W longitude are analyzed together with the extensive geophysical data in the region. The mean and standard deviation of 13 values on Iceland are $139\pm74 mWm^{-2}$, and $105\pm70 mWm^{-2}$ for 77 marine values around Iceland. The measurements closest to sea level (0-80 m elevation) are among the highest values (up to 310 mW m^{-2}) and have the largest data scatter on Iceland, suggesting redistribution of heat by pore water advection. Analogously, the oceanic measurements exhibit maximum data variability at the shallowest oceanic depths (600-2500 m), probably the result of hydrothermal circulation in the youngest seafloor of the region. On the other hand, most of the oceanic data on seafloor older than 10 M.y. are reasonably fit to the standard heat flow vs. crustal age relationship for other ocean basins. Almost all the marine measurements are associated with significantly shallower depths than the standard depth vs. age relationship for other ocean basins (mean difference >2.1 km), indicating the widespread and long-lived (>60 M.y.) influence of the hot spot. With the oceanic heat flow data corrected for plate cooling, the most reliable values appear to have no significant mean trend of heat flux with distance from the approximate center of the Iceland platform.

T32C-06 1455h

Heat Flow measurements along a 14 Ma isochron paralleling the South-East Indian Ridge between 90E and 130E

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New heat flow data were obtained during the MD120-ANTAUS expedition of R/V Marion Dufresne (Oct. 12th - Nov. 7th 2000), along a profile paralleling the Southeast Indian Ridge, between 90° and 130°E, on 14 Ma old sea floor. The prime objective of the cruise was to quantify the temperature anomalies within the earth upper mantle associated with the Australian-Antarctic Discordance (AAD), an anomalously deep section of the Mid-Ocean Ridge that is often attributed to a mantle "cold spot". The second objective was to collect sediment cores from the southern ocean in order to study past climate changes.

Despite rough weather and bad seas, a total of 25 thermal measurements was obtained, using 9 autonomous digital temperature probes fitted on a 18 m-long, 13 cm-diameter, gravity corer. Full penetration of 18 m was regularly achieved. In order to quantify water advection, sediment samples sealed in copper tubes will be analyzed to determine the 3He/4He isotope ratio, used as a tracer of hydrothermal activity (with the assumption that if water has circulated within the crust, then the 3He/4He isotopic signature is expected to be that of the crust and upper mantle).

The data are highly variable and the measured heat flow is everywhere less than the theoretical heat flow predicted by conductive lithospheric models, probably because of advective heat transport linked to hydrothermal circulation, which is most certainly still active on 14 Ma old crust. Within the deep AAD region, the thermal gradient in the sediments departs from linearity as it approaches the water/sediment interface, probably because of step-changes in the bottom water temperature. The AAD is a major passageway for deep water formed around Antarctica (AABW: Antarctic Deep Bottom Water), and our data reveal 0.05 to 0.08°C temperature fluctuations of this deep water mass. The average heat flow is lower inside the AAD than outside, but this could be the result of differing sedimentation in the two regions that induce differences in hydrothermal activity.

We suggest that variations in hydrothermal crustal cooling induced by the eastward decrease in sedimentation may partly explain the large variations in subsidence rate that have been documented along the South-East Indian Ridge between 90°E and 140°E (e. g. Hayes and Kane, JGR, 99, 19679-19692, 1994).

T32C-07 1530h

Upwelling Rates Beneath Hotspots : Evidence From U-Series in Basalts From the Mid-Atlantic Ridge and the Azores Islands

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In this study, we have analyzed U-series in lavas from the Azores islands and the nearby Mid-Atlantic Ridge (FAZAR cruise) in an attempt to assess the relative importance of melting processes versus source variations in the context of ridge-hotpsot interaction. The lavas were analyzed for ^{238}U-^{230}Th (Turner et al. 1997, Bourdon et al. 1996) ^{226}Ra-^{230}Th and ^{235}U-^{231}Pa disequilibria by thermal ionisation mass spectrometry.
Our results for the historic lavas from the Azores islands show that the ^{231}Pa excess are at the low end of the trend found for other OIB (Pickett et al. 1997 and Bourdon et al. 1998) and fall on a positive correlation in a $^{231}Pa/^{235}U$ versus $^{230}Th/^{238}U$ diagram. In contrast, lavas from the nearby Mid-Atlantic ridge are characterized by larger ($^{231}Pa/^{235}U$) activity ratios

for similar and greater ($^{230}Th/^{238}U$) ratios. There is also a weak correlation between $^{226}Ra/^{230}Th$ and $^{231}Pa/^{235}U$.
These data do not indicate a simple mixing trend between an N-MORB and an enriched component in the $^{231}Pa/^{235}U$ versus $^{230}Th/^{238}U$ diagram since the MORBs which do not have the most radiogenic isotope signatures compared with the Azores island basalts have some of the largest ($^{230}Th/^{238}U$) and $^{231}Pa/^{235}U$. Clearly, the dynamics of melting must have played a role in generating larger ^{230}Th and ^{231}Pa excesses beneath the Mid-Atlantic ridge. We infer that this must be due to the absence of a lithospheric lid as larger excesses of ^{230}Th and ^{231}Pa can be generated for longer melting columns. Thus, ridge-hotspot interaction cannot imply a simple transfer of melt from the hotspot to the ridge.
The $^{230}Th/^{238}U$ and $^{226}Ra/^{230}Th$ data across the Azores plateau shows a maximum for the island of Terceira and mimics the depth anomaly which is thought to result from the hotspot. This trend is also consistent with observations of rare gases (M. Moreira pers. comm.) and suggests that it must be related to the presence of deep material. The U-series trend is the reverse of the trend found in Hawaii by Sims et al. (2000) which was attributed to variations in upwelling rates across the rising plume. This observation can be rationalized in the context of an equilibrium melt transport model (Spiegelman and Elliott, 1993) where U-series disequilibria are sensitive to upwelling rates. For slow upwelling rates such as below the Azores, larger ^{230}Th excesses are predicted in the center of the plume. This suggests that the upwelling rate beneath the center of the plume must be of the order of a few cm per year which is an order of magnitude lower than values estimated for Hawaii.

Turner et al. 1997, Chem. Geol. 139, 145-164. Bourdon et al. 1996, Earth Planet. Sci. Lett. 142, 175-189. Pickett et al. 1997, Earth Planet. Sci. Lett. 148, 259-271. Sims et al. 1999, Geochim. Cosmochim. Acta. 63, 4119-4138. Spiegelman and Elliot, 1993, Earth Planet. Sci. Lett., 118, 1-20.

T32C-08 1545h

The Foundation Hotspot-Pacific-Antarctic Ridge System: What Happens When a Ridge Approaches a Hotspot?

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The Foundation chain formed during the last 21 Ma by the action of a hotspot, presently located roughly 35 km west of the axis of the Pacific-Antarctic Ridge (PAR). The Foundation-PAR system is the best documented case of a fast spreading ridge approaching a hotspot and interacting with it. The eastern part of the chain, near the Pacific-Antarctic ridge, is formed by volcanoes younger than 5 m.y., built on a plate less than 5 Ma old. They are distributed along two subparallel lines. The distance between these two lines diminishes towards the PAR. The north line, corresponding to the larger volcanoes, is the main locus of the volcanism. The south line was probably formed along fissures on top of the flexural arch resulting from the emplacement of the north line. The approach of the PAR to the hotspot resulted in the reduction of the effective elastic thickness (Te) of the plate towards the spreading ridge from 5 to 0 km. This spatial variation of Te correlates with a change in the morphology and in the volume of the volcanoes and with the reduction in the distance between the north and south lines, suggesting an important control of the lithosphere on the volcanic processes. Off axis, the chemical and isotopic composition of the basalts reveal a growing influence of the ridge on the plume volcanism. The pattern is coherent with a mixing between two sources, occurring when the two melting zones merge and overlap. The morphology, crustal structure and the chemical composition of the lavas of the axial area of the PAR show evidence of the influence of the hotspot. The crust is 1.5 km thicker where the hotspot is nearer to the PAR. Anomalous ridge elevation is 650 m and the along-axis width of the chemical anomaly is at least 200 km. A comparison of these axial parameters with those derived for other ridge-hotspot systems, suggests that the amount of plume material reaching the ridge axis is smaller for the Foundation-PAR system. This implies a weaker connection between plume and ridge. Cumulative effects of a fast spreading rate and of a fast ridge-hotspot relative motion can be responsible for this weak plume-ridge flow. The flow from the hotspot may be less efficiently channeled towards the ridge axis when a fast ridge is rapidly moving towards a hotspot.

T32C-09 1600h

Geodynamic models of motion of the Easter Hotspot Plume, and implications on its location relative to the East Pacific Rise during the past 40 Ma.

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Models of deformation of a plume conduit in large-scale mantle flow are used to compute the motion of the Easter hotspot in a mantle reference frame. A large number of different models of mantle flow, and with different values for plume buoyancy, age and location were computed to test the robustness of the results. Consistently all models showed an initial eastward motion of the plume, followed by a westward motion. The former corresponds to eastward flow in the upper part of the mantle, from the upwelling in the central Pacific to the subduction zone under South America, the latter to the flow in opposite direction in the lower part of the mantle: The upper part of the plume conduit gets dragged towards the subduction zone, but then the conduit straightens up due to its buoyancy. Hence the transition from eastward to westward motion happens earlier, if an older plume age, or a larger buoyancy is assumed.

Predicted hotspot track, age progression and relative location of hotspot and ridge additionally depend on plate motions in the same mantle reference frame and evolution of the Pacific-Nazca plate boundary, hence models and uncertainties of those will be discussed.

The number of acceptable models can however be severely constrained by comparision of predicted and observed geometry and age progression of the hotspot track, as well as by the different gravity signature of Nazca versus Sala y Gomez ridge, which may indicate that the former was formed by a plume beneath the ridge, while the latter was formed by an off-ridge plume. Some more speculative thoughts on how details of the hotspot track may relate to ridge reorganizations and related changes in mantle flow pattern will also also be presented.

T32C-10 1615h INVITED

Plume Capture by Divergent Plate Motions: Implications for the Distribution of Hotspots, Geochemistry of Mid-Ocean Ridge Basalts, and Heat Flux from the Core-Mantle Boundary

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The coexistence of mantle plumes with plate-scale flow is problematic in geodynamics. Significant problems include the fixity of hotspots with respect to plate motions, the spatial distribution and duration of hotspots, the geophysical and geochemical signatures of plume-ridge interactions, and the relation between mantle plumes and heat flux across the core-mantle boundary. We present results from laboratory experiments aimed at understanding the effects of an imposed large-scale circulation on thermal convection at high Rayleigh number (up to 10^9) in a fluid with a strongly temperature-dependent viscosity. In a large tank, a layer of corn syrup is heated from below while being stirred by large-scale flow due to the opposing motions of a pair of conveyor belts immersed in the syrup at the top of the tank. Three regimes are observed, depending on the velocity ratio V of the imposed horizontal flow velocity to the rise velocity of plumes ascending from the hot boundary. When $V<<1$, large scale circulation has a negligible effect and convective upwelling occurs as randomly-spaced axisymmetric plumes that interact with one another. When $V>10$, plume instabilities are suppressed entirely and the heat flux from the hot lower boundary is carried by a central sheet-like upwelling. At intermediate V, ascending plumes are advected along the bottom boundary layer, and the heat flux from the boundary is found to scale (according to a simple boundary layer theory) with V and the ratio of the viscosity of cold fluid above the thermal boundary layer to the viscosity of the hottest fluid in contact with the bottom boundary. For large viscosity ratios (10-100), only about 1/5th or less of the total heat flux from the hot boundary layer is carried by plume instabilities, even for modest imposed horizontal flow velocities (V of order 1).

When applied to Earth, our results suggest that plate-scale flow focuses ascending mantle plumes toward mid-ocean ridges, and that plumes may be entirely captured by sufficiently rapid upwelling flow beneath ridges. This behavior may explain why hotspots are more abundant near slow-spreading ridges than near fast ridges. Such a model also predictes, in apparent accord with geochemical observations, that while slow ridges exhibit more variable isotopic and trace element signatures than fast ridges, their average signatures should be about the same. The laboratory experiments further suggest that plumes originating at the core-mantle boundary (CMB) may carry only a small fraction of the total CMB heat flux, the remainder being swept away by large-scale mantle flow associated with plate-scale convection.

T32C-11 1635h

Geophysical Evidence for a Possible Late Jurassic Mantle Plume in the Gulf of Mexico

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Gravity, magnetic and seismic refraction data reveal a prominent basement structure beneath the Keathley Canyon area of the western Gulf of Mexico. Several seismic refraction profiles acquired near and over the structure indicate depths to its crest range from 10.5 to 12 km, rising from basement depths of 14 to 16 km below sea level. Because of the presence of extensive salt features, seismic reflection data are unable to accurately image the structure but several reflection profiles indicate the existence of a basement high in the area. A positive free-air gravity anomaly associated with this basement structure extends 200 km from 93.9° W, 26.4° N along a roughly WNW-ESE directed path to 91.7° W, 25.9° N where it turns northeastward. Bathymetric and seismic reflection data indicate the gravity anomaly is not produced by seafloor topography or shallow sedimentary sources, but can be attributed to the basement relief documented. Its amplitude and wavelength decrease to the ESE, from 70 mGal and 100 km wavelength to 35 mGal and 40 km wavelength. A positive magnetic anomaly with a 130 nT amplitude and 30 km wavelength coincides with the WNW end of the free air gravity anomaly. It extends to the ESE in a similar manner to the gravity anomaly, but its amplitude decays more rapidly.

Most models for the formation of the Gulf of Mexico basin culminate in a late Jurassic-early Cretaceous phase of seafloor spreading as the Yucatan Block rotates counterclockwise away from North America. The shape of the free air gravity anomaly over the deep basement structure defines a geometry that is similar to those produced by other hotspot tracks, such as the New England Seamounts, Rio Grande Rise or Vitoria-Trindade seamount chain. The WNW-ESE direction is broadly consistent with motion of North America in the hotspot reference frame at the time of basin formation. Such an interpretation suggests that a minor mantle plume may have been active during spreading and played a significant role in the development of the basin. We consider the westerly end of the gravity anomaly to roughly delineate the ocean-continent boundary beneath >15 km of sediments off the Texas coast. At its eastern end, the gravity anomaly turns northeastward and may correspond to the location of a fossil sea floor spreading center.

T32D MC: 310 Wednesday 1330h

Processes Within the Subduction Factory: Arc and Back-arc Basin Composition and Structure *(joint with OS, S, V, DI, MR)*

Presiding: **P Fryer,** University of Hawaii**; J Ryan,** University of South Florida

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T32D-01 1330h

Volcanoes Track Mantle Flow Beneath Luzon Arc

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