## U72A-12 1330h POSTER

### Ridge Push and Plume Push

Wolf R Jacoby[1] (+49 6131 3923223; jacoby@mail.uni-mainz.de)

Herbert Wallner[1] (+49 6131 3923173; wallner@mail.uni-mainz.de)

[1]Earth Sciences, University of Mainz, Saarstr. 21, Mainz 55099, Germany

Driving forces of plate movements are an aspect of mantle convection. Ridge push (RP) is generally accepted, plume push (PP) is less certain; an assessement is attempted. Stresses are generated by lateral density variations subject to gravity and by drag from flow. The former can be estimated, the latter has a trade-off between viscosity and flow. Dynamic topography, geoid or gravity anomalies may give some hints. A simple model (thickening elastic lithosphere, viscous asthenosphere) permits evaluation by parameter variation (relative elevation, plate thickness and density, asthenosphere viscosity, ridge length vs. plume "length). Most plumes exert insignificant PP, except the Iceland plume in the North Atlantic (NA). The ridge axial bathymetry falls off from +1 km in Iceland to -4 at 1600 km distance S and N (average bulge elevation excess 2.5 km), corresponding to RP at 60 Ma age (initial opening). The "standard" RP of the whole MAR is increased by 20% (NA: 30%). The influence of other ridge-near plumes is insignificant. The simple estimates are backed up by FE modelling to evaluate the influence of the rheological structure. Only the non-elastic, flowing parts permit to expend driving work (RP x spreading). Simple parametrisation shows thick continental crust not to spread, while "hot" ridges and plumes with low-viscosity cores "work", depending on other plate boundary conditions (slab pull). While different model aspects are examined, the results by Bott (Tectonophysics, 200,17, 1991) are supported. Plumes, except Iceland, play no significant role in the plate force balance, in contrast to the energy balance.

## U72A-13 1330h POSTER

### Shear-Wave Splitting Around Hawaii: Testing Kinematic Models of Lithosphere/Asthenosphere Interaction for a Plume

Kristoffer T. Walker[1] (650-725-0278; ktwalker@stanford.edu)

Goetz H. R. Bokelmann[1] (650-725-9181; goetz@pangea.stanford.edu)

[1]Stanford University, Department of Geophysics, Stanford, CA 94305, United States

Observations of shear-wave splitting in plume regions may give important observational insight into the kinematics of upper-mantle flow and lithosphere/asthenosphere interaction. The "parabolic flow model" predicts the geometry of flow above a mantle upwelling. Specifically, it predicts a characteristic spatial pattern of anisotropy, which allows us to constrain volumetric flow rate and relative motion of the plate with respect to the plume source. Shear-wave splitting and anisotropy can also help constrain rheological material behavior since it distinguishes regions of dislocation creep from those of other deformation mechanisms.

In general, dislocation creep controls deformation in the lithospheric mantle. However, in regions of elevated mantle temperature, the zone of dislocation creep may deflect into the asthenospheric mantle. In regions around mantle plumes therefore, upper-mantle shear-wave splitting may provide information about the kinematics (and also the dynamics) of the interaction between the lithosphere and asthenosphere. This presentation will focus on testing kinematic models of the interaction between the lithosphere and asthenosphere by comparing teleseismic splitting measurements of SKS, SKKS, S, and ScS with those predicted for the various models. We use previously published shear-wave splitting measurements from five stations on the Hawaiian Islands (PELENET and KIP), and augment them with measurements from an ocean-borehole seismometer located 220 km SW of Hawaii (OSN-1 pilot study) and an ocean-bottom seismometer located between Hawaii and California (H2O). Waveforms from these stations are very important, as they provide well-constrained measurements that are not influenced by the Molokai fracture zone, which possibly influences splitting measurements beneath nearby island stations. In addition, the high quality of these data and the splitting measurements document the importance of ocean-bottom seismometers.

Preliminary data suggest that splitting beneath H2O can be explained by a single-layer model with an ENE fast polarization direction that is consistent with a fossilized lattice preferred orientation of olivine parallel to the spreading direction. Preliminary data from OSN-1 can also be explained by a single layer of anisotropy, but with an ESE fast polarization direction and a relatively large delay time. We cautiously interpret this splitting and the splitting beneath the islands as due to upper-mantle anisotropy predicted by the "parabolic flow model". This implies that basal tractions under Hawaii resist plate motion rather than drive it, as it indicates the relative motion between lithosphere and underlying mantle.

URL: http://pangea.stanford.edu/∼ktwalker/Hawaii

## U72A-14 1330h POSTER

### Evidence for Recently Induced Deformation in the Mantle Beneath the Eifel Volcanic Fields (Germany) from Shear Wave Splitting Analysis

Guenter Bock[1] (+49-331-288 1212; bock@gfz-potsdam.de)

The Eifel-Plume Team

[1]GeoForschungsZentrum Potsdam, Telegrafenberg, Potsdam 14473, Germany

Splitting of $SKS$ phases is a reliable diagnostic feature for horizontal anisotropy in the lithosphere and asthenosphere. Fast $S$-wave velocity directions and delay times between fast and slow split wave were determined for temporary seismic stations deployed between November 1997 and June 1998 in the area of the Eifel plume. Mantle plumes are regions where the preferred subhorizontal alignment of olivine causing $SKS$ splitting may be lost as a result of rising mantle rock. Results of splitting analysis of $SKS$ and $SKKS$ phases can be summarized as follows: (1) Subhorizontal anisotropy is low in the Eifel area as evidenced by low delay times of not more than 0.5 s; (2) the directions of the fast split waves are approximately NNE which is nearly parallel to the tensional component of the regional stress field; (3) the measured fast split wave directions are significantly different from the regional anisotropy directions which are approximately E-W. The results are interpreted by a model of mantle material rising into the lithosphere where olivine is partly re-aligned parallel to the horizontal tension direction of the present-day regional stress field.

## U72A-15 1330h POSTER

### Evidence for Lithospheric Coupling in Anisotropic Body Wave Polarizations

Vera Schulte-Pelkum[1] ((858) 534-8119; vera@mahi.ucsd.edu)

Donna K Blackman[1]

[1]Scripps Institution of Oceanography, 9500 Gilman Dr. A-0225, La Jolla, CA 92093, United States

The study of seismic anisotropy can address a fundamental question in lithosphere-asthenosphere interaction. If the orientation of upper mantle anisotropy coincides with surface tectonic features, mantle convection can be inferred to be a significant plate driving force. Alternatively, if the alignment of mantle anisotropy corresponds to current absolute plate motion then a passive response of the asthenosphere is indicated. Most commonly, $SKS$ splitting and surface waves are used to infer mantle anisotropy, but these phases lack vertical ($SKS$) or lateral resolution (surface waves). We present new observational evidence of anisotropy from a global dataset of long-period $P$ particle motion anomalies. This new technique is sensitive to seismic structure in the upper 300 km of the mantle underneath the station. By comparing fast directions of $P$ polarization to other workers' results from $SKS$ splitting and $P_n$ travel time analysis, we add new depth constraints on the upper mantle anisotropy. Modelling of the effect of different anisotropic symmetries and orientations on $P$ and $S$ phases provides additional constraints. Our results suggest that lithospheric coupling is predominant in regions of past and present tectonic activity and that, therefore, mantle convection is a significant plate driving force in these areas. In contrast, anisotropy underneath cratons appears to be aligned with absolute plate motion indicating passive flow of the mantle in these regions.

## U72A-16 1330h POSTER

### Does Seismic Anisotropy at the Base of the Lithosphere Reflect Lithospheric Drag?

Michel Cara[1] (33-3-88416377; mcara@eost.u-strasbg.fr)

Eric Debayle[1] (33-3-88416484; Eric.Debayle@eost.u-strasbg.fr)

Jean Jacques Leveque[1] (33-3-88416378; leveque@sismo.u-strasbg.fr)

[1]IPGS-EOST, 5 rue R. Descartes, Strasbourg F67084, France

Seismic anisotropy is mainly governed by lattice-preferred orientation of olivine crystals in the upper mantle. At the base of the lithosphere, the olivine a axis should be parallel to the direction of maximum extensional strain. For large horizontal strain, the azimuth of the preferred orientation of olivine a axes is thus expected to indicate the direction of relative motion of the lithosphere above the underlying mantle. Depending on the hypotheses made on the asthenospheric flow, different patterns of seismic anisotropy are expected. Beneath continents both the directions of forces acting at the base of the lithosphere and the geometry of the asthenospheric flow may be related to the observations of seismic anisotropy in the depth range 150-300 km.

Changes in anisotropic directions with a vertical resolution of about 50 km can now be resolved thanks to the use of waveform modeling of Rayleigh waves. In addition, when dense array of broadband stations are available, this vertical resolution can be combined with a lateral resolution of a few hundreds of kilometers. Permanent IRIS and Geoscope broadband stations complemented by temporary deployment of portable stations are thus well suited for mapping the azimuthal anisotropy at depth in several continental regions. As already observed beneath oceans where the directions of fast SV velocities at sub-lithospheric depth correlate with the directions of absolute motion of the plates, we show that evidence starts to accumulate beneath continents. We present examples from India and Australia showing that the rather simple patterns of azimuthal anisotropy around 200 km could be related to the direction of the present-day plate motion while this is not the case at shallower depth where much more complicated patterns are observed within the lithosphere.

## U72A-17 1330h POSTER

### Mantle Flow at a Slab Edge: Seismic Anisotropy in the Kamchatka Region

Jeffrey Park[1] ((203) 432-3172; jeffrey.park@yale.edu); Vadim Levin[1]; Valerie I Peyton[3]; Mark T Brandon[1]; Jonathan M Lees[2]; Evgenii Gordeev[4] (gord@emsd.iks.ru); Alexei Ozerov[4] (ozerov@emsd.iks.ru)

[1]Yale Univ., PO Box 208109, Dept of Geology, New Haven, CT 06520-8109, United States

[2]Univ. of North Carolina, Department of Geological Sciences, Campus Box 3315, Mitchell Hall,, Chapel Hill, NC 27599-3315, United States

[3]USGS, Albuquerque Seismological Laboratory, Albuquerque, NM 87115, United States

[4]Russian Academy of Sciences, Far Eastern Branch, OMSP, 683006, Petropavlovsk, Kamchatka, Kam, Russian Federation

The junction of the Aleutian Island chain and the Kamchatka peninsula defines a sharp turn in the boundary of the Pacific and North American plates, terminating the subduction zones of the northwest Pacific. Near a dangling slab, sharp lateral gradients of flow-induced anisotropy in the mantle should produce spatial variations in shear-wave splitting and long-period Love-to-Rayleigh surface-wave scattering. During 1998–1999 US and Russian investigators maintained a network of 15 broadband portable seismometers on the Kamchatka peninsula. Shear-wave splitting is weak ($\tau < 1$ sec) throughout the Kamchatka array, but exhibits a consistent pattern. Birefringence observations in southern Kamchatka and near the Aleutian junction indicate a trench-parallel fast-polarization direction for stations above the Kamchatka seismogenic zone, and trench-normal fast polarization for stations beyond the slab edge. Weak splitting in S waves from local events argues against strong anisotropy in the supra-slab mantle wedge. Love-to-Rayleigh scattering is strong for Love waves that approach Kamchatka from the north, within the overriding plate, consistent with a mantle shear gradient near the slab edge. Asthenospheric mantle is inferred to suffer trench-parallel extension immediately beneath the slab as it descends into the upper mantle, and to flow around and beneath the disrupted slab edge. Seaward retreat of the Kamchatka trench would induce asthenospheric flow from the Pacific to the Eurasian side of the slab. Weak SKS splitting and weak Love-to-Rayleigh scattering on the seaward side of the subduction zone suggest that trench retreat is modest, but not zero. Low seismic velocity and a lack of deep-slab seismicity near the Aleutian corner suggest that the slab edge has eroded at depth, perhaps due to a breakup of the slab. The resulting loss of downdip load and the influence of asthenospheric flow around the slab edge may explain the shallowing dip of the Kamchatka Benioff zone at the Aleutian junction. If ablation of the Kamchatka slab-edge occurred as a transient event rather than as a steady-state process, a subsequent lofting of the residual slab edge could induce pressure-release melting of the shallow mantle. Such a process could plausibly influence Klyuchevskoy volcano, which lies above the shallowed slab edge, and is the most active eruptive center on the Pacific Rim.