field reasonably well. The Longitudinal Valley fault zone (LVF) has the highest strain rates with magnitude of 1-2.5x10^{-6}/yr. The strain rates in the deformation front fault zone (DFFZ), west of the Central Range in western Taiwan, are also relatively high, with magnitudes ranging from 1x10^{-7} to 2x10^{-6}/yr, increasing from north to south. The deformation style in both the LVF and DEFZ are primarily pure compression in northwest-southeast direction. In the Central Range, between LVF and DEFZ, extensional strain rates predominate. The extension regime in the Okinawa basin north of the Ryukyu subduction zone extends westward to the Ilan plain in northeast Taiwan. The rate of NS extension in the east, offshore of northeast Taiwan, could be as high as 20-40 mm/yr. West of Ilan plain, the extension rates decrease rapidly. The transition from extension to compression occurs in the northern Central Range, where strain rates are close to zero. In order to understand the dynamics driving the deformation we directly solve the force balance equations, using both a thin elastic layer and a thin viscous sheet formalism, for estimates of the styles and magnitudes of vertically averaged deviatoric stress. The observations that constrain the solutions are gravitational potential energy, inferred from topography, and the styles of strain, inferred from the kinematic solution. The solutions consist of two parts: vertically averaged deviatoric stresses associated with internal body forces (gravitational potential energy), and stress boundary conditions. The stress boundary conditions are sought such that the styles of total deviatoric stress match the styles of deformation inferred from the interseismic deformation field. Vertically averaged stress levels are approximately 100 bars in northern Taiwan, and are smaller in the southern Taiwan with stress levels ranging from 10-50 bars. Both the elastic and viscous solutions yield extensional deviatoric stresses over high topography, consistent with gravitationally driven extension. Although full solutions will require the treatment of basal tractions, the presence of extension over high topography is consistent with crustal scale, thin-skinned, type models where there is significant coupling between the elastic upper crust and a deeper viscous layer.

T51G-04 1110h

Subduction Zone Locking and Forearc Rotation in the North Island, New Zealand From Inversion of Geodetic, Seismologic, and Geologic data

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The GPS velocity field in the North Island of New Zealand is dominated by the long-term tectonic rotation of the Hikurangi forearc (eastern North Island) and elastic strain from the Hikurangi subduction zone. We simultaneously invert horizontal GPS velocities, earthquake slip vectors, and geological fault slip rates in the North Island for poles of rotation of elastic blocks and the degree of coupling on faults bounding the blocks. This approach allows us to estimate the distribution of locking on the subduction zone interface beneath the North Island, as well as the kinematics of the forearc blocks. In agreement with previous studies, we find that the subduction zone beneath the lower North Island is strongly coupled in the interseismic period and that the degree of coupling decreases northwards along the margin. We also find a small locked patch on the subduction zone in the northeastern North Island, very close to where an aseismic deformation event occurred in October 2003. Much of the eastern half of the North Island is rotating clockwise at 2-4 degrees/Myr relative to Australia, about a pole just west of the central North Island. This forearc rotation accommodates most of the margin-parallel component of motion between the Pacific and Australian plates. The motion of the forearc with respect to the Pacific plate agrees well with seismological inferences of slip partitioning at the Hikurangi margin, although the GPS do suggest that motion on the subduction interface might become more oblique south of -41 degrees latitude. We infer that the forearc rotation is due to an along strike variation in the properties of the lower plate being subducted at the Hikurangi margin, where the buoyant Hikurangi plateau is being subducted at the southern end of the subduction zone, and oceanic crust is being subducted further north. This mechanism for rotation is similar to that seen in other locations (for example, Papua New Guinea).

T51G-05 1125h INVITED

Dynamic And Kinematic Models Of The Yellowstone Hotspot Constrained By Seismic Anisotropy, GPS Measurements And Fault Slip Rates

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The Yellowstone-Snake River Plain (YSRP) volcanic system is comprised of the Yellowstone Plateau and the eastern Snake River Plain – a region of young basalt flows overlying older silicic calderas and believed to be the track of the Yellowstone hotspot. The YSRP is characterized by an anomalous10-m geoid-high centered on Yellowstone, and a parabolic pattern of high topography and active seismicity surrounding the low topography and aseismic eastern Snake River Plain. We will discuss an integrated study of the upper-mantle flow and the structure, kinematic deformation and strength for the YSRP. Mantle flow and structure are assessed by shear-wave splitting and tomography, while lithospheric deformation is determined by GPS measurments. The stress field and strength of the lithosphere is then obtained from integrated dynamic modeling of the deformation field and the geoid. The kinematic deformation field is derived from the integration of GPS surveys of the YSRP and Basin-Range from over 200 campaign and permanent stations constrained by L. Quaternary fault-slip data. The kinematic models reveal a rotation of the velocity field from NE-SW extension of 4 mm/yr in the YSRP to E-W extension of 2 mm/yr in the eastern Basin-Range. The teleseismic data were recorded by 79 temporary PASSCAL seismographs combined with data from 5 permanent regional networks, with an additional 90 stations, centered on Yellowstone. Teleseismic shear-wave splitting indicates that the fast-polarization directions are dominantly aligned parallel to the direction of N. America Plate motion. The observed anisotropy can be explained by simple asthenospheric flow, although lithospheric deformation may be important along the SRP. Mantle tomographic images reveal a relatively shallow, < 250 km, low-velocity, 1-3%, P-wave anomaly, beneath Yellowstone and the SRP consistent with a partial melt. Overall deformation of Yellowstone and the eastern Basin-Range region makes up about 25

URL: http://www.mines.utah.edu/~rbsmith/research.html

T51G-06 1145h

Sequential Strain Maps of Continental Extension: Comparing Variations in Geologic to Geodetic Strain Rates in the Basin and Range

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We compare GPS (BARGEN) data to kinematic reconstructions across the Basin and Range province of western North America to show the patterns of plate boundary deformation over a wide range of temporal scales. The Basin and Range province of western North America is a classic example of large magnitude diffuse deformation. More is known about timing, amount, and spatial variations of extension within the Basin and Range province than in any other comparable region, making the western United States one of the most appealing locations to look at the driving forces behind large magnitude diffuse deformation. Even though in selected portions of the Basin and Range are rich in kinematic data, the kinematic history of the province as a whole is still not well understood. The critical body of data required to adequately compare GPS velocity data to velocity data over geologic (10^6 yr.) time scales is the detailed kinematic history of the region of interest. We compiled kinematic data (amount, timing and direction of displacement) along three transects through the northern (40°N) central (36°-37°N) and southern (34°N) Basin and Range. Extension in each of these areas was sequentially restored using the kinematic data and ArcGIS. The sequential restorations highlight misalignments, overlaps or large gaps in each incremental step, particularly in the areas between the data transects. We use the regions where the kinematics are known to constrain adjacent areas where the kinematics are not defined. For instance, strain compatibility requires that the timing and amount of northward motion of the Sierra Nevada block along the eastern California shear zone be complementary across the north-south extent of the region. The northward motion of the Sierra Nevada block must be coupled to the deformational history of the Mojave region for strain compatibility between the three transects. The sequential reconstructions provide province-scale strain maps of horizontal velocity vectors over 2 Myr to 20 Myr intervals. The reconstructions also illustrate the path of a series of points (representing individual ranges) through time. The horizontal velocity maps over 2 Myr increments can be compared to each other and to horizontal velocity maps of GPS solutions to show how different regions of western North America (Basin and Range, eastern Californian shear zone, Garlock fault, the Mojave desert) have evolved and continue to evolve through time. As an example, these maps show a progressively westward migration of strike-slip deformation associated with the eastern California shear zone from 10 Ma to present.

T51G-07 1200h

A Model with Rigid Rotations and Slip Deficits for the GPS Derived Velocity Field in Southwest Japan

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In order to determine the kinematic features of arc tectonics, we analyzed the GPS derived velocity field in southwest Japan. We consider two factors; one is the elastic deformation caused by fault dislocations (or slip deficits), and the other is rigid motions of regional tectonic blocks (or plates). Rigid motions might cause significant errors in the estimation of slip deficits if they are not properly accounted for. For example, the velocity field in southwest Japan cannot be fully explained by a model with only slip deficits. Residuals in such a model imply the westward migration of the outer arc of southwest Japan and backarc spreading along the northern extension of the Okinawa trough.
We interpret the GPS derived velocity field in southwest Japan by a superposition of the elastic deformation caused by fault interactions (slips or slip deficits) and rigid motions of tectonic blocks (or plates). Based on the strain rate field and crustal seismicity, we apply a model with 3 blocks (Inner Arc, Outer Arc, and northern Ryukyu) and slip deficits along the block boundaries.
Some characteristics of the model are found:
(1) westward motion of the outer arc relative to the Amurian plate and the inner arc,
(2) southward motion of the N-Ryukyu block relative to the Amurian plate,
(3) small right lateral slip deficits along the boundary at latitude 32° N in southern Kyushu,
(4) small left lateral slip deficits along the Median Tectonic Line and the Beppu-Shimabara Graben,
(5) slip deficit rates on the plate interface smaller than those for the case without consideration of rigid block motions,
(6) clockwise deflection of the slip deficit rate vector from that estimated for the case without consideration of rigid block motions.

T51H MCC: 3005 Friday 1020h

Structure and Dynamics of the Oceanic Upper Mantle III *(joint with OS, S, V)*

Presiding: **J Gaherty,** Georgia Institute of Technology**; S Zhong,** University of Colorado

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T51H-01 1020h INVITED

Melting Processes Beneath Mid-Ocean Ridge Spreading Centers

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The variations in major element composition of mid-ocean ridge basalts (MORB) provide significant insight into the temperature structure in the upper mantle beneath ocean ridges. In their landmark paper Klein and Langmuir (1987, JGR 92, 8089) showed that there were global correlations in MORB chemical composition that reflected extent and the depth interval of melt generation (notably Na and Fe, respectively). These parameters were also shown to correlate with ridge bathymetry and variations in oceanic crustal thickness. These observations led to a renaissance in understanding MORB generation. When all the evidence is considered, near fractional adiabatic decompression melting is required in order to produce the major compositional characteristics of the global MORB array. In near fractional melting increments of melt are extracted continuously from a melting column and aggregated. The result is an average of the melts produced over a range of pressures from a mantle that is progressively depleted as it melts. Experimental studies have calibrated the range of melting conditions. In particular, the work of Kinzler (1997, JGR 102, 853) provides a robust set of numerical models for predicting physical conditions. Melting is controlled by variations in mantle potential temperature, which range from 1460 $^{\circ}$C to 1325 $^{\circ}$C. Melting begins when the adiabat crosses the solidus and ends at very shallow mantle depths ($\sim$ 9 km or 0.3 GPa). At the high potential temperature end of the spectrum melting starts at a pressure of 3 GPa, resulting in 11 % melting and production of 9 km of oceanic crust. At the low potential temperature end melting begins at 1.5 GPa, resulting in 7 % melting and production of 3 km of oceanic crust. In contrast to the MORB environment, Hawaii is our best example of a hotspot melt generation environment. Rare picritic magmas reveal a melting environment that is complicated by interaction of the mantle melt with a thick, cooler lithosphere (Wagner and Grove, 1998, CMP, 131,1). The mantle potential temperature beneath Hawaii is 1535 $^{\circ}$C, but assimilation of lithospheric mantle modifies the picrite primary magma composition and lowers magma temperature to 1400 $^{\circ}$C. Therefore, mantle melts record a 200 $^{\circ}$C potential temperature variation in the Earth's mantle today.

T51H-02 1040h

Wet Melting in the Oceanic Mantle

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Mantle melting beneath spreading centers is driven by adiabatic decompression, but the amount of melt generated is a function of both mantle potential temperature (T_p) and water content. Separating these two effects, while a petrological challenge, is of fundamental consequence to the structure and rheology of the oceanic plate and upper mantle. Back-arc basin spreading centers provide a natural setting to quantify the effects of water and T_p on mantle melting. In one view, back-arc basins are like small mid-ocean ridges, where the volume and composition of mantle melts is well explained by T_p variations. Viewed another way, back-arc basins tap regions of mantle that have been recently hydrated by subduction, and so should reflect water-fluxed melting systematics. Here we try to reconcile these two views, and quantify the melting systematics of the oceanic mantle. Almost ten years ago, Stolper & Newman (EPSL, 1994) illustrated a linear relationship between the amount of water (H_2O_o) and the fraction of melting (F) in the mantle beneath the Mariana back-arc. Here we extend their approach to several back-arc basins where recent studies have determined water contents in submarine basaltic glasses. We use Ti as a proxy for F after correcting for crystal fractionation, and account for Ti source composition with a model based on Ti/Y variations in mid-ocean ridge basalts (MORBs). We use F then to calculate H_2O_o, which varies from low values typical of average MORB mantle (100's ppm) to 0.5 wt% H_2O. Each back-arc basin forms a distinct, nominally linear trend in F vs. H_2O_o, where the F intercept at zero H_2O_o reflects dry, decompression melting driven by T_p variations similar to global MORB (T_p = 1300 - 1500°C, in the order of Scotia, Marianas, Manus and Lau). The slopes of the trends also appear to vary with T_p, with more productive wet melting at higher T_p (dF/dH_2O =25-75 wt% melting/ wt% H_2O). These systematics should also apply to melting beneath mid-ocean ridges, although melt pooling at low water contents may lead to regional arrays with inverse slopes (Asimow & Langmuir, Nature, 2003). We have also observed positive linear F-H_2O_o correlations for several volcanic arcs (see Kelley et al., this meeting). For example, Mariana arc basalts broadly extend the back-arc trend, consistent with decompression of mantle with similar T_p to the back-arc, but with higher water contents (up to 1 wt% in the mantle source). Thus wet melting beneath ridges, back-arcs and arcs can be approximated with a linear dependence on H_2O, combined with dry, decompression melting that varies globally as a function of mantle temperature.

T51H-03 1055h

Melt Generation and Mantle Dynamics Beneath the Southern East Pacific Rise: Insights From the Mantle ELectromagnetic and Tomography (MELT) Experiment EM Data

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Electrical conductivity structure models allow inference of mantle dynamics based on melt and water distribution beneath a mid-ocean ridge system. The electromagnetic data from the Mantle ELectromagnetic and Tomography (MELT) experiment were collected on two survey lines. The major line crosses the East Pacific Rise at 17°S where the ridge segment is inflated, suggesting an abundant magma supply. The northern line crosses at 15°45'S to the north of an overlapping spreading center on a magma-starved ridge segment. The data are inverted for a two-dimensional anisotropic conductivity structure that incorporates correction for three-dimensional topographic effects on the magnetotelluric responses. The model space allows for different conductivity values in the along-strike, cross-strike, and vertical directions along with imposed constraints that the model be smooth and that the three conductivities be as close together as possible. The strength of these constraints is variable, and hence a range of models from isotropic to anisotropic can be explored. The anisotropic models are more consistent with other geophysical and laboratory data, and hence are preferred. Best fitting anisotropic models display three remarkable features. First, the mantle is more conductive in the cross-strike direction to the east of the rise at depths of 60-150 km and is quite resistive above 60 km. Second, the resistive-conductive boundary is not dependent on the crustal age. Third, there is a narrow, highly conductive pipe in the vertical conductivity located immediately beneath the ridge axis at 17°S which never appears beneath the ridge at 15°45'S. The first two features are well resolved by the data. However, the conductive pipe is not strongly required by the data. These results suggest that melt exists over a wide region, but is more highly concentrated and connected in the vertical at ridge axis. The deep (>60 km) conductive region to the east of the ridge crest is consistent with the preferred orientation of olivine under wet conditions. The flat resistive-to-conductive boundary at 60 km agrees well with the inferred depth of the dry solidus of olivine. These results suggest that the extraction of water from olivine due to partial melting substantially reduces mantle conductivity.

T51H-04 1110h INVITED

Melt segregation, strain partitioning, olivine CPO, and the origin of seismic anisotropy in oceanic lithosphere

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Early in the development of the theory of plate tectonics, seismic anisotropy in the upper mantle beneath the ocean basins was associated with mantle flow-induced crystallographic preferred orientation (CPO) of olivine. Now, seismologists are able to resolve depth-dependent anisotropy in oceanic lithosphere with surface waves, and perform detailed regional studies with P-and S-wave tomography to understand the spatial distribution of anisotropy. However, the origin of seismic anisotropy is not well understood. Recent studies on the effects of water content and stress level on the CPO of olivine have produced complicated relationships between stress orientation and CPO, and thus anisotropy, questioning the long-standing assumption that flow direction parallels the seismic fast direction. Analysis of partially molten mantle rocks deformed in simple shear demonstrates that (i) stress drives melt segregation, (ii) melt segregation leads to strain partitioning between melt-rich bands and melt-depleted lenses, and (iii) when strain partitions between melt-rich and melt-poor regions, the CPO is dramatically altered such that the olivine a-axes (seismic fast direction) align normal to the shear direction. This relation between a-axes and shear direction may be very sensitive to imposed flow boundary conditions, currently under investigation using several different deformation geometries. We discuss the implications of the observed relations between CPO, strain partitioning, and deformation geometry for seismic anisotropy and evolution of lithosphere. Observed seismic anisotropy may record the effects of a melt-rich network, olivine CPO, or the superposition of both. In seismic studies of upper mantle structures beneath plate margins, complex patterns of seismic anisotropy often emerge, such as $V_{SV} > V_{SH}$ beneath the Reykjanes Ridge south of Iceland and the plume-related azimuthal anisotropy beneath Iceland. We illustrate possible relationships between seismic anisotropy and mantle flow in these settings from models based on our experimental observations.

T51H-05 1130h INVITED

Lattice Preferred Orientations in Naturally Deformed Peridotites: A Link from the Lab to Mantle Dynamics

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Our understanding of the rheological behavior of the Earth's mantle has been greatly enhanced by microstructural observations of both naturally and experimentally deformed rocks. The analysis of microstructures in naturally deformed rocks provides a critical link between theoretical and experimental studies and large-scale geologic processes. A current limitation in the application of both experimental observations on the development of lattice preferred orientations (LPO) in mantle rocks, and theoretical studies that are tested using the same data, is that the experiments are conducted at considerably higher stresses (or temperatures) than those experienced during deformation in the asthenosphere (or lithosphere). However, since specific deformation processes produce diagnostic microstructures, analyses of textures preserved in rocks can be used to constrain the applicability of experimental flow laws. In this talk I will present our new data obtained using EBSD (Electron Backscatter Diffraction) on LPOs in naturally deformed mantle rocks with well-constrained deformation histories. I will (1) discuss how the evolution of LPO with increasing strain in natural shear zones (Singletary and Hirth, in prep) compares with that determined experimentally (e.g., Zhang et al., 2000; Bystricky et al., 2000) and theoretically (e.g., Wenk and Tome, 1999; Kaminski and Ribe, 2001). (2) Illustrate the possible effects of grain boundary sliding (GBS) on the development of LPO (Braun, Hirth and Kelemen, in prep) and describe microstructural evidence that a transition from dislocation creep to diffusion creep can result in randomization of a pre-existing LPO and promote strain localization in the mantle lithosphere (Warren and Hirth, in prep). Throughout the talk I will compare the interpretations provided by the microstructural observations to predictions based on the extrapolation of experimentally determined flow laws for olivine aggregates (e.g., Hirth and Kohsltedt, 2003) and discuss their implications for the dynamics of the oceanic upper mantle.

T51H-06 1150h

Mid-Ocean Ridge Mantle Processes Constrained by the FAIM Seismic Refraction Experiment

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The seismic structure (e.g. velocity, velocity gradients, anisotropy) of the shallow upper mantle of oceanic lithosphere constrains the degree of melt extraction at mid-ocean ridges and the shear deformation of the lithosphere. The variation of fine-scale structure with depth is difficult to resolve with teleseismic data but, with some notable exceptions, seismic refraction techniques - which have excellent depth resolution - have not been used to elucidate oceanic upper mantle structure. Here we report further results from the FAIM (Far-offset Active-source Imaging of the Mantle) seismic refraction experiment conducted along an 800-km-long flow-line transect and a 150-km-long ridge-parallel transect in the western north Atlantic. Sixteen short-period, vertical-component ocean-bottom seismometers (OBS) were deployed along the spreading-parallel transect in 3-km-separated pairs spaced 80-120 km apart, and 3 OBS were deployed orthogonal to the primary transect to a maximum distance of 350 km. Shot spacing was 1 km. Coherent P-wave arrivals were observed to 350-km distance, and the amplitude of this phase and its increasing and fast apparent-velocity suggest that energy is propagating to $\sim$24 km depth below the Moho. Two-dimensional travel-time analyses predict velocities of $\sim$8.25-8.55 km/s over the uppermost 24 km of the mantle on the flow-line-parallel transect and velocities of $\sim$8.05-8.25 km/s over the uppermost 10 km of the mantle on the ridge-parallel transect. At face value, these values indicate P-wave anisotropy is at least $\sim$3.0% throughout the upper 10 km of the mantle. However, velocities in only two orthogonal directions cannot constrain the precise direction and magnitude of anisotropy. To improve this estimate we analyzed the travel times of P-waves with good signal to noise from shots at ranges of 75-250 km, with an azimuth range spanning $\sim$100°. When plotted as a function of propagation azimuth, these travel times display a strong variation, with slower travel times arriving near an azimuth of 100-120° relative to the fossil flow-line, i.e. nearly perpendicular to the fossil spreading direction. Assuming that azimuthal anisotropy in the region is constant, we can estimate its magnitude and direction by fitting delay times with a function that is periodic in 2θ. The best-fitting model has a fast propagation direction at $\theta = 10^\circ$, with a peak-to-peak δt variation of 0.3 s, which corresponds to a P-wave anisotropy of 4.0%, approximately 50% smaller than that observed in comparable experiments on lithosphere formed at faster spreading rates in the Pacific ocean. The large positive velocity gradients measured along both transects are not readily explained with existing predictions of upper mantle deformation. Likewise, the observations are unlikely to be due to depth variations in cracking because cracking in the mantle might be expected to have a preferred direction. One possible explanation for the large gradients is the presence of gabbro plutons in peridotite due to melt retention in the shallow mantle.

T51H-07 1205h

Localized Deformation Beginning more than 15 km Beneath the Mid-Atlantic Ridge, 14 to 16 N

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ODP Leg 209 drilled 19 holes at 8 sites along the Mid-Atlantic Ridge from 14°43 to 15° N. All sites were surveyed by submersible, and chosen to be $<$ 200 m from peridotite or dunite exposed on the seafloor; outcrops of gabbroic rock were also close to some sites. One of our primary goals was to constrain the mechanism of mantle upwelling, corner flow and exhumation of shallow mantle rocks. Drilling at Sites 1268, 1270-72, 1274 and 1275 penetrated 1075 meters, and recovered 354 m of core. At Sites 1268 and 1270-72 we recovered 25% gabbroic rocks and 75% residual mantle peridotite. Core from Site 1274 was mainly residual peridotite, while core from Site 1275 was mainly gabbroic. Most of the residual peridotites have nearly undeformed, protogranular textures. Orthopyroxenes are interstitial to olivine or even poikilitic. Rare, isolated clinopyroxene grains are also interstitial. Skeletal spinel grains have mm-scale extensions in three dimensions, with no discernable shape fabric. These textures are clearly different from porphyroclastic textures typical in ophiolites and fracture zone dredges. As described elsewhere at this meeting, impregnated peridotites contain olivine, 2 pyroxenes, plagioclase and spinel, and equilibrated at 0.54 GPa ($\pm$0.14 GPa, 2σ) and 1220°C ($\pm$16°C, 2σ) [Kinzler & Grove, JGR 92]. Melts entered the thermal boundary layer beneath the Mid-Atlantic Ridge at about 20 km [e.g., Sleep, JGR 75; Reid & Jackson, MGR 82; Grove et al JGR 92; Cannat JGR 96; Michael & Chase CMP 97; Braun et al., EPSL 00], and began to crystallize within impregnated peridotites and as discrete plutons intruding peridotite. Gabbroic rocks and peridotites from most sites underwent large tectonic rotations since aquiring remanent magnetization. At some sites, rotations may have exceeded 60° around near-horizontal axes parallel to the Mid-Atlantic Ridge. Such large rotations are unlikely to have been accomodated along a single fault, and instead blocks were progressively rotated along a series of fault systems. Sites 1270 (25% gabbroic) and 1275 (75% gabbroic) were drilled into large, low angle fault surfaces previously identified as oceanic core complexes. Deformation at Site 1270 is similar to most other Sites, while core from Site 1275 is the most weakly deformed. However, high pressure igneous assemblages indicate that some Site 1275 rocks were exhumed from depths of 20 km or more, as were residual peridotites at the other Sites. At all sites except 1269, 1273 and 1275, we recovered high temperature mylonitic shear zones (mainly with impregnated peridotite mineralogy, but also mylonitic gabbros), and intervals of low temperature fault gouge. Shear zones and faults are not all parallel; numerous, cross-cutting planes of localized deformation formed at $>$ 1000°C to $<$ 100°C, from $>$ 15 km depth to near the seafloor. These accommodated nearly all subsolidus deformation during corner flow and exhumation of residual peridotites (plus high pressure igneous rocks), in keeping with the inference that the thermal boundary layer in this region extends to at least 20 km. Penetrative, viscous deformation of blocks between shear zones and faults was minor. If this is a general process at slow-spreading ridges, then one would predict that shallow mantle anisotropy in the Atlantic would be less pronounced than in the Pacific, consistent with recent seismic data [FAIM Experiment, Gaherty, Collins et al, this session].

T52A MCC: Level 1 Friday 1330h

Analysis of Plate Boundary Deformation Using Stress and Strain Rate Data in Tandem III Posters

(joint with G, S)

Presiding: **J Townend,** Victoria University of Wellington**; S Mazzotti,** Geological Survey of Canada**; S Miyazaki,** Stanford University**; K Wang,** Geological Survey of Canada

T52A-0229 1330h POSTER

Strain and stress partitioning of the Pacific/North America interaction along the Queen Charlotte Islands-Alaska Panhandle

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Along the western margin of central British Columbia and southern Alaska, the Queen Charlotte (QC) and Fairweather faults accommodate most of the predominantly transform motion (50 mm/yr) between the Pacific and North American plates. This fault system is 1000 km long and was the locus of M=7-8 earthquakes in the last century. Off the Queen Charlotte Islands, the relative Pacific/North America motion also has a 10-15 mm/yr convergence component. New GPS data acquired over the last 5 years allow us to estimate the distribution of transient and permanent strain along this plate boundary. We show that the Queen Charlotte-Alaska Panhandle margin is affected by both transient and long-term dextral shear strain, respectively in response to the interseismic locking of the QC-Fairweather Fault and a 6-7 mm/yr NNE migration of the continental margin. The impact of postseismic deformation following the 1949 M=8.1 QC earthquake is likely not significant. The stress pattern derived from earthquake focal mechanisms is consistent, to a first order, with the GPS kinematic model. Earthquake mechanisms indicate a partitioning between strike-slip and compression on the oceanic side (QC Fault and Terrace). The continental margin (northern QC Islands and Hecate Strait) is affected by a N to NE maximum compression associated with dextral shear of the crust. Long-term dextral shear and shortening of the continental margin is also supported the tectonic inversion of the Miocene normal faults that form the QC Basin. Several kilometers of shortening and strike-slip deformation have been identified on these structures that affect Upper Miocene and Pliostocene deposits.

T52A-0230 1330h POSTER

Assessing lateral variations of stress and strain build up along the Himalaya from geodetic and seismicity monitoring

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The uneven micoseismic activity along the Himalayan arc might be taken suggests significant lateral variations of stress and stress build up. On the other hand, the geodetic data show a rather uniform pattern of interseismic straining, colinear with long term geological deformation and the stress distribution as indicated from focal mechanisms. The uneven distribution of microseismicity is shown to result in fact from the influence of the topography on the stress field. The geodetic data and seismicity distribution are indeed reconciled from a model in which microseismicity is intrepreted as triggered by Coulomb stress increase due to elastic build up in the interseismic period. The model assumes a fully locked fault zone with its downdip extremity following the arcuate shape of the High Himalaya front. The observed influence of the topography requires the deviatoric stresses to be low, less than about 30 MPa, implying an apparent friction of the Main Himalayan thrust Fault of the order of 0.1. Arc normal thrusting along the Himalayan front and E-W extension in Southern Tibet are quantitatively reconciled from the model. So we can exclude that asperities on the himalayan megathrust would result from heterogeneous strain buildup in the interseismic period. Recurring transient slip events, including large earthquakes an aseismic slip event, in particular afterslip, must sum up so that heterogeneities are smoothed out in the long term. The pattern of co-seismic slip during a particular earthquake is thus probably strongly controlled by the heterogeneous stress distribution left by previous transient events.

T52A-0231 1330h POSTER

Collisional Deformation, In Situ Stress, and Topographic Relief in Central Japan

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By amalgamating travel time and first motion data from three Japanese seismic networks, we have obtained a comprehensive focal mechanism catalog with which to investigate tectonic stress directions throughout most of Japan. The axis of maximum horizontal compressive stress agrees well with the axis of greatest contractional strain rate in central and southwest Japan once the effects of interseismic strain accumulation have been removed from geodetic observations according to an elastic dislocation model of subduction thrust locking. This residual deformation is presumed to be independent of deformation associated with strain accumulation and release in the subduction zone earthquake cycle, and to represent net geologic deformation of the upper plate. Moreover, it is broadly confined to the area of pronounced topography in central Japan, and is consistent in both spatial extent and principal strain rate directions with the deformation expected for horizontal motion of the Amurian plate with respect to northeastern Honshu. We conclude that the state of crustal stress in central Japan and the concentration of neotectonic deformation within the Japanese Alps are controlled by crustal collision and are relatively insensitive to earthquake processes on the main subduction zone thrusts beneath.

T52A-0232 1330h POSTER

Intraplate Stress Directions and Magnitudes Induced by an Orogenesis: Data From Pyrenean, Alpine and Appalachian Collisions

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