cusp region structure and its correlation with the IMF components polarity. It is found that, besides the established dependence on $B_z$, the boundary positions are affected by $B_y$ and show a distortion that can be related with the predictions of models of antiparallel magnetic field merging.

T12-12A 1645H

Mapping hydrothermal plumes in three dimensions on the East Pacific Rise near 13°N: Results from HYDROFAST 1986

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In December of 1986 we investigated the distribution of $CH_4$, Mn, $^3He$, temperature, and salinity in the vicinity of an active geothermal region on the EPR near 13°N. We used conventional CTD casts, thermistor chains attached to a side-looking sonar and a new tool called a palanque dynamique which collected 40 bottles of water at four different levels in the water column while towed continuously over distances of 10 miles. In addition, heat flux instruments were attached and towed with the bottles to provide a three dimensional view of the temperature and salinity at multiple positions in the water column. The combined data sets allow us to trace a major plume of activity which has its source between 12°50' and 45'N. The plume extends to the south along the axis and can be traced up to 350 m off bottom. Methane reveals concentrations of greater than 50 times the back ground values. Temperatures in the plume are on average 0.06°C greater than ambient at 150 m above bottom. In three dimensions the plume is rather egg shaped being >30 miles long and >10 miles across at its widest point. It is not symmetrically draped about the axis, however. In contrast, it appears to spill over the rise axis onto the western flank suggesting that it may be more dense than the ambient water. The greatest concentration appears to be centered near a near-axial seamount suggesting again that there is an intimate connection between rise axis seamount chains and major geothermal sites.

T41A-01A 0845H

Aluminum and Hydrogen Defects in Quartz: Enhanced Diffusion at High Pressure and High $f(H_2)$

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Samples of single crystal natural quartz together with quartz powder were annealed at 1.5 GPa and 900-1000°C for up to 40 hours in water alternately tagged with the isotopes hydrogen, deuterium, oxygen-16, and oxygen-18. $H_2$ and $D_2$ fugacities were buffered to nickel-nickel oxide or iron-wustite conditions. Small amounts of Al and alkalis were introduced into the quartz powder during grinding. The incorporation of additional impurities into the quartz lattice by diffusion has been investigated by making ion probe and micro-infrared measurements on selected uncracked and unrecrystallized regions of the sample. Concentrations of Al and D in excess of 2000 atoms per million atoms Si (p.p.m.a.) penetrated the sample to depths of up to 0.1 cm. Comparable experiments performed under conditions buffered to copper-copper oxide, or lower $f(H_2)$, have shown little change in Al and less than a 100 p.p.m.a. increase in hydrogen. The high defect concentrations achieved by these experiments provide a much improved infrared spectrum of the mobile hydrogen defect in quartz than previously obtainable. The IR spectrum is composed of sharp peaks polarized perpendicular to the c-axis and is very consistent. Isotopic frequency shifts due to the hydrogen-deuterium pair prove these peaks are due to hydrogen defects. There is little isotropic broad band absorption (i.e. molecular $H_2O$) in the lattice except in a surface layer of reprecipitated quartz. Frequency shifts due to oxygen-18 were present only in a single recrystallized sample. The infrared spectra indicate that two kinds of hydrogen defects are present: (1) interstitial $H^+$ near Al and (2) hydroxyl independent of Al or alkalis and characteristic of synthetic quartz and amethyst.

T41B-17 0830H POSTER

In-Situ Stress Discontinuity Across the Appalachian Plateau Decollement

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Commercial hydrofracture pressure records are used to show that a discontinuity in horizontal stress level occurs at the stratigraphic level of the salt beds that underlie the northern Appalachian Plateau. The data are analysed to map lateral variations in stress-ratio across the northern Appalachian basin. Stress ratio is defined as the ratio of least horizontal stress (assumed equal to the downhole initial shut-in pressure) to the overburden load at the depth of the hydrofracture. Two different stratigraphic levels are commonly fractured in this region; the lower Silurian Medina/Tuscarora sandstone and the Devonian black-shales and sandstones. Between these two horizons lie the extensive salt beds of the upper Silurian Salina group which constitute the principal detachment horizon underlying the Appalachian plateau.

The results show that below the stratigraphic level of the salt, the stress ratio across the northern Appalachian basin from central Ohio to near Syracuse, New York is fairly constant, lying in the range 0.6 to 0.7, with a trend towards higher values in the north. Three data points obtained in Cambrian sediments immediately above basement to the south of Lake Erie were consistent with this result. In contrast, stress-ratios determined in the Devonian section overlying the salt were consistently greater, usually approaching or exceeding unity. Although there is evidence that significant localised variations in stress-ratio do occur within the Devonian section, the vast majority of data suggest that the Devonian section is characterized by high least horizontal stresses which approach or exceed the overburden. As high stresses are observed in Devonian sandstones and limestones as well as shales, viscoelastic creep within the shales seems an unlikely explanation.

These data suggest that the Devonian section is mechanically decoupled from the underlying section by the salt and that the ratio of least horizontal stress to vertical stress is much greater above than below the salt. However, the orientation of maximum horizontal stress appears to be ENE both above and below the salt implying that the dominant stress component affecting both sections is ENE compression.

T41B-18 0830H POSTER

Seismic Diffraction Around the Magma Chamber

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We have calculated finite element synthetic seismograms simulating a refraction experiment over a rise axis crustal magma chamber. The crustal model used was that derived from travel time modeling of the rise crossing refraction lines collected during expedition MAGMA at 13° N on the EPR (McClain et al., JGR, v. 90, pp 8627-8639, 1985).

Our calculations place a receiver at 5 km from the rise axis, and sources to 5 km beyond the rise axis. The grid extends from the seafloor to 7 km depth, the dominant frequency is 5 to 10 Hz. The crust away from the magma chamber is a standard model (eg. high velocity gradient in upper crust). The magma chamber is about 4 km in diameter and has a P velocity of 5 km/sec. A computation was also made with no magma chamber.

The purpose of these finite element calculations was to determine the degree to which seismic energy propagates around the outside of the magma chamber. The original travel time modeling was based on the assumption that first arrivals were associated with geometric ray paths. If the first arrivals were actually diffracted around the low velocity magma chamber, they would have exhibited reduced travel time anomalies. This diffraction effect would result in travel time models which underestimate the size of the chamber and overestimate the velocities inside (McClain et al., 1985). The majority of studies which conclude that the magma chamber is small or nonexistent have been cross sectional in nature -- where diffraction can be an important mode of propagation -- while studies parallel to the rise axis have provided strong evidence for the chamber.

Our results indicate that, for rise crossing paths, the first arrival is diffracted over the top of the magma chamber. Further, geometrical arrivals from through the magma chamber are of negligible amplitude. Beyond 10 km total range the first arrival is from below the magma chamber. There is clearly a need for more thorough modeling of the rise crossing refraction data, data which may well be ill suited for the determination of rise axis crustal structure.

T41B-19 0830H POSTER

Correlation of Mechanical Properties and In-Situ Stress Contrasts

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A 1 km profile of mechanical properties and in-situ stress was obtained in the Wilkins-1 well, located in S. Canisteo, NY. The well penetrated Devonian aged sandstones and limestones interbedded in mudstones and siltstones (shales). Dynamic elastic moduli logs were computed from bulk density and full waveform sonic logs prior to hydrofracturing 43 intervals. Other logs run included: resistivity, neutron porosity, gamma ray spectroscopy, dipmeter, temperature, borehole televiewer, and a prototype electrical imaging log.

Stresses measured in sandstones and limestones are consistently greater than stresses measured in adjacent shales. Also an abrupt drop in stress was observed in shales near the base of the Rhinestreet at a depth of 740 m. Above 740 m both horizontal principal stresses equal or exceed the vertical stress. Below 740 m the minimum principal stress is significantly less than the vertical stress.

Logging data show that stress magnitudes within shales and interbedded sandstones or limestones are correlated with Young's modulus and anti-correleated with Poisson's ratio such that the stiffer rocks have higher stress. The stress drop below 740 m correlates with decreased Poisson's ratio, and bulk modulus but does not correlate with Young's modulus. This is consistent with results of a study of the preferred orientation of chlorite in core from a nearby well which suggests that shales below the Rhinestreet are undercompacted.

These data suggest that small scale lithologic stress contrasts are due to tectonic compression oriented ENE. Overburden erosion may contribute to the anti-correlation of Poisson's ratio and stress magnitude however, the stress drop below the Rhinestreet appears to be different in origin and may be related to undercompaction.

V12A-11A 1635H

MELT MIGRATION BENEATH MID-OCEAN RIDGES

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Mid-ocean ridge volcanism is largely concentrated within a few kilometers of the spreading axis. Melt buoyancy effects alone would cause vertical melt migration beneath spreading centers. This would suggest that geophysical models which predict significant melting within a 50-100 kilometer wide region beneath a ridge axis would also predict significant off-axis volcanism over this zone of upwelling-induced melting. I have constructed models of melt migration to investigate this problem. The potentially high connectivity of low fractions of basaltic melt within a mantle matrix suggests that melt flow within the mantle can be thought of as a porous flow phenomena. If melt particle velocities are significantly larger than the upwelling velocities of the mantle matrix then the two-phase flow equations for melt and mantle motions lead to a D'Arcy flow equation for melt migration where the driving forces for melt migration are melt buoyancy and pressure gradients due to mantle flow. In this formulation the matrix permeability can also be solved for along melt migration streamlines which are characteristics of the equation governing matrix permeability. The pressure gradients due to the plate spreading component of mantle flow tend to concentrate melt migration towards the ridge axis. The relative importance of melt buoyancy forces to plate spreading flow induced mantle pressure gradients can be expressed in terms of a dimensionalless ratio $M=4\mu U/\pi\Delta\rho g L^2$, where U is the plate spreading velocity, $\mu$ is the mantle viscosity, $\Delta\rho$ is the density difference between melt and mantle matrix, g is the acceleration of gravity, and L is the depth to the melting region. If $M>10^{-2}$ mantle pressure gradients due to plate spreading can significantly perturb melt migration streamlines towards the ridge axis. For $\Delta\rho=0.5$gr/cc, L=100km, and U=10mm/yr this implies that $\mu\geq10^{21}$ Pa-s, significantly higher than current guesstimates of $\mu=10^{19}$ Pa-s for ridge axis asthenosphere. I am currently investigating thermal/melt models of a spreading center which include the above characterizations of melt and mantle matrix flow.

V21A-11A 1150H

Double-Diffusive Convective Control of Salinities Within the Salton Sea Hydrothermal System

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In a paper published in 1968, H. C. Helgeson noted that (1) the salinity of the brine in the geothermal reservoir within the Salton Sea geothermal system increases with increasing temperature, (2) the formation fluids at the depths of production have a density about equal to 1, and (3) the hot concentrated brines apparently exist in pressure equilibrium with comparatively cold dilute pore waters in the surrounding rocks. These conditions are precisely those that would be expected if double-diffusive convection is the main process that controls depth-temperature-salinity relations within the hydrologic system. However, on the basis of heat transfer calculations Helgeson (1968) concluded that below about 900 to 1200 m the salinity of the reservoir fluids in a given well may be constant with increasing depth.

The Salton Sea Scientific Drill Hole has provided additional information about the depth to which double-diffusive convection is likely to control salinities. The calculated density of the pre-flashed reservoir fluid sampled from a depth interval of 1865-1877 m, where the temperature is about 305°C, is 0.99 ± .02, which suggests that double-diffusive convection operates to at least that depth. A flow test conducted at 3170 m produced brine that was contaminated by drilling fluid and may have had components of formation fluids from both 2700 and 3170 m. A flow test scheduled in the future should correct these problems. The salinity of the pore fluid at 3170 m and 355°C should be about 10 percent greater than that at 1870 m if double-diffusive convection is the controlling factor.

V22C-08B 1615H

Gabbroic Xenoliths from the East Pacific Rise

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Six of the 122 dredges during the CHEPR expedition recovered gabbroic xenoliths. All six dredges were from a limited segment of the EPR extending from 9km to 83km south of the Clipperton Transform Fault (10°06'N to 9°21'N). The occurrence of xenoliths in the basalt from this region coincides with unusually intense magmatic activity as evidenced by morphologic, petrologic, and seismic data. This ridge segment has a broad, flat-topped axial profile, and shows very little variation in axial depth. Basalts from this region are remarkably similar in chemistry, liquidus temperature, and crystallinity, except for a slight change in chemistry across a Deval at 9°53'N. The multi-channel seismic axial reflector is stronger and more continuous here than in any other surveyed region of the EPR (Detrick et al., in press). The probable existence of a magma chamber in this region coupled with the partially crystalline nature of the xenoliths provides an unusual opportunity to investigate magma chamber crystallization in progress.

The xenoliths are of three types. Type 1 is partially crystalline and has mineral assemblages more