[2] School of Earth and Space Sciences, University of Science and Technology of China 96 jinzhai road, Hefei, ANH 230026, China

Current tomographic models of the Earth display perturbations to a radially stratified reference model. However, if there is a chemically dense structure at the base of the mantle with low thermal expansivity, high conductivity, and viscosity, and low Rayleigh number (Anderson , 2002), it will develop enormous relief, perhaps with boundaries closer to vertical than radial (Davaille , 1999). Typically, we plot record sections of seismograms (data shifted in distance for alignment) when exploring for horizontal structure and in azimuth (fan-shots) when searching for vertical structure. Such plots for various S-phases gathered from the South African Array show more orderliness in azimuth than in distance indicating a preponderance of vertical structure and can be explained with a large-scale ridge-like velocity anomaly beneath Africa. Conventional record sections show sharp jumps in slowness when ray paths cross the structured boundaries at right angles. Paths crossing at other angles usually display multi-pathing (complex waveforms) which can be modeled by 3D methods involving sharp boundaries. The geometry for such paths control the multi-pathing and dictates a preferred orientation of data assembling. Vectors produced in this manner point towards the center of the ridge-structure. The structure starts from the southern Indian Ocean and extends a few thousand km northwestward into the Atlantic Ocean, with its base on the core mantle boundary rising about 1200km into the mid-mantle. The structure has a 3% in shear velocity, while the compressional velocity is PREM-like. Sharp and vertical boundaries, anomalous P/S ratio, possible increased density and huge volume all support a chemical origin of the structure

T24A-04 1615h

The Evolution of Small, Cool Plumes in the Mantle

Amber C Harris[1] (401 241 6874; aharris@gso.uri.edu)

Chris Kincaid[1] (kincaid@gso.uri.edu)

[1] Graduate School of Oceanography University of Rhode Island, Box 200 S. Ferry Rd., Narragansett, RI 02882, United States

There has been significant debate recently over the attributes and even existence of mantle plumes. Among the arguments being raised against plume-like upwellings are that models of both heads and tails suggest plumes may be overly hot and volumetrically too large to match surface observables. Results are presented from numerical experiments on the growth, rise and dispersion of mantle plumes. We use a finite element method to solve for the conservation of mass, momentum and energy, as well as chemical transport. Models include distributions of eclogite and harzburgite material within the plume source region (e.g. D″). This material is heavy and light with respect to ambient mantle at similar temperatures. The 670 km boundary is represented as a phase and/or a chemical interface. Results show the evolution of plumes with distinct morphologies from the D″ thermal boundary layer. One mode involves the growth and rise of relatively cool, small-headed plumes driven by the buoyant harzburgite component. Results also show the 670 km boundary may act as an efficient warm-pass filter for rising plumes that also modulates the chemical mixture within the plume as it passes through the upper mantle. Both a chemically heterogeneous source region and filtering influence of the 670 km interface may result in near-surface plumes that are relatively small and cool. These features generate short, low-amplitude crustal production events.

T24A-05 1630h

Derivation of Large Igneous Provinces of the past 200 million years from long-term heterogeneities in the deep Mantle

Kevin Burke[1] (kburke@UH.EDU)

Trond H. Torsvik[2] (trond.torsvik@ngu.no)

[1] Department of Geosciences, University of Houston 312 S&R1 Houston, Houston, TX 77204-5007, United States

[2] Vista, Geological Survey of Norway Leif Eirikssons vei 39, Trondheim 7491, Norway

Large Igneous Provinces (LIPs) result from local catastrophically rapid dissipation of great quantities of internal heat. LIPs are overwhelmingly of basaltic affinity representing partial melting of the mantle at shallow depths but whether any of the heat or material involved in the generation of LIP rocks comes from great depth has remained controversial. To address this fundamental issue we restored 25 LIPs of the past 200 My to their eruption sites using a new global palaeomagnetic reference model. 90% of the LIPs, when erupted, lay above low-velocity seismic-shear-wave regions of the D” zone just above the Core-Mantle Boundary (CMB) and 50% overlay CMB low-velocity regions with delta Vs $<= -1\%$. Considering the modifying effects of plume advection, palaeolongitudinal uncertainty and plate circuit errors, the majority of the restored LIPs may in fact overlie regions with delta Vs $<= -1\%$. Because those low velocity regions occupy only 27% of the D” zone, the concentration of LIPs above them indicates that the low velocity (hotter ?) regions are the sources of the mantle plumes that generated the LIPs. We demonstrate that most LIPs of the past 200 My owe their origin to plumes that rose from low-velocity regions of the lower mantle, and that this long-term association indicates that the low-velocity regions have been relatively stationary with respect to the Earth’s spin-axis and the core since the Early Jurassic.

T24A-06 1645h

Numerical investigation for the interaction between the Afar plume, the Kenya plume and the Tanzania craton

Shu-Chuan Lin[1,2] (1-734-764-6377; skylin@umich.edu)

Ban-Yuan Kuo[2] (886-2-27839910ext507; byk@earth.sinica.edu.tw)

Ling-Yun Chiao[3] (886-2-2363-6040ext211; chiao@ccms.ntu.edu.tw)

[1] Academia Sinica, 128 Academia Road, Sec. 2, Taipei, Taiwan

[2] Department of Geological Sciences, University of Michigan, 2534 C. C. Little Building, 425 East University, Ann Arbor, MI 48109-1063, United States

[3] National Taiwan University, #1, Sec. 4, Roosevelt Road, Taipei, Taiwan

Geochemical evidence suggests that the Tertiary basalts along the East African Rift were created by two series of volcanic eruptions from separated mantle sources. The basalts in Tanzania, Kenya, and southern Ethiopia were attributed to the Kenya mantle plume initiated 45 Myr ago, while the Ethiopia-Yemen basalts were products of the younger (31 Ma) Afar plume. We carry out numerical modeling to investigate how this double plume system, the Tanzania craton, and the African plate motion interplay to result in the spatial-time pattern of magmatism observed. The African plate motion and the Tanzania craton were implemented as known physical parameters. The models were then tuned on the locations and strengths of the plumes and the range of rheology of the upper mantle against two critical observations: the coexistence of basalts derived directly or indirectly from the two plumes in southern Ethiopia, and buoyancy flux estimation of the Afar plume. The confrontation between plumes will generate an approximately stationary stagnant streamline between the plumes. Therefore, the plume head material will not mix or underplate each other, making the isolation of the mantle sources for melting. With the plausible physical parameters, our preferred model can generate a good match for the spatial and temporal magma distribution in Ethiopia and Yemen. The south-coming Tanzania craton and the expanding flow front of the Afar plume together deflect the Kenya plume material to the sense of asymmetry. However, it is insufficient to explain the observation in which the abundant magmatism along the eastern branch vs. little on the western branch of the rift. The plume has been eroding the cratonic root since 20 Ma.

T31A CC: 220 C-E Wednesday 0830h

Visualizing the Evolving Fault Zone III Posters *(joint with G, S, MR)*

Presiding: **P Young,** University of Toronto**; A Schubnel,** Lassonde Institute, University of Toronto

T31A-01 0830h POSTER

Experimental and Modeling Study of Fluid-Pressure Driven Fractures in Darley dale Sandstone

Sergio Vinciguerra[1] (vinciguerra@ov.ingv.it)

Philip G. Meredith[2] (p.meredith@ucl.ac.uk)

James Hazzard[3] (j.hazzard@utoronto.ca)

[1] Osservatorio Vesuviano - Istituto Nazionale di Geofisica e Vulcanologia, Via Diocleziano 328, Naples 80124, Italy

[2] Rock and Ice Physics Laboratory, Department of Geological Sciences, University College London, Gower Street, London WC1E6BT, United Kingdom

[3] Lassonde Institute, University of Toronto, 170 College Street, Toronto M5S3E3, Canada

Fundamental understanding of how fluid-pressure driven fractures progressively nucleate and propagate is crucial to understanding a range of crustal weakening processes. We report measurements of acoustic emissions generated during formation and growth of fluid-pressure driven fractures in cylindrical samples of Darley Dale sandstone (100mm long x 40mm diameter) that were co-axially pre-drilled with an 8mm hole in order to allow an internal pressure to be applied. The experiments were performed in a triaxial cell at a confining pressure of 6.5MPa. A set of 3 to 6 fractures initiate at the wall of the internal bore at a fluid pressure around three times that of the confining pressure, but only 3 propagate to the outer wall of the sample at approximately 120° to each other. Time and spatial distributions of acoustic emissions show two distinct bursts of activity, associated with initiation and propagation, respectively.A Particle Flow Code (PFC) has been used to model the micro-mechanical behaviour of hydrofracturing in sandstone. Micro parameters (particle stiffness, bond strengths, particle packing, etc.) dictate the macro behavior of the material. The models are fully dynamic, and an explicit calculation scheme is used such that stored strain energy can be released from contacts when bonds break and simulated AE can propagate through the system. The numerical model quantitatively reproduces the most important features of the time and spatial distribution of AE observed in the laboratory experiments. This suggests that, for a relatively homogeneous rock in an axisymmetric stress field, the propagation of three evenly distributed radial fractures may represent the most efficient geometry for energy dissipation.

T31A-02 0830h POSTER

Influences of grain comminution on the frictional properties of simulated fault gouge

Yonggui Guo[1] (yonggui@rice.edu)

Julia K Morgan[1] (713-2248-6330; morganj@rice.edu)

[1] Rice University, Dept Earth Science MS-126 6100 Main Street, Houston, TX 77005, United States

Previous DEM (Distinct Element Method) simulations of granular shear have qualitatively reproduced experimental observations of shear zone deformation and also provided insight into the frictional behavior of fault gouge. Gouge deformation, however, was accommodated by grain rolling and sliding alone, with no grain comminution. We examine the influences of grain comminution on frictional behavior of simulated fault gouge using DEM including breakable bonds between adjacent particles. In this way, arbitrarily shaped grains can be generated to reproduce more realistic fault gouge, and grain size and shape can evolve by grain fracture during shear. Two types of grains, rounded grains composed of 7 close-packed spherical particles and triangular grains composed of 6 close-packed spherical particles were designed to generate quartz gouge; Four different grain sizes were generated using four different particle sizes. Both the rounded and triangular grain have four breakable bonds and can break down into two irregular-shaped subgrains due to tensile and shear forces during shear, allowing for a wide range of grain sizes and shapes. DEM experiments were conducted by shearing identical granular assemblages composed of either the rounded or triangular grains under identical boundary conditions (i.e., wall surface roughness), over a range of normal stresses from 5 MPa to 100 MPa. The results show that the intensity of grain comminution is not only a function of normal stress, but also strongly dependent on grain shape. The triangular grains are much easier to break down at certain normal stresses than the rounded grains, a result of the smaller number of intergrain contacts and higher contact forces. The probability of breakage of the smallest grains is much higher than for the larger grains. The results support the constrained comminution mechanism in which the probability of particle fracture is strongly dependent on the relative size of nearest neighbors. As a less expensive deformation mechanism than rolling and sliding at high stress, our results demonstrate that comminution itself weakens the deformed granular assemblage. On the other hand, because comminution also changes grain shape and size, it increases the frictional strength of granular assemblage by increasing grain angularity. Grain shape becomes the most important factor that affects the frictional strength of fault gouge.

T31A-03 0830h POSTER

Elastic wave velocities and permeability evolution during compaction of Bleuswiller sandstone.

Jerome Fortin[2] (Jerome.Fortin@ens.fr)

Alexandre Schubnel[1] (alexandre.schubnel@utoronto.ca)

Yves Gueguen[2] (Yves.Gueguen@ens.fr)

[1]Lassonde Institute - University of Toronto, 170 College street, Toronto, ON M5T 1S7, Canada

[2]Laboratoire de Geologie -ENS Paris, 24 rue Lhomond, Paris 75005, France

Field observations and laboratory experiments have recently documented the formation of compaction bands in porous sandstones ([Mollema and Antonellini, 1996],[Olsson and Holcomb, 2000], [Besuelle, 2001a], [Klein et al., 2001]). It has been observed experimentally ([Wong et al., 2001], [Baud et al., 2003],[Fortin et al., 2003] that under axisymmetric compression, compaction bands develop sub-perpendicular to the main compressive stress which is predicted theoretically in the framework of strain localization theory ([Bésuelle, 2001a],[Issen and Rudnicki, 2000]).
Volumetric strain, fluid transport and elastic properties are intimately coupled to one another, for they all depend on few intrinsic parameters such as the porosity, the crack density, and the matrix and fluid elastic properties. On one hand, [Scott et al., 1993] showed that elastic wave velocities were clearly affected during the deformation of porous sandstones. On the other hand, [Zhu and Wong, 1997] showed that the relation between the evolution of permeability and volumetric strain during compaction of sandstones was not straightforward.
In this tudy, we present for the first time the simultaneous evolution of volumetric strain, elastic wave velocities and permeability for a set of deformation experiments of Bleuswiller sandstone. We show that, although very coherent to one another, those three sets are not systematically correlated. Indeed, inelastic compaction, whether it is distributed or localized, is accompanied by a drastic decrease of elastic wave velocities due to grain crushing, a decrease of permeability and porosity due to pore collapse. Using simple statistical physics concepts based on [Kachanov, 1993] and [Guéguen and Dienes, 1989], we try to understand and address the issue of coupling/decoupling between volumetric strain (mainly sensitive to equant porosity variations), elastic properties (mainly sensitive to crack density) and permeability (theoretically sensitive to both) during the formation of compaction bands. Finally, we show that the mineral composition of a sandstone is a key parameter controlling the effective pressure at which the onset of pore collapse P^* takes place.

T31A-04 0830h POSTER

Understanding how Fault-bounded Blocks Deform in 3D by Inverse Modelling

Gaetan Jouen[1] (jouen@esc.cam.ac.uk)

Nicky White[1] (nwhite@esc.cam.ac.uk)

[1]University of Cambridge, Bullard laboratories Madingley road Madingley rise, Cambridge CB3 0EH, United Kingdom

Normal faults play a crucial role in modifying basin stratigraphy. At the exploration scale, the internal deformation of tilted blocks is governed by the three-dimensional geometry of large-scale faults which bound these blocks. At the reservoir scale, the geometry and growth of normal faulting control the deformation of strata and the compartmentalisation of reservoir intervals. Despite their importance, large-scale normal faults are often difficult to image. The purpose of structural validation is two-fold: to determine the 3D shape of normal faults and to investigate the relationship between fault geometry and deformed stratigraphy including the intra-block faults. We have developed methods for tackling structural validation at a variety of scales in two and three dimensions. The cornerstone of our approach is the use of geophysical inverse theory to calculate optimal fault geometries from deformed strata. This approach allows us to focus on key questions: does a solution exist? Are there several possible solutions or just one unique one? In a complex normal fault system, which part of the fault controls the motion responsible for the deformation in the hanging-wall? Traditional forward modelling cannot answer these fundamental issues. We have applied the inversion on seismic data in particularly complex areas in the northern North Sea. The aims of this project are to determine the geometry of the basin-bounding fault, to assess the likelihood of out-of-plane motion as well as understanding the mode of deformation leading to the complexity of the present structure. Closely spaced inverse models show that the basin-bounding fault on the UK side is steeper and more planar than previously thought. This method also helped us to have a better view of what could have been the cause of the organisation and density of the intra-block faulting where it occurs. The North Cormorant study has shown how inverse modelling can yield important, quantitative, insights. Our quantitative approach can be used to determine the geometries of major basin-bounding faults, intra-block faults, and crestal slump faults.

T31A-05 0830h POSTER

Thermal emission before earthquakes by analyzing satellite infra-red data

Dimitar Ouzounov[1] (ouzounov@eosdata.gsfc.nasa.gov)

Patrick Taylor[1] (ptaylor@ltpmail.gsfc.nasa.gov)

Nevin Bryant[2] (nab@mipl.jpl.nasa.gov)

Sergey Pulinets[3] (pulse@geofisica.unam.mx)

Friedemann Freund[4] (ffreund@mail.arc.nasa.gov)

[1]NASA GSFC, MS 921, Greenbelt, MD 20771, United States

[2]JPL, California Institute of Technology, MS 169/315, Pasadena, CA 91109, United States

[3]Institute of Geophysics, UNAM, Ciudad Universitaria, Delegación de Coyoacán, Mexico 04510, Mexico

[4]NASA Ames Research Center, MS 239-20, MOFFETT FIELD, VA 94035, United States

Satellite thermal imaging data indicate long-lived thermal anomaly fields associated with large linear structures and fault systems in the Earth's crust but also with short-lived anomalies prior to major earthquakes. Positive anomalous land surface temperature excursions of the order of 3-4°C have been observed from NOAA/AVHRR, GOES/METEOSAT and EOS Terra/Aqua satellites prior to some major earthquake around the world. The rapid time-dependent evolution of the "thermal anomaly" suggests that is changing mid-IR emissivity from the earth. These short-lived "thermal anomalies", however, are very transient therefore there origin has yet to be determined. Their areal extent and temporal evolution may be dependent on geology, tectonic, focal mechanism, meteorological conditions and other factors.This work addresses the relationship between tectonic stress, electro-chemical and thermodynamic processes in the atmosphere and increasing mid-IR flux as part of a larger family of electromagnetic (EM) phenomena related to seismic activity.We still need to understand better the link between seismo-mechanical processes in the crust, on the surface, and at the earth-atmospheric interface that trigger thermal anomalies. This work serves as an introduction to our effort to find an answer to this question. We will present examples from the strong earthquakes that have occurred in the Americas during 2003/2004 and the techniques used to record the thermal emission mid-IR anomalies, geomagnetic and ionospheric variations that appear to associated with impending earthquake activity.

T31A-06 0830h POSTER

Kinematics of an Active Plate Boundary: Insights on the Philippine Mobile Belt through Analysis of GPS Observations and Satellite Imagery

Gerald A. Galgana[1,3] (1-812-855-1008; ggalgana@indiana.edu)

Michael W. Hamburger[1] (1-812-855-2934; hamburg@indiana.edu)

Qizhi Chen[1] (qizchen@indiana.edu)

Ernesto Corpuz[2] (ecorpuz@phivolcs.dost.gov.ph)

[1]Department of Geological Sciences, 1001 East 10th Street, Bloomington, IN 47405-1405, United States

[2]Philippine Institute of Volcanology and Seismology, C.P. Garcia Avenue, U.P. Campus, Diliman, Quezon City, MM 1101, Philippines

[3]Manila Observatory, Ateneo Campus, Loyola Heights, Quezon City, MM, Philippines

The Philippine Mobile Belt is a rapidly deforming region, sandwiched between two opposing subduction zones (the East Luzon Trough and the Manila Trench), characterized by extensive strike-slip faulting (Philippine Fault) and multiple volcanic arcs. We use campaign-mode GPS observations from 1996 through 2002 to examine plate motions, microplate movements, and internal deformation within the island of Luzon. The orientation, extent, and activity of faults were defined, in part, by analysis of LANDSAT imagery. We used Karhunen-Loeve Transforms, band ratios, deconvolution, and directional filtering to highlight important neotectonic and geomorphic features. Results of image processing are correlated with GPS site velocity vectors to provide better constraints on tectonic deformation of the Philippine arc. Based on our analysis, we can divide the island of Luzon into five principal tectonic units separating the Philippine Sea and Eurasian plates: (1) Ilocos block (NW Luzon, Cordillera Central); (2) Cagayan block (NE Luzon, Northern Sierra Madre); (3) Central Luzon (W. Central Luzon, Metro Manila); (4) Southern Tagalog block (SW Luzon, southern Sierra Madre); and (5) Bicol block (SE Luzon, Bicol Peninsula). Results of GPS analysis indicate that Luzon island is rapidly deforming, with the Cagayan block moving 30 mm/yr NW with respect to the Central Luzon block, defined by continuous stations MMA8 and PIMO in Manila. This motion is accomodated by sinistral shear along the Philippine Fault. The Ilocos block moves 8 mm/yr SW with respect to Cagayan block, accomodated by shear along western splays of the Philippine Fault. Similarly, there is NW motion of the Bicol block with respect to Southern Tagalog (26 mm/yr), parallel to the southern Philippine Fault. Significant relative motion (17 mm/yr ENE) is also taking place between the Bicol block with respect to the Cagayan block. Counter-clockwise rotation is noted within the Southern Tagalog block, where the 'Macolod Corridor' is located, based from 10 to 18 mm/yr ENE-trending velocities for sites located in southwesternmost Luzon and the Verde Passage, consistent with the observations of the dense network of Okhura et al. (2001). Internal deformation is observed within the Central Luzon block, near the Central Valley Suture, as evidenced by 10 mm/yr east-west strain within the block. Geodetic strain in the central part of the island is strongly dominated by elastic strain associated with the Philippine Fault. Elastic strain accumulation along the Philippine Fault is consistent with an elastic half-space model with uniform slip below a sub-surface locking depth, yielding a slip rate of about 40 mm/yr and a locking depth of 15 km.

T31A-07 0830h POSTER

The anisotropic poroelastic response of a granular fault gouge

N M Beeler[1] (nbeeler@usgs.gov)

D A Lockner[1] (dlockner@usgs.gvo)

[1]USGS, 345 Middlefield Rd, ms 977, CA 94025, United States

The undrained pore pressure changes accompanying seismic faulting, used in estimates of stress-transfer, can be assumed proportional to the mean stress change according to isotropic poroelastic theory. However, geologic observations show that rocks, soils, and fault zones typically have anisotropic and inhomogeneous material properties. In addition, the high differential stress usually associated with seismic faulting can induce elastic and poroelastic anisotropy in otherwise isotropic materials. Significant elastic anisotropy has been qualitatively accounted for in models of Coulomb stress change by assuming pore pressure change proportional to changes in fault normal stress (see Cocco and Rice, 2002). However, in anisotropic materials changes in differential stress as well as changes in mean stress will induce changes in pore pressure when the rock is undrained (i.e., no fluid flow into or out of the pores), meaning that changes in both shear and normal stress will induce changes in pore pressure. While an anisotropic response can be predicted on theoretical grounds, experimental verification has been limited. In terms of earthquake occurrence, and triggered seismicity, it is necessary to evaluate the importance of both inherent and stress-induced anisotropy. We have begun a laboratory and theoretical research program to understand the role of anisotropy on the poroelastic response of fault zones in the seismic crust. Preliminary results, reported here, are measurements of the undrained poroelastic properties of a granular, quartz fault gouge at confining pressures between 5.0 and 50.0 MPa and differential stresses from 0 to 60 MPa. In previous tests reported by Lockner and Stanchits [2002], bulk granular quartz is isotropic at hydrostatic stress conditions but has stress-induced anisotropy which increases with applied differential stress. Tests were carried out under axisymmetric loading conditions so that the aggregate has transverse induced anisotropy. In the present study, the quartz fault gouge shows stress-induced anisotropy in poroelastic response that is somewhat different than the bulk granular quartz at the same applied stress conditions, suggesting that the stress state inside the fault gouge is different than the applied stress state [e.g., Rice, 1992; Cocco and Rice, 2002]. We measured the pore pressure response to changes in mean stress (B), confining pressure and axial stress over entire range of confining pressure and differential stress. No comparable measurements have been made previously for faults. In addition we directly determined the pore space storage coefficient. Finally, for application to stress-transfer calculations, we measured the sensitivity of pore pressure to shear and normal stress changes. As expected pore pressure depends on both shear and normal stress for all conditions where differential stress is greater than zero. At the highest differential stresses, the normal stress coefficient is positive and approximately the same size as B while the shear stress sensitivity is negative and roughly 1/2 of the normal stress coefficient.

T31A-08 0830h POSTER

Measurements of Bismuth-214 in Soils to Locate Fault Traces

John J LaBrecque[1] (+58-212-504-1215; jjlabrec@ivic.ve)

Luis Melo[2]

Perdo R Cordoves[1]

Franco Urbani[3]

[1]Instituto Venezolano de Investigaciones Cientificas (IVIC), Apartado 21827, Caracas 1020A, Venezuela

[2]Venezuelan Foundation for Seismological Research (FUNVISIS), Apartado 76880, Caracas, Venezuela

[3]Universidad Central de Venezuela (UCV), Apartado 47028, Caracas 1041A, Venezuela

A simple and rapid technique to determine the relative counts of Bi-214 in surface soils to locate active fault traces of the El Pilar Fault in the state of Sucre, Venezuela will be presented. The method employed 300 seconds of measuring time using a portable differential gamma ray spectrometer on site. Three transects across the El Pilar fault that had very different geological aspects were studied. The first two at San Miguel and Guaraphiche showed clear positive anomalies at the fault trace, while a large positive anomaly was seen by radon-222 measurements at the San Miguel site and a small negative anomaly at the Guarpiche site. At the Las Toscanas site neither the measurements of the relative Bi-214 or the relative counts of radon-222 could confirm the fault trace, it has been suggested that since all the value of radon-222 and Bi-214 along this transect were high, that all of the measuring points were over very fracture soils. One of the advantages of this technique in respect to determining radon-222 in soil-gas is that no soil-gas probes are required to be inserted in the soil and the problem to know which is the appropriate depth. Finally, it has been suggested that measurements of 1000 seconds would be preferred rather than 300 seconds for future studies even though this would limit the number of measurements to about 20 per day.

T31B CC: 220 C-E Wednesday 0830h

Crustal Structure and Tectonics: Geophysical Observations and Models Posters *(joint with G, S, V, NS)*

Presiding: **E Bourlon,** St. Francis Xavier University**; J H Bedard,** Geological Survey of Canada

T31B-01 0830h POSTER

TECTONIC ANALYSIS OF ESH EL-MALLAHA AREA, GULF OF SUEZ USING EULER DECONVOLUTION FOR AEROMAGNETIC DATA

Essam Aboud (+81-92-642-3643; e.aboud@mine.kyushu-u.ac.jp)

Keisuke Ushijima (++81-92-642-3639; ushijima@mine.kyushu-u.ac.jp)

Esh El-Mallaha area is located on the western coast of the Gulf of Suez which is considered the main source of hydrocarbon resources in Egypt. The main exploration problem of the Gulf of Suez (and areas around) is the existence of the Pre-Miocene salt that masks the seismic energy and as a result, seismic method is not usually able to provide information about the subsurface structure. A solution may be existed using potential field methods such as magnetic which is highly sensitive to basement and not affected by salt. Herein, aeromagnetic data over Esh El-Mallaha area have been interpreted to provide a new look on the subsurface structure and tectonics of the area. This interpretation includes the application of Euler method which has been considered as a sufficient tool in magnetic interpretation. Comparing the results of Euler method with the available geologic data (wells, geologic maps), Euler method facilitates in identification of new faults as well as mapping of known faults from geologic information. Generally, the area is characterized by two basins structure trending in the NW-SE (parallel to the Gulf of Suez) direction. These two basins are separated by a high topographic feature (Esh El-Mallaha range) and bounded by faults of most probably normal type.

T31B-02 0830h POSTER

Error reductions from far-field analysis of regional gravity data

Timothy E. Leftwich[1] (614/292-1434; leftwich.12@osu.edu)

Ralph R. B. von Frese[1] (614/292-1434; vonfrese@geology.ohio-state.edu)

Orlando Hernandez[1] (614/688-8438; hernandez.135@osu.edu)

Laramie V. Potts[2] (potts@geology.ohio-state.edu)

[1]Deprtment of Geological Sciences, The Ohio State University, 275 Mendenhall Lab 175 S. Oval Mall, Columbus, OH 43210, United States

[2]Department of Civil and Environmental Engineering,, The Ohio State University, Columbus, OH 43210, United States

Typically, gravity observations are evaluated at the surface for their geologic componenets such as isostatic condition, crustal thickness, and subsurface density anomalies. However, when measured at the surface the free-air gravity anomaly (FAGA) may contain substantial terrain effects. We find the terrain gravity effect is roughly 20% of the surface free-air gravity anomaly for terrain compensated at 35 km depth. However, the differential effects of the terrain and its compensation at depth are substantially attenuated as altitude is increased so that sensitivity for the regional isostasy should be enhanced. Additional complications in performing surface gravity analyses arise from uncertainties in terrain gravity effects due to density and elevation errors. We find the increase in elevation from the terrain also increases the signal-to-noise ratio of the terrain effects. The relative error in terrain gravity estimates may approach 28% for 500m bathymetry error at the surface. However, at 20km elevation the relative terrain gravity error is reduced by roughly 20%. Hence, performing gravity field analyses at altitudes above the source grid, while attenuating the relatively short wavelength features in the observations, can greatly enhance the sensitivity of the analysis relative to surface analyses where terrain effects and their errors are more important.

T31B-03 0830h POSTER

Tectonic Implications of Reflective Fabrics in Dzhabyk Batholith, Russia

Mark A Loken[1] ((330) 972-7630; mal27@uakron.edu)

David Steer[1] ((330) 972-2099; steer@uakron.edu)

[1]University of Akron, Department of Geology 252 Buchtel Commons, Akron, OH 44325-4101, United States

Explosive-source data from the Urals Reflection Seismic Experiment and Integrated Studies (URSEIS) seismic reflection profile were reprocessed over the East Uralian Zone to improve understanding of the tectonic history of the region. The East Uralian Zone is interpreted as a Precambrian microcontinent of Siberian affinity partially covered with a batholith of Late Carboniferous and Early Permian granites. Analyses of the reprocessed data and the existing vibroseis source image revealed several sets of previously unidentified shallow reflections within this batholith. The reflections were observed in both the unmigrated and migrated data at approximately 3.4 km depth at western end of the zone, shallowed to 2.4 km depth 31 km farther east where they abruptly terminated. The reflection pattern appeared to resume about 2 km farther east where 10 km of reflections shallow from 3.8 to 2 km depth. Approximately 6 km of discordant reflections were imaged 46 km from the eastern end of the East Uralian Zone. A final set of reflections was imaged between 2 and 3 km depth on the eastern-most portion of the East Uralian Zone. Deeper reflections commonly interpreted at the bottom of the Dzhabyk batholith were imaged across the entire East Uralian Zone. The newly identified reflections illustrated that the Dzhabyk batholith is not transparent as is typically observed in such plutons. These shallow reflections have several possible explanations. They could be due to previously unrecognized compositional variations. These variations may be a result of multiple episodes of magma emplacement that trapped country rock. Entrapment of non-granitic materials would provide the acoustic impedance needed to generate reflections. Compressional or extensional faults could also create zones of low impedance that generate reflections. A deformation related model would be consistent with documented deformation further west, the apparent lack of widespread extension in the Urals and the geometry of the observed shallow reflections.

T31B-04 0830h POSTER

Anomalous Crustal Structure of the Northern Juan de Fuca Plate - A Consequence of Oceanic Rift Propagation?

Alastair McClymont[1] (amcclymont@eos.ubc.ca)

Ron Clowes[1] (1-604-822-4138; rclowes@eos.ubc.ca)

[1]Department of Earth and Ocean Sciences, The University of British Columbia, 6339 Stores Road,, Vancouver, BC V6T1Z4, Canada

Anomalous crustal structure of the northern Juan de Fuca plate is revealed from wide-angle seismic and gravity modelling. A 2-D velocity model is produced for refraction line II of the 1980 Vancouver Island Seismic Project (VISP80). The refraction data were recorded on three ocean bottom seismometers (OBSs) deployed at the ends and middle of a 110 km line oriented parallel to the deformation front of the Cascadia subduction zone and immediately south of the Nootka fault zone. The velocity model is constructed via ray tracing and conforms to travel time observations of direct, converted and reflected phases. Synthetic seismograms are produced from calculated first-arrival phases for comparison with the recorded seismogram sections. Travel time picks for turning ray phases with shot offsets of $>$ 60 km indicate significantly different lower crustal and upper mantle velocity structure toward each end of the profile. The variation in travel times is modelled by a pronounced increase in igneous crustal thickness of the Juan de Fuca plate, from $\sim$ 7 km at the southern part of the model to $\sim$ 10 km at the northern part (a thickness increase of 43%). A complementary 2-D gravity model using the geometry of the velocity model and velocity-density relationships characteristic of oceanic crust is produced. The densities required to match the gravity field indicate the presence of serpentinized peridotites rather than excess gabbroic crust. Anomalous travel time delays and unusual reflection characteristics observed from proximal seismic refraction and reflection experiments suggest a broader zone of serpentinized peridotites that coincides with the trace of a pseudofault. This correlation implies that the inferred partial serpentinization of the upper mantle may be a consequence of slow-spreading at the tip of a propagating rift.

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Late Tertiary and Quaternary Geology of the Queen Charlotte Basin Area: An Interpretation From High-Resolution Multi-channel Seismic Data in Hecate Strait

E Julie Halliday[1] (jhallida@uvic.ca)

N Ross Chapman[1] (chapman@uvic.ca)

Kristin M. M. Rohr[2] (krohr@shaw.ca)

George D Spence[1] (gspence@uvic.ca)

J Vaughn Barrie[3] (vbarrie@nrcan.gc.ca)

[1]School of Earth and Ocean Sciences, University of Victoria, P.O. Box 3055 STN CSC, Victoria, BC V8W3P6, Canada

[2]Rohr Geophysics, 719 Birch Road, Sidney, BC V8Z5S1, Canada

[3]Geological Survey of Canada, Pacific Division, P.O. Box 6000, Sidney, BC V8L4B2, Canada

In 2002 high-resolution multi-channel seismic data were collected off the west coast of Canada in the Hecate Strait area of Queen Charlotte Basin. The primary targets were regions where shallow sediments were known to be gas charged. The seismic data allow not only a means to recognize whether this gas may have originated from a deep source, but also an opportunity to identify potential geohazards in the surveyed area. A 120 cubic inch airgun seismic source was used, along with a 64-channel, 300m receiver array. One 2-D grid of data was collected on the western side of the strait, and a second on the eastern side. The eastern grid consists of 20 lines, 10 N-S and 10 E-W, yielding approximately 160 km of acoustic data. The seismic data were processed to migration. Consistent stacking velocities yield interval velocities that are reasonable for late Tertiary sandstones, and consequently provide a means to estimate lithological depths and thicknesses. Geologic interpretation has yielded a late Tertiary & Quaternary geologic history of the survey area. Important features include folding and faulting of late Tertiary sediments, with subsequent erosion of these sediments by incision of paleo-channels.

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