T31A-08 0830h POSTER

Measurements of Bismuth-214 in Soils to Locate Fault Traces

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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

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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

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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

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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?

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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.

T31B-05 0830h POSTER

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

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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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T31B-06 0830h POSTER

Anatomy of the Main Martir Thrust: a Non-terminal Suture in the Peninsular Ranges, Baja California, Mexico.

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We investigate part of the exhumed Peninsular Ranges batholith, a Mesozoic-Cenozoic continental margin magmatic arc. We use structural and microstructural data to constrain the displacement and kinematics of the Main Martir thrust (MMt) and compare these to a model. The thrust, which has been interpreted as a non-terminal suture, is a one to two kilometer-wide shear zone that divides the batholith into an eastern part underlain by continental crust and a western part underlain by juvenile oceanic crust. The thrust is not associated with any known occurrences of ophiolites or deep marine sediments, which could be expected if the oceanic arc had accreted with a continental margin above a subduction zone. From east to west the shear zone includes orthogneisses, epidote-bearing metavolcanic gneisses, migmatites, and garnet amphibolites in the hanging wall, as well as a 50m section of calc-silicates mostly underlain by upper greenschist-facies metavolcanic phyllites in the footwall. Phyllites form a continuous footwall assemblage in all traverses and are part of the Albian Alisitos Formation, which towards the thrust shows a progressive increase in metamorphic grade consistent with juxtaposition against hotter rocks of the hanging wall. Within the hanging wall some units are attenuated, discontinuous, or pinch out and the metamorphic grade varies from andalusite-bearing schists to sillimanite-bearing metapelitic migmatites. Metamorphism appears to have accompanied deformation. Oriented rock samples from both sides of the MMt record mylonitic fabrics with shallowly plunging mineral lineations. Rounding a bend in the MMt these lineations swing from northeast-plunging in the western segment to north-plunging in the southern segment. Our work shows that significant differences in lithology, metamorphic grade, and lineation orientation occur along strike of the MMt. The diverse lithologies suggest that some components of a subduction complex might be present, whereas the different peak metamorphic temperatures recorded could suggest that hanging wall metamorphism occurred during periodic, variable heating episodes. Our study area spans a sharp bend in the thrust, and we explore the possibility that an indentor corner caused the distinctive lineation pattern and variation in metamorphic grade.

T31B-07 0830h POSTER

Gravity analysis of the Bam Earthquake Region

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On 26 Dec. 2003, the city of Bam and surrounding villages of the Kerman Province in southeastern Iran were severely shaken by a 6.5 Mw earthquake. Preliminary results show the earthquake's epicenter at 29.004N, 58.337E with a 14 km focal depth. The earthquake was triggered by right-lateral strike-slip motion along a north-south oriented fault. The earthquake was centered at the intersection of three concentrated zones of earthquake activity. This area includes an aeromagnetic anomaly minimum that overlies the Qale Ali Hasan volcano. These results are consistent with regionally demagnetized crust by an elevated Curie isotherm. Spectral correlation analysis of available free-air gravity anomalies and the gravity effects of the terrain modeled by Gauss-Legendre quadrature integration suggest that the isostatic balance of the Bam earthquake region is strongly disturbed. In this study, we investigate these results for constraining the crustal stresses that may have triggered the earthquake.

T31B-08 0830h POSTER

Mountains of water and repeated release in earthquakes

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The largest earthquake-induced increase in streamflow ever recorded, with a total excess water of 0.7 km3, occurred in central Taiwan after the 1999 (Mw = 7.5) Chi-Chi earthquake. Analysis of stream gauge data and well records suggests that the excess water originated in the mountains that showed extensive high-angle tensile fractures after the earthquake. The consequent increase in vertical hydraulic conductivity allows rapid draining of water from the mountains. We suggest that mountains in tectonically active areas may be repeatedly flushed by meteoric water on a time scale comparable to the recurrence interval of large earthquakes.

T31B-09 0830h POSTER

Implications of Stratigraphic and Structural Data from the Bitter Spring Region, Southern Nevada

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Deposition of the Tertiary Horse Spring Formation (HSF) in southern Nevada has been used to infer varying styles of extensional and strike-slip basin formation. Beard (1996) proposes an initial large contiguous basin of Rainbow Gardens age (ca. 26-18 Ma) that is subsequently broken up into sub-basins during Thumb time (16-14 Ma). A key locality to test this hypothesis is near the southern end of East and West Longwell Ridges, on the Bitter Spring USGS 1:24000 quadrangle (BSQ). However, the stratigraphic framework in this area is poorly defined. The BSQ is located west of the Overton arm of Lake Mead near the junction of the Las Vegas Valley Shear Zone and the Lake Mead Fault System. By mapping a portion of the quadrangle at 1:5000 scale, measuring detailed sections, and collecting ash samples from key localities, we investigated the structural and sedimentary framework of the area and have begun to clarify the stratigraphic relationships between members of the HSF. Faults fall into three categories: one set strikes north and dips moderately to the west; another strikes east-northeast and dips shallowly to the northwest; and the last strikes north and dips to the east. Many of these faults show an oblique sense of movement and may be related to movement on the White Basin (WBF) and Rodgers Spring Faults (Bohannon, 1983). A distinctive resistant limestone caps gypsiferous and clastic units on both sides of the north-south trending WBF. To the west of the WBF, this limestone is mapped as the Bitter Ridge Limestone Member of the HSF, whereas to the east it is mapped as the Thumb Member by Beard (unpub) and as the Rainbow Gardens Member by Bohannon (1983). We suspect that these limestones may be correlative; geochemical and petrographic fingerprinting of numerous ashes from our sections should allow correlation of these units across the WBF. In addition, sections from the east side of the WBF spaced over 1.5 km show conglomerate at the base, overlain by a sequence of red sandstone, gypsum, and carbonates (mainly oncolitic and peloidal limestone). These units show rapid lateral facies changes and thickness variation suggesting comparable changes in accommodation-space creation, possibly related to extensionally-induced subsidence. Paleocurrent data from the central portion of the mapping area indicate that flow was east- to southeast-directed, indicating that West Longwell Ridge may have been a topographic high during Thumb time. This interpretation is further supported by stratigraphic relationships near the basin margin, where conglomerate was deposited in buttress contact against Paleozoic limestones at the southern end of the ridge. Future work in this area includes continued mapping, Ar-Ar dating of ash mineral phases, and provenance analysis of sedimentary units.

T31C CC: 516 B Wednesday 0830h

Strain Partioning: Theory and Measurement *(joint with G, S)*

Presiding: **K Tiampo,** University of Western Ontario**; D Bowman,** California State University, Fullerton

T31C-01 0830h INVITED

Strain and stress partitioning of the North America/Pacific interaction along the Queen Charlotte margin

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Based on GPS data acquired over the last 5 years, we estimate the distribution and partitioning of crustal strain associated with the Pacific/North America (PA/NA) relative motion along the western margin of central British Columbia and southernmost Alaska. Combining GPS velocities and earthquake focal mechanisms, we show that the present-day transpressive PA/NA interaction is partitioned, from offshore to inland, between shortening in the Queen Charlotte Terrace, pure strike-slip along the Queen Charlotte Fault, and distributed dextral shear along the continental margin. The Queen Charlotte Fault was the locus of the great 1949 M=8.1 earthquake and is currently fully locked. Our GPS data cannot yet resolve whether the Pacific plate is actively subducting underneath North America or not. Partitioning of the PA/NA motion over the last 5 Myr is also supported by seismic reflection profiles that indicate shortening in the Queen Charlotte Terrace and in the Queen Charlotte Basin formations, respectively seaward and landward of the main strike-slip plate boundary. In order to assess the importance of lateral heterogeneities in composition and strength across the margin (sedimentary basins, major faults, etc.), we are developing a 3D finite-element model to investigate the distribution of crustal and lithospheric strain in response to the PA/NA relative motion.

T31C-02 0845h

Strain Partitioning of Oblique Convergence: Initiation of Subduction on the Queen Charlotte Margin?

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The seismic hazard within the Queen Charlotte Islands (QCI) is poorly understood. The present tectonic setting of the region is dominated by the Queen Charlotte Fault (QCF), the transpressive plate boundary ($\sim 320^{\circ}$) between the North American and Pacific plates along the western margin of Canada. The plate motion along the fault is primarily right-lateral transform at rates of $\sim$50 mm/a with a small component ($\sim$20 mm/a) of compression across the boundary. Convergence is confirmed by GPS velocities indicating northward oblique to the margin motions of 5-15 mm/a and the distribution of seismicity in the region of the QCF, which is partitioned into strike-slip events along the main fault and thrust events on subsidiary faults within the Queen Charlotte Terrace. Two end-member models have been proposed for the accommodation of the oblique convergence, internal deformation of both plates and underthrusting of the oceanic Pacific plate. Evidence for underthrusting includes the characteristic subduction zone trench and accretionary prism, low heat flow over the west coast of the Island consistent with a model of subduction, and the presence of an underthrust slab of oceanic crust imaged by teleseismic