Predicting of horizontal fault-dilatancy zones of heterogeneities within the crust round the deep wells by 3D vertical seismic sounding method

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We propose principally new 3D seismic method of study of low-velocity layers and inhomogeneities within the Earth crust. Along with obtaining of standard data on study of geometry of the structure this method allow to determine also material composition of rocks on depths in any surface point and nearby. The method of local forecast of the section by distinguishing of reservoirs of oil-gas bearing basins, determination of their outlines and assessment of character and degree of fluid saturation in 3D on the base of new methods of interpretation of velocity and energetic analysis of the observed wave fields of the reflected waves. For the first time the paper deals with the algorithm of important new parameter, expressing the energetic state of reservoirs in dependence on its physical properties. What is more important that this method allows to choose correctly the place of location of prospecting wells excepting the cavities (non-productive) having conducting preliminary short-term and not-capital-intensive studies. A high effectiveness of the proposed method and technology is demonstrated on some oil-gas fields and near the ultra-deep drilling of Saatly well (15 km) in Azerbaijan. This effectiveness of method is the confirmation of right doing of 3D seismic in real states and should be interested in discussions with potential end-users. New approaches to analysis of the dynamic characteristics are based on the energetic notions of the recorded signals of the reflected waves. On their base the method of energetic analysis of the wave field of reflected waves is developed. A significant qualitative parameter of anomalies of the rounding energogrammes – relation of its amplitude Ai_{max} to period Tí is entered with purpose to determine also the character and degree of saturation of reservoir formation. It determines the energetic state of reservoir formation and disconsolidated zone made by it. In the present paper an algorithm of this important parameter had been received for first time, it expresses the energetic state of reservoir formation in dependence upon its physical properties. New method gives a unique possibility to study the well bore section and near-well area not only at the recovery intervals, but also below drift way. The most important is by conducting the preliminary short-terms researches without strong capital investments, the method allow correctly to choose the site of search and prospecting wells, excluding gaps (unproductive). The experimental materials, obtained form a number of oil and gas – bearing zones in Azerbaijan, indicate on the high effect of proposed method and technologies.

3D seismic; Azerbaijan; interyals; inhomogeneities.

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Structure of the lithosphere beneath Tien Shan

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ABSTRACT

The structure of the lithosphere beneath the active orogenic belt Tien Shan, a typical intercontinental mountain belt, has been interpreted in a context of physical properties of mafic granulites, peridotite xenoliths, eclogites, gneisses, and monzonite-granites compared with the field observations of magneto-telluric and seismic data. The principal objective of the research is to find some new laboratory constraints on rock compositions along the lithosphere transect directed from the north western Tarim Basin in China to the central Tien Shan of Kyrgyzstan. The seismic velocity data have been obtained from a near-vertical deep seismic reflection sounding, acquired during the summer campaign of 2007. The electric resistivity cross-section data have been obtained from the inversion of MT data (*Bielinski et al., 2003*). The thermal field beneath the cross section has been modelled by using thermal properties of rocks and seismic boundaries. The methodology of the research based on the laboratory measurements of electrical conductivity and elastic wave velocities in mafic granulite, gmonzonite-granite, gneiss, eclogite and peridotite xenoliths collected from basaltic outcrops along the geophysical profile and on the interpretation of the field data with the help of laboratory derived constraints.
The laboratory measurements have dealt with measurements of electrical conductivity of rock samples at pressures and temperatures corresponding to their geothermobarometry. The electric impedance measurements were conducted at pressures from 1 to 2.5 GPa and in the temperature range from 200 to 1100°C (*Bagdassarov et al., 2007*). The elastic wave velocities have been measure by the pulse transmitting method at normal conditions and extrapolated to high pressures and temperatures. The seismic reflection results combined with the magneto-telluric measurements along the profile revealed some general quasi-vertical features of the continental lithosphere structure in the active orogenic environment. MT- and seismic data suggest that the continental lithosphere of the Tarim Basin may be subducted beneath the southern margin of the Tien Shan with an average dip angle about 20-25°. There are similar subduction boundaries between Tarim Basin and Tien Shan belt both revealed in conductivity and by seismic models. This small dip subduction angle explains a much smaller shortening accommodated by Tien Shan as a response to the India-Eurasia convergence. The superposition of laboratory measured electrical conductivity and electrical resistance inversed from MT-data versus temperature demonstrates a good agreement between these parameters. The rocks below 60-70 km are most likely composed of spinel lherzolite and harzburgite experienced a high degree of partial melting. This immense melting of the lithospheric mantle beneath Tien Shan may be genetically connected with a rise of a core-mantle boundary mega plume which caused also the occurrence of Deccan trapps in India about 66 M*a* ago (*Simonov et al., 2007*). The outcrop of eclogites at At-Bashi ridge and their presence up to the depth about 100 km according to the geoelectric model, evidences about a paleo oceanic crust subducted into the upper mantle prior to the onset of collision and the orogenic thickening of Tien Shan at about 50-55 M*a* ago due to the India's penetration into Asia (*Abdrakhmatov et al., 1996*).

Key words: orogenic belt, continental lithosphere, electrical resistance, elastic wave velocities, xenoliths.

PRESENTER'S BIOGRAPHY

Bagdassarov N., Dr., graduated from the Department of Physics at Moscow University in 1977. He obtained Ph. D. from the Institute of Physics of the Earth, Russian Academy of Sciences in 1985. Humboldt Fellowship in 1991-92. He stayed at Bavarian Institute for Experimental Geochemistry and Geophysics from 1990 to 1995. Since 1995 he is a permanent Faculty staff member of the Geosciences Department, Section of Geophysics at Frankfurt am Main University in Germany. The field of principle interests includes rock physics, Earth and planetary interior physics.

Using Very Fast Simulated Annealing for Joint Inversion of Direct Current (DC) and Electromagnetic (EM) Data

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ABSTRACT

One of the way to improving the information content of a set of field data is combining the interpretation of disparate data sets. Data from different types of geophysical surveys offer the possibility for reducing the ambiguity of an interpretation. The case of interest in the present work is the joint inversion of electromagnetic (EM) and direct current (DC) resistivity data. Both data sets are generated by the same physical property (electrical conductivity) of the earth by different physical principles and hence these data sets can be regarded as genetically related. Therefore, when a conductivity structure of the subsurface is investigated, joint inversion of these data sets should yield better results in comparison with the joint inversion of EM or DC with other data sets which are not genetically related, for example seismic, gravity, magnetic, etc. Individual inversion of the EM data set can resolve a conducting layer reasonably well but it fails when the layer is either thin or resistive with respect to the surroundings. On the other hand, the individual inversion of the DC resistivity data suffers from an inherent equivalence problem. For these reasons, the joint inversion of EM and DC data sets is carried out to study the possible reduction in ambiguities over different types of 1D earth structure. As optimization tool for inversion very fast simulated annealing (VFSA) algorithm was used. VFSA is a global optimization technique which allows a faster temperature schedule compared to the classical simulated annealing schemes.

Individual and joint inversion of resistivity data obtained from horizontal coplanar low-frequency induction soundings and Schlumberger vertical electrical soundings were performed. To test the algorithm, both noise-free and noisy synthetic data were used, which imitated real 1D EM and DC sounding for three-layer (H- type) and five-layer earths. To combine EM and DC resistivity data the following objective functions were tested:

$$\varepsilon_1 = \frac{1}{N}\left[\sum_{i=1}^{N}\left(\frac{\rho_i^o - \rho_i^c}{\rho_i^o}\right)^2_{VES} + \sum_{i=1}^{N}\left(\frac{\rho_i^o - \rho_i^c}{\rho_i^o}\right)^2_{EM}\right]$$

$$\varepsilon_2 = \frac{1}{N}\left[\sum_{i=1}^{N}\left(\frac{\ln(\rho_i^o) - \ln(\rho_i^c)}{\ln(\rho_i^o)}\right)^2_{VES} + \sum_{i=1}^{N}\left(\frac{\ln(\rho_i^o) - \ln(\rho_i^c)}{\ln(\rho_i^o)}\right)^2_{EM}\right]$$

where ρ_i^o and ρ_i^c are observed and computed apparent resistivity for vertical electrical soundings (VES) and electromagnetic (EM) soundings. As a result of calculations better agreement between the assumed parameters of the model and those calculated after inversion was obtained for ε_2. The equivalence of the model (H-type curve) was taken into consideration. Analysis of obtained outcomes demonstrate that using joint inversion gives significantly better results in solving values of parameters with equivalence in comparison with separate inversions of VES and EM soundings. Also, it was observed that the starting model do not need to be close to the real geoelectric earth in case of using VFSA. However putting the constrains on the model's parameters using *a priori* knowledge on the interpretation space or analysing the character of apparent resistivity curve could reduce time of computations, especially for multi-layer earth cases.

Key words: simulated annealing, joint inversion, electrical resistivity

PRESENTER BIOGRAPHY

Justyna Bała is a PhD student in the Department of Geoinformatics and Applied Computer Science, Faculty of Geology, Geophysics and Environmental Protection, AGH University of Science and Technology, Krakow. She is interested in application of joint inversion for geoelectrical methods, especially for vertical electrical soundings and low-frequency induction soundings. Over the years this interest has generated research activities in possibility and effectiveness of different optimization methods for joint inversion and application of parallel computations in inverse problems.

Drop-down formation of deep basins along the Dead Sea and other strike-slip fault systems

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ABSTRACT

Extensional sedimentary basins often lie along large shear faults. The Dead Sea continental transform is associated with some of the larger and unusually deep basins (width/depth ratio sometimes less than one) whose formation cannot be explained by current pull-apart models. Among these basins, the southern Dead Sea is the deepest. Studies suggest that pull-apart formation of the Dead Sea basin requires normal or high heat flow, but heat flow is anomalously low in this basin. The Dead Sea basin is associated with deep seismicity and is bounded by deep normal faults in the southern part rather than the lystric transverse faults of the pull-apart model. We investigate the origin and evolution of deep basins along the Dead Sea fault and propose that when strike-slip faulting initiated, heavy magma bodies, formed in the crust or upper mantle during previous stages of regional magmatism, dropped down into the mantle and formed the basins. Numerical simulations indicate that the resulting basin is rhomb-shaped and grows by the addition of distinct segments to its edges. The proposed mechanism accounts for the observed heat flow and deep seismicity in the Dead Sea and can probably explain the evolution of large sedimentary basins along other continental transforms, such as the San Andreas Fault.

The proposed drop-down mechanism of deep basin formation is studied by simulating the evolving seismicity and fault pattern in a 3-D numerical model. The model has three layers: weak sediments (3 km thick); crystalline crust up to Moho (30 km depth); upper mantle. A small, heavy spherical magma body is embedded at Moho depth. We use a damage rheology in the seismogenic zone and a power-law ductile rheology in the lower crust and upper mantle. The damage rheology simulates the macroscopic effects of evolving distributed cracking. A prescribed depth-dependent temperature distribution, corresponding to the regional heat flux of 40 mW/m^2 in the Dead Sea, controls the ductile strain and is kept constant during the simulation. The boundary conditions correspond to motion of the Arabian plate. Relative to the modeled area, the eastern part of the plate moves northward at 2.5 mm/yr, while the western part moves southward at the same rate. The forces applied to the model edges are defined by regional stresses that are assumed proportional to slip deficit, i.e., the mismatch between plate motion and displacement of model boundaries. Ongoing loading associated with motion of the Arabian plate leads to nucleation and development of the Dead Sea fault and stress amplification around the inclusion. At a certain stage, depending on inclusion size and rock strength, new faults nucleate around the heavy body and it detaches from the surrounding rock. Results of the modeling suggest that the deepest part of the Dead Sea basin formed first and later the basin grew larger by extending north and south, a situation which is probably also true for the southern Sea of Galilee and the central Gulf of Aqaba.

Key words: Dead Sea fault, pull-apart basins, strike-slip faults, basin formation, continental transforms.

GERALD SCHUBERT

The presenter is Distinguished Professor of Geophysics and Planetary Physics in the Department of Earth and Space Sciences and the Institute of Geophysics and Planetary Physics at the University of California, Los Angeles. He has contributed to the field of geodynamics for several decades and is coauthor of “Geodynamics” by D. L. Turcotte and G. Schubert and “Mantle Convection” by G. Schubert, D. L. Turcotte, and P. Olson.

The lithospheric structure beneath the Congo Basin, a combined interpretation of gravity, seismic tomography, and subsidence

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ABSTRACT

Variations in the long wavelength free-air gravity over Africa show a number of positive gravity anomalies related to regions of high topography, and two large negative anomalies in NW Africa and above the Congo Basin. Recent surface wave tomographic studies have indicated that there are slow seismic wavespeed anomalies in the uppermost mantle beneath many of the uplifted areas, perhaps suggesting a thermal, convective contribution to the topography. In contrast beneath the Congo Basin most tomographic models have shown fast wavespeeds extending to at least 200km depth, frequently interpreted in terms of thick, cold lithosphere. The Congo Basin has a long (~500 Ma) subsidence history and sediment thickness of around 5km within much of the basin. The large gravity anomaly would not be expected if the sediments were isostatically compensated simply by changes in crustal thickness.

In order to improve our knowledge of the lithospheric structure of this region we investigate what range of crustal thickness and density, and upper mantle density can be combined in order to produce the observed gravity anomaly. A reference model was used with crustal thickness of 30km and a lithosphere of 100km thick. The gravity anomaly is then calculated using a simple disc model. Crustal thickness and density are first varied, and then the mantle density is required to vary such that the total column is in equilibrium with the reference model. The lithospheric thickness is constrained to be that indicated by the surface wave tomography.

The results suggest that the only configuration that is consistent with the observed long wavelength gravity anomaly is that the crust is relatively thick and light, and the mantle correspondingly heavy (i.e. barely depleted at all). This configuration, however, would be inconsistent with the isopycnal hypothesis, where thick cratonic roots are associated with depleted lithospheric mantle. It remains unclear whether the Congo cratonic root really is different to other larger cratons around the world, or if in fact the gravity anomaly has some other origin, such as a convective downwelling, which would itself be difficult to explain due to the long, steady subsidence history of the basin.

Key words: Congo Basin, Gravity, Seismic Tomography, Subsidence

PRESENTER'S BIOGRAPHY

Stewart Fishwick completed a PhD at the Research School of Earth Sciences, Australian National University in 2005, then following a post-doctoral position (2006-2007) at the University of Cambridge (UK), took up a New Blood Lectureship in Geophysics at the University of Leicester (UK) in October 2007.

Illuminating crustal development using countrywide airborne geophysical surveys – the Central Gabon case

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ABSTRACT

Gabon situated on the West Central African platform extends along and across the equator about 500 km in each case. The Council for Geoscience in collaboration with Southern Exploration Services recently accomplished an airborne magnetic and radiometric survey over the central parts of Gabon comprising 150.000 line kilometers to upgrade geologic mapping. Central Gabon reveals quite a variety of Archean and early Proterozoic cratonic blocks. Part of them was remobilized during the Eburnian orogenic event. Farther in the south-west of the survey area, there are several metasedimentary and magmatic terrains of late Proterozoic (Pan-African) age which form part of the West Congolian orogenic belt. We are illustrating the various magnetic and radiometric signatures typical of the tectonostratigraphic terranes occurring in the survey area to elucidate the geodynamic evolution of the Precambrian basement. Faults and lineaments reflected by the geophysical data will be highlighted to reconstruct the stress pattern during Precambrian age. Modelling of a number of typical traverses will enhance the results of the qualitative assessment. In the north of the survey area, thorium-rich tonalitic orthogneisses of Archean age are wide-spread. Their magnetic fabric is oriented NW-SE, though their foliation is SW-NE. The central part of the survey area is covered by the early Proterozoic Ogooué block with vulcanosedimentary rock of the Ndjolé-Kolissen block extending along its western flank. The narrow band of metasedimentary rock of the Okanda block extends N-S on the east flank of the Ogooué block and reflects a thin, thrust-bound package of east-verging tectonic slivers thrusted upon the Archean socle. This set of early Proterozoic blocks displays a heterogenous magnetic signature of near-to-surface and deep-seated source bodies and is confined in the southwest by the Ikoyé-Ikobé fault, a sinistral shear zone extending some 250 km. In the magnetic and ternary images this prominent fault zone is reflected by a set of narrow parallel running anomaly chains. Some parts of the fault are aggravated by a magnetic minimum indicating that magnetic material was accumulated along the fault (geomagnetic inclination is -30°!). The structure of the Ndjolé block is reflected by narrow magnetic anomalies describing an anticlinorium with tight isoclinal folding. West of the Ikoyé-Ikobé fault, where the known Mabounié carbonatite intruded rock of the early Proterozoic Lambaréné block, eye-catching geophysical anomalies are produced. A shallow magnetic anomaly field reflects the area of the Pan-African Nyanga synclinorium which extends over 200 km in NW-SE direction in the southern half of the survey area indicating that the metasedimentary fill is largely non-magnetic. The W-E trend of the magnetic anomalies supports the conclusion that they originate from the Archean basement buried at a depth of less than 10 km. The Nyanga synclinorium is encompassed by rocks of the Lambaréné block whose mid-amplitude signature is irregular, but reveals a number of areas with a highly fractured anomaly pattern, e.g. the Mont Doudou Complex. Between the Lambaréné block and the Nyanga synclinorium a band of pan-African mafic to ultramafic intrusives, e.g. the Mont Pélé escarpment, produces strong magnetic anomalies.

Key words: Gabon, airborne geophysics, crustal evolution, Archean basement, Proterozoic belt.

PRESENTER'S BIOGRAPHY

Detlef Eberle has received his MSc and Doctor degrees in geophysics from the Ludwig-Maximilian University, Munich. He joined the Federal Institute for Geosciences and Natural Resources (BGR) of Germany in 1971 where he developed his strong interest in airborne geophysical data acquisition and interpretation. He has been involved in many mineral exploration, groundwater and capacity building projects around the world. Since 1982 he has been a part-time lecturer at the Berlin University of Technology where he received the habilitation degree and 'venia legendi' in 1993. From 1993 - 2000 he was seconded to the Namibian Geological Survey where under his auspices the first airborne magnetic map of Namibia was compiled and used for a revision of the country's mineral potential. In 2003 the University of Pretoria had invited him to lecture geophysics at post-graduate level. He is currently a project manager at the Council for Geoscience and an active member of SAGA, SEG and ASEG.

Advanced differential interferometry for detection of crustal warping and potential movement along the Baviaanskloof fault - towards earthquake hazard assessment

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ABSTRACT

The ability to detect, measure and monitor crustal deformation in the vicinity of faults, and any potential movement along these faults, is critical in determining the potential seismic hazard of an area. The nature of local deformation and the area affected by it near a fault may determine the extent of seismic hazard. A new research project is currently underway that proposes the application of advanced differential Interferometry (DInSAR) techniques to detect, measure and monitor surface deformations associated with possible isostatic adjustment along the Cape Isostatic Anomaly, and to determine its effect along the Baviaanskloof fault, situated on the southern side of the anomaly, southwest of the town of Willowmore in the Eastern Cape Province of South Africa.

South Africa is generally considered to be an area of low seismicity but is known to have experienced events in excess of M6 on the Richter scale. The location, magnitude and time at which such earthquakes occur cannot be predicted prior to the event. However, monitoring deformation of the earth's crust, especially differential movement along faults and over broad surface areas, will be invaluable for the assessment of seismic hazard that potentially affects well-developed areas along the southern to south-eastern coast of South Africa. Here, a major east-west striking normal fault, known as the Ceres-Kango-Baviaanskloof-Coega (CKBC) fault system, is of interest. A strong negative gravity anomaly in the area implies that isostatic adjustment is incomplete, and vertical uplift along the northern foot-wall side of the fault system may be expected. Geological evidence for reactivation of the Kango fault segment of the CKBC fault system suggests that such adjustments have occurred previously, the most recent being at the start of the Holocene Epoch, about 11,000 years ago.

The Baviaanskloof fault segment of the CKBC fault system is of interest due to several prevalent conditions including:

- It forms an eastward extension of the recently reactivated Kango fault
- There is accurately-located seismic activity on the fault in 2006, at the segment boundary with the Kango fault
- There is accurately-located seismic activity on the adjacent Kouga fault in 2001.
- The relationship with the Cape Isostatic Anomaly
- Proximity to the Baviaanskloof Thrust

These conditions suggest that movement long the Baviaanskloof fault is a distinct possibility. If either surface deformation in the vicinity of these faults is detected, or movements along this fault, or adjacent faults are observed, the area potentially to be affected by earthquake activity can be established. This will imply that the technique could contribute towards an early warning system and would be invaluable for decision-making strategies on current and future infrastructure.

Key words: Differential Interferometry, Crustal deformation, Fault movement, Earthquake hazard, Isostatic adjustment

PRESENTER'S BIOGRAPHY

Jeanine Engelbrecht has three years experience in the application of remote sensing technologies in the geosciences field, including remote sensing for geological mapping and minerals exploration. Current research activities are focused on the development of radar remote sensing techniques for various applications in the geosciences field. The current research project focuses on the development of advanced radar interferometry techniques for geohazard assessment in South Africa and is also the topic of PhD research currently underway through the University of Cape Town.

An evaluation for electrical conductivity variation of amphibolite associate with dehydration

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ABSTRACT

Dehydration process in the crust and mantle is accepted that there is some correlation between fluid and seismic activity. If dehydration occurs in the crust and/or laboratory, clear phase change or decomposition of mineral and/or rock might be observed. The physical property: electrical conductivity is not only sensitive to variation of geo-thermo, but dehydrated water and fluid. Thus, the variation of conductivity data ultimately can be utilized to detect dehydration process in rock. In particular, conductivity of hydrous mineral and rock contains hydrous mineral vary drastically due to the effect of water content and influence of ionic water. To detect electrical conductivity variations associate with dehydration process, we have conducted different types of laboratory measurements. Electrical conductivity measurements of basic rock and amphibolite were conducted. During the several heating and cooling cycles up to 900 K, it can be seen stabilized gradient of electrical conductivity of basic rock and linear relationship was found between 600 and 900 K. This linear trend can be applied to Arrehenius equation and we can observe intrinsic conduction mechanism operated for thermally activated phenomena. We also measured and observed conductivity of amphibolite. Temperature was raised gradually less than metamorphic temperature. Once temperature was increased over metamorphic temperature, conductivity variation does not show linear trend and maintained high values. When temperature exceeds metamorphic condition or is near phase boundary condition, electrical conductivity of the sample increase drastically by 2 to 3 order of magnitude. As amphibolites contain much hydrous minerals, conductivity of the sample may be high after dehydration. For this phenomenon, we evaluate the effect of water and the influence of ionic fluid after dehydration, quantitatively. Even though small amount of H2O is formed after dehydration, bulk conductivity of the sample varies drastically. This increase of the conductivity associate with dehydration is often observed by EM soundings in and around the subduction zones in the Earth. The purpose of the present paper is to give a detailed explanation of the experiment results of electrical conductivity variation associate with dehydration. Our experiment also contributes to study of dehydration process of rocks in the crust and around the subducting plate.

Key words: conductivity, dehydration , amphibolites , subducting plate

PRESENTER'S BIOGRAPHY

The author received the M. S. and Ph. D. degrees from Kobe University, Hyogo, Japan, in 1991and 1994, respectively. From 1996 to 2007, the author worked for Earth and Planetary Sciences, Faculty of Sciences, Kobe University as an assistant Professor. Presently, the author is an associate Professor of Graduate School of Engineering, Osaka University, Osaka, Japan. The author's current research interests are high pressure- temperature experiment, Electro-Magnetic soundings and Simulations for Solid-Liquid states.

The Genesis of the New Zealand Plate Boundary: Extension-Transpression-Subduction

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ABSTRACT

The present New Zealand plate boundary – the Hikurangi subduction zone (North Island), the Alpine Fault, and the Puysegur/Fiordland subduction zone (South Island) - has developed and evolved in response to substantial changes in Pacific-Australia plate motions as a result of a rapid migration of the rotation pole. This transition from transpression to subduction started approximately 30 Ma with a rapid southward migration of the Pacific-Australia rotation poles leading to a rapid cessation of extension and the simultaneous initiation of transpression along the newly developing plate boundary and subduction beneath northernmost North Island. Since that change from extension to transpression/convergence, the southward emplacement of subduction into the previously transpressive system - a fundamental mechanism of subduction initiation – has lengthened the Hikurangi subduction system to approximately 800 km. We determine the details of this subduction initiation/emplacement by combining present-day kinematics and seismicity patterns with the history of lithospheric response as recorded in the geologic record. Subduction initiation along the Hikurangi margin involves the removal, by active delamination, of the transpressively-thickened lithosphere. This allows the presently observed simple subduction geometry to rapidly form within a few million years of the initial emplacement of subduction at that location. The tectonic signature of this subduction initiation/emplacement is dominantly in the form of an uplift/subsidence/uplift sequence, with little shortening. The rapid development of this plate boundary indicates that the tectonic signature of subduction initiation can be localized, migratory, and transient.

Key words: Lithospheric processes, plate tectonics, subduction initiation, New Zealand

PRESENTER'S BIOGRAPHY

Kevin Furlong is professor of geosciences at Penn State University. His research focuses on plate boundary processes, and in particular the lithospheric scale processes that lead to the formation of new plate boundaries and their evolution.

Numerical Modeling of Contemporary Mantle Flow and Tectonic Stress Beneath the Central Mediterranean

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ABSTRACT

The structure, density and effective viscosity of the crust and uppermost mantle beneath the Central Mediterranean influence the lithospheric deformation, mantle flow, and tectonic stress state. To estimate the contribution of buoyancy forces to the regional dynamics, three-dimensional finite element models of contemporary uppermost mantle flow are developed, and tectonic stresses predicted by the models are analyzed. We use density models for the crust and uppermost mantle derived from *S*-wave seismic velocities and constrained by gravity data. The viscosity model is constrained by the observed strain rate and regional heat flow data. The movement of the uppermost crust predicted by the preferred model is consistent with the northeast-oriented motion of the lithosphere and is in an agreement with the geodetic measurements. The modeled flow patterns of the lower crust and uppermost mantle are consistent with the regional observations: the northwest-oriented movements beneath the southeast part of the Adriatic Sea region; the northeastern subduction beneath the western part of the Adriatic Sea; the upwelling beneath the Tyrrhenian Sea and its eastern coast; the western movement of the Ionian Sea sub-plate; and the subduction beneath the western Calabria region. Our models predict the distinct compressional regime along the northeast part of the Italian peninsula and to the east of Sicily, and the tensional regime beneath the Tyrrhenian Sea, Umbria-Marche region, and Ionian Sea. The predicted tectonic stress regimes in the northern and central Apennines are in agreement with stress regimes derived from earthquake fault plane solutions. Changes in the predicted crustal stress pattern and magnitude are likely to be caused by buoyancy-driven mantle circulation beneath the region rather than by gravitational potential energy differences in the crust itself. Based on the model results, we conclude that the buoyancy forces play an important role in the contemporary tectonics of the region.

Key words: deviatoric stress, viscous flow, buoyancy, finite element modeling, Central Mediterranean

PRESENTER'S BIOGRAPHY

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Laboratory-based interpretation of upper-mantle seismic tomograms: progress and prospects

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ABSTRACT

During the past decade, torsional forced-oscillation techniques have been used intensively to probe the high-temperature viscoelastic behaviour of fine-grained synthetic polycrystalline olivine. The result has been substantial progress in understanding the grain-boundary processes responsible for the attenuation and associated shear modulus dispersion in such materials. We review the experimental dataset from the ANU and University of Wisconsin laboratories for fine-grained olivine polycrystals, derived from either natural or synthetic precursors, and for a dunite mylonite. The ANU data have been re-processed to correct for the newly documented influence of interfacial compliance as part of an updated assessment – with emphasis on the grain-size sensitivity of the viscoelastic relaxation and the influence of a small melt fraction. Alternative models for description of the contrasting behaviour of genuinely melt-free and melt-bearing olivine are compared and contrasted, and their seismological implications briefly reviewed. Finally, we highlight emerging opportunities for experimental studies of dislocation damping and the role of water.

Key words: upper mantle, seismic-wave dispersion, attenuation, interpretation of seismological models

PRESENTER'S BIOGRAPHY

Ian Jackson trained in physics and geophysics at the University of Queensland and the Australian national University (ANU) followed by post-doctoral experience at the California Institute of Technology. His research at ANU, has been focussed on the laboratory measurement of seismic properties of geological materials and its application to the structure of the Earth's interior. Awards include the Pawsey Medal of the Australian Academy of Science and Fellowship of the American Geophysical Union, and he is currently serving as junior Vice-President of IASPEI.

Velocities and conductivities of mantle mineral assemblages for cratonic lithosphere based on laboratory observations coupled with extremal bound theory

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ABSTRACT

Can mineral physics and mixing theories explain field observations of seismic velocity and electrical conductivity, and is there an advantage to combining seismological and electromagnetic techniques? These two questions are at the heart of this paper. Using phenomologically-derived state equations for individual minerals coupled with multi-phase, Hashin-Shtrikman extremal-bound theory we derive the likely shear and compressional velocities and electrical conductivity of mineral assemblages of the lithosphere of the central part of the Slave craton and beneath the Kimberley region of the Kaapvaal craton based on known petrologically-observed mineral abundances and magnesium numbers, combined with estimates of temperatures and pressures. We demonstrate that there are measurable differences between the physical properties of the two lithospheres for the upper depths, primarily due to the different ambient temperature, but that differences are negligibly small at 200 km. We also show that there is an advantage to combining seismic and electromagnetic data, given that conductivity is exponentially dependent on temperature whereas the shear and bulk moduli have only a linear dependence in cratonic lithospheric rocks.

Focussing on a known discontinuity between harzburgite-dominated and lherzolitic mantle in the Slave craton at a depth of about 160 km, we demonstrate that the amplitude of compressional (P) wave to shear (S) wave conversions would be very weak, and so explanations for the seismological (receiver function) observations must either appeal to effects we have not considered (perhaps anisotropy), or imply that the laboratory data require further refinement.

Key words: electrical conductivity, seismic velocity, cratonic lithosphere, Slave craton, Kaapvaal craton.

PRESENTER'S BIOGRAPHY

After earning his Ph.D. (Edinburgh), Alan G. Jones spent four years in Germany, then 22 years in Canada, before moving to his present position of Senior Professor and Head of Geophysics at the Dublin Institute for Advanced Studies. He has been involved in all aspects of developing the magnetotelluric method to its current state, and now works on formally combining electrical information of the Earth with other information from seismology and other geoscientific data.

Geometry and structures of the Southern African lithosphere revealed through deep-probing electromagnetics: The SAMTEX project

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ABSTRACT

The Southern African Magnetotelluric Experiment (SAMTEX) is imaging the properties and geometries of the lithosphere below southern Africa to depths of 200+ km. Electrical conductivity is highly sensitive to ambient temperature, and to the presence of an interconnected conducting phase, such as a solid phase like graphite or sulphides, a fluid phase like partial melt, or bound water through hydrogen diffusion. Thus primary geometrical information can be readily obtained from lithospheric-scale MT experiments about the three-dimensional variation in conductivity that can be related to formation and deformation processes. One important piece of information easily obtained from MT data is the depth to the lithosphere-asthenosphere boundary (LAB), due to the sensitivity of conductivity to small fractions (<1%) of partial melt.

SAMTEX measurements have been made at a total of more than 700 MT sites over an area in excess of a million square kilometers, making it by far the largest-ever MT project undertaken. One of the most significant results from SAMTEX is the mapping of the LAB beneath the Archean cratons and bounding mobile belts of Southern Africa, particularly of the previously unknown regions of Namibia and Botswana. The LAB is shallow (150 km) beneath the mobile belts, deep (250 km) in the centres of the cratons, and transitional at the edges. Diamondiferous kimberlites are located primarily where lithosphere is transitional in thickness, or where there is a change in its anisotropy properties, both of which are craton edge effects.

The electrical properties of the continental mantle derived from SAMTEX data can be compared with seismic ones derived from data from the South African Seismic Experiment (SASE) of the Kaapvaal Project. Generally there is very good predictive linear agreement between seismic velocity and log(conductivity), indicative of both being influenced by the same bulk property factors, such as temperature, Mg# and composition.

Key words: Southern Africa, lithosphere, magnetotellurics, kimberlites, conductivity-velocity comparison.

PRESENTER'S BIOGRAPHY

After earning his Ph.D. (Edinburgh), Alan G. Jones spent four years in Germany, then 22 years in Canada, before moving to his present position of Senior Professor and Head of Geophysics at the Dublin Institute for Advanced Studies. He has been involved in all aspects of developing the magnetotelluric method to its current state, and now works on formally combining electrical information of the Earth with other information from seismology and other geoscientific data.

Vertical components of the ground magnetic study of Ijebu-jesa, Southwestern Nigeria.

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Abstract
The ground magnetic study of Ijebu-jesa town in Oriade Local Government Area of Osun State, Southwestern Nigeria was carried out. The actual position of Iwaraja Fault in eastern part of Ilesa schist belt Southwestern Nigeria has been a major concern to the geoscientists in the area, as presently no serious work has been published to unveil the real position of this major fault. This therefore, necessitated the present study which involves use of Vertical Components of ground magnetic anomaly as interpreted from field data to delineate subsurface geological structures in the area. The interpretation of magnetic data acquired gives information on the range of magnetic anomalies values over the different rock types. These values vary between about -240 gammas to about 470 gammas. Depth to the basement rock was estimated using half slope method. The results were used to construct the geomagnetic section across the traverses of interest. These helps to delineate rock boundaries, bedrock topography major and minor faults in the area.

Key words: magnetic intensity, residual ground magnetic, geomagnetic sections, rock boundaries, bedrock topography, Ijebu-jesa.

Conductivity of the Earth crust and the upper mantle of Ukraine

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ABSTRACT

On the western slope of the Ukrainian Shield (USh) in the depth (H) from 3 to 6 km lies Volynian conductive anomaly (CA) with specific resistance (ρ) of the order of 10 Ohm•m (fig.1). Chernovtsy-Korostenian CA on the USh territory manifests itself beginning at the surface (the depth of the cover is at 50 m) to 1.5 km as two local sections with ρ=10 Ohm•m. They are galvanic connected with submeridian CA (H=3-15 km, ρ=10 Ohm•m). Chernovtsy-Korostnian CA outside of USh was found on the southern part of Volyn-Podolian plate (VPP) (H=6-15 km, ρ=10 Ohm•m). The anomaly gets deeper in the north (H=15-30km). Section of the anomaly with ρ=5 Ohm•m is located within the borders of Rosinian and Podolian megablocks and contains an objects with ρ=1000 Ohm•m. Western part of CA (ρ=20 Ohm•m) stretches outside of the USh in two directions – south and southwest, along Podolian fracture zones till Golovanian seaming zone (SZ). On the northwestern part of USh on the border of Volynian and Rosinian blocks in the Earth Crust (H=15-30 km) lies Korostenian CA (ρ=30 Ohm•m).

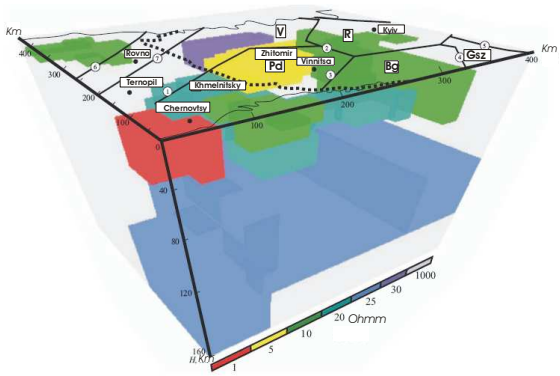

Fig.1

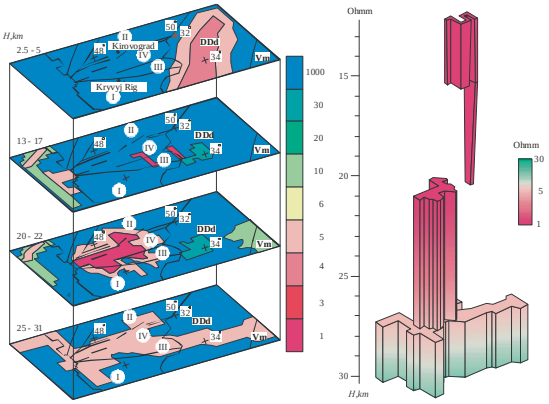

Fig.2

Kirovogradian CA in the Earth Crust stretches far beyond central part of USh north into the Voronezh massif and south under the Pre Black Sea depression (PBSd) (fig.2). On the north of Ingulets-Krivoy Rog SZ and the border of Dneeper-Donetz depression (DDd) can be distinguished two zones: with ρ=1 and 30 Ohm•m (H=10-13 km). At the depth of 13-20 km their shapes and intensity almost do not change. In the south within the borders of PBSd lies sublatitude zone with ρ=5-10 Ohm•m (H=10-25 km). Full scale CA of isometric shape H=20-25 km is fixed by two contours with different ρ – 1 and 5 Ohm•m. CA extends over almost all of the eastern part of Ingulian megablock and Ingulets-Krivoy Rog SZ and western part of Middle Peridneprovian megablock of USh. In the interval of 25-30 km CA is an elongated from south to norh – north-east structure (ρ=5 Ohm•m). In the east USh is fixed by Periazovian CA (ρ=50-100 Ohm•m, H= 2-20 km) which covers almost all of West Periazovian massif.

Geoelectrical parameters are also observed to be considerably non-uniform in the USh mantle (fig.1). In the southwestern part of USh was found a conductor with the cover at 50-70 km with ρ=25-30 Ohm•m. Its boundaries lie at: the northern is along 50^0 northern latitude, the eastern is between 31^0 and 32^0 eastern longitude, the southern is undetermined, south from 48^0 northern latitude and the western is along 26^0 eastern longitudes. In the west the conductor deepens to 90-100 km and is galvanic connected with the anomaly in the upper mantle of the Carpathian region.

Key words: conductive anomaly, specific resistance, the Earth Crust, mantle.

Geoelectrical anomalies and diamond (Ukrainian Shield)

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ABSTRACT

Our work is devoted to building of high depth geoelectrical models of the Earth crust and upper mantle (up to the depth of 200 km) of Ukraine and adjacent territories, to finding of regions and layers of anomalously high electric conductivity and also to explanation of the nature of their origin. The data of magnitovariation profiling and magnitotelluric sounding at approximately 2500 locations was analyzed. We developed a methodology for building geoelectric models of the Earth crust and upper mantle, which is based on using the apparatus of 3D modeling in a low-frequency range of natural electromagnetic fields.

Regions of anomalously low magnitudes of electric resistivity were found and geoelectric models of the Earth crust and upper mantle of Ukraine were built. Ukrainian Shield (USh) is rich by anomalous objects of high electrical conductivity in the Earth crust and upper mantle. Geoelectrical parameters are also observed to be considerably non-uniform in the USh mantle. In the southwestern part of USh was found a conductor with the upper layer at 50-70 km with ρ=25 – 30 Om-m. In the west the conductor reaches the depth of 90-100 km and is galvanically linked with the anomaly in the upper mantle of the Carpathian region. This deep mantle anomaly could be considered analogous to the Slave province of Canada.

All kimberlite pipes that have been found in the Ukraine correlate with the anomaly of conductivity of the Earth crust: with Priazovian, Kirovogradian and Volynian. In Podolian megablock area the kimberlites has not been found, but the presence of their indicating minerals are rather common. The pyropes were formed in the wide range of the pressure conditions. In the region of the mantle's anomalies the mantle is poorly depleted and is metasomaticly changed and consists from eclogites and similar rocks, whose melting temperature is lower than the melting temperature of the surrounding mantle rocks. From the seismic data it is possible to assume the existence of the powerful lithosphere. Above the "diamond-graphite" stability level, the carbon could exist in the form of the high conductivity graphite, when below that level the carbon crystallizes into the diamond with the high electrical resistivity. Ancient lithosphere of the upper mantle was characterized by the low values of oxygen volatility. For this oxidation-restoration state of the depth matter corresponds the existence of carbon saturated fluids with the high concentration of hydrocarbons.

Key words: conductive anomaly, the Earth Crust, mantle, kimberlite pipe.

The crust and upper mantle structure around Yellow Sea: the implication of geodynamics

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The Yellow Sea is located on the east of China, west of Korean Peninsula, northwest of Ryukyu Islands, that is, it is located on the margin between Eurasian Plate and Pacific Plate(Philippine Plate). The 3-D seismic tomography images of three parts(114°-124°E,29°-39°N; 120°-127°E, 30°-40°N; 125°-130°E, 34°-40°N) have been inversed by using the Multiphase Traveltime method after relocated earthquakes.. The crust can be divided into upper, middle and lower, the bottom depth and interface velocity of them are: h_1=12-15km with v_1=6.16-6.27km/s, h_2=22-26km with v_2=6.74-6.80 km/s , h_3=29.1-39.8km with v_3=7.88-8.21km/s, respectively. The features of deep structure for various sub-tectonic provinces are obvious in East China and Korean Peninsula. The Tancheng-Lujiang fault belt with 2400km long is biggest deep fault in east of China,. It appears different movement mode for various segments. In the southern segment （south of 33°N）the velocity in belt is higher than out. The velocity difference both side of fault belt is obvious, it is appears thrust or normal fault. The compressional action from Dabie Orogenic Zone to Lower Yangtze Block may be the causation for the feature. In 33°-38°N, the velocity in belt is lower than out., it is appears strike slip with thrust, may be the tectonic action is not stronger between North China Block and Lower Yangtze Block.

The lithosphere thickness for Lower Yangtze Block is 90km, for eastern North China Block is 72km, the Lower Yangtze Block may subduct into North China Block under Sulu Orogenic Zone, the high-velocity slab is also remnants ancient subducted Yangtze Block. The thickness of lithosphere in west Pacific marginal Seas, Yellow sea, North China,East China, South China and continental shelf of East Sea are 50-80km with 4.25-4.4km/s of bottom S velocity, but in Pacific Plate and Philippine Plate, the lithosphere thickness is about 55km, and S-velocity is 4.74km/s, higher than above, appears the Pacific Plate subduct into Eurasian Plate. The thickness of lithosphere in the middle and west of east Asian continent are about 80-100km with 4.5-4.6km/s of bottom S velocity, the thickness of asthenosphere are about 40-100km. There is a big lower velocity zone in upper mantle, like as velocity structure of Pacific mid-oceanic ridge. May be it is the evolution result from Mesozoic to Cenozoic period for East Asian continent.

Key words: 3-D velocity tomography of crust and upper mantle, Yellow Sea, geodynamics

PRESENTER'S BIOGRAPHY

Li Qinghe, Professor of Earthquake Administration of Jiangsu Province, China. The experience in geophysical technology, especially in seismic wave: theory and application has been for 32 years. Specific expertise in seismic wave theory and applications: interpretation of data, inversion method, S-wave velocity structure, shear wave splitting, anisotropy of seismic and electric, 1-D and 2-D inversion of Q-factor, seismic tomography, integrative geophysical interpretation, earthquake prediction, seismic wave scattering and so on.

Investigation of the crust in the Southern Karoo using the seismic reflection technique

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ABSTRACT

Several deep seismic reflection surveys were conducted in South Africa from 1986-1992 under the auspices of the National Geophysical Programme. These surveys targeted some of the most important geological and geophysical features in the region, such as the Bushveld Complex, Limpopo Mobile Belt, Witwatersrand Basin, Vredefort impact structure, Namaqua Province/Kaapvaal Craton boundary, and the Beattie Magnetic Anomaly in the southern Karoo. However, the Southern Karoo profile was never published. In this paper we describe the recent re-processing and interpretation of the Southern Karoo profile. The 100.5 km profile was surveyed along the N12 national road between Beaufort West (in the north) and the village of Sunnyside in September 1992 using a Vibroseis® source. The Karoo Supergroup is exposed over the northern part of the profile, and the Cape Supergroup in the south. The main objectives of our research project were: (i) to process the data optimally, (ii) determine the stratigraphy and structure of the supracrustal strata, (iii) image the source of the Beattie magnetic anomaly, and (iv) to establish the thickness of the crust. The seismic data was processed by Loots at the GeoForschungsZentrum (Potsdam) using ProMax® software to produce a migrated time section extending to 16 s two-way time. Published seismic velocities determined by other refraction and wide-angle reflection surveys were used to estimate the depths of reflectors. The unconformable boundaries between the Karoo Supergroup, the underlying Cape Supergroup, and the crystalline basement are clearly revealed, as well as the deformation produced by the Cape Orogeny of strata towards the southern end of the profile. A very strong continuous reflector at a depth of 37 km (about 75 km from the southern end of the profile) is interpreted to be the Moho. A 7 km wide 'cluster' of strong reflectors at a depth of 6-12 km (about 47 km from the southern end of the profile) is interpreted to be the source of the Beattie magnetic anomaly. These preliminary findings are in accord with other published results.

Key words: Seismic reflection, crust, Beattie magnetic anomaly, Moho.

PRESENTER'S BIOGRAPHY

Professor Ray Durrheim is a Fellow in the Natural Resources and the Environment Unit of the Council for Scientific and Industrial Research (CSIR) and holds the South African Research Chair in Exploration, Earthquake and Mining Seismology at the University of the Witwatersrand. He is co-director (with Prof. Andy Nyblade of Penn State University) of research and training for AfricaArray, a 20-year pan-African research and capacity-building programme in geophysics launched in July 2004. Core partners are the University of the Witwatersrand, the Council for Geosciences, and Penn State University, with participating institutions from across Africa, Europe and the USA. AfricaArray science is aimed at determining the structure of the African plate and underlying mantle. Ray is the co-supervisor (with Trond Ryberg of GFZ) of Letticia Loots' MSc research work. He participated in the processing and interpretation of several of the Witwatersrand Basin and Limpopo Belt deep seismic reflection profiles.

How rigid is a rigid plate? Geodetic constraint from the TrigNet CGPS network, South Africa.

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ABSTRACT

The motion and the rigidity of the Nubian plate provides a critical constraint to the geodynamics of the surrounding plates. Unfortunately, the sparse distribution of geodetic continuous GNSS stations across the plate does not provide a high precision solution for an Eulerian pole and to test statistically for the rigidity. The presence of 3 separate cratons, Rift Valleys, and old deformation belts along the cratons' sutures, indicate that in geological time the plates have not been completely rigid. The amount of current deformation is very difficult to derive from the GPS observations and it has been constrained to be smaller than few mm/yr. Here, we present the velocity field for 42 stations of the continuous GPS network TrigNet, a network covering the South Africa with an average distance of 200 km. We present the velocity field for the period 2004-2008, the strain rates between individual TrigNet sites, and the relative Eulerian pole and corresponding residuals assuming rigid motion of the network. The distribution of these stations on the stable part of the Kalahari craton, allows computing a pole of rotation that can be compared with the rest of the stations within the Nubian plate. Preliminary results show that the entire network behaves as a rigid block with negligible average residual. Exceptions to this rigid motion are some of the coastal stations, mining areas around Johannesburg and the northeast portion of the TrigNet network. The relative motion of the TrigNet network with respect to the African plate is investigated using the Eulerian pole that minimizes the residual for the IGS stations on the Nubian plate shows that the average residuals are well within the errors indicating that the Nubian plate behaves as a rigid block within our resolution. On the other hand, the analysis of the strain within the TrigNet network and the non-random distribution of the azimuth of the residual with respect to the motion described by a TrigNet only Eulerian pole , does not exclude a possible CCW rotation of the craton with respect to the Nubian plate and an influence of the Nubia/Somalia plate boundary for the northeastern region of South Africa that at this stage still cannot be distinguished from the noise.

Key words: Tectonics, Plate Rigidity, Nubian Plate, Plate Kinematic, Geodesy

PRESENTER'S BIOGRAPHY

Rocco Malservisi
Scientific Interest: Dynamics of the lithosphere; Collection, analysis and modeling of geodetic data to study the deformation of the lithosphere; numerical modeling of lithospheric dynamics to link and interpret related geological, geomorphologic and geophysical datasets; effects of rheological properties of the lithosphere on the surface deformation. **Education:** 1996, degree in Physics at the University of Bologna (Italy) (effect of mass anomalies in the mantle to true polar wander). 2002, PhD in geosciences at Pennsylvania State University (USA) (numerical models of lithospheric deformation). **Professional Experience:** 1996-97 Visiting researcher at Università di Bologna (Italy) depart. of physics, 1997-2002 Research assistant the Penn State University USA dept. of geosciences. 2002-2004 Post-doctoral associate at University of Miami (FL, USA) division of Marine Geology and Geophysics. Since 2004 Junior Professor of geodynamics at the Ludwig-Maximilians University in Munich, Germany.

Lithospheric structure, evolution and diamond prospectivity of the Rehoboth Terrane and western Kaapvaal Craton, southern Africa: constraints from broadband magnetotellurics

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16 Now at EMGS, Norway

ABSTRACT

A 1400 km-long, 2-D magnetotelluric (MT) profile across the western Kaapvaal Craton, the Rehoboth Terrane and the Ghanzi-Chobe/Damara Belts reveals significant heterogeneity in the electrical resistivity structure of the southern African lithosphere in areas not imaged previously.

The Eastern Kimberley Block of the Kaapvaal Craton is characterised by thick, resistive lithosphere, while that beneath both the Western Kimberley Block of the Kaapvaal Craton, below the Kheis Fold Belt, and the Rehoboth Terrane is significantly thinner and less resistive. The Ghanzi-Chobe and Damara Belts are characterised by the thinnest, most conductive lithosphere. Based on laboratory measurements of electrical conductivity versus temperature for mantle minerals, the lower average resistivities of the Western Kimberley Block, Rehoboth Terrane and the Ghanzi-Chobe/Damara Belts can be accounted for by lithosphere that is ~30 km, ~40 km and ~60 km thinner, respectively, than that of the Eastern Kimberley Block. The best estimate of lithospheric thickness (in a "thermal" definition) for the Eastern Kimberley Block is ~220 km ± 30 km, and in good agreement with the ~75.5 kbar intersection pressure (~226 km depth) with a 1300°C mantle adiabat for the ~40 mWm-2 best-fit geotherm in the mantle xenolith P-T array data from the Kimberley kimberlite field. The close agreement suggests the structure of the Eastern Kimberley Block has remained unchanged since the time of Mesozoic kimberlite eruption.

The non-diamondiferous Gibeon, and the "marginally" diamondiferous Tshabong fields are located within terranes today characterised by significantly reduced "diamond windows" (lithospheric thickness below the diamond stability field), estimated, from the MT resistivity models, to be ~30 km and ~40 km thick below the Rehoboth Terrane and Western Kimberley Block respectively, compared with ~80 km for the Eastern Kimberley Block.

Mantle xenolith P-T arrays from the Kimberley and Gibeon fields suggest, however, that the Rehoboth Terrane and the Eastern Kimberley Block had probably equilibrated to a similar conductive geotherm (~40 mWm-2) at some stage prior to Mesozoic kimberlite eruption. Maximum-pressure estimates for Cr-saturated garnets using Cr/Ca-in-pyrope barometry indicate that the chemically-depleted lithosphere extends significantly deeper beneath the Eastern Kimberley Block (138 – 167 km) than beneath the Rehoboth (117 km). To reconcile the xenolith constraints with the present-day MT observations,

an evolutionary model is required in which (i) the lithospheric thickness of the Rehoboth was similar to that of the Eastern Kimberley Block at around ~150 Ma, thickened probably by underplating of cooled, fertile asthenospheric-mantle, and (ii) a subsequent heating or delamination event occurred, affecting only the Rehoboth, at the latest sometime before kimberlite eruption at ~72 Ma, but probably earlier, between ~150 – 100 Ma, to account for the current thinner, hotter configuration of the Rehoboth lithosphere and the absence of Gibeon diamonds. While there is evidence in the disruption of the high-temperature Gibeon xenolith P-T array data to suggest thermal perturbation of the Rehoboth Terrane either at, or shortly before, the time of eruption, whether such an evolutionary model is plausible, as well as better constraints on the timing of the thermal evolution, remain to be established with thermo-dynamic modelling.

Key words: Magnetotellurics, Xenolith, Lithospheric-geotherm, Southern Africa, Diamonds

PRESENTER'S BIOGRAPHY

Mark Muller is a Research Fellow at the Dublin Institute for Advanced Studies (DIAS), where he is investigating lithospheric structure and evolution within the framework of the southern African Magnetotelluric Experiment (SAMTEX). He holds a Ph.D. from the University of Cambridge, U.K., and an M.Sc. from the University of the Witwatersrand, South Africa. Prior to taking up his current research position at DIAS, he worked as a geophysical consultant within the mining industry, working on exploration and in-mine projects in many parts of the world, over gold, platinum, base-metal, diamond, potash, coal and ground-water targets, using seismic, magnetic, gravity, electrical and radar methods. He is also a past President of the South African Geophysical Association.

Oblique convergence and slip partitioning along the Bocono fault system and Venezuelan Andes

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ABSTRACT

The southern Caribbean plate boundary is well defined in eastern Venezuela by the nearly east-west striking San Sebastian-El Pilar dextral fault system, along which the Caribbean plate slips easterly at a rate of 20,5 ± 2 mm/a relative to South-America. Towards the west, in northwestern South-America and offshore northern Colombia, however, the plate boundary is multibranched and broadens (>300 km), and several seismically active fault systems accommodate the relative plate motion. The most prominent of these are the 550 km-long, northeast-striking Bocono dextral fault system that runs along the venezuelan Andes together with a series of sub-parallel thrust faults that occur along the Andean margins.

In order to investigate the current role of these faults in accommodating plate motions we performed a series of Global Positioning System (GPS) observations between 1994 and 2007 at 23 sites aligned along three profiles perpendicular to the 100 km-wide Andean cordillera plus a series of sites located in the regions far to the north-west and south-east of the said mountain ranges. Our GPS velocity vectors and subsequent elastic modeling indicate that oblique convergence occurs in the venezuelan Andes. This oblique convergence is partitioned in 12 ± 2 mm/a of pure dextral slip on a north-east trending nearly vertical (Bocono) fault that creeps at depths below 14 ± 4 km, and 4 ± 2 mm/a of pure convergence across the Andes in the regions ± 100 km from the main trace of the Bocono fault. As a result of the latter, pure thrusting occurs on the northeast-striking faults along the Andean margins. Farther (>400 km) to the northwest of the Andes, including the regions offshore northern Colombia, the southwestern Caribbean plate moves obliquely with respect to northwestern Venezuela, resulting in 12 mm/a of south-east convergence, such as indicated by the GPS velocity vectors in those regions obtained by us and other authors.

Key words: Caribbean tectonics, GPS geodesy, slip partitioning.

PRESENTER'S BIOGRAPHY

Omar J. Perez is currently a Professor of Earth Sciences at Simon Bolivar University in Caracas, Venezuela. He got his PhD degree in 1983 from the Department of Earth Sciences of Columbia University, New York, USA, where he was associated to the Lamont-Doherty Earth Observatory. He has published a series of seismological and geodetic articles focused on the kinematics of plate motion between the Caribbean and the South-American plates and associated earthquake hazards, as well as a series of seismology papers regarding the world instrumental seismicity catalogs, the tectonics and earthquake potential of the Gulf of Alaska region, and the seismic cycles of very great shocks in the Circum-Pacific.

European mantle lithosphere - thickness, structure and composition

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ABSTRACT

We model a depth of the lithosphere-asthenosphere boundary (LAB) and anisotropic structure of the European mantle lithosphere. We observe noticeably different lithosphere thicknesses in tectonic provinces of different ages and of various settings. Depth of the LAB varies from ~60km beneath some basins (e.g., the Pannonian Basin, the Po Plain), parts of the Hercynian massifs (e.g., the southern French Massif Central, the Rhenish Massif), and beneath the Phanerozoic North-German Platform, to about 200-220 km for the orogenic roots (e.g., the Western and Eastern Alps) and in large portions of the Precambrian Europe east of the Trans-European Suture Zone. The LAB has distinct relief with step-like thinning/thickening at prominent sutures. Our models are based on array travel-time deviations which consider also seismic anisotropy. Velocity anisotropy of the lithosphere reflects its fossil olivine fabrics with dipping high-velocity foliations or lineation, while asthenosphere below the continental plates is characterized by mostly sub-horizontal anisotropy reflecting the present-day mantle flow. Due to different orientations of seismic anisotropy within the lithosphere and asthenosphere, the velocity contrast at the lithosphere-asthenosphere boundary can be larger than that produced by compositional variations and/or by a thermal state. We compare our model with findings from mantle xenolits and calibrate our empirical P-residual – LAB thickness relation. In several regions, we found a good agreement with estimates of the lithosphere thickness based on surface waves, S receiver functions and magnetotelluric soundings.

Key words: Seismic anisotropy, P-wave tomography, shear-wave splitting, joint inversion

PRESENTER'S BIOGRAPHY

Jaroslava Plomerová, born in Czechoslovakia, graduated at Charles University, Prague in 1970. Since then she has been working in seismology with main focus on structure of the continental lithosphere, evaluating body-wave anisotropy (P-wave tomography, anisotropy, shear-wave splitting, joint inversion) and modelling the lithosphere thickness.

Ground deformations monitoring in the Upper Silesian Coal Basin (Poland) using PSInSAR technique

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ABSTRACT

The development of satellite radar interferometry is giant step forward better control of unstable regions. It provides rapid and economic methods for monitoring large areas. In this work the usability of PSInSAR (Permanent Scatterers Interferometry Synthetic Aperture Radar) technique in the monitoring large, unstable areas has been presented.

PSInSAR technique uses set of several dozens of radar images (minimum 30). It derives information about ground deformations in PS points with millimeter accuracy. PS points are stable radar targets (they have stable amplitude and phase in the satellite radar images) and they correspond very well with man-made features on the surface like buildings, bridges, viaducts etc. Permanent scatterers interferometry supplies information only about these ground movements, which values do not exceed several cm/yr.

In this work the analysis of PSInSAR data in the area of Upper Silesian Coal Basin (south Poland) has been done. Data used in our work were collected between 1992 and 2003 by ESA's satellites. In Upper Silesia region the intensive coal exploitation has been carried on for over 200 years. This region is also crossed by many faults. The coal exploitation and geological structure cause that this area is particularly hazarded by terrain deformations. The analysis was performed using statistical and geostatisticals methods. The values of subsidence have been studied in relation to the locations of main tectonic units and mining areas. Preliminary analysis of ground deformation in this region has confirmed strong correlation between subsidence and faults system.

Performed analysis indicates that two factors have an affect on the values of subsidence in this region. First factor is a contemporary tectonic activity of this area e.g. isostatic subsidence and the second factor, with less influence, is underground coal exploitation performed there for the long time. Continuous monitoring by PSInSAR is expected to clarify the cause of the ground movements. The knowledge about mechanism of subsidence helps us to undertake right decisions and operations, which can protect surface and subsurface infrastructure. Despite the fact that PSInSAR technique cannot be independent and basic tool in terrain deformation monitoring, it considerably complements the conventional leveling and GPS surveying.

Key words: PSInSAR, ground deformations, mining areas

PRESENTER'S BIOGRAPHY

Miss Stanislawa Porzycka is a PhD student in the Department of Geoinformatics and Applied Computer Science, Faculty of Geology, Geophysics and Environmental Protection, AGH University of Science and Technology, Cracow (Poland). This is her third year of study. In her research she uses PSInSAR technique, geostatistics methods, and GIS tools to study ground small, long-period ground deformations. She has participates in the nine conferences and she is coauthor/author of several publications.

Joint inversion of seismic and magnetotelluric data from an anisotropic Earth

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ABSTRACT

Model resolution can be significantly improved through joint inversion. Commonly joint inversion is undertaken of different datasets that are sensitive to the same physical parameter, but our work involves inverting simultaneously for different physical parameters, namely electrical conductivity and seismic velocities. We build on prior work of joint inversion of teleseismic receiver functions and long-period magnetotelluric data that was applied successfully to recover one-dimensional isotropic structure for the lithospheric mantle of the Slave Craton of northern Canada. Here we extend this work to include surface wave dispersion data, and also extend the models from isotropic layers to anisotropic layers.

Our work is motivated by the observations of approximate agreements between geoelectric strikes and seismic fast axis directions, inferred from shear wave splitting studies, that been found in various regions, such as the Great Slave Lake shear zone of northern Canada, across the Grenville Orogen of southern Canada and the Sao Francisco craton of Brazil. These parallelisms suggest a common origin in both seismic and electrical anisotropy. Assuming that seismic and electrical anisotropy have a common origin, we can thus expect superior resolution of azimuthal anisotropy for lithospheric and sub-lithospheric depths combining these two techniques.

We examine the capabilities and limitations of this new approach with synthetics datasets and we apply this new joint inversion of anisotropic parameters to real datasets. The Slave Craton in Northern Canada is of particular interest but other regions are being investigated, including southern Africa.

Key words: electrical anisotropy, seismic anisotropy, surface wave studies, joint inversion

PRESENTER'S BIOGRAPHY

After earning his Ph.D. (Edinburgh), Alan G. Jones spent four years in Germany, then 22 years in Canada, before moving to his present position of Senior Professor and Head of Geophysics at the Dublin Institute for Advanced Studies. He has been involved in all aspects of developing the magnetotelluric method to its current state, and now works on formally combining electrical information of the Earth with other information from seismology and other geoscientific data.

Crustal structure beneath the Lower Tagus Valley region, Southwestern Iberia from analysis of teleseismic receiver functions

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ABSTRACT

The Lower Tagus Valley (LTV) region, in SW Iberia, is located on an aborted rift of Triassic age. It can therefore be expected to have weaker than normal continental lithosphere, and this is confirmed by the concentration of intraplate seismicity, with destructive historical earthquakes. This seismic activity is the response of old basement fractures to the current convergence between Africa and Iberia. However, little is known about the deep structure of the crust. To address this issue, receiver functions for several teleseismic earthquakes recorded at 5 broadband seismic stations deployed in the LTV were analyzed to map the Moho depth and crustal Vp/Vs variations. We used a well-established stacking algorithm which sums the amplitudes of receiver function at the predicted arrival times of *Pms*, *PpPs* and *PpSs+PsPs* Moho-converted phases using a grid search technique of different crustal thicknesses (H) and Vp/Vs ratios. This technique transforms the time domain receiver functions directly into the H-Vp/Vs domain without identifying these phases and picking their arrival times. The best estimations of crustal thickness and crustal Vp/Vs ratio are obtained when these three phases are stacked coherently. By stacking receiver functions from different directions and different epicentral distances, effects of lateral variations of crustal structure are reduced, and an average crustal model beneath a station is obtained. The crustal thickness beneath the LTV varies from 24 to 30 km with an average of 27 km, which is remarkably lower than the global average. The crustal Vp/Vs ratio varies between 1.65 and 1.81, with an average of 1.75. The crustal thickness decreases generally toward the west near the coast of the Atlantic Ocean being consistent with the extensional tectonic episodes that led to the opening of the Atlantic in the Middle Jurassic. However, more teleseismic receiver functions from earthquakes recorded at denser seismic stations with more widespread lateral coverage are necessary for a more detailed crustal model beneath this tectonically active region owing to the oblique convergence between the African and Eurasian plates.

Key words: Crustal Structure, Teleseismic Receiver Function, Lower Tagus Valley, Southwestern Iberia

PRESENTER'S BIOGRAPHY

Mohamed K. Salah

The presenter of this poster is Mohamed Kamaleldin Salah, an Egyptian seismologist working permanently at the Geology Department, Faculty of Science, Tanta University, Egypt. Currently, I am on a postdoctoral fellowship in the Higher Technical Institute (Instituto Superior Técnico), Technical University of Lisbon, Lisbon, Portugal. I conducted my PhD studies in seismology at the Geodynamics Research Center (GRC), Ehime University, Matsuyama, Japan starting from April, 2001 until March 2004. The topic of my PhD was seismological studies of southwestern Japan with emphasis on the structure and geodynamics of the Japan subduction zone. In August 2005, I joined the Earthquake Research Institute (ERI), University of Tokyo, Japan as a JSPS fellow until August, 2007. My research in ERI was focused on the seismic anisotropy structure of southwest Japan using waveform data generated by slab earthquakes. I have published several papers about seismic tomography, seismic attenuation, seismic anisotropy, and Moho depth estimation in international geoscience journals such as Tectonophysics, Physics of the Earth and Planetary Interiors, Journal of Geodynamics, Journal of Asian Earth Sciences, and the Journal of Seismology.

The Low-Frequency Electric Field Fluctuations in the Ionosphere: are They Related to the Crustal Dynamics?

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Study of the ionosphere anomalies is the promising way of the real-time monitoring of the Upper Crust dynamics. However, the direct causality between the crustal and upper atmosphere phenomena are still questionable. To test them we selected the tectonically active region of the Central Tien Shan (39º -44º N, 71º-80º E) crossed by numerous active faults, one of which – the Talas-Fergana right-lateral strike-slip fault (TFF) – is considered as one of the main seismogenic structures of the Central Asia region. It is characterized by expressive right-lateral offsets of the Holocene gullies indicating recent activity. However, regional GPS measurements do not reveal any significant movements along this zone nowadays.

According to the 3D tomography models for P and S waves that were compiled for the study area, significant velocity variations could be traced up to 40-50 km, up to the M boundary.

Spatial-temporal analysis of local seismicity demonstrate much higher activity of the area to the south-west from the TFF compared with the north-east one from the fault and some irregularity in earthquake distribution in time.

Measurements performed by the Dynamic Explorer-2 satellite showed that there are areas in the ionosphere outside of Auroral zone characterized by sharp increasing of the low-frequency electric field amplitude in the range 1-500 kHz and the spectral density of the plasma fluctuations of the decameter scale. Several such anomalies have been identified within study area and one of them could be related to the TFF north-west from the Toktogul reservoir.

Several hypotheses about nature of this anomaly and its possible relation to the modern geodynamic processes in the upper lithosphere are proposed and discussed.

Spatial 3D Velocity Model for the North Ossetia Alaniya Territory Based on the Data from Local and Regional Earthquakes

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Spatial 3D velocity models of the North Ossetia Alaniya territory structure were constructed based on the data for P and S waves arrival time. The Catalogue of events for 2004 - 2007 was used as the source of initial data. In total it was selected 115 seismic events with M>= 3. These events occurred at the territory within 42^0-45^0 N and 43^0-47^0 E and have been recorded by at least 10 - 15 stations. Ten of these events occurred inside the local station network of North Ossetia. The past of them took place on May 11, 2008 in the area of Vladikavkaz deep fault, that is one of the most seismic hazardous zones where earthquakes with M=7 can occur. Significant inhomogenuity of crust and upper mantle velocity structure is shown. This inhomogenuity can be a reason of the pronounce difference in wave forms at different stations. The areas that are able to accumulate tectonic stresses have been identified.

Strength and elastic thickness of the European lithophere

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Rheology and strength of the Earth's lithosphere have been debated since the beginning of the last century, when the concept of a strong lithosphere overlying viscous astenosphere was introduced. The issue of strength of the lithospheric plates and their spatial and temporal variations is important for many geodynamic applications. For rocks with given mineralogical composition and microstructure, temperature is one of the most important parameters controlling rheology. Temperature estimates for the deeper horizons of the lithosphere, where the heat transport is mostly conductive, require a precise knowledge of many crustal parameters (mainly thermal conductivity and heat production) and are extremely uncertain. Therefore, indirect approaches, such as seismic tomography are commonly used to determine temperature distribution within the lithosphere. We have recently inverted for temperature a new tomography model, which is principally improved by correcting before-hand for the crustal effect. For the correction we use EuCRUST-07, a new digital model of the European crust. Although the inversion approach is similar to those used in previous studies, the employment of a more robust tomography model essentially improves the result. EuCRUST-07 and the new thermal model are employed to calculate the strength distribution within the European lithosphere. Differently from previous studies, the new model adopts lateral variations of lithology and density, which are derived from the crustal model. The lithosheric rheology is employed to calculate variations of the elastic thickness of the lithosphere. According to these estimates, in Western Europe the lithosphere is more heterogeneous than that one of Eastern Europe. Western Europe with predominant crust-mantle decoupling is mostly characterized by lower values of the strength and elastic thickness. High strength values are found in the areas having the average/low thermal regime and strong crustal rheology (the EEP, the North German Basin and the Bohemian Massif). Weak zones correspond to the areas affected by the tertiary volcanism and mantle plumes, such as the European Cenozoic Rift System (ECRIS) and the Massif Central. Both the integrated strength of the lithosphere and of the crust demonstrate similar trend in most parts of the study area. One of the most interesting result is the high contribution provided by the crustal strength (~50% of the integrated strength for the whole lithosphere) in the most part of the study area (~60%). The contribution of the thickness of the mechanical strong lithosphere to T_e is low (<10 km) in the most part of Western Europe. No clear relationship between T_e and the thermal age is found in the continental part of the study area: in the tectonic provinces older than 85 Ma the T_e values are significantly smaller than that ones theoretically predicted as a function of the age and crustal thickness, while the opposite is true for the younger provinces.

Keywords: Rheological model, Strength map, Elastic thickness, Europe

Presenter's Biography

Magdala Tesauro

Magdala Tesauro is currently a PhD student at the Tectonic Department of the Vrjie Universiteit of Amsterdam (The Netherlands). The topic of her research is the estimation and the integration of geophysical data (such as temperature, density, velocity) to improve the knowledge of the European lithosphere. She will defend the PhD thesis "An integrated study of the structure and thermomechanical properties of the European lithosphere" at the beginning of next year in Amsterdam. She is (until the end of November 2008) a guest at the GeoForschungsZentrum of Potsdam (GFZ) in section 1.3 Gravity field and Gravimetry. As a result of her PhD work, she has published two articles and has submitted some others to international peer-reviewed. She submitted many abstracts to international conferences (e.g. EGU, AGU, IUGG, IGC), in which she took part. Before starting the PhD she took a degree in Geological Science at the university 'Federico II' of Naples (Italy), she had two scholarships at the Vesuvius Observatory in Naples (about volcanic risk and geodetic surveillance), she was employed for one year at the European Space agency (ESA) under the Young Graduate Trainee (YGT) Scheme assigned to the Solid Earth Unit in the European Space Research and Technology Centre (ESTEC) in Noordwijk (The Netherlands) and she had a contract of one year and half as Scientific Assistant in Zurich (Switzerland) at the Institut fur Geodasie und Photogrammetrie, Geodesy and Geodynamics Laboratory department, ETH (Institute of Technology Zurich).

ABSTRACT

SENEGAL AIRBORNE GEOPHYSICAL PROJECT

In the month of March 2008, began the survey of airborne geophysics in the oriental Senegal.
This survey covers a surface of 30,712 km2.
The specifications of data acquirement are defined.
The survey is about magnetism and the Radiometry. To the continuation of these block results have been targeted for the electromagnetism.

Magnetism

The magnetic data treatment permitted to establish the map of the total magnetic field corrected in relation to IGRF, the map of the 1 vertical derivative and the map of the analytic signal.

Radiometry

With the radiometry it is established the map of Potassium, thorium, uranium, total count and the ternary map.
The products of the maps are:
the zone of the survey scale 1: 500000 (1dv, Ternary and lines of flight);
sheets scale 1: 200000;
sheets scale 1: 50000 (fly path overlaid on topographic base map only)
The interpretation of the data is in progress and the products will be delivered at the end of the year.

Electromagnetism (EM)

After the acquirement and the magnetic and radiometric data treatment some blocks have been targeted for the electromagnetic survey.
The choice of these zones is based on the importance of information to pull.
The applied method is the Tempest.
The survey begun in the month of April 2008 is nearly finished and cover a surface of 22831,1 Km.

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Delineating prospective kimberlite regions using potential field methods – from space to surface

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ABSTRACT

Clifford's rule states that diamondiferous kimberlites are hosted in Archean cratons. However, defining the edges and extent of cratons in the lithospheric mantle can be challenging in areas of more recent cover, in collision zones where younger rocks may overlie and obscure the craton boundary, or in regions where the keel may have been disrupted (India/Madagascar; Brazil). While tomographic images of seismic velocity variations clearly delineate cratonic keels, these experiments are expensive and often difficult to conduct with high enough resolution to be useful for exploration purposes. However, a variety of potential field data are often readily available that can assist with defining craton edges and internal structure. These data sets are expanding rapidly and are often underutilized even though many are freely available.

At the longest wavelengths are the newest generation of satellite gravity and magnetic data. These data, available from several satellite missions, have unprecedented detail and can also be used for temporal comparisons. For example, it may be possible to investigate temporal loading signals in the gravity data and resolve laterally varying strength properties of the lithosphere that are related to keels. The integrated lithosphere magnetic field is still difficult to interpret as it matches poorly with integrated airborne magnetic data. This mismatch is most likely due to the inevitable loss of long wavelength information as various airborne data sets from different dates, altitudes and survey parameters are stitched together. The satellite magnetic data forms the background for the freely available "magnetic map of the world". Both the satellite magnetic and gravity data sets can aid greatly in areas with little to no coverage, or in areas where the coverage is from many disparate surveys by providing a consistent backdrop for merging the data sets.

Airborne gravity is one of the newest tools made available in the last 10 years. The battle between the full tensor gravity gradiometer vs. vertical component systems is still being waged, but there are no losers and there is no question that airborne gravity is in full production mode. While the holy grail of a platform with sub mgal noise levels was only achieved by the ultimately ill-fated De Beers Zeppelin project, having access to gravity data for large tracks of inaccessible land is huge step forward, especially in regions where ground gravity data did not previously exist. Many countries are flying the entire country with high resolution airborne gravity to greatly improve on the sparse ground data sets that often date back to the 1960s and suffer from poor elevation control. Gravity remains one of the most useful tools both for the detailed work of outlining individual kimberlites but also large scale work outlining the cratons that host diamondiferous kimberlites. Recent studies clearly show that, except in tectonically active areas, classic Airy isostasy often doesn't apply in old cratonic areas, making the interpretation of large scale gravity data in cratonic regions all the more challenging. As a field, gravity is much easier to interpret and more directly related to the underlying sources than magnetics. Older ground gravity data sets can still yield information about the edges of cratons through wavelength filtering, although modeling at a craton wide scale should include independent contributions from topography, crustal thickness and mantle velocity variations.

Airborne magnetic data continue to be collected at significantly higher resolution, with large scale helicopter gradiometer surveys being common. Airborne tensor magnetometer systems are under development, which should aid in the interpretation of magnetic remanence and assist with the delineation of large scale crustal blocks.

Large-scale, very broad-band electromagnetic studies using the natural-source magnetotelluric technique (MT) enable the rapid mapping of lateral variations in the electrical resistivity structure of the sub-continental lithospheric mantle and into the underlying asthenosphere. The electrical response of mantle rocks is complicated and dependent on temperature, depletion (Mg#) and composition of the mantle and overlying crust. However, it provides an independent dataset that can aid the delineation of keel edges. While lineament analysis continues to be popular, there are glaring "sweet spots" that have been extensively explored, and that appear to be barren. These tend to occur in the interior of cratonic regions with the thickest mantle keels. This observation supports the conclusion of kimberlite distribution studies, MT and seismic tomography data that diamondiferous kimberlites are found closer to the edges of cratons where gradients in electrical conductivity and seismic velocity dominate and keels are not quite so thick.

Key words: Craton, magnetics, gravity, magnetotellurics, kimberlite

PRESENTER'S BIOGRAPHY

Susan Webb originates from upstate New York and received her B.Sc. in Geophysics from State University of New York at Binghamton, USA. She then moved to Newfoundland, Canada, where she received her M.Sc. in geophysics from Memorial University. Currently she is a lecturer in potential field methods in the School of Geosciences at the University of the Witwatersrand and conducts research on the interpretation and modeling of gravity and magnetic data. She also runs the AfricaArray international geophysics field school and is active on several committees of the SEG.

Applications of Time Domain Electromagnetic Soundings under Different Geological Settings in Southern Africa

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ABSTRACT

Electromagnetic survey methods are most successful and versatile tools of exploration, in particular, when measurements will be conducted in the time-domain. The scope where time-domain electromagnetic (TDEM) methods are used is large and covers search for oil, gas and mineral occurrences, engineering and environmental geology, geological mapping and hydrogeology. We are discussing our experience made in southern Africa using two time-domain electromagnetic devices that are quite different with respect to depth of investigation and easiness of operation.

Pioneering research in the field of TDEM was done by Russian researchers during the sixties of the past century. Meanwhile a few commercial TDEM devices have been manufactured and are commercially available, e.g the Protem-47, the Australian terraTEM or the Zonge TEM system. The TEM-FAST 48 is a new portable TDEM instrument developed and sold by the Dutch-registered AEMR company. This unit ideally suits shallow exploration applying a common loop to transmit and receive. The side length of the square shaped loop can be varied from 1m to 25 and 50 m to achieve a depth of investigation from 50 cm to about 60 m depending on the sub-surface conductivity. The Tzikl-5 device is manufactured by ELTA-GEO, a company based in Novosibirsk, Russia. This instrument consisting of transmitter and receiver units, a laptop computer to operate the system and record data, receiver coils of different effective areas, and external battery power supply has been developed to investigate a depth range from near-to-surface down to one kilometre and even more.

Both instruments have been used by the Council for Geoscience for the past few years. We are presenting three case studies where the above two devices were successfully used for field work:

From an integrated interpretation of TEM-FAST 48, aerial photo and gravity data a palaeo-channel in the Barkley West area could doubtlessly be delineated. The conductivity-depth sections from each individual TDEM station were compiled to provide maps of depth to basement and thickness of the sedimentary layers. The integrated interpretation revealed that only the deepest remnants of the palaeo valley have been preserved from erosion. An area with maximum thickness of 23 m could be located and mining was immediately directed to this spot.

Mapping the border of mined-out and non mined parts of a coal mine area was conducted using the TEM-FAST 48 device with a single loop sized 25 m by 25 m. Evaluation of the TDEM data was done using the 'S-plane' technique. The distinct resistivity contrast between fresh coal and mined-out places was found to be a clear indicator of the border line, which was confirmed by assessment of existing boreholes.

An area conspicuously rich in gossan was recently surveyed using both the TEM-FAST 48 and the Tsikl-5 devices to produce conductivity-depth sections along a few traverses and integrate them with magnetic, radiometric and apparent conductivity data. The latter had previously been acquired using the Geonics EM-34 frequency-domain device. The time-domain counterpart device TEM-FAST 48 turned out to be clearly superior to the EM-34 device.

Key words: Time domain electromagnetics, resistivity, Sτ version, mapping, exploration.

PRESENTER'S BIOGRAPHY

Valeriya ZADOROZHNAYA obtained a MSc degree in Geology and Exploration Geophysics from Saratov State University and a PhD degree in Exploration Geophysics from the All-Russian Research Institute of Geophysics, Moscow, Russia. From 1971 to 1999, she worked at the Nizhnevolzhsky Geology and Geophysics Research Institute in Saratov, Russia. From 2003, she has been working at the Council for Geoscience, South Africa, as a Senior Scientist. Her fields of specialization are theoretical research in petrophysics, TDEM, seismo-electric and induced polarization. She developed an approach to understand the seismo-electrical effect, a polarization model caused by constrictivity of pores, and the electro-osmosis effect as an indicator of ground water contamination by hydrocarbon compounds. She is the author and co-author of 37 publications and presenter of more than 50 talks at international and national conferences. She is an active member of SEG, ASEG, SAGA, EAGE, and the EM community.

Structure of lithosphere-asthenosphere system beneath western China and its adjacent areas from surface wave tomography

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At the continent-continent collision between Indian and Eurasian plates, the shallow and deep structure of western China and its adjacent areas are very complicated with different orogenic belts and basins. In the recent decades, many deep explorations have been and a series of important results about the collision models of Indian and Eurasian plates and their deep structures have been gained, but the studies on the fine structures of the lithosphere-asthenosphere system are still a few. In our study area (20ºN- 50ºN,70ºE -110ºE) we collect long period and broad-band seismic data from the global and regional seismic networks surrounding the area: G, XA, XR, YA, II/IU, IC, YL and KZ during the period of 1987-2005. The data set is enriched by several seismic records from Indian stations, made available to us by S.S. Rai of NGRI. Group velocities of fundamental mode of Rayleigh waves are measured using the frequency-time analysis (FTAN). A set of dispersion curves is obtained for 791 paths. The group velocity of Rayleigh wave crossing the south Tibet Plateau decreases, with increasing period, going from 16s to 35s to increase at longer periods. The gradient, between 40s and 60s, of the dispersion curves crossing the Tibet Plateau is not steeper than that of the other dispersion curves. A 2-D surface-wave tomography method is applied to calculate lateral variations in group velocity distribution at different periods in the range from 8 to 150s. The method evaluates the average lateral resolution of the lateral heterogeneity to be about 200km in most western China. To be consistent with the resolution level, the group velocity maps, at different periods, are discretized in cells of 2^{o} X 2^{o}. The most conspicuous low group velocity anomaly from 25s to 40s of period appears in whole Tibet Plateau, while the Indian Plate, Mongolia, the Yangtze block and the region around Balkhash Lake are characterized by high group velocity anomalies. At the intermediate periods (50-80s) the most dominant feature is the NW-SE directed low velocity anomaly lying in the Tibet Plateau. At long periods the velocity anomaly is comparable with the anomaly at the lower periods. These surface wave tomography maps are transformed into shear wave velocity-depth models with the non-linear hedgehog inversion method.

PRESENTER'S BIOGRAPHY

Zhang Xuemei was born in Nanyang, China on 10 November, 1974. She obtained her master degree in Earth exploration and information technology from Chengdu Technology of University in 1999. Now she is a double Italian-Chinese Ph. D student in the field of Geophysics of the lithosphere and Geodynamics. Her study field of interest is surface wave tomography and nonlinear inversion.

GPS measurement strain rate in the North China and its geodynamical implications

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ABSTRACT

Strain rates computed from GPS measurements can provide important information for continental dynamics research. In this research, we choose the velocities of 230 GPS survey stations obtained in the North China in the period of 2004 and 2007. By applying these GPS data, the strain rates in the North China are calculated. First of all, we introduce the Kriging method in geostatistics to GPS velocity field. Interpolating the scattered GPS velocity data of the North China with the longitude of 112°- 121°, and latitude 37°- 42°, to grid point values by Kriging, then we calculate the strain rates from these nodal values in each grid cell similar to derivative of shape functions (essential Lagrange interpolation function) in finite element algorithm, and obtain the stable distribution of strain rate field in the North China. The results show that the orientations of maximum principal strain rates are consistent with those of the P axis and T axis in focal mechanism in general. The surface dilation strain rate is positive in Shanxi fault zone, where it is in the state of tectonic extension. The maximum shear strain rate is located in Tianjin and adjacent areas, basically corresponding to the seismic atctivities. However, we also found that the errors of the strain rates in the North China are not neglectable. Therefore it is necessary to raise the accuracy of GPS data as soon as possible.

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Keywords: Strain rates; GPS measurements; North China

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Shoubiao Zhu is now a research worker at Institute of Crustal Dynamics, China Earthquake Administration. He got his Ph.D at Graduate University, Chinese Academy of Sciences in 2003. Later he worked as PostDoc at Peking University, China. His research interests mainly are: 1) modeling the earthquake processes by finite element method, and 2)geodynamical research from GPS measurement.

Some publication papers:

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Mechanisms of the post-seismic deformation following the M_w7.6, 1999 Chi-Chi, Taiwan, earthquake

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The mechanism of the postseismic deformation related to strong earthquakes is important in geodynamics. It is generally believed that the afterslip or the viscoelastic relaxiation are responsible for postsesimic deformation. In this study, we assume that the interaction of viscoelastic relaxation, afterslip, rupture of faults, poroelastic rebound, flow of underground fluids, and something like that altogether contributes the surface displacements after the main shock. Taking 1999 Chi-Chi earthquake as an example, the viscoelastic relaxation, afterslip, and the variations of focal medium properties which equivalently represent poroelastic rebound, flow of underground fluids, and so on, are inverted by applying the GPS temporal series measurement data. Instead of popular method of grid search, a new approach is put forward to invert the viscosities in the lower crust and the upper mantle, afterslip and the material property variations of focal media. Combining the genetic algorithm (GA) and the Marquardt inversion, we regard the optimum model sought by GA as the initial one to carry out inversion by the Marquardt method, in which the Jacobian matrix is produced by small perturbation. The focal region is decided mainly by the range of spatial distribution of the aftershocks and the velocity changes of seismic wave. We utilize viscoelastic finite element method with discontinuous deformation to invert the viscosities, afterslip and focal medium properties in Taiwan. Inversion results show that the inversion method is high efficient and stable. The afterslip rate evolution along Chelungpu fault and down dip of the decollement is obtained. The preliminary result suggests that viscosities of the lower crust and the upper mantle in Taiwan is 2.8×10^{18}pa·s and 5.1×10^{20} pa·s, respectively, and the afterslip contributing postseismic deformation of ~60% in Chi-Chi earthquake with the other ~40% caused by viscosities, poroelastic rebound, the flow of liquids and so on.

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Keywords: Postseismic deformation; Afterslip rate; Viscoelastic finite element; GPS temporal series data; Chi-Chi earthquake

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