IASPEI Scientific Program for Cape Town 2009

Apr 29, 2008

SEISMICITY, NETWORKS (S)

S1 - Symposium on Seismological Observation and Interpretation

Conveners: D Storchak <dmitry@isc.ac.uk>, H Sato <sato@zisin.geophys.tohoku.ac.jp>, E R Engdahl <engdahl@colorado.edu>, P Richards <richards@ldeo.columbia.edu>, J Dewey <dewey@usgs.gov>

The essence of seismology lies in the observation and interpretation of earthquakes and earthquake-generated ground motions, effective data analysis, archiving and dissemination. The real Earth structure varies in three-dimensions and is anisotropic and anelastic in part. Thus, methods for seismogram interpretation need to take into account complexities in the Earth, which are revealed in the currently available high-quality data. Papers are invited for the topics:

1. Developments in seismic instrumentation, networks and data centres, early warning systems, large-scale portable networks, international data exchange and management of massive data sets.
2. Comprehensive seismogram analysis at single stations, seismic networks and arrays - requirements, potentials and future developments.
3. Rapid and routine determination of earthquake parameters, particularly in the context of natural disasters as well as the verification and detection associated with the Comprehensive Nuclear-Test-Ban Treaty (CTBT).
4. Role of international data centres in improving and modernizing the global catalogues of earthquakes.
5. Advances in wave propagation in heterogeneous media, including synthetic seismograms and waveform modeling in realistic Earth structures, theory and observations of scattering, attenuation, anisotropy and seismic wave interferometry.
6. Developments in seismological interpretation, including development of inversion techniques, seismic tomography and whole-Earth analysis methods.
7. Earthquake location and relocation, reference events.

S2 - Large Historical Earthquakes in Africa, Historical Seismology, Paleoseismicity

Conveners: G Graham <gerhardg@geoscience.org.za>, R Musson <rmwm@bgs.ac.uk>

The seismicity of Africa is mostly associated with the northern part of the continent bordering the Mediterranean, the Gulf of Aden, and the East Africa Rift System. Although southern Africa is not known for its large earthquakes and it is generally believed to be one of the most stable regions of our planet, it is not free of tectonic seismicity. The documented seismic history of the southern African subcontinent is rather short and incomplete. This session would encourage papers related to the review of the seismic history of Africa, especially studies that may lead to extending existing catalogues for the continent at large. Scientists from countries in which such reviews have been successful, are encouraged to share their experience and methodologies followed. Paleoseismic investigations, with the aim of contributing to the record of seismicity, will also be promoted through this session. Information on specific large earthquakes, whether pre-historic, historic or recently recorded through modern networks can be shared in this forum. The development of seismology in Africa plays an important role in understanding the available data and information on the seismic history of the continent, with implications for seismic hazard and risk studies, and authors are invited to present their experiences and knowledge on the subject as part of this session. Analysis of the seismicity of Africa in terms of seismicity maps, the completeness of existing earthquake catalogues, frequency-magnitude relationships and maximum expected magnitude are also acceptable topics for this session.

S3 - Seismicity, Seismic Hazard and Regional Co-operation in North Africa

Cosponsored by ESC and UNESCO

Conveners: Frederick Simon <fredericksimon@msn.com>, M Garcia Fernandez <mgarcia@mncn.csic.es>, D Benouar <dbenouar@yahoo.com>, S Riad <nriad@link.net>, B Roubhan <B.Rouhban@unesco.org>

The seismicity of northern Africa is widely distributed and there are many earthquake hazards. Among the most notable recent seismic events are the 1980 M=7.3 El Asnam (Algeria) earthquake, the 1992 M=5.9 Cairo (Egypt) earthquake, the M=6.8 2003 Boumerdes (Algeria) earthquake, and the 1994 and 2004 M=6+ events in the Al Hoceima region of Morocco. This session would encourage papers related to the review of the seismic history of northern Africa, especially studies that may lead to extending existing catalogues for the North African region. Scientists from countries in which such reviews have been successful, are encouraged to share their experience and methodologies followed. Paleoseismic investigations, with the aim of contributing to the record of seismicity, will also be promoted through this session. Information on specific large earthquakes, whether pre-historic, historic or recently recorded through modern networks can be shared in this forum. The development of seismology in northern Africa plays an important role in understanding the available data and information on the seismic history of the continent, with implications for seismic hazard and risk studies, and authors are invited to present their experiences and knowledge on the subject as part of this

session. Analysis of the seismicity of northern Africa in terms of seismicity maps, the completeness of existing earthquake catalogues, frequency-magnitude relationships and maximum expected magnitude are also acceptable topics for this session.

S4 - Induced seismicity

Conveners: S Lasocki <lasocki@agh.edu.pl>, A Kijko <kijko@geoscience.org.za>, A do Nascimento <aderson@dfte.ufrn.br>, G van Aswegen <gerrie@issi.co.za>

Human technological activity provokes various, often unwanted responses. The phenomenon of triggered and induced seismicity is one example of such unwanted by-products. It can result from stress or pore pressure changes, from a volume change, from loading or unloading in the rockmass or from combinations of such causes. Therefore, induced earthquakes usually accompany mineral exploitation, hydrocarbon production, reservoir impoundment, geothermal energy production and many other technological processes that perturb the boundary conditions in the affected rockmass. In general these events give rise to a smaller energy release than that associated to natural earthquakes, yet they can be dangerous, often damaging and occasionally devastating. The hazards associated with triggered earthquakes are still frequently unpredictable and uncontrollable. The goal of this session is to summarize a present state of knowledge about the induced and triggered seismicity processes and to discuss future trends in the field. In South Africa where mining induced seismicity problems are of paramount importance the discussion, begun in Induced Seismicity workshop during the last IUGG in Perugia, will be continued. The problem of induced seismicity is intrinsically interdisciplinary, because it comprises a combination of human action on rocks with the rock response. Its research involves, therefore, also studies of the particular, quite different technological processes that lead to the induced seismic activity. The session is meant to help in identifying common areas of various induced seismic processes: the mining induced, reservoir induced, thermal induced etc. Similarities and differences between the natural and human induced seismicity are other aspects to be discussed. Which methods of earthquake seismology can and which cannot be transferred onto induced seismicity problems? To what extent induced activity can be considered as a scale laboratory relevant for natural seismic processes? Contributions addressing the above topics and all other problems of the induced seismicity are welcome.

S5 - Intraplate seismicity

Conveners: G Gibson <kelunji@mac.com>

Intraplate earthquakes differ from plate boundary events in more than their location within plates, low recurrence rates, and lower maximum magnitudes. Study of intraplate earthquakes provides the opportunity for particularly useful insights into earthquake processes, but is limited by the cost of a high density seismograph monitoring network that can be justified in more active regions.

Earthquakes are infrequent on intraplate faults, which become quite strong, so stress builds to higher levels before failure than in active regions. Energy is released from a smaller volume,

fault rupture areas are smaller, and the resulting ground motion has greater high frequency content.

Precise determination of earthquake location (particularly focal depth), magnitude and mechanism requires a dense network, whether the events are intraplate or interplate. Seismicity rates in intraplate regions can be orders of magnitude lower than in interplate regions, so earthquake hazard is lower, and it is difficult to justify the cost of seismograph networks with comparable instrument density, limiting the resolution of most studies in intraplate regions.

The limit to event volume caused by the limited thickness of brittle crustal and thus shallow depths of intraplate earthquakes mean that the maximum credible magnitudes are lower than in more active regions, and that relatively smaller events provide a greater proportion of the earthquake hazard, with higher frequency ground motion and higher peak ground accelerations for a given magnitude.

Because intraplate earthquakes have sparse recurrence in space and time, such earthquakes provide an excellent opportunity for the study of earthquake clustering. Precursory activity before major events, and adjustment activity over much longer periods than normal aftershock activity, is more apparent than in regions with greater activity.

Although intraplate earthquakes are shallow when compared with subduction events, their depth distribution varies. The maximum earthquake depths vary with local geology, and there appears to be significant variation in both source properties and recurrence parameters with depth.

Another place where the spatial variation of source properties and recurrence parameters may be apparent is in plates within tens to hundreds of kilometers of plate boundaries, especially within either the subducting plate or the overriding plate near subduction regions.

The session will welcome contributions on these or related phenomena, especially observations from recent intraplate earthquakes and comparisons of results from different regions.

S6 - Recent Large Earthquakes

Convener: H Gupta <harshgupta@nic.in>

Earthquakes are one of the worst natural calamities. During the first decade of the 21st Century, devastating earthquake in Bhuj, India on January 26, 2001; the second largest ever-recorded Sumatra earthquake of December 26, 2004 and the resultant most damaging tsunami claiming more than 2,50,000 human lives; and the Muzzafarabad earthquake of October 8, 2005 are just a few examples. Lessons are learnt from every disaster. It is important to develop local specific earthquake scenarios. Japanese seismologists estimate that if the Kanto earthquake of 1923, which destroyed Tokyo and Yokohama, repeats today, the financial losses may exceed 1.3 trillion US $. The symposium will focus on recent large earthquakes and how

the knowledge gained can be used to reduce the extent of disaster from the future earthquakes. Contributions are invited on related aspects of recent large earthquakes.

S7 - Volcano Seismology

Conveners: J Neuberg <J.Neuberg@see.leeds.ac.uk>, H Kumagai <kumagai@bosai.go.jp>

Volcano Seismology requires often special consideration due to the fact that source mechanisms as well as wave propagation effects are significantly different from conventional tectonic earthquakes.

Seismic monitoring of active and dormant volcanoes remains the key element of any monitoring program undertaken by volcano observatories or research institutions. Major advances in volcano seismology have been made in recent years allowing us to identify several categories of volcanic seismic events, and interpret them in terms of different magmatic or tectonic processes encountered on a volcano. Attempts based on multi-disciplinary methodologies turned out to be particularly successful.

This session is dedicated to latest developments in volcano seismological monitoring techniques, interpretation and modeling methodology in a wider volcanological context.

We invite contributions for both oral and poster presentations that deal with any seismological aspects relevant to volcano monitoring, new methodologies as well as case studies from a wide variety of volcanic settings. This includes advances in seismic instrumentation, as well as theoretical approaches. Particularly welcome are studies that combine seismology with other monitoring or modeling techniques, such as ground deformation, gas monitoring, petrology and fluid dynamics of magmatic systems.

S8 - Arrays, Networks, Instrumentation and Stations in Africa

Conveners: G Suarez <gerardo@geofisica.unam.mx>, A Nyblade <andy@geosc.psu.edu>, G Graham <gerhardg@geoscience.org.za>

The objective of this Session is to bring network operators across Africa together to share information and their experiences in operating local and national seismic networks.

Presentations should concentrate on the recent developments in the installation of seismological stations in Africa. Network operators are also encouraged to make presentations on the history of the development of Seismology in their various countries. Operators should also highlight the lessons they learned in the development of their networks, decision making regarding the location of stations, co-location of equipment, the roles they play in contributing to global networks, equipment used and data release policies.

Operators of mine, reservoir and other small-scale local networks should join this forum to expose their particular approach monitoring seismic disturbances.

Presentations on the development of equipment and innovative techniques and new software that form the backbone of networks are particularly welcomed.

S9 - Extending land networks into the sea and oceans

Conveners: R Stephen <rstephen@whoi.edu>, P Favali <paolofa@ingv.it>

Seafloor seismic monitoring can be a valuable extension to land networks for problems of global, regional and local interest. The technology for deploying seafloor monitoring systems has matured to the point where a number of countries have active programs involving permanent (twenty years or more), multi-disciplinary seafloor observatory networks. This session will focus on topics related to seafloor seismic monitoring including scientific pilot experiment results, technical requirements and developments, progress reports on network installations, and proposed and visionary scientific programs.

S10 – Scientific and technical advances in seismology and their relevance to the CTBT

Conveners: B Romanowicz <barbara.romanowicz@gmail.com>, Zhongliang Wu <zhl@gucas.ac.cn>, Domenico Giardini <giardini@seismo.ifg.ethz.ch>

More than ten years have elapsed since the International Monitoring System (IMS) and the associated International Data Centre (IDC) have been established in support of the Comprehensive Nuclear-Test-Ban Treaty (CTBT). While a scientific review of the present system is underway, considerable advances have been achieved in the past decade in technology and science relevant to the CTBT. The extensive deployment of permanent and temporary broadband seismic networks has spurred the development of new approaches to investigate three dimensional structure and seismic sources for both sparse and dense array configurations, such as, for example, those based on noise cross-correlations. New algorithms for event detection, and the determination of source parameters and shake maps in real time have been developed and implemented in the context of earthquake monitoring and early warning, requiring rapid access to dense high quality data. Advances in numerical algorithms and increased computer speed and memory are allowing the modeling of crustal and upper mantle structure with unprecedented detail. Powerful “data mining” procedures have been developed in different fields of science.

We solicit presentations on new theoretical and practical data analysis methods that could improve the present capabilities of the IMS, particularly those making use of the CTBT data. Likewise, we encourage presentations illustrating how the CTBT data may contribute to the advancement of basic science.

LITHOSPHERE STRUCTURE (L)

L1 – Structure and Dynamics of the Lithosphere: Observations, Modeling and Laboratory Constraints

Conveners: K Furlong <kevin@geodyn.psu.edu>, I Jackson <Ian.Jackson@anu.edu.au>, S Cloetingh <cloeting@geo.vu.nl>

This symposium will cover a broad range of research focusing on both the structure and processes of the lithosphere. It is intended to bring together active researchers with interests in lithospheric structure from such fields as seismology, gravity and electrical methods; who make observations of lithospheric deformation from geodesy; who model lithospheric geodynamics; and who provide and incorporate constraints from petrology, geochemistry and rock/mineral physics. The intent of this breadth in the symposium is to motivate enhanced integration across all aspects of lithospheric processes. We encourage all scientists with an interest in the lithosphere to consider submitting a contribution to this symposium.

L2 - East Africa Rift System

Conveners: M Kendall <gljmk@bristol.ac.uk>, P Davis <pdavis@ucla.edu>, A Ayele <atalay@geobs.aau.edu.et>, K Furlong <kevin@geodyn.psu.edu>

The 3000km-long East Africa Rift system is a striking feature of the African continent that captures all stages of rift development from the most juvenile to nascent seafloor spreading. It provides a natural laboratory for studying a fundamental, and yet enigmatic, component of plate tectonics. A mechanism for rupturing thick, cold, continental lithosphere is not readily apparent in conventional models of mechanical stretching. However, magma production will weaken the plate and serve to localize strain, thus better facilitating rifting. Studies of seismicity and volcanism provide insights into this problem and a variety of geophysical, geochemical and geological studies can be used to better understand the role of the crust and mantle in continental breakup. We welcome contributions from a wide range of disciplines that deal with observations, numerical modeling, hazard assessment and sub-surface imaging of the East Africa Rift system.

L3 - Illuminating crust and upper mantle structure with large-scale seismic deployments

Nick Rawlinson <nick@rses.anu.edu.au>, Bob Woodward <woodward@iris.edu>
K Furlong <kevin@geodyn.psu.edu>

On-going programs involving the large-scale deployment of passive or active seismic arrays with the aim of spanning a large geographic region with high-density data coverage have recently gathered momentum. Two pertinent examples are the USArray in North America and the WOMBAT Array in Australia. Both of these experiments involve the deployment of a dense rolling array of seismometers with the long-term goal of spanning a significant portion of a large continent. Data from such experiments can be used in a variety of ways, including surface and body wave tomography, ambient noise imaging, receiver functions, shear wave splitting and array studies of the deep mantle and core. Researchers who seek to exploit large volumes of seismic data from experiments of this type are invited to submit an abstract to this session. Of particular interest are studies, which attempt to combine multiple datasets to image both the crust and upper mantle at high resolution.

TSUNAMIS and ODP (T)

T1 - Tsunami in Africa - Indian Ocean, Atlantic, Mediterranean

Conveners: K Satake <satake@eri.u-tokyo.ac.jp>, A Rabinovich <abr@iki.rssi.ru>, S Tinti <stefano.tinti@unibo.it>, D Roberts <droberts@geoscience.org.za>, C Hartnady <chris@umvoto.com>

The Sumatra tsunami of 26 December 2004 strongly affected the Indian Ocean coast of Africa. Hundreds of people were killed on the coast of Somalia; several casualties were on the coasts of Kenya, Tanzania and South Africa. Tsunami waves were recorded not only on the east and south coasts of Africa, but even at remote sites such as the coast of Ghana and the Canary Islands. Historical data indicate that the 1960 Chile tsunami also reached the coast of Africa. Several destructive earthquake and associated tsunamis are known for the Mediterranean coast of Africa, including the recent 2003 Algerian earthquake and tsunami, as well as the 1856, 1954 and 1980 events. The 1755 Gulf of Cadiz tsunami strongly affected Europe (Portugal and Spain) and Africa (Morocco), and was also observed in the Caribbean region. Thus, the African coasts are vulnerable to tsunami hazard, although this fact has not been well recognized, tide gauges are rare and not designed for tsunami recording, and tsunami-warning systems do not exist. This session emphasizes tsunamis that affect the African continent. Topics include, but are not limited to, tsunami sources, propagation and detection, coastal hazard and its mitigation, case studies and database.

T2 – Leveraging ODP boreholes and submarine cables

Conveners: Masanao Shinohara <mshino@eri.u-tokyo.ac.jp>, R Stephen <rstephen@whoi.edu>

This session will focus on scientific results, scientific strategies, and future plans for seafloor seismic monitoring systems that leverage assets that are already installed or that may become available in the near future. For example many copper and fiber-optic transoceanic telecommunication cables have been, or are in the process of being, retired. Also a number of deep ocean boreholes are suitable for borehole seismic installations. These include existing

boreholes at the Mid-Atlantic Ridge, at the Hawaii-2 Observatory, on the Ninety-East Ridge and in the Equatorial Pacific that could provide valuable coverage for global seismology. Furthermore future drilling on ridges (for example the Juan de Fuca) and in subduction zones (for example the Nankai Trough) will provide opportunities for seafloor borehole seismic monitoring systems to address regional and local problems.

EARTHQUAKE SOURCE and PREDICTION (E)

E1 - Symposium on Earthquake sources: Modeling and Monitoring for Prediction

Conveners: A Zavyalov <zavyalov@ifz.ru>, G Papadopoulos <papadop@gein.noa.gr>

The purpose of the Symposium will consist in promoting advances of experimental and theoretical researches in the field of earthquake physics, with special emphasis to their forecast methods, development of new and existing models of seismic process at different scales and their validation in the natural frameworks of seismogenic regions and mines.

Earthquakes represent a class of non-linear processes, where the non-linearity of the system is related to the variety of processes, covering a wide range of spatial and temporal scales, which take part in the stress redistribution in the earth crust and generates power-law distributions that are often associated with the basic concepts of complexity. In the late 20-th century, several efforts have been devoted to the application of non-linear dynamics approaches to the description of earthquakes preparation and nucleation processes, as well as to the evaluation of the impact of such concepts on the problem of earthquake prediction. In this framework, studies assessing the relevance of space-time scales in the modeling and predictability of non-linear systems are envisaged.

The perception, according to which the preparation of a strong earthquake can be considered from common positions of the theory describing behavior of physical system in a vicinity of critical point, actively developed during last decades. Accordingly, when a strong earthquake approaches, specific features in the behavior of Earth's crust elements cease to be essential and, in the area of preparation of the earthquake, collective processes should be observed over a wide range of system scales. On the other hand, a system that is close to the critical state should be highly sensitive to even small external perturbations. Several works suggest that weak quasi-periodic perturbations can control/synchronize irregular relaxation process, such as seismicity driven by tectonic forces; these observations, however, are mainly qualitative or remain still unproved. Hence studies on triggering and synchronization of seismic/acoustic events by weak external forcing appear relevant to the modeling and prediction of earthquakes.

Recent advances in the representation of the fractal structure of geological environment, as well as the understanding of self-similarity of processes that characterize it at different scales and the self-organization of seismicity, suggest applying in seismology methods from physics of non-equilibrium processes. This approach to the study of seismogenic processes provides the opportunity to make use of results from laboratory experiments, thus allowing for repeated

experiments at known and controllable parameters, which are necessary for verification and comprehension of the basic laws and their dependence on tested parameters. In the meanwhile laboratory experiments are never fully representative, due to the different space and time scales involved and to the impossibility of accounting for all variety of processes involved in earthquake preparation. Therefore it is mandatory to check the properties derived from laboratory experiments against field observations.

Following a basically different approach, physical models for the entire cycle of earthquake generation, constrained by seismological and geodetic observations, can be developed. The newly available high quality positioning data (e.g. GPS and InSAR) may permit monitoring deformations that can be combined with routinely updated seismic information. Realistic simulation models may thus provide a new framework for studying earthquake precursory phenomena and, once validated against available observations, may have direct application to earthquake hazard quantification.

Seismological observations at the mining enterprises are actual direction of researches of earthquake sources from the theoretical and practical point of view. Mines can be viewed as natural laboratories, where it is possible to investigate seismic processes at an intermediate scale level, between regional scale observations, on the one hand, and experiments on rock samples, on the other.

The Symposium aims to promote research and discussion ranging from generalized scale invariance to the interpretation of earthquake as a critical point, from theoretical source models to rheological models of damage of rocks. Special attention must be paid to verification and validation of new and existing models, based on past observations and monitoring.

Contributions to the session are invited for the following topics:
1) Physical modeling of earthquake processes;
2) Modeling and monitoring of earthquake processes for prediction;
3) Fault zone processes and constitutive properties;
4) Fault system complexity and its dynamics;
5) Triggering and synchronization of seismicity;
6) Variations and synchronization of geophysical fields in the earthquake preparation area;
7) Tectonic loading, stress-state evolution, and seismicity changes;
8) Earthquake forecasting and evaluation;
9) Seismicity as manifestation of critical behavior of the crust.

E2 - Geophysical anomalies and Earthquake prediction

Conveners: D Jackson <djackson@ucla.edu>, A Zavyalov (GeoRisk) <zavyalov@ifz.ru>

In this session we aim to assess the current status of earthquake prediction by different geophysical methods, focusing on the results of repeatable, well controlled experiments. Presenters should address the following questions:

- How are anomalies defined, and what are the characteristics of the normal behavior or “baseline” against which anomalies are distinguished?
- What effects other than tectonic stress or other earthquake triggers might cause anomalies, and what corrections have been made to the data?
- What is the set of earthquakes, defined by location, magnitude, time, focal mechanism, etc., that ideally would have been predicted by the technique if it worked perfectly?
- How many successful predictions, false alarms, unpredicted events, and successful non-predictions were there, or alternately, what fraction of the eligible space-time was covered by alarms, and what how many events occurred in an out of the alarmed regions?
- Has the methodology been tested prospectively? If so, how have the predictions been announced?
- What plans have been made, or should be made, for future prospective testing?
- In assessing prediction success, what earthquake catalog is used, and how have completeness, location and magnitude errors, and aftershock occurrence been treated?

E3 - Prospective Testing of Earthquake and Faulting Probability Models

Conveners: D Rhoades <d.rhoades@gns.cri.nz>, D Jackson <djackson@ucla.edu>

Prospective testing of models of earthquake occurrence and fault rupture probability provides the ultimate measure of their worth. Developers of such models face difficulties of limited data sets and many free parameters, formally or informally estimated, in the specification of their models. Therefore retrospective testing, however rigorous, cannot unequivocally measure the performance of a model.

Recently, an international collaborative effort has begun to develop testable models of earthquake occurrence, and to formally test them against future occurrences, using verifiable procedures and accepted standards for how forecasts of earthquake occurrence should be evaluated. Testing centers are being established in several regions with a goal of formalizing the process of validating earthquake forecasts. Earthquake catalogues and other geophysical databases may now have improved to the stage where the development and testing of global models can be contemplated.

The aim of this symposium is to encourage this collaborative effort. The scope includes:

- Descriptions of national or international research projects aimed at prospective testing of such models;
- Results of formal prospective tests already undertaken, or in progress;
- Development of testable models of earthquake occurrence and fault rupture probability, whether on a local, regional or global scale, and based on any type of input data. These models may have a view to forecasting on any timescale, e.g. 5 years, 3 months, or 24 hours.
- Statistical procedures for assessing regional earthquake likelihood models and other well-defined models of earthquake occurrence and fault rupture probability;

- Adequacy of databases on a local, regional or global scale for development of models and formal testing.

GEODYNAMICS (G)

G1 - Earth Structure and Geodynamics

Conveners: G Houseman <greg@earth.leeds.ac.uk>, T Lay <thorne@emerald.ucsc.edu>, R Durrheim <Raymond.Durrheim@wits.ac.za>, C Reeves <reeves.earth@planet.nl>

Co-sponsored by SEDI

An understanding of large-scale structures within the Earth is constrained by seismological, electromagnetic, geodetic, thermal, and other physical measurements, and informed by models of the governing physical processes.

Central to our understanding of geodynamics is the large-scale movement of mass and heat within the Earth caused by thermal convection in the mantle and the core. Much progress in recent years has followed on the development of detailed tomographic images of the mantle and structures within it, including subducted slabs and thermal plumes. Understanding of these structures depends however on the development of self-consistent thermal and dynamical models which explain the observations.

The mantle convection system has two major thermal boundary layers, the lithosphere and D". Interaction with the lithosphere ultimately drives plate tectonics and continental tectonics. Much progress has also been made in recent years in mapping the structure of the lithosphere and understanding the modes of deformation of continental lithosphere.

Structures in the D" layer and the core beneath may be no less important, though more difficult to map.

Contributions are invited on any aspect of the above topics, in relation to the Earth or other terrestrial planets, and in particular:

(1) Measurement and mapping of lithospheric, mantle and core properties using seismic, geodetic, or electromagnetic methods.
(2) Theoretical, laboratory, and numerical models of thermal convection in the mantle or core.
(3) Models and measurements of lithospheric deformation and thermal evolution
(4) The subduction process and subducted slabs
(5) Mantle plumes and the mantle transition zone
(6) Core dynamics and core-mantle interaction

HEAT FLOW (H)

H1 - From Heat Flow to Geothermal Energy

Conveners: C Clauser <c.clauser@geophysik.rwth-aachen.de>, J Safanda <jsa@ig.cas.cz>, M Jones <michael.jones@wits.ac.za>, W D Gosnold <william_gosnold@und.nodak.edu>, L Rybach <rybach@geowatt.ch>

Co-sponsored by the International Geothermal Association

The symposium will focus on those aspects of basic geothermal research, which have relevance for geothermal energy use. We welcome in particular studies addressing (1) a downward extrapolation of surface and shallow subsurface temperatures to depths accessible by boreholes, including estimates of uncertainty; (2) the role of groundwater, groundwater flow, and chemical water-rock interaction in geothermal energy exploitation; (3) transients in field variables (such as temperature, pressure, and stress) and rock properties (such as porosity and permeability) during and after exploitation; (4) estimation and mapping of terrestrial heat flow, geothermal potential, and mean annual ground surface temperature based on both upward extrapolation of geothermal measurements and on climatic data; (5) dependence of the mean annual ground temperature on the latitude, altitude, type of vegetation, soil and anthropogenic effects. Highly appreciated are also all types of case and sensitivity studies based on heat flow and other geothermal studies, which estimate the parameters of geothermal systems.

H2 - Workshop “Geothermal Studies: Instruments, Measurements, and Interpretation

Conveners: Y Popov <yupopov@dol.ru>, S Roy <sukantaroy@yahoo.com >

The workshop aims to compile and disseminate information on currently used techniques in acquisition and interpretation of geothermal datasets and to stimulate better understanding of experimental data quality in basic and applied geothermics. A major thrust of the workshop would be to deliberate on present-day measurement practices for basic geothermal parameters - borehole temperatures, temperature gradient, heat flow, thermal conductivity and diffusivity of rocks, radio-elemental (U, Th and K) analysis of rocks and heat production estimates, various corrections applied to temperature, rock's thermal property and heat flow datasets. Other provisional topics include: (1) Problems of temperature measurements in continental boreholes, ocean areas and permafrost temperature monitoring with traditional tools and distributed temperature sensors, (2) Measurements in high temperature geothermal wells, (3) Problems of measurements of rock's thermal properties for water, oil and gas-hydrate bearing formations in laboratory conditions and boreholes, (4) New developments in geothermal measurements, (5) Applications of geothermal datasets in hydrology, climate change research and other disciplines, (6) Case studies of high-quality experiments in basic and applied geothermics, (7) Data analysis and interpretation procedures.

HAZARD AND RISK (R)

R1 - Earthquake Hazard

Conveners: Wu Zhongliang <wuzl@cea-igp.ac.cn>, A Kijko <kijko@geoscience.org.za>

The objective of the session is to address and discuss the new trends, initiative and issues related to the Earthquake Hazard Analysis such as: seismic sources, near fault, seismicity, strong ground motion attenuation, deterministic and probabilistic approaches, how to use GIS and remote sensing data for SH analysis and mapping, and finally the strong ground motion time history prediction.

R2 - Earthquake Risk

Conveners: M Ghafory-Ashtiany <ashtiany@iiees.ac.ir>, J Hlatywayo <djhlatywayo@nust.ac.zw>

The objective of the session is to address and discuss the new initiative and issues related to the Earthquake Risk Analysis such as: Structural vulnerability analysis, socio-economic vulnerability analysis, risk analysis methodologies (deterministic and probabilistic), earthquake risk modeling, earthquake quick loss estimation, how to use GIS and Remote sensing data for SR analysis and mapping. In particular the following topics are of interest:

1. Seismic risk and vulnerability analysis
2. Risk response and spectra
3. Fault rupture models for risk analysis
4. Structural seismic risk (highway systems and high rise structures)
5. Seismic risk analysis methodologies
6. Risk evaluation and mitigation
7. New trends in seismic risk analysis software.

R3 - Workshop “Effects of Surface Geology”

Conveners: H Kawase <kawase@arch.kyushu-u.ac.jp>, A Cichowitz <artur@geoscience.org.za>

Site response measurements provide information on the amplification of ground motions generated by near surface geology. Analyses of large earthquakes have revealed that damages during the earthquakes are often caused by the amplification of seismic waves in near surface layers. The purpose of the workshop is to present recent studies on the effects of surface geology on seismic motion with the emphasis on new advances or novel applications of existing methods. The methods should be suitable either for typical applications or for the analysis of the critical structure.

Contributions are sought from scientists working on all aspects of site characterization, from the development of processing techniques to a new understanding of the complexity of the

effects of surface geology by utilizing field and borehole observation and laboratory studies. Scientists are encouraged to submit their contributions to the long-standing debate on whether the response of surface geology is the same to strong-ground motion and to weak motion.

The characterization and description of material properties are the key element of site response analysis. The earthquake source parameters do not sufficient explain the variations in ground motion at the site, and the geotechnical site characterization variability can have the dominant influence on ground motion. However, extensive laboratory and field studies have to be conducted to model the response of soils to the dynamic load.

The purpose of this session is to bring together members from the various disciplines with the purpose of evaluating the reliability of methods used to estimate the site effect.

R4 - Seismic Source Modeling and Ground Motion Prediction

Conveners: K Irikura <irikura@geor.or.jp>, A Cichowicz <artur@geoscience.org.za>

The purpose of this session is to bring together seismologists representing a broad range of disciplines from seismic source modeling to predicting ground motion with the emphasis on new theoretical advances or novel applications of existing methods. Earthquakes source dynamic provides key elements for the prediction of ground motion. Contributions are encouraged from scientists working on all aspects of earthquake modeling, from the development of theoretical and numerical methods to a new understanding of the complexity of the rupture process.

The session aims to evaluate synthetic time histories resulting from various predictive models, and to provide guidelines for implementing strong ground motion estimation in low and high frequency ranges. A key component of this process is the development and validation of strong ground motion prediction methodologies, as well as quantifying their uncertainties. Large numbers of earthquake ground motions can be predicted for the scenario earthquake by considering possible sets of the source, path, and site parameters. Characterizations of source rupture processes are based on earthquake source dynamics, and observational evidence. Site parameters characterization is controlled by the subsurface geologic structure. Contributions are invited on near-fault broadband simulation techniques. Analyses of ground motion from damaging earthquakes show that long-period pulses caused by rupture directivity characterize near-fault ground motion.

In particular, studies are invited on addressing the ground motion prediction of intraplate areas where large earthquakes are rare and infrequent. In regions such as southern Africa no strong motion recordings are available for use as the empirical Green’s function. This session will explore practical issues related to the selection and scaling of natural and simulated acceleration histories for engineering application. Currently, site-specific ground motion prediction is costly and generally acceptable only for the analysis of the critical structure. The engineering community requires cost-effective methods to develop ground motion simulation for use in typical applications.

R5 - Earthquake Risk Reduction and Preparedness: Socio-economic aspects, particularly in developing countries

Conveners: M Ghafory-Ashtiany <ashtiany@iiees.ac.ir>, J Hlatywayo <djhlatywayo@nust.ac.zw>

Our aim is to address and discuss the socio-economic aspects and benefits of Earthquake Risk Reduction initiatives and Programmes, as well as the socio-economic incentives for Earthquake Preparedness. Discussion will cover possible ways to ensure that Risk Reduction will become a National Priority, especially in developing countries, with a strong institutional basis for implementation.

APPLIED GEOPHYSICS (A)

A1 - Electromagnetic prospecting and crustal structures

Conveners: K Furlong <kevin@geodyn.psu.edu>, E Stettler <estettler@thani.ae>, J de Beer <JHdeBeer@mweb.co.za>

The electromagnetic method provides one with the ability to study the crust from very shallow to very great depths, even reaching down to the mantle in extreme cases. A large number of different EM systems exist, including airborne, ground and marine instruments, and are applied in vastly different studies, ranging from exploring for groundwater, to countrywide projects studying the tectonic development of cratons. New data collection, processing and interpretation techniques are continuously being developed, making this a very exciting field of study in geophysics.

Presentations addressing the following issues are welcomed:

1. Conductive structures in the crustal and marine environment: -advances in constraining models and imaging.
A vast amount of work is done on developing and improving 2D, 2.5D and 3D forward modeling and inversion software.

2. New and novel EM methods in optimizing groundwater and mineral prospecting.
Southern Africa is rich in mineral deposits, and exploiting these is crucial for the economic development of the area. On the other hand, large parts of the region have a very dry climate and groundwater is an important resource that influences the day-to-day existence of local communities. This topic aims to look at new and innovative electromagnetic methods that have been used in prospecting for these resources, such as Nuclear Magnetic Resonance (NMR), Induced Polarisation (IP) etc.

3. Airborne EM systems abound, so what next?
A large number of airborne EM systems are commercially available and new systems are continuously being developed. These include fixed-wing and helicopter-borne systems. Existing systems are also constantly being further developed to obtain better results. Papers on topics such as new developments in equipment to improve the quality of data being collected

and improvements made to processing, modeling and inversion software will be addressed in this session.

4. Can models for large conductive crustal structures be reconciled with the results from other geophysical techniques?
How do results from EM surveys applied to crustal studies compare to those from other geophysical techniques? For example, how compatible are deep seismics and magnetotelluric models? How can perceived incompatibilities be explained? Case studies showing the results from multidisciplinary studies may help to shed light on this question.

A2 - Geochemical and geophysical signatures of diamond fields

Conveners: A Jones <alan@cp.dias.ie>, John Gurney <John.gurney@minserv.co.za>, Anton le Roex <aleroex@geology.uct.ac.za>

What are the geochemical and geophysical signatures of diamond fields? What are the appropriate regional-scale geochemical and geophysical techniques that can aid us in area selection for diamond exploration? Once we have found a prospective area, what local-scale techniques do we need to use to gain as much information about diamond prospectivity? Are there indicators of possible diamond quality? Are there methods for combining disparate geochemical and geophysical datasets in a formal way rather than only qualitatively? These questions lie at the heart of this symposium, which will explore how to improve our knowledge of the Earth in an optimal manner in order to become more effective at discovering high-quality diamond deposits.

E&O (O)

O1 - Capacity Building and capturing undergraduate students to geophysics/seismology

Conveners: J Taber <taber@iris.edu>, P Dirk <Paul.Dirks@wits.ac.nz>, M. Grobbelaar <michelle@geoscience.org.za>, S Webb <webbs@geosciences.wits.ac.za>

Geophysicists are in high demand in such fields as oil, gas, and mineral exploration, geothermal energy development, water resource management, and earthquake hazard mitigation. To meet this demand within a country it is necessary to both attract qualified students to the field and to have sufficient long-term capacity to provide ongoing education and training.

Many secondary and university students do not become aware of the existence of geophysics programs until it is too late to take a sufficient number of physics and math courses, while physics and math majors often do not know that their backgrounds are appropriate for entry to geophysics graduate programs. Therefore strategies are required to introduce the field at an early enough stage and to provide engaging learning opportunities for a range of students.

Symposium presentations are encouraged that focus on examples of effective strategies for building long-term capacity within a country as well as capturing and retaining students in geophysics programs worldwide. Examples might include the establishment of effective long-term international partnerships, successful undergraduate research experiences, geophysics field courses, or targeted introductory courses.

O2 - Discussion panels

Convener: R Musson <rmwm@bgs.ac.uk>

Panel Discussion 1 – Seismic Hazard: Living with Uncertainty

Seismic hazard, in the sense the topic is understood today, is still a relatively young branch of seismology, and has evolved rapidly over the last 40 years. From relatively simple concepts such as "maximum possible ground motion", we have moved to ideas of design ground motion expressed as probabilities, with increasing emphasis on the handling of uncertainty – both the randomness associated with highly complex stochastic processes (aleatory variability) and our own ignorance of the true long-term values of parameters of processes we glimpse only through short-term time samples (epistemic uncertainty). Hazard values, and hence design parameters, can change drastically given different ways of dealing with these uncertainties; and there is no common agreement within the hazard community as to the best procedures. Furthermore, although probabilistic analysis is by far the most established approach to seismic hazard at present, there are still those who question its desirability. Given that seismic safety issues hang on the results of hazard analysis, fundamental disagreements over methodology have implications that go well beyond academic interest.

In this panel discussion, four invited experts will give their opinions on the direction seismic hazard analysis should be going, followed by a discussion open to contributions and questions from the floor.

Panel Discussion 2 – Earthquake Prediction: What the Future Holds

In visions of expected scientific developments in the next 50 years, as foreseen in the 1950s and 1960s, earthquake prediction is invariably cited as a breakthrough that can confidently be expected on the timescale of a few decades. Yet, as the first decade of the 21st century approaches its close, we seem still to be far from consulting a bulletin of next month's earthquakes as a matter of routine form. Certainly, a number of schemes have been hailed (by their proponents) as successes; but the same schemes are derided by their detractors as merely presenting spurious statistics to give the illusion of accurate forecasting. Furthermore, leaving aside whether the current level of success in earthquake prediction is statistically significant, is it socially useful? What is the minimum degree of confidence and precision required in an earthquake prediction before it can be used for civil defense? Are we on the way to achieving that level of accuracy, and how long will it take us to get there?

In this panel discussion, four invited experts will be invited to predict the future of earthquake prediction, and to give their opinions on the current state of the art, followed by a discussion open to contributions and questions from the floor.