New IGCP Projects accepted and starting in 2008

Project No. 559 Crustal Architecture and Landscape Evolution

Countries involved: Australia, Canada, China, Finland, Japan, Netherland, New Zealand, Russia, South Africa, Spain, USA
Full title: Crustal Architecture and

Images—Structural controls on landscape, resources and hazards

Project leaders: Dr. Bruce R. Goleby (Australia)

Duration: 2008–2012

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This project will focus on that part of planet Earth that has the most significance for the world's communities, namely the Earth's crust, that outer part of the planet on which we all live. The project will make available to communities-at-large a wealth of information and seismic imaging that is commonly only available to research workers but yet has a profound effect on how we think of the landscapes, natural environments and their controlling geological processes and tectonic influences.

An understanding of crustal architecture and tectonic history/processes is fundamental to any appreciation and understanding of landscapes, surface geology and natural hazards at a local, regional and global scale.

The project aims to bridge the gap between scientific effort and the public interest and give a real insight into nature of the major geological processes in the outer 50–70 km of the Earth that directly affects our lives.

Through the project's web site development phase, it will link and archive images and sources of information on crustal architecture from world-wide seismic imaging programs. Through the sponsorship of key international symposia the project will foster international cooperation and knowledge transfer.

The project has widespread relevance to decision making in the areas of natural resource development, urban and national infrastructure planning, university teaching, groundwater management and natural hazards assessment on all continents.

Project No. 565 Geodetic Monitoring of the Global Water Cycle

Countries involved: Germany, Italy, Republic of Korea, South Africa, USA

Full title: Developing the Global Geodetic Observing System into a Monitoring System for the Global Water Cycle

Project leaders: Prof. Dr. Hans-Peter Plag (USA), Dr. Richard S. Gross (USA), Prof. Dr. Markus Rothacher (Germany), Prof. Norman L. Miller (USA), Prof. Susanna Zerbini (Italy), Chris Rizos (Australia)

Duration: 2008–2012

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Water is essential to life and central to human welfare, progress and sustainable economic growth. The global hydrological cycle operates on a continuum of temporal and spatial scales. Its variability which regulates flood, drought, and disease hazards is being continuously transformed by climate change, erosion, pollution, agriculture, and civil engineering practices. Despite its fundamental role for mankind, and despite the challenges through increasingly limited availability of water for human activities, knowledge of key quantities of the hydrological cycle is still associated with large uncertainties, and urgent questions cannot be answered.

Geodetic observations relate to the Earth's gravity field, shape, and rotation and their changes in time (the three fundamental areas of geodesy). At time scales from weeks to decades, hydrological loading of the Earth's surface dominates non-secular variation in each of these areas of geodesy. Thus, geodesy naturally provides integral constraints on the water cycle at multiple spatial and temporal scales. Space-geodetic sensors capture the signals of variation in the entire fluid envelope of the solid Earth, including the terrestrial water storage. Space geodetic observations of surface mass variability are inherently strong at regional to global scales, and could be an important complement to traditional in-situ measurements of terrestrial water storage.

The Global Geodetic Observing System (GGOS) of the International Association of Geodesy (IAG) has the capability to monitor mass transport in the Earth system and particularly the global water cycle. Crucial to this application are the gravity satellite missions that measure the temporal variability of the Earth's gravity field. The GRACE mission has demonstrated the great potential of these missions, but the continuity of the satellite missions is not secured. Moreover, the utilization of the full suite of the geodetic observations is hampered by model insufficiencies, inconsistencies, and a lack of integration of the different space-geodetic techniques. As a consequence, the dissemination of products into practical water management has not taken place.

The proposed project aims to develop GGOS into a monitoring system for the hydrological cycle on global to regional scales. The intergovernmental and international frames of the Group on Earth Observation (GEO) and GGOS, respectively, will be used to ensure suf-

ficient satellite gravity missions, particularly with participation of emerging space agencies in Africa and Asia. Ongoing and planned research will: address the combination of space-geodetic observations, particularly GPS and GRACE-type observations, in order to exploit their individual strengths and mitigate their weaknesses; improve the geophysical models for the processing of the observations; enhance the extraction of highly accurate information on changes in terrestrial water storage, prepare the assimilation of the observations in integrated predictive models of the hydrological cycle, and focus on the interpretation of the space-geodetic observations in terms of regional groundwater and soil moisture changes.

Through cooperation with research institutions in developing countries, the project will support capacity building in the field of space-geodetic data processing, modeling of the hydrological cycle, and interpretation of the observations in terms of terrestrial water storage. Through interaction with water management authorities particularly in developing countries, the practical use of the products for regional water management will be promoted. Coordination of the research and capacity building will be provided through a series of five annual workshops, with the first one focusing on satellite gravity missions, a second and third one on data processing, technique integration, modeling and interpretation, and the last two on hydrological applications, particularly in developing countries. Expected results are an improved understanding of mass redistribution in the water cycle, in particular, changes in groundwater; better exploitation of the space-geodetic observations for hydrology; and societal benefits through an improved knowledge basis for regional water management.

Project No. 567 Earthquake Archaeology

Countries involved: Armenia, Austria, Belgium, Canada, France, Germany, Greece, India, Israel, Italy, Japan, Jordan, Kyrgyzstan, Spain, Turkey, UK, USA, Venezuela

Full title: Earthquake Archaeology:

Archaeoseismology along the Alpine–Himalayan seismic zone

Project leaders: Prof. Dr. Manuel Sintubin (Belgium), Dr. Iain Stewart (USA), Prof. Dr. Tina Niemi (USA), Prof. Dr. Erhan Altunel (Turkey)

Duration: 2008–2012

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How can planners and politicians prepare for earthquakes? Damaging earthquakes on fault lines typically recur at intervals of centuries to millennia but the seismographs that register them have only been around for

about hundred years. To reduce the hazard from earthquakes we need a longer record of them than can be provided from such instruments. On the assumption that future earthquakes will be like those of the geologically recent past, we need to look back in order to forecast forward. Archaeological evidence is especially valuable for determining earthquake activity over millennial time spans, especially where integrated with historical documents and geological evidence.

Archaeology can be used in three ways to help confront the seismic-hazard threat.

- 1) First, where archaeological relics are displaced they can be used to find earthquake faults, show in which direction they slipped during the earthquake and from these cultural 'piercing points' establish comparative fault slip-rates.
- 2) Second, archaeological information can date episodes of faulting and shaking, with some cultural artifacts (e.g., epigraphic or numismatic (coins) data, pottery typology) yielding age estimates more precisely than high-resolution geological stratigraphies.
- 3) Third, we can search for ancient signs of seismic damage. The obvious difficulty with the last approach is that it is hard to distinguish between damage caused by an earthquake and that caused by another destructive event, such as war or the natural failure of foundations.

Typologies of earthquake-characteristic damage have been proposed—most based on inferences drawn from seismic damage to modern constructions but some derived from engineering analysis of ancient structures—but rarely have they been subjected to a critical and systematic analysis. Consequently 'archaeoseismic indicators' are accepted by some earthquake scientists and rejected by others.

An important element of this project will be to go from the shaking table to the archaeological remains in developing a broadly accepted methodological framework to what reliably constitutes seismic damage. The key element of this project is our contention that archaeological evidence has the potential to make a valuable contribution to long-term seismic-hazard assessment in earthquake-prone regions where there is a long and lasting cultural heritage. We have identified the Alpine-Himalayan region as the ideal laboratory, because the archaeoseismological studies that have already taken root in the Eastern Mediterranean can be extended to neighbouring regions, most importantly south along North African shores, north into the Caucasus Mountains, and east into western Asia. As well as trying to establish a common methodological framework that is crucial for archaeoseismology to develop into a recognized and legitimate field of earthquake science, case studies from these regions will address specific questions relating to the locations, timing and size of past destructive earthquakes and so will aim to contribute specific information for seismic hazard analysis.

But there is a wider remit for our activities, because our research clearly has important humanitarian and economic implications. As illustrated by the 2003 collapse of the World Heritage site in the Bam (Iran) earthquake, cultural heritage sites themselves are threatened by seismic destruction. Clearly, there is a growing need to understand how ancient structures and monuments respond to faulting and ground shaking. On an even broader scale, our work will contribute to our understanding of ancient history, elucidating why some cities were abandoned or why former societies suffered decline, and confronting the enduring attraction of fault lines in luring peoples, ancient and modern, to settle along persistent danger zones. In other words, this project will contribute to our own cultural heritage.

Project No. 572 Permian-Triassic Ecosystems

Countries involved: Argentina, Australia, Austria, Canada, China, Croatia, Czech Republic, France, Germany, Hungary, India, Iran, Israel, Italy, Japan, New Zealand, Norway, Poland, Romania, Russia, Slovenia, Spain, Thailand, Turkey, Switzerland, UK, USA

Full title: Restoration of marine ecosystems following the Permian-Triassic mass extinction: Lessons for the present

Project leaders: Zhong Qiang Chen, Dr. Richard J. Twitchett, Dr. Jinnan Tong, Dr. Margaret L. Fraiser, Dr. Sylvie Crasquin, Dr. Steve Kershaw, Dr. Thomas J. Algeo, Dr. Kliti Grice

Duration: 2008–2012

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Many marine ecosystems are under threat at the present day. This is nothing new, as the marine realm has suffered major extinction and upheaval on numerous occasions over the geological past, the most serious of which occurred during the Permian-Triassic transition. Of the major factors supposed to have caused the Permian-Triassic biotic crisis, such as increased carbon dioxide concentrations, oceanic anoxia, hypercapnia (CO₂ poisoning) and rapid global warming, some are observed in the present day, and others may happen in the near future. The Permian-Triassic rock and fossil records may thus record a natural experiment in global-scale ecosystem collapse that, if properly deciphered, could provide an insight into the possible responses of modern marine ecosystems to present day climate and environmental change. This links into current global concerns and issues such as the "sustainable use of global biodiversity", "biodiversity response to global warming" and "keeping our planet environmentally sustainable".

The proposal aims to investigate the recovery of marine ecosystems following the

Permian/Triassic (P/Tr) mass extinction through analyses of the rock and fossil records of South China, Tibet, elsewhere in Asia, eastern Europe, Russia, Japan, Canada, Greenland, Spitsbergen, western US, western Australia and New Zealand. Through detailed studies of Early Triassic biostratigraphy, palaeontology, palaeoecology, sedimentology, geochemistry and biogeochemistry in the above regions, this project will attempt to formulate recovery patterns of various fossil groups; to reconstruct the global Early Triassic oceanic and climatic conditions; to construct a database of P/Tr ecosystem types; and to correlate all of this data in a global stratigraphic framework. Ultimately, this project will reveal the patterns and processes of marine ecosystem restoration following the P/Tr mass extinction; will elucidate the factors controlling the recovery rates of marine communities in various habitats and climate zones; will determine the similarities and differences in the responses of different marine groups to biotic crisis; and will assess the effects of climate or other geological events on the restoration of the defaunated marine ecosystems.

These goals will be achieved primarily by collaborative fieldwork in key Early Triassic successions in more than 10 different countries over five years and related laboratory work in over 20 different countries. The results of our project, which are to be published in four edited books and special volumes, in international peer-reviewed journals, in annual symposium proceedings and on the world-wide-web, will advance scientific understanding of the interactions between the biosphere and geosphere and lead to a better understanding of ancient defaunation events. The firm support and active involvement in this project of most top scientists in this field from around the world will lead to unique training opportunities for postgraduate students from a range of countries (Argentina, Austria, Australia, Canada, China, Japan, France, Germany, Iran, India, Switzerland, UK, USA) as well as professionals from developing and developed regions alike. As a result, the proposed project will provide a friendly platform for participants to communicate their own research results and also bring together global experts, and research facilities to solve a truly global-scale problem. The competitive track records of the proposers underscore this project's high chance of academic success as well as its potential to achieve significant societal benefits in the form of knowledge sharing and enhanced scientific cooperation between nations.

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