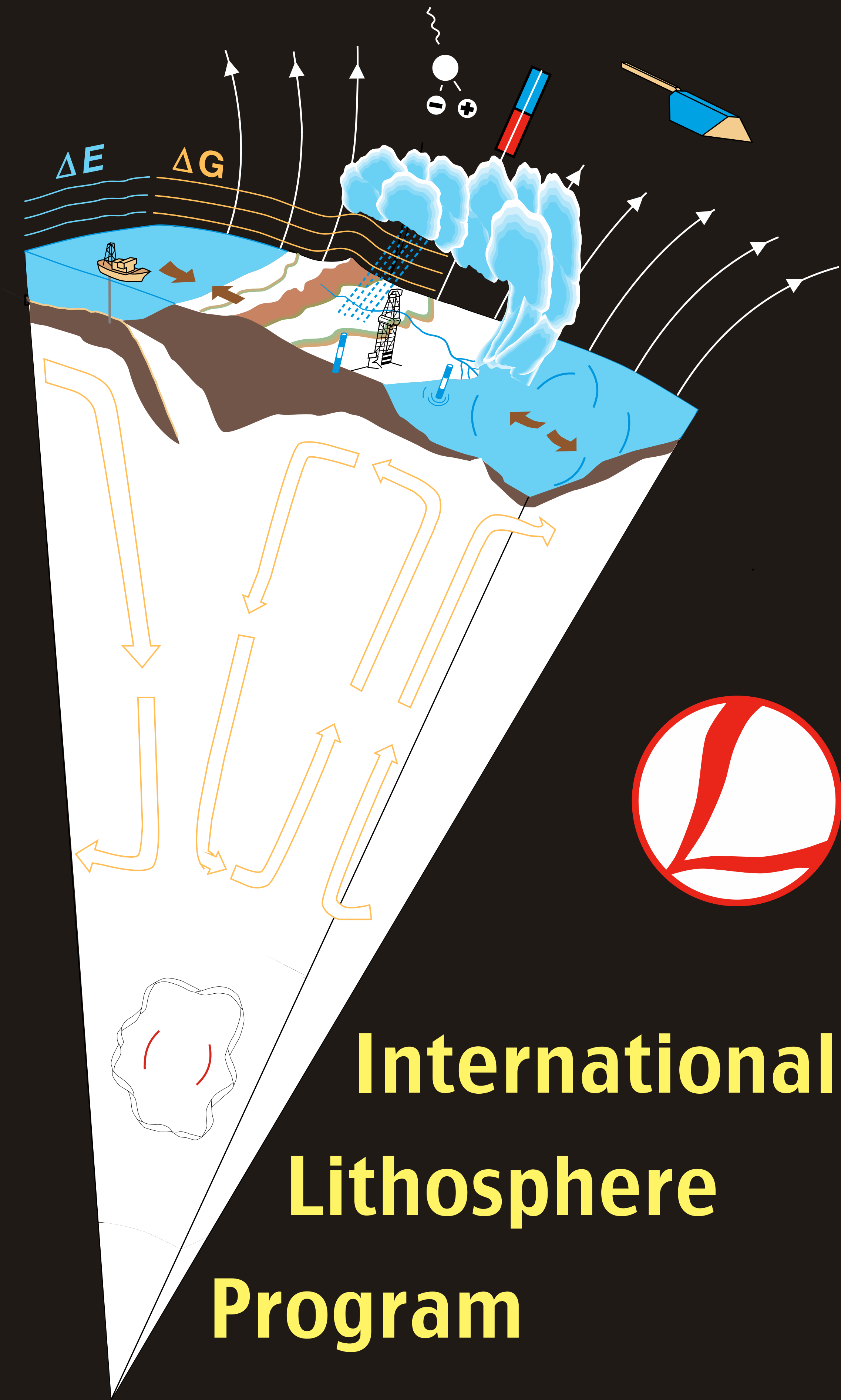
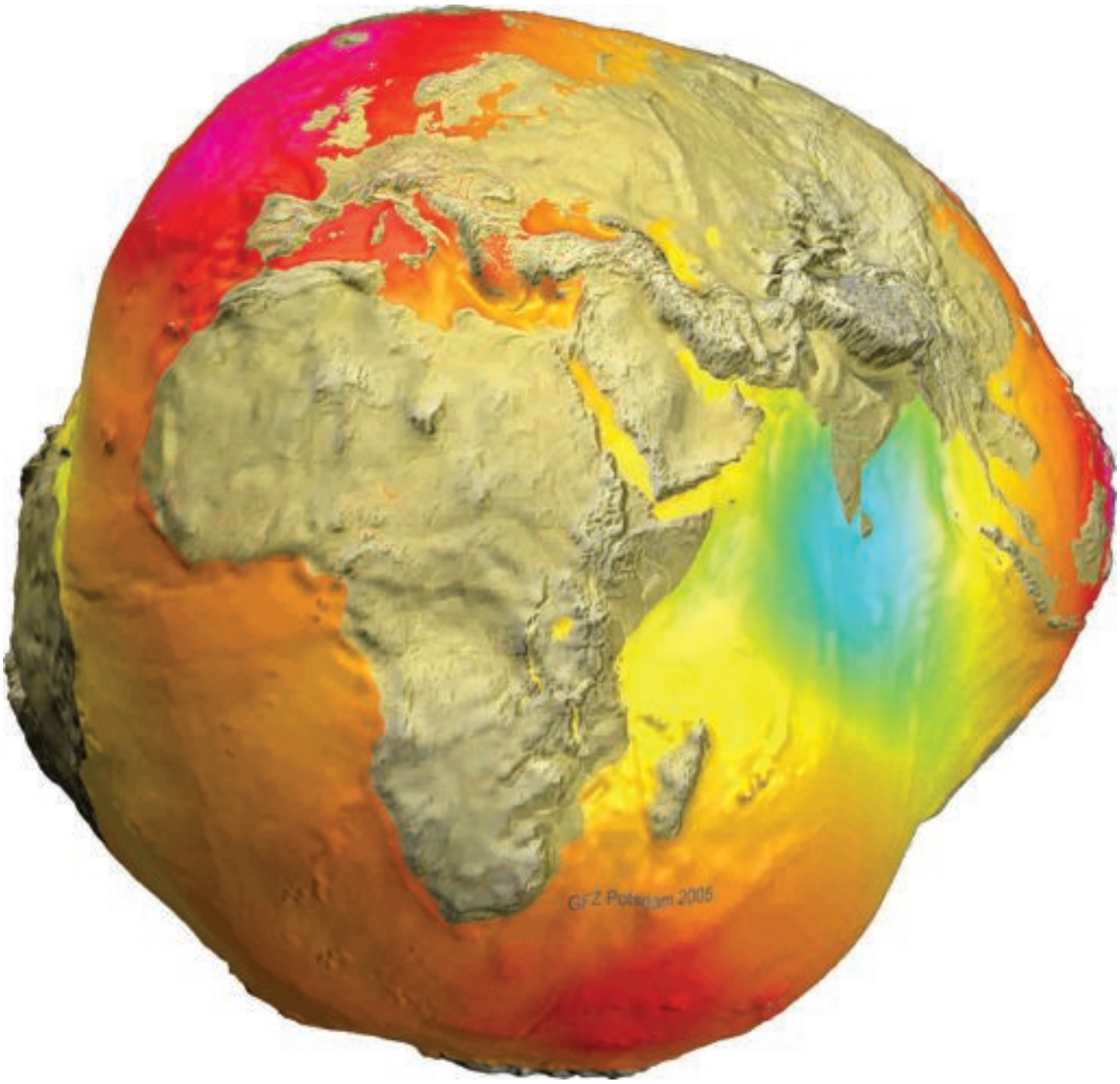


International Lithosphere Program



Gravity model as geoid (EIGEN-CG01C) calculated from CHAMP and GRACE data.

ILP – an IUGS and IUGG initiative established by ICSU (International Council of Scientific Unions) in 1980

The International Lithosphere Program (**ILP**) seeks to elucidate the nature, dynamics, origin and evolution of the lithosphere through international, multidisciplinary geoscience research projects and coordinating committees.

The ILP is charged with promoting multidisciplinary research projects of interest to both the geological (IUGS) and geophysical (IUGG) communities.

The ILP seeks to achieve a fine balance between: *“addressing societal needs”*, e.g. understanding natural catastrophes and other solid earth processes that affect the biosphere, providing information for improved resource exploration and environmental protection; and *“satisfying scientific curiosity”*.

Additionally, ILP has the mandate of ICSU to act as an Interdisciplinary Body with the special task of evaluation and recommendation of scientific projects submitted to ICSU.

Since 1990, **ILP** projects have been operating under the umbrella of four broad research themes:

1. Geoscience of Global Change
2. Continental Dynamics and Deep Processes
3. Continental Lithosphere
4. Oceanic Lithosphere

MISSION AND PROFILE

The Integrated Solid Earth perspective is key to the mission of **ILP** since:

- The Lithosphere is **the** connection between the deep Earth and the Earth´s surface;
- The Lithosphere is **the** topic for focused cooperation between geology, geophysics and geotechnology (i.e. **the** focused interface between IUGS and IUGG);
- Breakthroughs in the study of the Lithosphere can only be achieved through integration of imaging and monitoring, reconstruction and process modelling.

For futher detailed information see: http://www.sclilp.org

NEW ACTIVITIES OF ILP (Task Forces) (2005-2009) AND REGIONAL COMMITTEES

"Earth Accretionary Systems (in space and time)" (ERAS)

(Task Force I), Chair: Peter Cawood; Co-Chair: Alfred Kröner

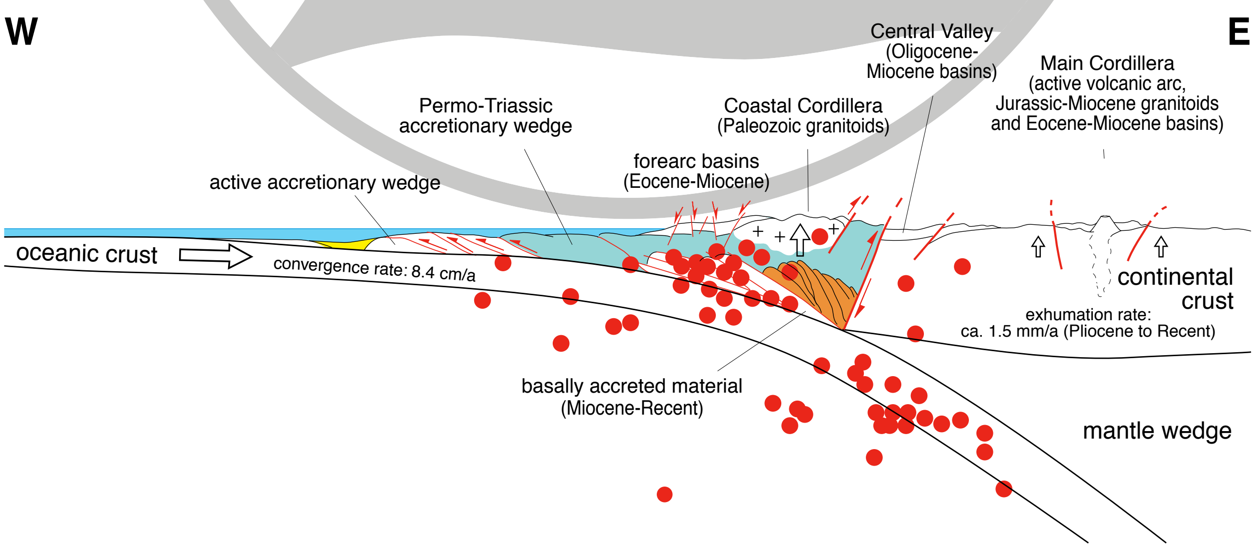
Scientifc rationale and objectives

Classic models of orogens involve a Wilson cycle of ocean opening and closing with orogenesis related to continent-continent collision. Such models fail to explain the geological history of a significant number of orogenic belts throughout the world in which deformation, metamorphism and crustal growth took place in an environment of ongoing plate convergence. These belts are termed accretionary orogens but have also been referred to as noncollisional or exterior orogens, Cordilleran-, Pacific-, Miyashiro-, and Turkic-type orogens.

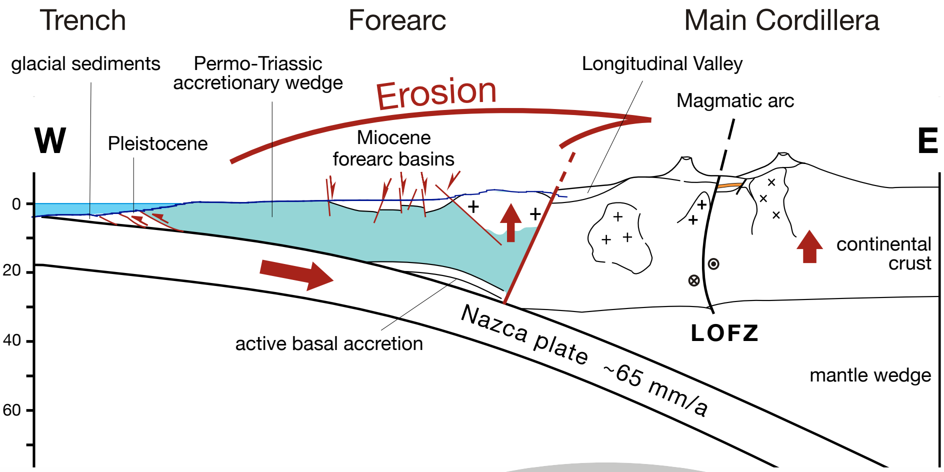
Accretionary orogens have been active throughout Earth history. They constitute major sites of continental growth and mineralization and include Archaean greenstone belts worldwide, Proterozoic orogens (e.g., the Birimian of West Africa, Svecofennian of Finland and Sweden, Cadomian of western Europe, Mazatzal-Yavapai in southwestern USA, and the Arabian-Nubian shield), Neoproterozoic-Palaeozoic orogens in Central Asia (Altaids), as well as Neoproterozoic to Recent orogens of the circum-Pacific and Caribbean. Accretionary orogens form at sites of subduction of oceanic lithosphere. They consist of accretionary wedges containing material accreted from the downgoing plate and eroded from the upper plate, island arcs, ophiolites, oceanic plateaus, old continental blocks, post-accretion granitic rocks and metamorphic products up to the granulite facies, exhumed high-pressure metamorphic rocks, and clastic sedimentary basins. Accretionary orogens contain the bulk of the mineral deposits formed throughout Earth history, and thus provide the mineralisation potential of many countries such as Australia, Canada, Zimbabwe, Saudi Arabia, Yemen, Nigeria, China, Kazakhstan and Mongolia.

Our understanding of the processes for the initiation and development of accretionary orogens is moderately well established in modern orogens such as Japan, Indonesia and Alaska, the broad structure and evolution of which are constrained by seismic profiles, tomography, field mapping, palaeontology and isotope geochemistry and geochronology. However, the processes responsible for the cratonization and incorporation of accretionary orogens into continental nuclei and the mechanisms of formation of pre-Mesozoic accretionary orogens are poorly understood. In a uniformitarian sense many of the features of, and processes of, formation of modern accretionary orogens have been little applied to pre-Mesozoic orogens. *Resolution and understanding of these processes form the central aim of this Task Force.*

This integrated, multi-disciplinary and comprehensive program in selected accretionary orogens will provide a common framework to better understand their development. The detailed work program of Task Force **ERAS** (**E**a**R**th **A**ccretionary **S**ystems in space and time) will be further developed and refined through meetings and international conferences. These will encourage interested scientists to join in developing plans to implement components of the program, to advance our understanding of accretionary systems in particular and continental evolution in general. The Task Force will bring together scientists from many disciplines of the Earth sciences.



Schematic geological profile across the Chilean continental margin at ca. 38° S (Southern Andes). Red dots denote the distribution of recent seismicity, as registered during the ISSA 2000 experiment (Echtler, H.: GFZ-Potsdam).



Schematic profile through the continental margin in South Central Chile. Arrows indicate direction of mass transport. LOFZ: Liquiñe-Ofqui fault zone (Echtler, H.: GFZ-Potsdam).

The common orogenic framework that this project will provide for accretionary belts is a major stimulus for the study of these highly significant orogenic systems. Recognition of the importance of accretionary orogens has been hindered by the lack of a unifying model, with different possible evolutionary paths, to explain their evolution, or recognition of a common suite of processes that operate in many accretionary orogens. Thus, this program has the potential to develop a new conceptual framework (paradigm) for accretionary orogens and to stimulate research in the coming decade not only on orogenesis but on topics ranging from basin analysis and mineralization to mantle flow and its controls on plate tectonics within such systems, just as the models for geosynclines, plate tectonics and mountain belts, terranes and supercontinents provided a stimulus to orogenic and geological research in past decades.

"*Tectonic causes of volcano failure and possible premonitory signals*" (*Volcano failure*)

(Task Force II), Chair: Alessandro Tibaldi; Co-Chair: Alfredo F.M. Lagmay, Vera Ponomareva, Theofilos Toulkeridis

Scientifc rationale and objectives

More than 500 million people live in hazardous zones adjacent to active volcanoes all over the world and volcano slope instability represents one of the most extreme hazards. Moreover, lateral edifice collapse has recently been recognised as a common event within the life cycle of all volcano types, spanning from small pyroclastic cones to giant stratovolcanoes. During the past 400 years more than 20,000 people have been killed by major volcanic avalanches or closely related events, lahars excluded. In addition, if we consider minor types of slope instability, such as enhanced slope erosion and debris flow development, the threat posed to human life and the socio-economic impact is even more significant. Finally, recent studies indicate that inactive volcanoes can also have unstable flanks leading to possible catastrophic failure, when the edifice lies above an active tectonic fault.

This project will contribute to understanding the fundamentals of edifice failure in active and extinct volcanoes with special emphasis on the assessment of possible patterns of precursor geological signals. For example, even one of the most monitored volcanoes in the world, Stromboli in Italy, showed enigmatic signals in the years-months before the 2003 crisis that generated unexpected landslides and, as a consequence, tsunamis. Instrumental monitoring is necessary but not enough if we are unable to correctly interpret the volcano's messages, or worse, if we are not able to locate the instruments in the most appropriate places, because forerunner signals extend over wider areas than those normally expected. Improved accuracy in predictions and interpretation of signals of volcano flank deformation will only come with a better physical and geological-structural understanding of the internal triggers responsible for initiating the failure process. It is extremely important to understand the relationships between processes such as surface erosion, channelled debris and mud flows and the general deformation of the cone, i.e., between exogenous and endogenous processes. We are starting to collect proofs that these processes can be fitted to a distinct model.

Most volcanologists and petrologists do not have the background in landslide studies to fully investigate volcano instability. Similarly, most engineering geologists and geomorphologists skilled in landslide analysis do not have a background in volcano geology. The field is essentially interdisciplinary, volcanoes are distributed over different geodynamic settings and co-operation is crucial if progress is to be made. Therefore, this is addressing to interested scientists all over the world.

High risk volcano Merapi, Java: glewing rock falls (Foto: BPPTK, Yogya).

"*Lithosphere-Asthenosphere Interactions*"

(Task Force III), Chair: Andrea Tommasi, Michael Kendall, Carlos J. Garrido

Scientifc rationale and objectives

This ILP project will focus on the interaction between the lithosphere, the outer shell on which we live, and the asthenosphere and/or deep mantle. The dynamic processes of the Earth's interior affect our day-to-day life in a profound way. Convection in the mantle shapes the Earth's surface through plate tectonics, giving rise to mountains ranges, oil-rich sedimentary basins and mineral-rich crust. It also controls catastrophic events such as earthquakes, landslides, tsunamis and volcanic eruptions. Yet, until recently, mantle convection and its surface expression – plate tectonics – have been studied as independent systems. In convection studies, plates were generally considered as rigid rafts dragged along by the convecting mantle. On the other hand, "lithospheric" studies focused on the motion and deformation of the plates, solely represented by slab pull, ridge push, or basal drag forces.

New developments, particularly in the fluid mechanics community, have strongly changed this scenario. Indeed, the last decade has seen a clear evolution of our understanding of how plate tectonics is produced by mantle convection. A new generation of convection models has been developed in which the cold upper boundary layer of mantle convection behaves as rigid, plate-like segment bounded by narrow weak domains. However, many problems remain to be solved. Plate generation in convection models requires "exotic" lithospheric rheologies, which are not observed in deformation experiments on mantle and crustal rocks. Although the subduction - the sinking of old, cold oceanic plates into the mantle - is the most evident record of mantle convection, many aspects of this process, in particular its asymmetry and initiation, are still not understood. Moreover, seismic anisotropy measurements suggest a decoupling between the subducting slab and the underlying trench-parallel mantle flow. Finally, the temporal evolution of the convecting system is poorly known. How do continental plates and, in particular, the ancient cratonic roots form? How do they interact with the convection? Which processes control their stabilization or erosion?
Answers to many of these questions depend on a better understanding of the physicochemical interactions between the lithosphere and the deep mantle. In addition to the new developments in fluid dynamics and convection models, significant advances on this subject have been made in recent years by both the geophysical and the geochemical communities that have challenged previously held ideas, provoked new controversies and even re-kindled some old ideas.

In geophysics, dense seismic networks are now giving unprecedented coverage and resolution in studies of the small-scale (order of 100 km) structure of the upper mantle. Seismic and large-period magnetotelluric surveys reveal large-scale seismic and electrical anisotropy patterns, which allow us to infer the flow patterns in the lithosphere and asthenosphere. New torsion devices for high-temperature, high-pression experimental deformation of mantle rocks allow the study of the effect of strain on the upper mantle rheology and the investigation of strain-softening mechanisms.

Likewise, recent geochemical and petrological studies of mantle xenoliths and ultramafics massifs highlight the role of magma-rock reactions in lithosphere-asthenosphere interaction processes. These studies show that reactive flow of melts into lithospheric peridotites may lead to profound changes in the composition and microsctructure of these peridotites, and hence modify the physical properties of the mantle. Geochemical data provides evidence for the longevity and stability of cratons since the Archaean (Kaapvaal and Siberia). In contrast some cratons, like the north China craton, have been completely eroded during the Phanerozoic due to thermo-tectonic processes.

"*Ultra-Deep Continental Crust Subduction*" *(UDCCS)*

(Task Force IV), Chair: Larissa Dobrzhinetskaya; Co-Chair: Patrick O´Brien, Yong-Fei Zheng

Scientifc rationale and objectives

Ultra-high-pressure metamorphic (UHPM) geology is a relatively new discipline in the Earth sciences that came into being after discoveries of coesite and microdiamond within rocks of continental affinities involved in collisional orogenic belts. It bridges the gap between upper-mantle and crustal processes and provides vital clues to understanding subduction and continental collision. The International Lithosphere Program has successfully united a wide international community focusing on studies of the mineralogy, geochemistry, petrology, geochronology and tectonics of UHPM rocks and terranes. This effort promoted research in the Central Chinese Orogenic Belts (CCOB) in preparation for the first Chinese Continental Scientific Drilling (CCSD) in the Sulu UHPM terrane. The intensive field-oriented and experimental studies have indicated that continental crust may be subducted to mantle depths but important questions still remain as to the mechanism by which these rocks are returned to Earth's surface from such depths. Petrotectonic fabrics, mineral zoning, and microstructural patterns of former UHP minerals recorded within UHPM rocks have allowed the study of fluid-slab-mantle interactions, and it is the further investigation of such features and processes that is crucial for understanding the formation of collisional mountain belts as well as the geochemical evolution of the mantle. UHPM terranes and UHP minerals and rocks present a "special natural laboratory," and, since their discovery, research on them has represented a new *frontier of science*.

Discoveries of olivine grains containing rods of ilmenite and plates of chromite or ilmenite-chromite intergrown patterns in garnet peridotites from the Alps and the CCOB, together with clinoenstatite lamellae containing anti-phase domains in diopside, have independently established a minimum depth of origin for these peridotites of > 250 km. Astonishing discoveries of pyroxene lamellae in naturally decompressed former majoritic garnet from peridotites of Norway and China, and coesite lamellae in titanite from the Kokchetav massif in Kazakhstan, have provided well-accepted evidence suggesting that continental rocks may be subducted to a depth of > 200 km and then returned back to Earth's surface, where they are incorporated into collisional orogenic belts. Intensive studies of micro-diamonds from the UHPM terranes of Kazakhstan and Germany have given a new perspective to studies of other sites featuring similar diamond formations in: Rhodopy, Greece; Indonesia; the Western Gneiss Region of Norway; the Qinlin territory of China and the Ural Mountains of Russia.

In addition, the discovery of the Qinlin diamonds established a bridge between the Dabie-Sulu and North Qaidam ultra-high-pressure terranes, which provided the first evidence for an UHP metamorphic belt, 4000-km long, formed during repeated continent-continent collision between the South and North China Plates in Paleozoic and Mesozoic times. Besides these recent discoveries, the most important advances have been: the development of experimental confirmation of the origin of diamond from COH-supercritical fluid in different laboratories in Japan, the U.S., and Russia; the experimental reproduction of diamonds with skeletal morphologies similar to the natural samples; and the understanding of the influence of XCO_2 activity on diamond formation in natural rocks. The application of the new focused ion beam technique (FIB) to diamond studies by transmission electron microscopy (TEM) established direct evidence of UHPM diamond origin from the fluid phase. Two stages of diamond crystallization have also been confirmed which has raised new questions related to the timing and sequence of fluid migrations through the lithologically diverse rock systems subjected to UHPM recrystallization. Despite the achievements mentioned, the diamond origin from COH fluid versus melt is still a matter of debate and requires further experimental constraints as well as exploration of nanometric solid/fluid inclusions inside of diamonds.

The presence, nature and volume of a melt fraction and how it could influence UHP metamorphic process are still largely unknown. However, such knowledge is crucial for understanding integral petrological and tectonic processes operating during subduction and exhumation. The tectonic return of deeply subducted continental crust to Earth's surface may be facilitated through buoyancy forces. In the case of UHPM rocks, the ubiquitous presence of a larger volume of rocks of continental affinity (which have also been shown to have experienced deep subduction) than the volume of more dense mafic and/or ultramafic rocks strongly suggests that the buoyancy of the continental material, once "unstuck" from the subducting slab, is sufficient to exhume it back to the surface. However, it is not known if the relative buoyancy of the crustal UHPM rocks persists at depths substantially greater than 150 km. It is believed that some components of the subducted continental crust, especially the more granitic upper crust, are returned promptly to shallow depths whereas less granitic lower crust becomes dense and sinks deeper into the upper mantle and even to the mantle transition zone. Therefore, it is conceivable that in the past the process of deep subduction of continental materials and their "recycling" into Earth's mantle might have operated on a globally significant scale.

Although in recent years many new UHP minerals have been synthesized in laboratories at P~ 6 to >20 GPa (e.g., wadeite, topaz-OH, phase egg, K- and Na-hollandite) in the KNASH, KASH and ASH chemical systems, none of these (except of topaz-OH) have been identified in natural rocks. There is thus still no clear indication whether a portion of subducted continental crust that has experienced these extreme pressures has managed to be returned to Earth's surface. One of the important questions is: what part of the continental crust will be molten and what part will continue merging into the mantle transition zone? New experimental programs need to be designed for the reproduction and evaluation of a volume of partial melt occurring in rocks of diverse crustal lithologies during deep subduction. Such data are strongly needed for numerical computer-assisted modeling of subduction and exhumation of continental slab and for predictions of what phases or products of their decompression may be found in natural UHPM rocks in the future.

Further exploration of the drill-core rocks obtained from the Chinese Continental Scientific Drilling Program will also cast light on the mentioned problems related to the understanding of the deep subduction of the continental lithosphere. The Directorate of the CCSD Program will release in 2005–2006 the drill core materials to the international community for further analytical studies and geophysical measurements. Principal Investigators of the CCSD program are active members of different projects supported by ILP.

Thus, the discipline, which was born as a UHPM chapter to crustal metamorphic petrology a decade ago, has grown now into a large multi-disciplinary subject that requires the involvement of new technologies, instrumentation, and the efforts of international scientists with different types of expertise and scientific approaches. Such a co-operation, and further scientific progress, will increase the application of state-of-the-art microanalytical techniques and technologies to geological materials. For example, a new mineral, kokchetavite, a new polymorph of KAlSi3O8, was recently discovered as tiny inclusions in clinopyroxene and garnet of Kokchetav garnet-pyroxene rock by TEM studies. International coordination of established scientists and the involvement of young researchers and students are also among the first priorities. To achieve these goals and promote further studies of UHPM terrains, this Task Force is related to the recently proposed ILP Theme: *Mantle dynamics (implication for lithosphere dynamics; fate of subducted lithosphere; deformation and evolution of the lithosphere).*

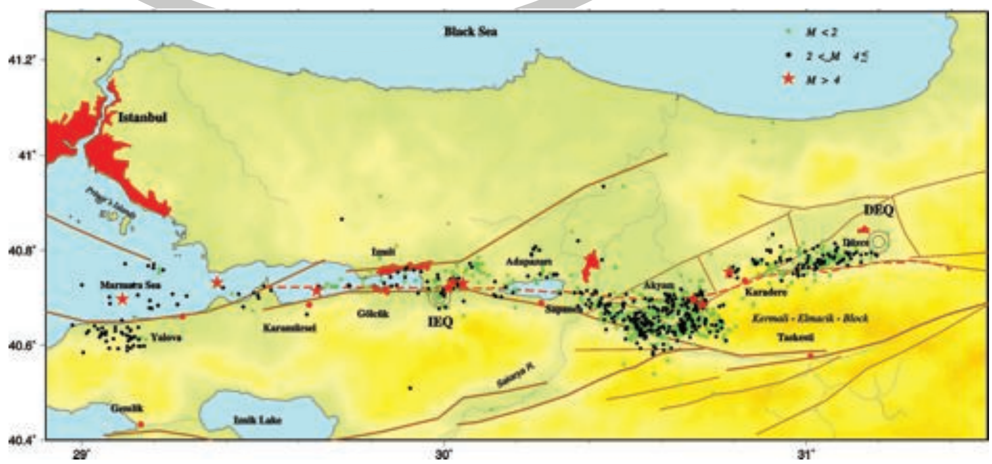
"*Global and regional parameters of paleoseismology; implications for fault scaling and future earthquake hazard*"

(Task Force V), Chair: Paolo Marco De Martini; Co-Chair: Eulalia Masana, Pilar Villamor, Kenji Satake, Suzanne Hecker, Carlos Costa, Shmulik Marco, Daniela Pantosti, Kelvin Berryman, Bob Yeats, Yoshihiro Kinugasa

Scientifc rationale and objectives

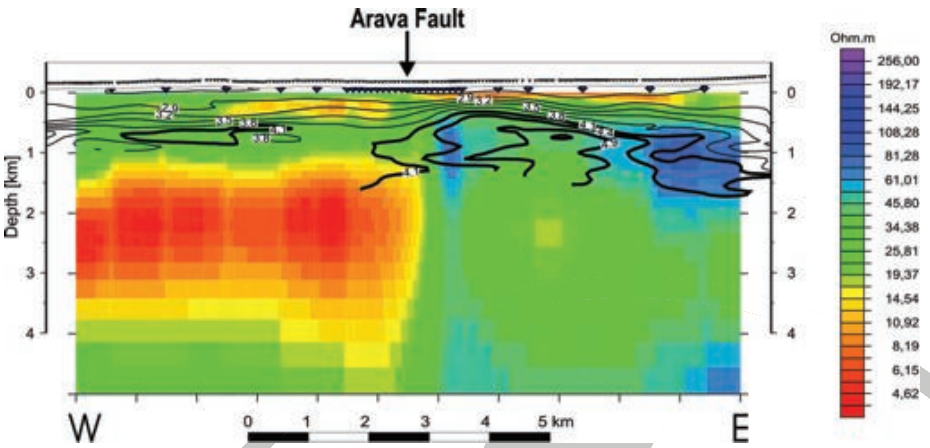
The main goals of the new Task Force will move in three principal directions:

- Support and promote the study of the main paleoseismological parameters at a global and regional scale in order to develop new ideas on fault scaling relationships and modern earthquake hazard estimates
- Maintenance of the worldwide database of independently-dated paleoearthquakes
- Develop paleoseismic research capability, especially in developing regions with high earthquake hazard



Epicentral distribution of about 2000 aftershocks of the Izmit earthquake 1999 calculated with the total net of 43 seismic stations
(Zschau, J.: GFZ-Potsdam).

The project now has about 50 members from several countries and new contacts have been established in 2005 during the January 17-24 (Awaji, Japan), Hokudan Symposium and the July 22-29 (Bulnay, Mongolia) Scientific field Conference on earthquake fault ruptures. Contacts and scientific exchanges are maintained through the electronic bulletin board at the new address: eq-geo-net@m.aist.go.jp (thanks to Yoshihiro Kinugasa) and the WEB page at http://www.ingv.it/paleo/ilp/



The colours display the model of the electrical resistivity as derived from magnetotelluric measurements superimposed on the isolines of seismic P-wave velocities. The Dead Sea transform DST (Arava Fault) separates low resistivity values west of the Arava fault from high resistivity values east of the Arava fault
(WEBER, M.: GFZ-Potsdam).

Initial goals are:
- Extend the network of members of the Task Force to include expertise in geodesy, seismology, and earthquake hazard
- Plan field-training courses in paleoseismology, recognizing regional variation in surface fault rupture characteristics
- Plan workshops and conference sessions
- Update and maintain the Recurrence DB
- Seek integration with the slip per event DB
- Maintain and update of the eqgeonet mailing list and the WEB page
- Define short-term and long-term goals for the Task Force
- Be complementary to, and collaborate with, the INQUA sub-commission on Paleoseismology

"*Sedimentary Basins*"
(Task Force VI), Chair: François Roure; Co-Chair: Magdalena Scheck-Wenderoth

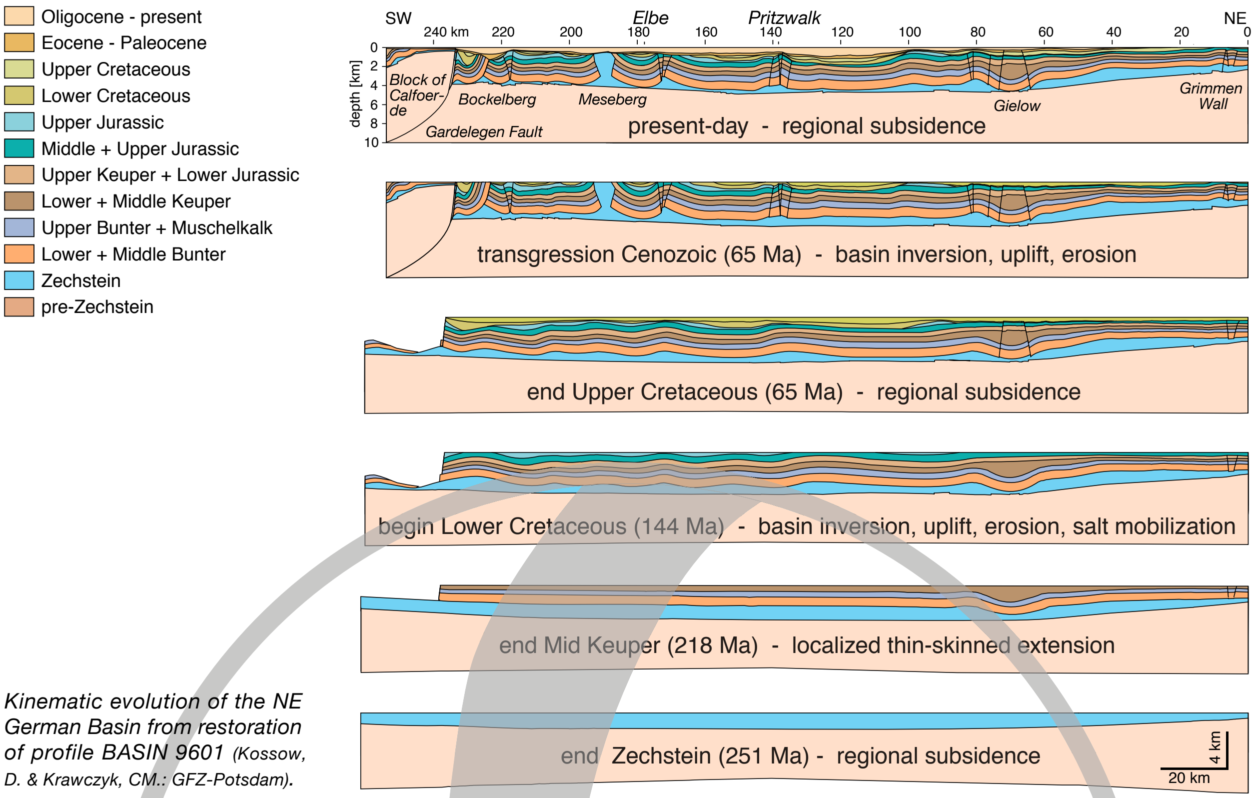
Scientifc rationale and objectives

The former Task Force III-2 on the "Origin of Sedimentary Basins" has considerably impacted the Earth Sciences community in the 90's, with an important series of yearly international workshops involving both Academic and Industry participants from various countries. Scientific contributions to these meetings resulted in high quality proceedings.
Longer term success of this task force relates also to the excellent network of European and extra-European scientists that was progressively established during these workshops, and which is still now interacting on such important topics as the origin and evolution of sedimentary basins.

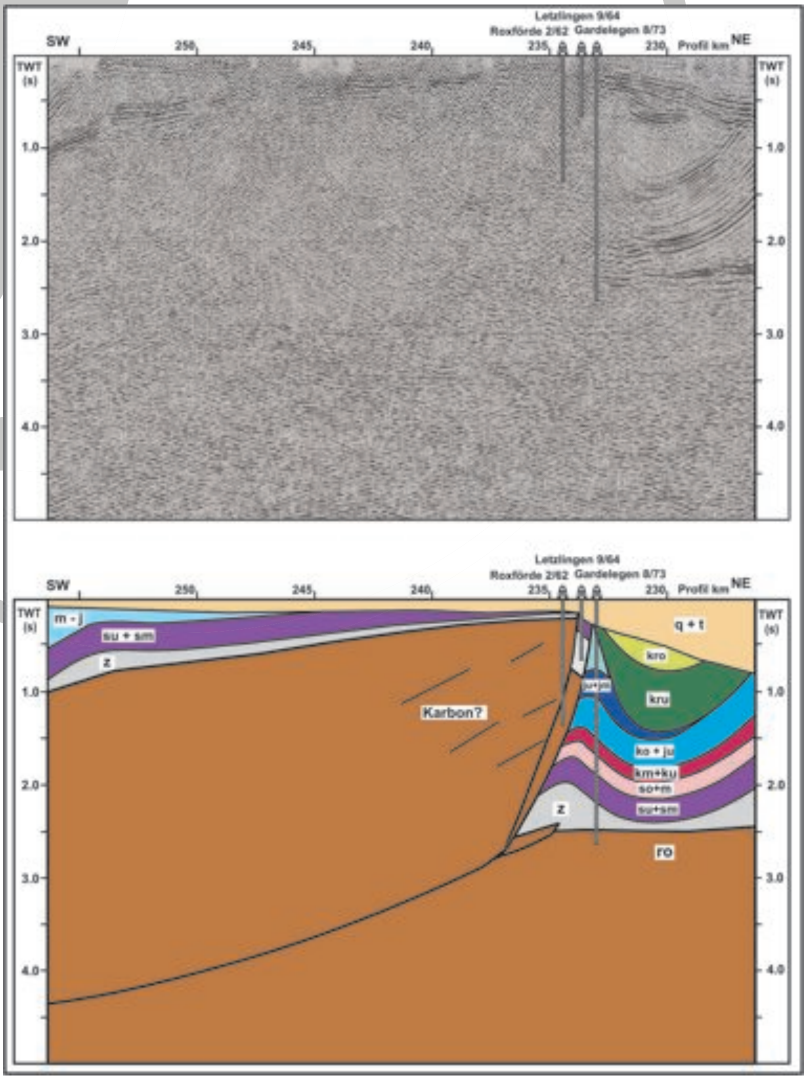
As the last workshop of Task Force III-2 was held in 1998 in Oliana in Spain, more than 6 years ago, it sounds timely to initiate a new Task Force on sedimentary basin, with rejuvenated scientific objectives, in order to involve again young scientists in this international network, and secure a new series of yearly workshops/field seminars.
In addition to topics already addressed by Task Force III-2, this new team will also work on the interactions between deep earth and surface processes, i.e., thermicity, fluid circulations and transfers, fluid-rock interactions, interactions between tectonics, erosion, sedimentation and climate.

Plans for the next five years include yearly workshops/field seminars hosting about 100 participants. Apart of the first meeting held in December 2005 in Rueil-Malmaison, other workshops will be linked with field trips in the Albanides, Southeastern France (Provence), or elsewhere in Europe, but also in North Africa, Alberta (Rockies and Canada Basin), Québec (Gaspé Appalachians) and Mexico (i.e., Cordoba Platform/Veracruz Basin).

Thrust belts and foreland basins record both the main phases of orogenic evolution and the coupled influence of deep (flexure, plate rheology and kinematics) and surficial (erosion, sedimentation) geological processes, at different time scales. They constitute important targets for scientists interested in both fundamental and applied (fluids, hydrocarbons) aspects. The workshop on Foreland Fold-and-Thrust Belts (FFTB) held in December, 2005, jointly sponsored by the Société Géologique de France and the Sociedad Geologica de España has offered the opportunity for geologists from various domains of our community to discuss and understand new data sets on high resolution seismicity, high-frequency sequential stratigraphy, geochemistry and provenance studies, geodesy and vertical motions. These modern aspects will be combined with (more) classical field studies and analogue/numerical modelling in order to provide a timely comprehensive overview of processes governing the evolution of orogenic belts and adjacent forelands.



Kinematic evolution of the NE German Basin from restoration of profile BASIN 9601 (Kossow, D. & Krawczyk, CM.: GFZ-Potsdam).



Migrated seismic section (upper) and interpretation (lower) of the Gardelegen fault at the southern margin of the Northeast German Basin
(Kossow, D. & Krawczyk, CM.: GFZ-Potsdam).

"*Temporal and Spatial Change of Stress and Strain*"

(Task Force VII), Chair: Oliver Heidbach

Scientifc rationale and objectives

Stress and strain are fundamental quantities which control and describe the geodynamic processes shaping the Earth. However, their relationship on different temporal and spatial scales in the Earth's crust is still under debate. Our collaborative project aims to identify, analyse and interpret the variations of crustal stress and strain patterns at diverse tectonic settings characterized by return periods for strong earthquakes in the order of 50-1000 years.
Relevant data have been collected in the data bases of the World Stress Map (WSM) and the Global Strain Rate Map (GSRM). The WSM provides the orientation of the contemporary tectonic stress (S_H, maximum horizontal compression) in the Earth's crust. S_H is deduced from diverse observations like borehole breakouts, geological fault-slip data, focal mechanism solutions, hydraulic fracturing and others. The GSRM provides information on the effective strain rate, mainly based on data from geodetic observations and, to a lesser extent, on focal mechanism solutions and geological data. Due to the different data types used in these two projects, these compilations deal with different time ranges:

• Strain rates deduced from satellite geodetic data are mainly based on observations from the last decade. The signal includes strain accumulation (storage of elastic energy), permanent plastic strain, and transient processes (earthquakes, viscous relaxation, silent slip, etc.).

• Strain rates derived from seismological data represent the seismic cycle or portions of it. The release of elastic energy radiated by seismic waves is followed by deformation through viscous relaxation, after-slip and poroelastic rebound. The static and transient stress changes from strong earthquakes are less than 10 MPa in the near field and in the order of 0.1 MPa in the far field.

• Strain rates obtained from geological data reflect average strain rates (seismic and aseismic) over a time span encompassing several seismic cycles. They usually reflect permanent plastic deformation.

• Stress orientations are generally controlled by the tectonic forces acting at plate boundaries being active on time scales in the order of million years.
The (heterogeneous) variations of these data in space and time raise fundamental questions about their interrelation. With the increasing number of data which became available during the last years, we now have the opportunity to make relevant contributions to solve these questions by addressing the following challenging issues:
- What is the link between observed strain rates and stresses?
- Quantification of strain rate and stress changes within the seismic cycle at different spatial and temporal scales.
- Quantification of 2nd order sources of tectonic stresses (local gravitational effects, viscous relaxation, silent slip, etc.) and comparison with 1st order effects (plate boundary forces).
- What can we learn from a comparison of strain rates from geodetic, seismological and geological data?
- What influence has strain partitioning on the regional stress field?

"*Baby-plumes in Central Europe*"

(Task Force VIII), Chair: Uli Achauer

Scientifc rationale and objectives

Baby-plumes – origin, characteristics, lithosphere-asthenosphere interaction and surface expression

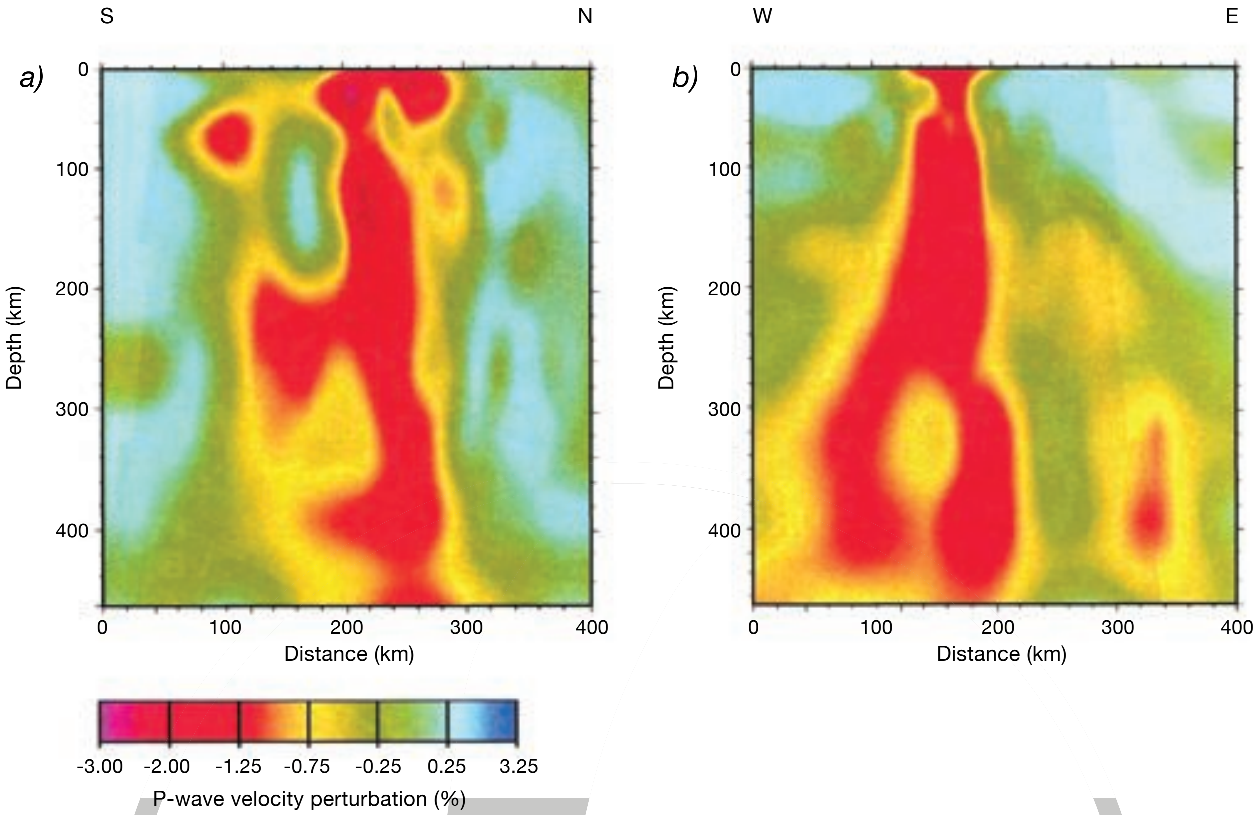
Over the last couple of years a number of high-resolution integrated seismic projects across the areas with Tertiary to recent volcanism in central Europe have been stimulated by the project TRACK (tracking a mantle plume by seismological means) and the ILP project II/6 in collaboration with detailed geochemical studies. These have proven the existence of a number of small-scale, almost cylindrical, upwellings of low-velocity zones of hot material (with 100-150 km in diameter), the so-called "baby-plumes". These "baby-plumes" have some very similar characteristics as the classical plumes (as proposed by Schilling and others), but two distinct differences:

• They are much smaller in size as classical plumes
• They don't seem to "have" a plume head

These baby-plumes suggest that there might exist a number of different classes of plumes (but all called, plumes), originating from different depths (i.e. different interfaces) within our planet. So far these baby plumes have only been postulated for the European continent, but of course similar regimes might exist on other continents. The following features seem to be related to these baby-plumes:

• Small-scale convective instabilities within the upper mantle beneath Europe appear to originate in the mantle transition zone (410-660km depth)
• There is a strong correlation between the location of "upwellings" and lithospheric architecture suggesting some form of top-down control
• Upwellings appear to be concentrated around the edge of a region of subducted slabs at the base of the upper mantle
• Basaltic magmas derived by decompression partial melting of the upwelling mantle "diapirs" have the distinctive geochemical signature of a common mantle source component – the European Asthenospheric Reservoir (EAR)
• The EAR may be the product of outflow from a lower mantle plume

The project will focus on interdisciplinary studies of baby-plumes to further steer the debate on the origin and nature of plumes in general and their geodynamic implications.



Tomographic section below the Eifel-Ardennes (from Ritter et al., 2001). Vertical cross sections through the tomographic model display perturbations of the P-wave velocity relative to the IASP91 model. (a) S-N cross section and (b) W-E cross section. The reddish areas in the mantle are characterized by relatively low seismic velocity, which most likely indicate increased temperature and the presence of an upper mantle plume.

TOPO-EUROPE: 4D Topography Evolution in Europe: Uplift, Subsidence and Sea Level Rise

CC-1/3: (Regional committee EUROPE), Chair: Sierd Cloetingh

Scientifc rationale and objectives

Continental topography is at the interface of processes taking place at depth in the Earth, at the Earth's surface, and in the atmosphere above it. During the last 20 Myr plate-tectonic and other geodynamic processes in the Earth's interior have caused many changes in the Earth's surface topography. The lithosphere responds to forces exerted by these processes, creating mountain belts (e.g. the Alps), elongated rift zones (e.g. the Rhine rift system) and large sedimentary basins (e.g. the North Sea, Paris and Pannonian Basins). Improved knowledge of the Earth's mantle and its coupling to the lithosphere and its surface is key to understanding the enormous forces that generate these features. The impact of Solid-Earth processes on surface topography at plate boundaries has been known for several decades, but their influence in intraplate areas, in particular coastal regions, is only just being appreciated. Furthermore, we now recognise that there are critical feedback mechanisms between Solid-Earth processes and topography.

The present state and behaviour of the shallow Earth system is a consequence of processes operating over a wide range of time and spatial scales. Time-varying phenomena include long-term tectonic effects on subsidence, uplift and river systems, residual effects of the ice ages on crustal movements, natural climatic and environmental changes over the last millennia and up to the present, and the powerful anthropogenic impacts of the last century. Relevant spatial phenomena include huge convection cells in the mantle, mantle plumes, major variations in the structure of deep Solid-Earth interfaces (e.g. crust-mantle and lithosphere-asthenosphere boundaries), ocean currents, major rivers, and streams.

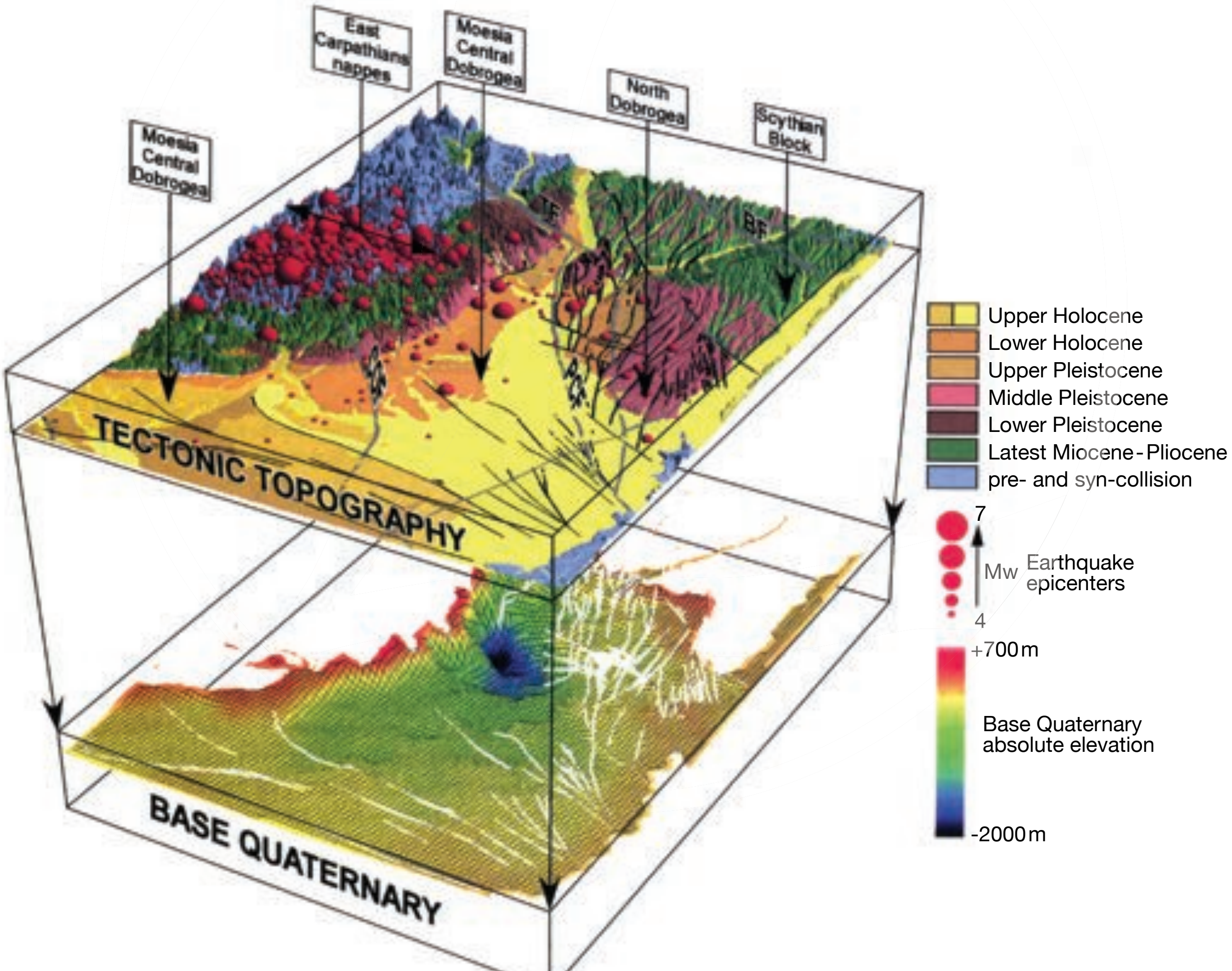
Societal relevance

Topography influences society, not only as a result of slow landscape changes but also in terms of how it impacts on geohazards and environment. When sea-, lake- or ground-water levels rise, or land subsides, the risk of flooding increases, directly affecting the sustainability of local ecosystems and human habitats. On the other hand, declining water levels and uplifting land may lead to higher risks of erosion and desertification. Catastrophic landslides and rock falls in Europe have caused heavy damage and numerous fatalities in the recent past. Rapid population growth in mountainous regions and global warming and associated increases in the number of exceptional weather events, are likely to exacerbate the risk of devastating rock failures. Along active deformation zones, earthquakes and volcanic eruptions cause short-term and localized topography changes. Although natural processes and human activities cause geohazards and environmental changes, the relative contributions of the respective components are still poorly understood. That topography influences climate is known since the beginning of civilization, but it is only recently that we are able to model its effects in regions where good topographic and (paleo)climatologic data are available.

Paleo-topography

Paleo-topgraphy poses some complex problems. Apart from the technical problem of dealing with topography that no longer exists, the size and timing of events and the evolution of the topographic life cycle proves to be a challenge to all scientists. This complexity means that no single sub-discipline is able to solve all the problems involved and therefore must look for assistance by other disciplines. The geographic scope of TOPO-EUROPE demands co-operation on a European scale to avoid a fragmented approach. Mountain ranges (increasing surface topography) and adjacent sedimentary basins (decreasing surface topography) record signals and proxies that tell the story of the topographic life cycle. The source to sink relationship is key to this issue. However, the signals and proxies are poorly known and we only have started to decipher the few we are aware of. A major challenge is to extract all available information contained in the system and to interpret it in terms of processes.

Innovative analytical techniques, improvements of methodology back-to-back with innovative conceptual and quantitative modelling are required to resolve this issue. If we are to understand the present state of the Earth system, to predict its future and to engineer our use of it, the spectrum of processes, operating concurrently but on different time and spatial scales, needs to be understood. The challenge is to describe the state of the system, monitor its changes, forecast its evolution and, in collaboration with others, evaluate modes of its sustainable use by society.



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3D geometry of Quaternary deposits and post-orogenic relationship with topography development in the foreland of the SE Carpathians. Note the unusual high elevation of Pleistocene sediments on the flanks (< 1 km) and the thick Quaternary package in the center of the Focsani Basin (> 2 km). The tectonic topography is developed in a late stage (> 10 Myr) of the post-orogenic evolution of the foredeep. Note also the coincidence of crustal earthquakes epicenters with the location of the active normal faults system on the eastern Focsani flank. TF, Trotus Fault; BF, Bistrita Fault; COF, Capidava-Ovidin Fault; PCF, Peceneaga-Camena Fault.

ICDP - A flagship of ILP

Continental Drilling

CC-4: (Coordinating commitee) Chair: Marc Zoback and Rolf Emmermann; see: http://icdp.gfz-potsdam.de

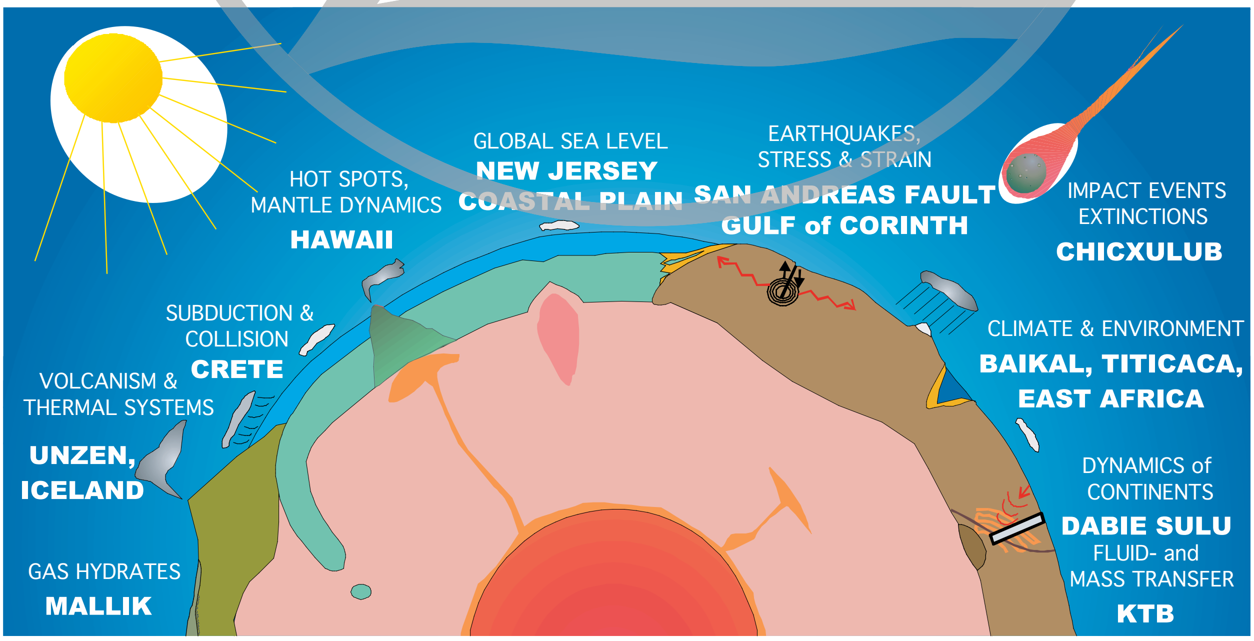
The International Continental Scientific Drilling Program, ICDP, coordinates continental scientific drilling efforts with research topics of high international priority. ICDP drilling projects are conducted at locations of global geoscientific significance where drilling provides unprecedented insight into active geodynamic processes of essential geoscientific and socio-economic relevance. The main objectives addressed in the program include geodynamics and natural hazards, volcanic systems and thermal regimes, Earth's history and climate, impact structures and mass extinctions as well as deep biosphere and gas hydrates.

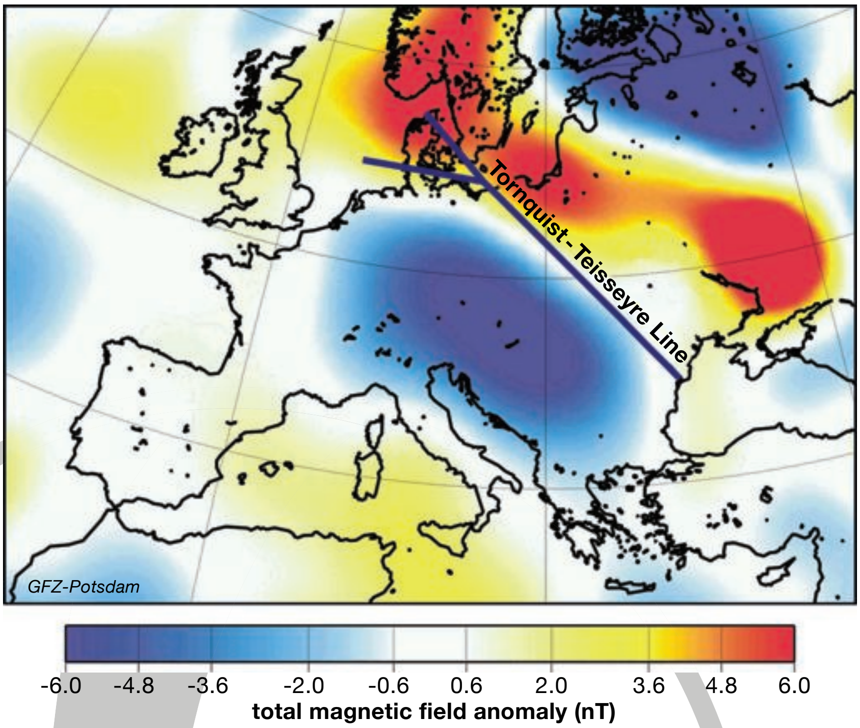
More than a dozen drilling projects have been executed to date. Activities related to fault systems include the Gulf of Corinth Multi-Borehole Observatory, the Chelungpu Fault Drilling Project (Taiwan) and the San Andreas Fault Zone Observatory at Depth (SAFOD). In the SAFOD project a 2.2 km pilot well was drilled in 2002 and was equipped with a geophysical observation string. Drilling of the main drillhole was executed in 2004 and 2005. The well is vertical for about 1 km and is then deviated towards the San Andreas Fault, which is truncated in 3.3 km for long-term in-situ observations of physical and chemical parameters of an active fault. A similar endeavor is currently underway in northern Taiwan in the compressional Chelungpu Fault Zone at a depth of 1 to 2 km to study the physico-chemical conditions in a recently ruptured large fault.

Scientific drilling projects in the Long Valley Caldera, on Hawaii and on the Unzen Volcano deal with volcanic activity and hydrothermal regimes. The Unzen drilling program in southern Japan was drilled as a deviated well to a depth of 800 m in 2003. The still hot magma conduit that fed violent volcanic eruptions has been cored in order to better understand degassing and eruption mechanisms.

Continental dynamics and orogenesis are studied in the Ultra-High Pressure Metamorphic Sulu Belt in Eastern China where a 3.5 km deep well is currently being deepened to a depth of 5.5 km. A number of ICDP projects investigate impact events such as the Chicxulub Crater in Mexico and smaller impact bodies such as Lake Bosumtwi in Ghana. The sedimentary inventory of large lakes such as Baikal, Titicaca, Malawi, or Bosumtwi is sampled for paleoclimate and neotectonic reconstructions in Quaternary and Neogene times. The two African lakes Bosumtwi and Malawi are both excellent archives of past climates which have recently been sampled very successfully. The ICDP also co-funded the Mallik 2002 Gas Hydrate Research Well Program, where a most comprehensive set of scientific data was obtained on gas hydrates recovered from permafrost regions. This project was the first one with a considerable microbiology component, an area which will be tackled more intensely in ICDP in the forthcoming years.

The scientific basis for coordinated international continental scientific drilling was laid out at a conference in Potsdam in 1993. Three years later, in 1996 the first member countries, Germany, the United States and China signed a Memorandum of Understanding which gave way for first ICDP funded operations in 1998. The ICDP currently comprises 11 member countries and 2 affiliated members. The membership fees are invested in the approved ICDP projects. ICDP co-funds drilling operations and provides technical assistance through its Operational Support Group (OSG) while research grants are mainly contributed through national agencies. Drilling operations are mainly performed through commercial drill rigs of opportunity that are contracted according to the needs of an individual project and supervised by the principal investigators. To date, the ICDP has co-financed 15 drilling projects, funded 26 international workshops, and has established an equipment pool comprising e.g. the global lake drilling facility GLAD800, a 5.5 km long wireline drillstring including a power swivel, a full set of downhole measurement tools as well as scientific instruments for a mobile field lab. The concept of commingled funding and international cost sharing, in addition to the joint international character of the science teams and sharing of technological capabilities and know-how, has contributed to the success of the ICDP.





GLAD 800 (ICDP).

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KTB (Kontinentale Tiefbohrung, Continental Deep Drilling, Depth: 9101 m)
The drilling rig at Windisch-Eschenbach (Bavaria, Germany) (Foto: KTB-Archive).