International Lithosphere Program – ILP

35 Years of ILP

“Celebrating Excellence in Solid Earth Sciences”

ILP’s Third Potsdam Conference
21-23 September 2015

GFZ German Research Centre for Geosciences

Programme & Abstracts

Edited by
Alexander Rudloff & Magdalena Scheck-Wenderoth

8 December 2015

Table of Content

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Introduction

In July 2007 GFZ hosted ILP's first Potsdam Conference, titled "Frontiers in Integrated Solid Earth Sciences". The results of this meeting were presented in an over 400 pages large Springer book, the first volume of a new series on the International Year of Planet Earth (IYPE).

In October 2010 ILP's Second Potsdam Conference took place, entitled "Solid Earth – Basic Science for the Human Habitat", again in Potsdam. More than 70 scientists from more than 20 states worldwide came together and shared their results, ideas and visions.

This time, in September 2015, ILP's 35th birthday was the motivation for "Celebrating Excellence in Solid Earth Sciences". Together with more than 50 scientists, members of the ILP Task Forces and Coordinating Committees, the ILP bureau and ILP's office came together for three days in September.

Group picture

Acknowledgements

The organizers highly appreciate the motivated support by Ingo Dressel and Peter Klitzke during the conference. Furthermore, without Christine Gerschke's and Alexandra Wille's dedicated work before, during and after the conference it would not has been possible to host such an event. Thanks to both of them also for the photo documentation of our meeting.

Financial and logistical support by the GFZ is acknowledged.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Programme

Monday, 21st September 2015

10:00 a.m. Registration (GFZ, Building H)

11:00 a.m. Opening Session and Welcome, Chair: A. Rudloff
Hüttl, R.F. (GFZ), Welcome address
Cloetingh, S. (UU), Scheck-Wenderoth, M. (GFZ), ILP Rationale

11:15 a.m. Keynote Lectures, Chair: S. Cloetingh
(20 Minutes Presentation + 5 Minutes Discussion)
Thybo, H. (EGU): *"ILP, EGU and the lithosphere"*
Gupta, H. (IUGG): *"IUGG and ILP"*
Oberhänsli, R. (IUGS): *"IUGS and ILP"*

(Group Picture)

12:30 a.m. Session: „ILP Highlights, Part I", Chair: S. Cloetingh
(15 Minutes Presentation + 5 Minutes Discussion)
Pease, V. (U Stockholm/SE), Coakley, B., Curtis, M., Faliede, J., Jokat, W., Meisling, K., Miller, E. & Stephenson, R. (Task Force I): *"Circum-Arctic lithospheric transects from onshore to offshore"*
Tibaldi, A. (U Milan Bic/IT) et al., Task Force II: *"Volcanoes and society: environment, health and hazard"*

01:10 p.m. Lunch Break

02:10 p.m. Session: „ILP Highlights, Part II", Chair: M. Scheck-Wenderoth
(15 Minutes Presentation + 5 Minutes Discussion)
Bohnhoff, M. (GFZ/DE) et al., Task Force III: *"Bridging the gap from micro seismicity to large earthquakes"*
Dobrzhinetskaya, L. (U Riverside/US, Task Force IV): *"Tracking Traces of the Subducted Continental Lithosphere in Deep Earth"*
Achauer, U. (U Strasbourg/FR) et al., Task Force V: *"The lithosphere-asthenosphere boundary depth paradox (LAB)"*
Matenco, L. (U Utrecht/NL), Nader, F. (IFP/FR) Task Force VI: *"Sedimentary basins"*
Heidbach, O. (GFZ/DE), Rajabi, M., Ziegler, M., Reiter, K. & the WSM Team (Task Force VII): *"The World Stress Map Project – an ILP Success Story"*
Burov, E. (UPMC/FR) et al., Task Force VIII: *"Lithosphere dynamics: interplays between models and data"*

04:10 p.m. Coffee Break and Poster Session

04:30 p.m. Session: „ILP Highlights, Part III", Chair: A. Rudloff
(15 Minutes Presentation + 5 Minutes Discussion)
Agard, Ph. (UPMC/FR) et al., Task Force IX: *"DISC – Deep Into the Subduction Channel"*
Hübner, A., Horsfield, B. (GFZ/DE) et al., Task Force X: *"The Unconventionals"*
Cloetingh, S. (U Utrecht/NL) et al., CC TOPO-Europe: *"TOPO-EUROPE - 4D Topography Evolution in Europe: Uplift, Subsidence and Sea Level Rise"*
Garrido, C. (U Granada/ES) et al., CC MEDYNA: *"MEDYNA - Mantle Dynamics and Plate Architecture Beneath North Africa"*

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Programme (to be continued)

05:50 p.m. Session: „ILP Guest-Speakers", Chair: A. Rudloff
(13 Minutes Presentation + 2 Minutes Discussion)

Gupta H.: *"Investigation of Artificial Water Reservoir Triggered Earthquake at Koyna, India"*

~~Jones A. et al: "Petrologically-consistent thermo-chemical modelling of the lithosphere"~~

Artemieva I.M., Vinnik L.P.: *"Density structure of the cratonic mantle in southern Africa: correlations with seismic velocities, xenolith data, and dynamic topography"*

06:35 p.m. Time for Transfer to Hotels

07:30 p.m. ILP Dinner ("Restaurant Schmiede 9", Neuer Markt, Potsdam)

Tuesday, 22nd September 2015

09:00 a.m. Keynote Lectures on ILP Themes, Part I, Chair: H. Thybo
(25 Minutes Presentation + 5 Minutes Discussion)

Haq, B. (NSF/US): *"Geoscience of Global Change"*

Cloetingh, S. (U Utrecht/NL): *"Contemporary Dynamics and Deep Processes"*

Oncken, O. (GFZ/DE): *"Continental Lithosphere"*

10:30 a.m. Coffee Break and Poster Session

11:00 a.m. Keynote Lectures on ILP Themes, Part II, Chair: H. Gupta
(25 Minutes Presentation + 5 Minutes Discussion)

Devey, C. (GEOMAR/DE): *"The Oceanic Lithosphere: ILP orphan or future star?"*

Gudmundsson, A. (U London/UK*): "Energies driving facture propagation and eruptions in volcanoes"*

12:00 a.m. Lunch Break

01:00 p.m. Session "New Task Force Proposals, Part I", Chair: M. Scheck-Wend.
(10 Minutes Presentation + 5 Minutes Discussion)

Agard, Ph. (UPMC/FR) et al.: *"DISC – Deep Into the Subduction Channel"*

Burov, E. (UPMC/FR) et al.: *"Lithosphere dynamics: interplays between models and data"*

Cloetingh, S. (U Utrecht/NL) et al.: *"TOPO-EUROPE - 4D Topography Evolution in Europe"*

Dobrzhinetskaya, L. (U Riverside/US), Zhang, J.: *"Fate of the Subducted Continental Lithosphere: Insight Through Analytical Mineralogy and Microstructures"*

Garrido, C. (U Granada/ES) et al.: *"Maghreb-EU integrated research on Geodynamics, Geohazards, and applied Geology in North West Africa"*

Martí, J. (ICTJA/ES), Tibaldi, A. (U Milan Bic/IT) et al.: *"Structural and Rheological Constraints on Magma Migration, Accumulation and Eruption Through the Lithosphere"*

02:30 p.m. Coffee Break and Poster Session

03:00 p.m. Session "New Task Force Proposals, Part II", Chair: S. Cloetingh
(10 Minutes Presentation + 5 Minutes Discussion)

Matenco, L. (U Utrecht/NL), Nader, F. (IFP/FR) et al.: *"Sedimentary basins as archives of lithosphere history"*

Plomerova, J. (Academy of Sciences/CZ) et al.: *"The Unknown Lithosphere - structure, boundaries (MLD, LAB) and dynamics (UNLIT)"*

Poutanen, M. (FGI/FI), Rogoshina, I. (GFZ/DE) et al.: *"DynaM-Ice – Dynamics and Interaction of Mantle, Lithosphere and Ice Masses"*

Plenary Discussion, Final Remarks Closing (Approx. 17:00 p.m.)

Programme (to be continued)

ILP Poster Session (Monday & Tuesday)

Arora, K. & Dhar, U.: *"Evidences of active faulting in Koyna-Warna seismic zone, India from Airborne LiDAR data"*

Beccalli, A., Tibaldi, A., Bonali, F.L., De Angelis, A., Rust, D. & Withworth, M.: *"Holocene deformation field at the junction between the Husavik-Flatey transform fault and the northern Iceland Volcanic Rift"*

De Angelis, A., Tibaldi, A., Beccalli, A., Bonali, F.L. & Cavallo, A.: *"Structure and petro-chemistry of an exceptionally-exposed cone sheet system: the Thverfell case, Esja Peninsula, Iceland"*

Oppizzi, P., Bellini, M. & Alfredo, L.: *„Landslides in residual volcanic soils of the Colombian Cordillera Occidental"*

Pierdominici, S. & Mariucci, M.T.: *„Present-day stress and other geophysical parameters from deep well data"*

Pierdominici, S., Montone, P., Schmitt, D.R., Paulsen, T.S., Wilson, T.J., Jarrard, R.D., Wonik, T. & Handwerger, D.: *"Present-day stress field in Ross Sea (Antarctica) contribution of AND-2A Well (Antarctica)"*

Scribano, V., Manuella, F.C., Carbone S. & Brancato A.: *"Abiogenic hydrocarbons in the Tethyan serpentinite basement of southeastern Sicily (Italy): a xenolith perspective"*

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Programme (to be continued)

Wednesday, 23rd September 2015

09:00 a.m. ILP Bureau Meeting (By invitation only; Room F309)

09:00 a.m. ILP Task Force II "Volcanoes and Society" (Building H, Room VR1-2)
Chairperson: Alessandro Tibaldi

09:00–09:25 Christoph Breitkreuz: *"Subvolcanic complexes in sedimentary basins - Processes, geometries, exogenous and applied aspects"*
09:25–09:50 Olivier Galland, Eoghan P. Holohan, Benjamin van Wyk de Vries, and Steffi Burchardt: *"Laboratory Modelling of Volcano Plumbing Systems: a review"*
09:50–10:05 Valerio Acocella and Daniele Trippanera: *"Shorter- vs. longer-term tectono-magmatic evolution of slow spreading divergent plate boundaries: overview and model"*
10:05–10:20 Nomikou Paraskevi, and Papanikolaou Dimitris: *"Exploring Submarine Volcanoes along the Aegean Volcanic Arc"*
10:20–10:35 Fabio Luca Bonali and Alessandro Tibaldi: *"Sensitivity analysis of earthquake-induced static stress changes on volcano magma pathways: the 2010 Mw 8.8 Chile case"*

10:35–10:55 Coffee Break

Chairperson: Benjamin van Wyk de Vries

10:55–11:20 Thomas R. Walter: *"Volcano interactions: An overview on observations, statistical relevance, and models"*
11:20–11:45 Akira Takada: *"How can dykes contribute volcano growth and eruption under the stress field?"*
11:45–12:00 Andrés Folguera, Guido Gianni, Jonathan Tobal, Lucía Sagripanti, Bruno Colavitto, Darío Orts, and Emilio Rojas Vera: *"Contrasting tectonic controls in the last 6 Ma of retroarc volcanism in the transition zone from the Central to the Patagonian Andes (36-42°S)"*
12:00–12:15 E.P. Holohan, M.P.J. Schöpfer, H. Sudhaus, T.R. Walter, and J.J. Walsh: *"Advances in volcano-tectonics from Distinct Element Method numerical modelling"*
12:15–12:30 Ayleen Gaete, Mehdi Nikkhoo, and Thomas R. Walter: *"Volcanism triggered by earthquake in Chile: model of magma propagation in the crust and ground deformation"*

12:30–14:00 Lunch Break

Chairperson: Agust Gudmundsson

14:00–14:25 Joël Ruch, Teng Wang, Wenbin Xu, Martin Hensch, Sigurjón Jónsson: *„Rift opening mechanisms revealed by episodic magma intrusion"*
14:25–14:40 Benjamin van Wyk de Vries: *"Craters of Elevation rise up again: classic geological ideas given new meaning though Geoheritage"*
14:40–14:55 Derek Rust, Malcolm Whitworth, Alessandro Tibaldi, Fabio Luca Bonali and F. Pasquarè Mariotto: *"Active structural interactions at a rift-transform triple junction, NE Iceland"*
14:55–15:10 Federico Pasquaré Mariotto: *"Communicating risk in a highly complex environment: the Vesuvius Volcano - Phlegrean Fields area, southern Italy"*
15:10–15:25 Paola Del Carlo: *"Tephra study as a tool for stratigraphic correlations and dating: examples from Etna volcano (Italy) and the Ross Sea (Antarctica)"*
15:25–15:40 Gulam Babayev, Alessandro Tibaldi, Fabio Luca Bonali, and Frakkadin Kadirov: *"Evaluation of earthquake-induced strain in promoting mud eruptions: the case of Shamakhi–Gobustan–Absheron areas, Azerbaijan"*

Approx. 16:00 End of Meeting

DOI: http://doi.org/10.2312/GFZ.ILP.2015

List of participants (in alphabetical order)

Achauer, Ulrich; EOST-IPGS, Université de Strasbourg - ulrich.achauer@unistra.fr
Agard, Philippe; Institut des Sciences de la Terre de Paris (ISTeP), Université Pierre et Marie Curie - philippe.agard@upmc.fr
Allahbakhshi, Masoud; GFZ - bakhshi@gfz-potsdam.de
Artemieva, Irina M.; IGN, University of Copenhagen - irina@ign.ku.dk
Babayev, Gulam R.; Geology and Geophysics Institute, Azerbaijan National Academy of Sciences - babayev74@gmail.com
Babuska, Vladislav; Institute of Geophysics, Czech Academy of Sciences - v.babuska@ig.cas.cz
Beccalli, Andrea; Department of Earth and Environmental Sciences, University of Milan Bicocca - andreabeck@alice.it
Bohnhoff, Marco; GFZ - bohnhoff@gfz-potsdam.de
Bonali, Fabio Luca; Department of Earth and Environmental Sciences, University of Milan Bicocca - fabioluca.bonali@gmail.com
Breitkreuz, Christoph; Geology Department, TU Bergakademie Freiberg - christoph.breitkreuz@geo.tu-freiberg.de
Burov, Evgueni; Institut des Sciences de la Terre de Paris (ISTeP), Université Pierre et Marie Curie - evgenii.burov@upmc.fr
Cloetingh, Sierd; ILP President, Utrecht University - sierd.cloetingh@uu.nl
De Angelis, Antonio; Department of Earth and Environmental Sciences, University of Milan Bicocca - lord.toto@hotmail.it
Del Carlo, Paola; Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Pisa - paola.delcarlo@ingv.it
Devey, Colin; GEOMAR Kiel - cdevey@geomar.de
Dobrzhinetskaya, Larissa F.;Department of Earth Sciences, University of California at Riverside - larissa@ucr.edu
Förster, Andrea; GFZ – andrea.foerster@gfz-potsdam.de
Gaete, Ayleen; GFZ - agaete@gfz-potsdam.de
Galland, Olivier; Department of Geosciences, University of Oslo - olivier.galland@geo.uio.no
Garrido, Carlos J. .; Instituto Andalúz de Ciencias de la Tierra (IACT), CSIC-UGR, Granada - carlosg@ugr.es
Green, Alan G.; Institute of Geophysics, ETH Zurich - alan.green@erdw.ethz.ch
Gudmundsson, Agust; Department of Earth Sciences, Royal Holloway University of London - a.gudmundsson@es.rhul.ac.uk
Gupta, Harsh; IUGG past President - harsheseg@gmail.com
Haq, Bilal; National Science Foundation U.S. - bhaq@nsf.gov
Heidbach, Oliver; GFZ - heidbach@gfz-potsdam.de
Holohan, Eoghan P.; GFZ - holohan@gfz-potsdam.de
Hübner, Andreas; GFZ - huebner@gfz-potsdam.de
Hüttl, Reinhard; GFZ - huettl@gfz-potsdam.de
Kind, Rainer; GFZ - kind@gfz-potsdam.de
Kuglitsch, Franz G.; IUGG Executive Secretary - fgkugl@gfz-potsdam.de

List of participants (to be continued)

Lewerenz, Björn; GFZ - lew@gfz-potsdam.de
Matenco, Liviu; Department of Earth Sciences, Utrecht University - L.C.Matenco@uu.nl
Nader, Fadi H.; IFP Energies Nouvelles, Rueil-Malmaison - fadi-henri.nader@ifpen.fr
Negendank, Jörg F. W.; ILP Fellow - neg@gfz-potsdam.de
Nikkhoo, Mehdi; GFZ - mehdi@gfz-potsdam.de
Novruzova, Nurana; Geology and Geophysics Institute, Azerbaijan National Academy of Sciences - nurane.n46@gmail.com
Oberhänsli, Roland; IUGS President - roland.oberhaensli@geo.uni-potsdam.de
Oncken, Onno; GFZ - oncken@gfz-potsdam.de
Oppizzi, Paolo; SwissGeotech - paolo.oppizzi@geolog.ch
Pasquaré Mariotto, Federico; Department of Theoretical and Applied Sciences, Insubria University - federico.pasquare@uninsubria.it
Pierdominici, Simona; GFZ - pierdo@gfz-potsdam.de
Plomerova, Jaroslava; Institute of Geophysics, Czech Academy of Sciences - jpl@ig.cas.cz
Poutanen, Markku; Finnish Geospatial Research Institute (FGI) - markku.poutanen@nls.fi
Rogozhina, Irina; GFZ - valmont@gfz-potsdam.de
Ruch, Joël; King Abdullah University of Science and Technology, Thuwal, Saudi Arabia - joel.ruch@kaust.edu.sa
Rudloff, Alexander; ILP Executive Secretary, GFZ - rudloff@gfz-potsdam.de
Rust, Derek; School of Earth and Environmental Sciences, University of Portsmouth, UK - derek.rust@port.ac.uk
Salamone, Alessandro; Department of Earth and Environmental Sciences, University of Milan Bicocca - a.salamone@campus.unimib.it
Scheck-Wenderoth, Magdalena; ILP Secretary General, GFZ - leni@gfz-potsdam.de
Sippel, Judith; GFZ – sippel@gfz-potsdam.de

Takada, Akira; Geological Survey of Japan - a-takada@aist.go.jp
Thybo, Hans; EGU President, Department of Geography and Geology, University of Copenhagen - thybo@geo.ku.dk, thybo@ign.ku.dk
Tibaldi, Alessandro; Department of Earth and Environmental Sciences, University of Milan Bicocca - alessandro.tibaldi@unimib.it
Tilmann, Frederik; GFZ – tilmann@gfz-potsdam.de
van Wyk de Vries, Benjamin; Laboratoire Magmas et Volcans, CNRS/IRD, Observatoire du Physique du Globe, Université Blaise Pascal, Clermont-Ferrand - b.vanwyk@opgc.fr
Walter, Thomas; GFZ - twalter@gfz-potsdam.de
Whitworth, Malcolm; School of Earth and Environmental Sciences, University of Portsmouth, UK - malcolm.whitworth@port.ac.uk
Wiersberg, Thomas; GFZ - wiers@gfz-potsdam.de

Abstracts (in alphabetical order of first author)

Shorter- vs. longer-term tectono-magmatic evolution of slow spreading divergent plate boundaries: overview and model

Acocella, Valerio (1), Trippanera, Daniele (1)

(1) Dipartimento di Scienze, Università Roma Tre, ITALY, email: acocella@uniroma3.it

Recent diking episodes along divergent plate boundaries activated normal faults, suggesting that an important part of faulting, and thus of the rift structure, is dike-induced, at least on the short term (1-101 years). The main features of these transient diking events are here summarized and reconciled with field (Iceland and, subordinately, Ethiopia) and experiments to define the possible longer-term (≥102 years) effect of diking on the rift structure. In Iceland, crustal dilation at depth largely occurs by means of dikes, with negligible normal faulting; faults focus towards the surface (<1 km depth) where, even though usually dike-induced, they commonly propagate downward from the surface. The intrusion frequencies of a very few hundreds of years in Iceland may induce all the observed surface deformation. The close similarities with transitional divergent plate boundaries (as Afar) and, in part, with continental magmatic divergent plate boundaries (Main Ethiopian Rift), suggest that prolonged diking may also explain most of the surface deformation along any slowly spreading (<2 cm/yr) magmatic plate boundary. A model, mostly applicable to Iceland and subordinately to transitional or continental divergent plate boundaries, is proposed. This shows how the frequency of diking episodes (~200 years in Iceland) does not allow enough accumulation of tectonic stress to be non-magmatically released through seismic or aseismic regional faulting. This implies that a diking episode locks most fault activity for decades or centuries (until the subsequent episode), limiting any impact of regional tectonics in shaping magmatic divergent plate boundaries.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Evidences of active faulting in Koyna-Warna seismic zone, India from Airborne LiDAR data

Arora, Kusumita (1); Dhar, Upasana (1)

(1) CSIR-National Geophysical Research Institute, Hyderabad, INDIA

Investigations for delineation of the detailed subsurface structure and weak zone characteristics of the Koyna-Warna region of reservoir triggered seismicity include study of high resolution surface elevation and geomorphological features, which may provide evidences of tectonic activities in the region. Airborne Lidar discrete return, waveform and intensity data as well as orthophoto images have been acquired in an area of 1064 sq km centered on the Koyna seismic zone. The aircraft uses a 125 kHz laser at line intervals of 250 m, hugging the terrain at about 600 m with flight speed of about 150 km/hr to generate nominal point spacing (NPS) of 8-12/m^2. The processed data has revealed the details of the bare earth, leading to topographic details in terms of relief, steepness, relation with drainage patterns, which may provide information about structural conditions from surface trends. A few examples of morphological features associated to tectonic activity are discussed. It is expected that mapping of the detailed surface geomorphology and inference of fine scale structures and lineaments would in conjunction with the subsurface structure derived from drilling and other geophysical studies, would help in understanding the stress field and seismo-tectonics of the region with respect to the reservoirs and their trigger effects on the seismicity in this region.

Density structure of the cratonic mantle in southern Africa: correlations with seismic velocities, xenolith data, and dynamic topography

Artemieva, Irina M. (1); Vinnik, Lev P. (2)

(1) IGN, University of Copenhagen, DENMARK, email: irina@ign.ku.dk
(2) Institute of Physics of the Earth, Moscow, RUSSIA, email: vinnik@ifz.ru

An unusually high topography in southern Africa may be caused by the dynamic support of the mantle below the lithosphere base and/or by a low density (high depletion) of the cratonic lithospheric mantle. We use free-board constraints to examine the relative contributions of the both factors to surface topography and present the model of density structure of the lithospheric mantle in southern Africa.
The calculated lithospheric mantle density values are in an overall agreement with xenolith-based data for lithospheric terranes of different ages. Density of the lithospheric mantle has an overall agreement with xenolith-based data and shows an overall trend in mantle density increase from Archean to younger lithospheric terranes. We observe a significant disagreement in mantle depletion beneath the Limpopo belt which we explain by the fact that the lithosphere of this block could have been melt-metasomatised after the kimberlite emplacement. From comparison of density anomalies in the lithospheric mantle with seismic Vp, Vs velocities at 100-150 km depth we conclude that density-velocity relationship is strongly non-unique and cannot be parameterized by one parameter such as Mg#.
The results indicate that 0.5-1.0 km of topography requires the dynamic contribution from the sublithospheric mantle because it cannot be explained by the lithosphere structure within the petrologically permitted range of mantle densities. We propose that dynamic topography may be associated with the low-density region below the depth of isostatic compensation (LAB). A likely candidate is the low velocity layer between the lithospheric base and the mantle transition zone, where a temperature anomaly of 100-200 deg may produce the required extra contribution to regional topographic uplift.

(Manuscript in review, Lithos)

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Evaluation of earthquake-induced strain in promoting mud eruptions: the case of Shamakhi–Gobustan–Absheron areas, Azerbaijan

Babayev, G. (1); Tibaldi, A. (2); Bonali, F.L. (2), Kadirov, F. (1)

(1) National Academy of Sciences, Institute of Geology, Baku, AZERBAIDSHAN
(2) Department of Earth and Environmental Sciences, University of Milan Bicocca, Milan, ITALY

Azerbaijan, mainly Absheron Peninsula and its Caspian coastline are home to nearly 400 mud volcanoes. Mud volcano of Azerbaijan has become an interest to many scientists. The mud volcano phenomena have always been a question in terms of tectonic stress regime, indication of mobilized fluids and earthquakes' occurrences. Although a relationship between the occurrence of the eruptions of close mud volcanoes and large earthquakes is well known, several uncertainties remain on understanding the triggering mechanisms. In the present study, we evaluate both the static and dynamic strains induced by earthquakes in the substratum of mud volcanoes. We studied the effects of two earthquakes of Mw 6.18 and 6.08 occurred in the Caspian Sea on 25 November 2000 close to Baku city, Azerbaijan. A total of 33 eruptions occurred at 24 mud volcanoes within a maximum distance of 108 km from the epicentres in the 5 years following the earthquakes. The overall eruption rate in the studied area of the 50 years before the 2000 earthquakes was 1.24 that is much smaller than the eruption rate of 6.6 of the 5 years following these earthquakes. The largest number of eruptions occurred within 2 years from the earthquakes with the highest frequency within 6 months. Our calculated earthquake-induced static effects show that crustal dilatation might have triggered only seven eruptions at a maximum distance of about 60 km from the epicentres and within 3 years. Based on our data, dynamic rather than static strain is likely to have been the dominating ''promoting'' factor because it affected all the studied unrest volcanoes and its magnitude was much larger.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Holocene deformation field at the junction between the Husavik-Flatey transform fault and the northern Iceland Volcanic Rift

Beccalli, A. (1); Tibaldi, A. (1); Bonali, F.L. (1), De Angelis, A. (2); Rust, D. (2); Withworth, M. (2)

(1) Department of Earth and Environmental Sciences, University of Milan Bicocca, Milan, ITALY
(2) School of Earth and Environmental Sciences, University of Portsmouth, Portsmouth, UNITED KINGDOM

Our study focuses on the Holocene tectonics in the area surrounding the junction between the NW-SE-striking Husavik-Flatey transform fault and the Theystareykir fissure swarm, located in northern Iceland. We aimed to determine the relationships between active tectonics, faults kinematics and tension fractures, by studying tectonically-induced deformation features in the field.
Data have been firstly collected by high-resolution satellite imagery in order to create a detailed map of faults and tension fractures, and then new data have been gathered by field surveying. For each fault segment we determined its kinematics and measured its: length, strike, dip direction and vertical offset. For each tension fractures we measured: length, strike, opening direction and opening amount. Furthermore, in the very north of the studied area, we recognized 12 sink holes, belonging to the termination of the Gudfinnugja Fault, aligned in N-S direction, testifying recent tension fractures opening in such area. The collected data allowed us to reconstruct the strain field of the area, and to understand the amount of deformation at the intersection between the Husavik-Flatey transform fault and the Theystareykir fissure swarm.

Sensitivity analysis of earthquake-induced static stress changes on volcano magma pathways: the 2010 Mw 8.8 Chile case

Bonali F.L. (1), Tibaldi A. (1)

(1) Department of Earth and Environmental Sciences, University of Milan Bicocca, Milan, ITALY

In this work, we studied in detail how a large earthquake is capable of inducing stress changes on volcano magma pathways, resulting in possible positive feedbacks in promoting eruptions. We have developed a sensitivity analysis that considers several possible parameters, providing also new constraints regarding the method. We focused our study on the M*w* 8.8 2010 earthquake that occurred along the Chile subduction zone near 24 historic/Holocene volcanoes, located in the Southern Volcanic Zone. We used six different finite fault-slip models to calculate the static stress change, induced by the coseismic slip, in a direction normal to several theoretical feeder dykes with various orientations. Results indicate different magnitudes of stress change owing to magma pathway geometry and orientation. In particular, the N–S and NE–SW-striking magma pathways suffer a decrease in stress normal to the feeder dyke in comparison to those striking NW–SE and E–W. As a consequence, we reconstructed the geometry and orientation of the most reliable magma pathways below the 24 volcanoes by studying structural and morphometric data, and we resolved the stress changes for each of them. Our findings suggest that pathway orientation plays a more relevant role in suffering stress changes, whereas the depth of calculation used in the analysis is not a key parameter. Regarding the possible positive feedbacks in inducing new eruptions, our results indicate that: i) volcanoes where post-earthquake eruptions took place, experienced earthquake-induced normal stress decrease or very small normal stress increase, ii) several volcanoes that have not erupted yet, are more prone to experience future unrest, from the point of view of the host rock stress state, because of earthquake-induced normal stress decrease. Earthquake-induced magma-pathway normal stress decrease might contribute to promote new eruptions at volcanoes as far as 450 km from the epicentre.

This work is a contribution to the International Lithosphere Program – Task Force II.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Subvolcanic complexes in sedimentary basins - Processes, geometries, exogenous and applied aspects

Breitkreuz, Christoph (1)

(1) TU Bergakademie Freiberg, Geology Department, GERMANY, email: cbreit@geo.tu-freiberg.de

Subvolcanic complexes include dykes (typically coherent, but also pyroclastic), sills and laccoliths. The majority of subvolcanic complexes are known from mantle plume-related supracrustal systems and from intra-continental magmatic zones, and they are often located within sedimentary basins.

Magma viscosity and volume, and the difference in strength between the emplacing melt and the host sediments are fundamental parameters controlling the type, geometry and size of subvolcanic bodies. Large igneous provinces (LIP), related to mantle plume magmatism, notoriously contain large sill complexes (e.g. Siberian Trapp, Karoo Basin, North Atlantic LIP, Amazonas). Melt emplacement in sediments with a high organic carbon content results in massive hydrothermal venting of climate-sensitive volatiles, contributing to mass extinction events, e.g., at the Permian-Triassic boundary and in the Early Jurassic.

Ascent of differentiated, high viscosity magma may lead to the formation of laccolith complexes. Magma force may be strong enough to lift up cover sediments as thick as 3 km! Depending on viscosity, vertical growth of laccolith takes place by ballooning or by successive emplacement of magma sheets. Phenocryst alignment, flow foliation, discrete shear zones and paleomagnetic orientation (AMS) may reveal internal flow pattern. Vertical growth results in deformation and tilting of host rocks. Large magma volume provided, vertical growth can lead to the formation of intrusive-extrusive complexes piercing through the cover sediments and forming subaerial lava domes.

Laccolith-induced up-doming may result in hazardous landslides and volcanic eruptions. It also changes intra-basinal topography and distribution of sedimentary environments (creation of alluvial fan, re-direction of rivers, formation of lakes by damming of valleys).

Emplacement of sills and laccoliths may strongly influence hydrocarbon plays. Formation of subvolcanic complexes may stimulate HC maturation and mobilization, create/change/destroy migration paths, change the thermal regime, create traps (Føring Basin, Rockall Trough) and even may function as reservoirs (Neuquén Basin).

The apparent affinity between deep sedimentary basins and subvolcanic complexes may be explained by 1) preexisting, active crustal extension, 2) the local stress field is dominated mainly by gravitation, 3) rising melt may devolatize during ascent, and 4) SiO_2-rich systems with low magma ascent rates favor formation of laccolith complexes (high rates would result in vigorous explosive eruptions), while SiO_2-poor systems may also emplace with high magma ascent rates, e.g. in hot spot settings.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Lithosphere dynamics: interplays between models and data

Burov, E. (1); Gerya, T. (2); Buiter, S. (3); Houseman, G. (4); Pysklywec, R. (5); Ismail-Zadeh, A. (6)

(1) University Pierre and Marie Curie Paris-6, UPMC, 4 Place Jussieu,, Paris Cedex 05, FRANCE
(2) ETH Zurich, Department of Earth Sciences, Sonneggstrasse 5, 8092 Zurich, SWITZERLAND
(3) Geological Survey of Norway (NGU), Geodynamics Team, Trondheim, NORWAY
(4) University of Leeds, School of Earth and Environment, Leeds, UNITED KINGDOM
(5) University of Toronto, Department of Earth Sciences, Toronto, CANADA
(6) KIT Karlsruhe Institute of Technology, Institute for Applied Geosciences, Karlsruhe, GERMANY

Thermo-mechanical geodynamic multi-process modelling is a large, growing, important scientific field that has become an independent branch of Earth Sciences, which is naturally cross-disciplinary and highly integrative. The role of physically-consistent thermo-mechanical modeling has evolved from simple illustration of first-order geological and geodynamic concepts to in-depth integration of geological and geophysical data in a physically consistent framework allowing not only for explanation of the existing data but also for formulation of new concepts, guidance for future field observations and laboratory experiments. The state-of-the art models can pinpoint internal inconsistencies in the input data thus orienting field and laboratory research towards verification and acquisition of new data. Modeling thus has also become a versatile tool for validation and interpretation of geophysical and laboratory data and geological observations, specifically of "data models" such as seismic tomography, geodesy, petrology, rheology models and concepts. Current challenges of geodynamic and small-scale modelling are therefore multifold, going from better understanding of physics of the geodynamic and geological processes to bridging the gaps between different spatial and temporal scales of observation and different, cross-disciplinary types of observations and elaboration of new geodynamic hypotheses and concepts. Of particular importance will be also discussion on input parameters for dynamic models, that is, also on the ways of parameterization and validation of data coming from laboratory experiments and field observations that are often subject to uncertainties inducing non-uniqueness of model results.

The goals and potential benefits of the project:

1. International integration and cooperation for multi-disciplinary research in a frontier of science and strengthening the relationship with other Task Forces of the International Lithosphere Program.
2. Promotion of quantitative physical solid Earth's sciences for understanding fundamental questions of lithosphere dynamics and mantle-lithosphere interactions and implementation of this knowledge to the needs of society.
3. Discussion, evaluation and dissemination of new numerical concepts that can be used to address the key questions of the project.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Lithosphere dynamics: interplays between models and data (to be continued)
Burov, E. et al.

4. Educational outreach: The project might bring together scientists and students from ~ 25 countries: Australia, Austria, Canada, China, France, Germany, Italy, the Netherlands, Norway, Russia, Switzerland, UK, Ireland and USA...

Non-exclusive list of Core Participants

1. UPMC Paris , France
2. ETH Zurich, Switzerland
3. U. Utrecht, Netherlands
4. U. Lausanne, Switzerland
5. U. Durham , UK
6. DIAS Dublin, Ireland
7. GFZ Potsdam , Germany
8. U. Munich /U . Mainz, Germany
9. U. Rome II, Italy
10. U. Frankfurt , Germany
11. U. Oxford, UK
12. R. Imperial College , UK
13. Leeds University, UK
14. U. Orleans, France
15. U. Toronto, Canada
16. IPGP, France
17. ENS, France
18. U.Nice , France
19. U. Montpellier , France
20. Geological Survey of Norway in Trondheim, Norway
21. Bergen, Norway
22. Monach U, Australia
23. U. Rennes, France
24. MIT Boston, United States
25. U. Texas, United States
26. U. Karlsruhe, Germany
27. U. Lyon, France

Task Force VIII. Lithosphere dynamics: interplays between models and data

Burov, E. (1); Gerya, T. (2); Buiter, S. (3); Houseman, G. (4), Pysklywec, R. (5); Ismail-Zadeh, A. (6)

(for affiliations, see Burov et al., page 17).

The Task Force VIII is devoted to studying lithosphere dynamics through thermo-mechanical geodynamic multi-process modelling as well as to establishing efficient interplays between models and data. Physically consistent numerical modelling is a large, growing, important scientific field that has become an independent branch of Earth Sciences, which is naturally cross-disciplinary and highly integrative. The role of physically-consistent thermo-mechanical modeling has evolved from simple illustration of first-order geological and geodynamic concepts to in-depth integration of geological and geophysical data in a physically consistent framework allowing not only for explanation of the existing data but also for formulation of new concepts, guidance for future field observations and laboratory experiments. The state-of-the art models pinpoint internal inconsistencies in the input data thus orienting field and laboratory research towards verification and acquisition of new data. Modeling thus has also become a versatile tool for validation and interpretation of geophysical and laboratory data and geological observations, specifically of "data models" such as seismic tomography, geodesy, petrology, rheology models and concepts. Current challenges of geodynamic and small-scale modelling are therefore multifold, going from better understanding of physics of the geodynamic and geological processes to bridging the gaps between different spatial and temporal scales of observation and different, cross-disciplinary types of observations and elaboration of new geodynamic hypotheses and concepts. The Task Force VIII has been launched in spring 2014. The most important activities within this period has been devoted to networking, in particular to the publication of the ILP special volume of Tectonophysics and organization of several joint meetings at EGU and AGU totalling several hundred participants. Specifically we are happy to report the publication of Special ILP volume of Tectonophysics published in September 2014 with around 20 articles contributed by more than 60 co-authors, most of which are participants of the Task Force VIII. Another important TFVIII action with large involvement of TF members refers to co-organization of XIV International Workshop on Mantle and Lithosphere Dynamics at Oleron (2015), which is one of the most important forums in geodynamic modelling. Hundreds of publications including several Nature and Nature Geosciences have been published by Core participants, targeting different topics on lithosphere dynamics, mantle-lithosphere interactions and lithosphere rheology and different spatial and time scales. We have fostered collaborations and contacts with the Mantle Dynamics Modelling community in the framework of preparation of the XIVth joint workshop in Oleron. Many new collaborations has been developed with the rock-mechanics community, seismic tomography community, mantle dynamic community. So far, members from 27 research groups from more than 10 countries including US, Canada and Australia have been involved in TFVIII collaboration.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

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

Cloetingh, S. (1); Willett, S. (2); Facenna, C. (3); Fernández, M. (4); Sternai, P. (5)

(1) University of Utrecht, Department of Earth Sciences, 3508 TC Utrecht, NETHERLANDS
(2) ETH Zurich, Department of Earth Sciences, Sonneggstrasse 5, 8092 Zurich, SWITZERLAND
(3) Roma Tre, Universitá degli Studi, Dipartimento di Scienze Geologiche, 00146 Roma, ITALY
(4) CSIC, Institut de Ciències de la Terra Jaume Almera, Barcelona, SPAIN
(5) University of California (UCLA), Earth, Planetary, and Space Sciences, Los Angeles, U.S.A.

Continental topography is at the interface of processes taking place at depth in the Earth, at 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.

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.

TOPO-EUROPE: 4D Topography Evolution in Europe: Uplift, Subsidence (to be continued)
Cloetingh, S. et al.

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 the proposed project 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.

TOPO-EUROPE has served as an important mechanism to integrate research efforts on a national level conducted in different countries in a pan-European framework. An example has been the EUROCORES TOPO-EUROPE coordinated by the European science foundation bringing together 23 different European countries and creating research opportunities and funding for more then 60 young researchers. TOPO-EUROPE has also provided the research motivation for the European plate observing system (EPOS) currently in the implementation phase of the European strategy forum for large-scale scientific infrastructure (ESFRI). EPOS brings together for more then 500 million euro in scientific infrastructure for the solid earth, offering novel unique research opportunities for integrated solid earth research in Europe. A continuation and further expansion of TOPO-EUROPE as a research platform is therefore a must. In a similar spirit and already starting in 2015 with the TOPO-EUROPE annual meeting in Antibes (South of France) hosted by GEO-AZUR, ILP-TOPO-EUROPE will be teaming up with the European Space Agency (ESA), for coordinating future use of satellite data coming from the upcoming ESA satellite missions. Further expansion of the role of solid earth research is aimed for the domain of geo-energy and natural hazards. This applies in particular in the fields of geothermal energy research and participation in research programs in the field of sustainability and resilience. In this context, TOPO-EUROPE will operate in close coordination with organizations such as the European Energy Research Alliance (EERA) and ACADEMIA EUROPEA, the European academy of science. Planned activities include annual workshops, special thematic volumes of international peer reviewed journals, summer schools and thematic short courses. Training new generations of young researchers will be a priority for TOPO-EUROPE.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Structure and petro-chemistry of an exceptionally-exposed cone sheet system: the Thverfell case, Esja Peninsula, Iceland

De Angelis, A. (1); Tibaldi, A. (1); Beccalli, A. (1); Bonali, F.L. (1), Cavallo, A. (1)

(1) Department of Earth and Environmental Sciences, University of Milan Bicocca, Milan, ITALY

The studied area is located along the Esja Peninsula, in South-Western Iceland. Our work is focused on the study of a cone sheet system, from the structural and petrochemical point of view.

The total population of intrusions is made of 35 inclined sheets, and for each of them we have collected several structural data, comprising strike, dip direction and inclination (useful for building 3D models), the thickness, and, wherever possible, we have also recognized the cross-cutting relationship between two or more inclined sheets. In addition to these data, we took the GPS coordinates of the outcropping tips of each sheet in order to place them in a precise way on the topographic map. For each inclined sheet, we have also taken a sample for chemical and petrographic analysis. Samples were characterized by means of transmitted optical microscopy (OM) on thin sections, X-ray powder diffraction (XRPD) and energy-dispersive X-ray spectroscopy (EDXRF).

In the present work we compare the new structural data with the available bibliographic data and with the new geochemical/petrographic data. This data integration allows to determine the complete geometry of the cone sheet system and to understand how many and which magmatic phases have contributed to its growth.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Tephra study as a tool for stratigraphic correlations and dating: examples from Etna volcano (Italy) and the Ross Sea (Antarctica)

Del Carlo, Paola (1)

(1) Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Pisa, via della Faggiola 32, 56126 Pisa, ITALY, email: paola.delcarlo@ingv.it

Tephra (from Greek 'ashes') layers are isochronous surfaces on a geological timescale. When distinctive and sufficiently widespread, they represent valuable stratigraphic tools for geological correlation and dating. As well as providing isochrons for synchronizing geological records and palaeo-environmental reconstructions, tephra through their geochemical analysis allow insight into volcanic and magmatic processes, and provide a comprehensive record of explosive volcanism and recurrence rates that can be used to establish time-space relationships of relevance to volcanic hazard analysis.

On this regard, a contribution leads to significant geological implications into two volcanic regions, very distant from each other.

Tephrostratigraphic investigations performed at Etna volcano (Italy) have represented an important tool with regard to the stratigraphic reconstruction of this stratovolcano. In particular, the identification and dating of several widespread pyroclastic fall deposits have allowed the relative dating of lava flows, improving the knowledge of the eruptive activity over the last 15 ka. In addition, the discovery of Etna tephra layers in cores from Ionian Sea and coastal areas have contributed to reconstruct the record of paleotsunamis that have affected the Eastern Sicily.

The study of tephra recovered in marine cores from the Ross Sea (Antarctica) has provided information about their volcanic sources, eruptions styles and new insights into their environment of deposition. The marine depositional environments close to the continent are key areas in Antarctica, where sediment input is directly related to environmental changes in the terrestrial environment. Most of these areas have been affected episodically during the Cenozoic by tectonic and volcanic activity linked to the West Antarctic Rift System. Petro-chemical analyses and radiometric dating on tephra from AND-2A drillcore have constrained the age model of the core and characterise the sediment deposition in the Victoria Land Basin since Early Miocene.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Tracking Traces of the Subducted Continental Lithosphere in Deep Earth

Dobrzhinetskaya, Larissa (1)

(1) University of California at Riverside, U.S.A, email: larissa@ucr.edu

Seismic tomography provides astonishing images which demonstrate that gigantic fragments of the lithospheric slabs are stagnated at the 660 km discontinuity, and some of them are subducted even deeper into the lower mantle to the depth ~1,500–2,700 km (e.g. van der Hilst *et al.*, 1997; van der Voo *et al.*, 1999). Calculations suggest that about 30% of the modern mass of the continents was subducted back into the mantle during Earth's history, and that 50-70% of the subducted sediments were re-incorporated back into the continental crust via underplating and calc-alkaline magmatisms, or tectonic exhumations (Colton, 2000).

Experimental studies have shown that during deep subduction a part of the crustal material that delaminated and avoided melting may be modified to become denser than surrounding mantle. These dense rocks "sunk down" into the mantle transition zone, and possibly the lower mantle to stagnate for a long geological time. High-pressure experiments showed that "the average continental crust" will be denser than the surrounding mantle by ~0.20 g/cm3 at depth ~410 km, whereas with increasing pressure at depth ~660 km, "the average continental crust" becomes slightly less dense than mantle rocks at ~0.15g/cm3 (Nishiyama et al., 2005). Therefore, the 660-km seismic discontinuity zone can be considered a place where continental materials can stagnate. Because samples of rocks at that depth are not directly accessible, studies of small fragments such as xenocrysts, xenoliths, or geochemical and mineralogical anomalies that might contain records of a crust-mantle interaction are first-order questions for modern geosciences.

The minerals and microstructures indicative of ultrahigh pressure (UHP) conditions are a window into an understanding of the fate of the subducted continental lithosphere. The number of tectonic settings in which new UHP minerals have been discovered is no longer limited only by orogenic belts. During the last five years, the numbers continue to grow and an interdisciplinary approach is required to understand how the fragments of the continental lithosphere are "amalgamated" with the mantle. The non-traditional settings where UHP minerals were found include ophiolitic mantle peridotite and chromitite, xenoliths from OIB, forearc sites and intraplate alkali basalt magmatism.

Besides of minerals which indicate high pressure conditions of their crystallization (diamond, moissanite, coesite/stishovite, quingsongite and others) there were also found the specific microstructural features of decompression in rock-forming mantle minerals (e.g. diopside with coesite lamella exsolution; olivine with ilmenite and chromite lamellae exsolution; pyropic garnet with lamellae of pyroxenes – a former precursor of majoritic garnet and others).

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Tracking Traces of the Subducted Continental Lithosphere in Deep Earth (to be continued)
Dobrzhinetskaya, L.

The most interesting example is our recent discovery of a new mineral, cubic boron nitride (cBN)-qingsongite occurred in the mantle section of the Tibetan ophiolite (Dobrzhinetskaya et al., 2014). This mineral has a mixed "parentage"—boron has a crustal origin, whereas nitrogen (δ15N = −10.4 ± 3 ‰) is most likely from the mantle. The mineral crystallized under highly reducing conditions accompanied by high pressure (10–15 GPa) and high temperature (~1300 °C) at the depth > 250–300 km, and it indicates an assimilation of the stagnated crustal lithosphere components into the mantle environment. Moissanite (SiC) from both the ophiolitic mantle and mantle xenoliths consist of carbon originated from a crustal reservoir (δ13C= -25-32‰), suggesting that this carbon is a product of recycling of the continental materials stagnated probably in the mantle transition zone or the lower mantle. The contribution includes a discussion of several scenarios for the possible crust-mantle interactions, as well as results of the Task Force IV' achievements in the period of 2010-2014.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Contrasting tectonic controls in the last 6 Ma of retroarc volcanism in the transition zone from the Central to the Patagonian Andes (36-42°S)

Folguera, Andrés (1); Gianni, Guido (1); Tobal, Jonathan (1); Sagripanti, Lucía (1); Colavitto, Bruno (1); Orts, Darío (2); Vera, Emilio Rojas (3)

(1) Instituto de Estudios Andinos, Universidad de Buenos Aires, Conicet, ARGENTINA
(2) Universidad de Río Negro, ARGENTINA
(3) YPF SA, ARGENTINA

Less than 6 Ma retroarc volcanism shows contrasting tectonic controls between 36 and 42°S. On one hand, in the northern sector, volcanism is associated with neotectonic contractional-transpressional structures that affect the Tromen volcanic plateau and the western Payenia volcanic plateau over the Malargüe fold and thrust belt. These contractional deformational belts are spatially linked to asthenospheric anomalies recently detected in magnetotelluric surveys (Burd et al., 2014), which suggests a probable linkage between a thermally debilitated lower crust and the sites of emplacement of retroarc products and shallow deformation. On the other hand south of 38°S, extensional troughs flanking the eastern Andean slope control arc and retroarc volcanism. These extensional structures are associated with crustal attenuated zones revealed from seismic and gravity data and with abnormally high thermal flows determined from magnetic data and previous seismic tomographies. These variations from retroarc volcanic fields associated with neotectonic compressional structures in the north to volcanism associated with extensional structures in the south can be explained by the strong tearing that the Nazca plate has suffered in the last 3-5 Ma visualized in seismic tomographies (Pesicek et al., 2012). These data show that south of 38°S, the subducted slab steepened in coincidence with the extensional structures that controlled volcanism at the eastern Andean slope in the last 5 Ma. Extensional deformation could be explained by the strong roll back that would have suffered the subducted slab in this sector produced by mantle flow ascending through the tearing at 38°S. Arc retraction described in previous proposals in the last 5-3 Ma is probably linked to this process.

Burd, A.I., Booker, J.R., Mackie, R., Favetto, A., Pomposiello, M.C., 2014. Three-dimensional electrical conductivity in the mantle beneath the Payun Matru Volcanic Field in the Andean back-arc of Argentina near 36.5 S: Decapitation of a mantle plume by resurgent upper mantle shear during slab steepening? Geophysical Journal International, 1: 1–12.

Pesicek, J.D., Engdahl, E.R., Thurber, C.H., DeShon, H.R., Lange, D., 2012. Mantle subducting slab structure in the region of the 2010 M8.8 Maule earthquake (30-40°S), Chile. Geophysical Journal International, 191: 317–324.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Volcanism triggered by earthquake in Chile: model of magma propagation in the crust and ground deformation

Gaete, Ayleen (1,*); Nikkhoo, Mehdi (1); Walter, Thomas R. (1)

(1) GFZ German Research Centre for Geosciences, Section "Physics of Earthquakes and Volcanoes", Telegrafenberg, 14473 Potsdam, GERMANY, *email: agaete@gfz-potsdam.de

Historic megathrust earthquakes have affected the number of volcano eruptions as well as the development of large fluid and magmatic systems. The southern and central Andes Volcanic Zone documents a century long history of volcanic activity associated with tectonic earthquakes. In a commonly discussed concept, changes of the crustal stress field may affect intrusive bodies under volcano, open magma pathways and faults, and decompress a magma-fluid system. The changing stress field may be permanent (static), delayed (quasistatic) or transient (dynamic), though the precise functioning of these stress field changes on a volcano remained unclear. In specific, the way external stress changes affect the paths of magmas from depth to the surface, has not investigated in detail.

We analyze possible dike and sill intrusion mechanisms associated with real topographic complexities and affected by subduction related stress field changes (static and dynamic), to specify the mechanisms that affect magma propagation along dikes and sills. Here we present first results derived from laboratory experiments. We simulate hydrofracturing in elastic media with different surrounding boundary conditions. The elastic media used was achieved in a gelatin tank, the intrusions made by a pump-controlled colored water injection. Geometry, elasticity of the gelatin and buoyancy contrasts of the liquid were scaled to natural conditions.

Endmember experiments reveal the large influence of the pre-existing topography stress on the injection paths, controlling the ascent, lateral migration and arrest of magma dikes and sills. Then we systematically vary the surrounding stress field condition in order to test how these dikes and sills diverge from their "normal" path and may eventually cause eruptions. We further discuss under which situations magma paths and ascent rates are augmented and hindered by the subduction earthquake.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Laboratory Modelling of Volcano Plumbing Systems: a review

Galland, Olivier (1); Holohan, Eoghan P. (2); van Wyk de Vries, Benjamin (3); Burchardt, Steffi (4)

(1) Physics of Geological Processes (PGP), Department of Geosciences, University of Oslo, NORWAY
(2) GFZ German Research Centre for Geosciences, Helmholtz Zentrum Potsdam, Potsdam, GERMANY
(3) Observatoire de Physique du Globe de Clermont-Ferrand, Blaise Pascal University, Clermont-Ferrand, FRANCE
(4) University of Uppsala, Uppsala, SWEDEN

Since the XIX century, Earth scientists have tried to replicate geological processes in controlled laboratory experiments. This contribution (Galland et al., in press) reviews such laboratory models of the complex development and dynamics of volcano plumbing systems, which set the stage for volcanic eruptions.

The first step of laboratory modelling is the choice of relevant model materials for rock and magma. We outline a broad range of suitable model materials used in the literature. These materials exhibit very diverse rheological behaviours, so their careful choice is crucial for proper experiment design.

The second step is model scaling, which successively calls upon: (1) the principle of dimensional analysis, and (2) the principle of similarity. The dimensional analysis aims to identify the dimensionless physical parameters that govern the underlying processes. The principle of similarity quantifies the extent to which the models are representative of the geological systems they intend to simulate. The application of these two steps ensures a solid understanding and geological relevance of the laboratory models. In addition, this procedure shows that laboratory models are not designed to exactly mimic a given geological system, but to understand underlying generic processes, either individually or in combination, and to identify or demonstrate physical laws that govern these processes.

From this perspective, we discuss past applications of laboratory models that aimed to understand the development of key features of volcanic plumbing systems, such as dykes, cone sheets, sills, laccoliths, caldera-related structures, ground deformation, magma/fault interactions, and explosive vents.

<u>Reference</u>

Galland, O. et al., in press. Laboratory modelling of volcanic plumbing systems: A review. In: Breitkreuz, C., Rocchi, S. (Eds.), Physical geology of shallow magmatic systems. Springer.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Energies driving facture propagation and eruptions in volcanoes

Gudmundsson, Agust (1)

(1) Department of Earth Sciences, Queen's Building, Royal Holloway University of London, Egham TW 20 0EX, UNITED KINGDOM; email: rock.fractures@googlemail.com

All rock fractures must form new surfaces, for which surface energy is needed. In volcanoes the surface-energy source is partly the strain energy stored in the volcano during inflation and partly the work associated with spreading or related crustal movements. From strain-energy calculations and stress-field modeling of volcanoes subject to various loadings the following conclusions are reached. (1) Close to magma chambers dike and sheet injections are almost always favored over faulting. This is one reason why caldera collapse/ring-fault slip is so rare in comparison with dike/sheet injections in volcanoes. (2) The strain energy stored during most unrest periods is too small to rupture the magma chamber; and when it is high enough for rupture and dike/sheet injection to take place, the energy is normally only sufficient to form non-feeders. (3) For feeder-dikes to form, inflation of the order of tens of centimeters or more is normally needed. (4) The deflation associated with dike injection can be used to estimate the likely dimensions of the resulting dikes/sheets. For example, the results show that laterally propagating dikes associated with typical deflation episodes as energy sources rarely reach lengths of tens of kilometers (5) Dikes/sheets whose paths are irregular are not only longer but propagate also in different fracture modes, thereby requiring larger energy to reach the surface than comparatively straight dikes/sheets. (6) Large strain energies and special stress conditions are required for vertical (caldera) and lateral (sector) collapses. These requirements are rarely met and can be monitored and forecasted. (7) Large effusive and explosive eruptions require very large elastic energies so as to squeeze out the magma from the chamber/reservoir. The stress and energy conditions that must be satisfied for such eruptions to occur are reasonably well understood and can be monitored and forecasted.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Investigation of Artificial Water Reservoir Triggered Earthquake at Koyna, India

Gupta, Harsh (1)

(1) National Geophysical Research Institute, Hyderabad-500007, Telangana, INDIA

Globally there are over 120 sites where artificial water reservoir triggered earthquakes are known to have occurred. Koyna, near the west coast of India is the most prominent site where triggered earthquakes are occurring since impoundment of the Koyna Dam in 1962. These include the M 6.3 December 10, 1967 earthquake, 22 M>5, and thousands of smaller earthquakes. The entire earthquake activity is limited to an area of about 20 km x 30 km, with most focal depths being within 6 km. There is no other earthquakes source within 50 km of the Koyna Dam. An ICDP Workshop held in March 2011 found Koyna to be the most suitable site to investigate reservoir-triggered seismicity (RTS) through deep drilling. Studies carried out in the preparatory phase since 2011 include airborne magnetic and gravity-gradient surveys, MT surveys, drilling of 6 boreholes going to depths of ~ 1500 m and logging, heat flow measurements, seismological investigations including the deployment of five borehole seismometers, and LiDAR. Significant results include absence of sediments below the basalt cover, the thickness of the basalt column and its relation with the surface elevation, and almost flat topography of the basement. The proposal submitted to ICDP for technical help in drilling two pilot boreholes has been recently approved. The future plan of work includes:

- Drilling of two 3 km deep pilot boreholes during 2015/2016.
- Concurrently planning of deep borehole(s), firming the specifications by the end of 2015, and setting up of the deep borehole observatory during 2016/ 2017.
- Plan for an international meeting and visit to Koyna in 2017.

Key words: Triggered Earthquakes, Koyna Dam

*On behalf of the Koyna Scientific Team including Shailesh Nayak (2), Brijesh Bansal (2), Sukanta Roy (2), Nemalikanti Purnachandra Rao (1), Satyanarayana H V S (1), Tiwari V M (1), Kusumita Arora (1), Patro B P K (1), Shashidhar Dodla (1), and Mallika Kothamasu (1).

(1) National Geophysical Research Institute, Hyderabad-500007, Telangana, INDIA
(2) Ministry of Earth Sciences, Govt. of India, Prithvi Bhawan, Lodhi Road, New Delhi-110003, INDIA

The World Stress Map Project – an ILP Success Story

Heidbach, Oliver (1); Rajabi, Mojtaba (2); Ziegler, Moritz (1); Reiter, Karsten (3), and the WSM Team

(1) GFZ German Research Centre for Geosciences, Telegrafenberg, 14473, Potsdam, GERMANY
(2) Australian School of Petroleum, The University of Adelaide, Adelaide, SA 5005, AUSTRALIA
(3) TU Darmstadt, Institute of Applied Geosciences, Schnittspahnstr. 9, 64287 Darmstadt, GERMANY

The World Stress Map (WSM) Project was initiated in 1986 under the auspices of the International Lithosphere Program. Focus of the first WSM phase was to characterize the intraplate stress field pattern and to publish an open access database of the contemporary crustal stress information. In 1992 the final project results were published in a special volume of the Journal of Geophysical Research [Zoback 1992] with the scientific results based on the WSM database with over 7300 data records. The key finding of the first phase is that for a number of major tectonic plates the orientation of the maximum horizontal stress SHmax is sub-parallel to absolute plate motion. The second phase of the WSM project lasted from 1996 until 2008 as a project of the Heidelberg Academy of Sciences and Humanities, located at the Geophysical Institute, Karlsruhe University. At the end of this phase the WSM database has increased to 21,750 data records. With this compilation regional and local deviations from the first-order plate-wide trend were identified and published in a special issue of Tectonophysics [Heidbach et al. 2010]. Since 2009 the WSM project is located at the GFZ Potsdam and a new database release is in preparation for the 30th anniversary of the WSM project in 2016. We present preliminary results of the new database release and two examples that show the practical use the WSM for the calibration of 3D geomechanical-numerical models; one represents a large scale model of the entire Alberta basin in Canada and the other is of smaller scale simulating the 3D in situ stress state of a potential waste disposal site in northern Switzerland.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Advances in Volcano-tectonics from Distinct Element Method numerical modelling

Holohan, E.P.(1); Schöpfer, M.P.J.(2); Sudhaus, H.(3), Walter, T.R.(1); Walsh, J.J.(4)

(1) GFZ German Research Centre for Geosciences, Section 2.1, Helmholtzstrasse 7, 14467 Potsdam, GERMANY; email: holohan@gfz-potsdam.de
(2) Department for Geodynamics and Sedimentology, University of Vienna, Althanstrasse 14, Vienna, AUSTRIA
(3) Institute of Geosciences, University of Kiel, Otto-Hahn-Platz 1, 24118 Kiel, GERMANY
(4) Fault Analysis Group, UCD School of Geological Sciences, University College Dublin, Dublin 4, IRELAND

Volcano-tectonic processes deform the lithosphere in many ways. Such deformation may relate to the emplacement, growth and depletion of magma bodies, the growth and instability of volcanic edifices and the interaction of volcanic systems with regional-scale tectonics. Large discontinuous strains of rock masses commonly result from these processes. These are successfully captured in analogue models, but less readily so by continuum-based numerical modelling. The Distinct Element Method (DEM) bridges past analogue and numerical approaches, by simulating the finite displacements and rotations of discrete particles. We here illustrate the application of DEM to volcano-tectonic processes by considering the case of caldera subsidence related to depletion of a magma body. The magma body and its host rock are represented as a region of non-bonded, low-friction particles within an assemblage of bonded, high-friction particles. Magma withdrawal is simulated by incrementally reducing the area of each reservoir particle. Resultant gravity-driven failure and fault-controlled subsidence of the overlying reservoir roof is explicitly replicated. The DEM produces the main structural features seen in both analogue models and nature. Moreover, the DEM reveals how stresses in the reservoir and its roof relate to these structures' formation and how those stresses change throughout the course of progressive deformation. Finally, the DEM models show how the development of large discontinuous strains in the host rock may influence the outcome of continuum-based source modelling typically used for understanding geodetic changes at active volcanoes. Other recent applications of the DEM in volcano-tectonics include simulations of volcano-spreading, volcano flank collapse, and sill intrusion. The DEM therefore represents a new path to closer integration of volcano-tectonic models with geodetic and seismic observations.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

The Unconventionals: Chance and Challenge for Europe

Hübner, Andreas (1); Horsfield, Brian (1)

(2) GFZ German Research Centre for Geosciences, Section "Organic Geochemistry", Telegrafenberg, 14473 Potsdam, GERMANY

Shale gas extraction, and whether it goes ahead on a global scale, is one of the big questions of our times. The ILP Task Force "The Unconventionals" was installed when the concept of shale gas was introduced to Europe. Leading research institutes like the German Research Centre for Geosciences GFZ, IFPEN in France, TNO in The Netherlands and RWTH Aachen University in Germany engaged in research as well as in information/outreach activities on unconventional hydrocarbons.

The industrial partnership project Gas Shales in Europe GASH (2009-2012) focused on the compilation of a European Black Shale Database and eighteen research projects on different shales. The overall scientific goal was to predict shale gas formation and occurrence in time and space. Major applications included gas in place, fraccability and heterogeneity of shales. GASH focused on the potential gas shales of Europe and also integrated proven US gas shales for calibration of key variables.

The BMBF-funded GeoEn project (2011-2013) included a shale gas part with research on organic geochemistry, basin modelling, sedimentology, and environmentally oriented topics. In total, more than 20 papers have been published from which eight were published in peer-reviewed journals. One main scientific result is a better understanding of geochemical processes leading to nanopore formation in gas shales. The other main scientific results concern the Lower Carboniferous in northern Germany (sedimentary controls of black shale formation, unconventional petroleum system modelling). A further major outcome is the establishment of the Shale Gas Information Platform SHIP.

To react to the growing public and political skepticism about unconventionals, ignited by the film "Gasland" with its pictures of flaming faucets, SHIP was launched in 2012 and TNO's Shale Gas Argument Map in 2013. Based on an international network of scientists, SHIP successfully engages in the public discussion of technical and environmental issues related to shale gas exploration and production. SHIP is ongoing and very active while scientific knowledge on unconventionals, and especially environmental topics, is increasingly growing and needs to be brought to the general public.

Other research projects have just begun, like the EU-funded "M4ShaleGas: Measuring, monitoring, mitigating managing the environmental impact of shale gas", and scientists keep on publishing in peer-reviewed papers and voicing statements like the recent Hannover-Declaration in Germany. The ILP Task Force "The Unconventionals" will continue to take part in the scientific and public discussion, gauging chances and challenges.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Integrated Remote Sensing and Numerical Modeling for Geohazard Characterization and Monitoring

Oommen, Thomas (1), Schaefer, Lauren (2), and Bouali, El Hachemi (2)

(1) Associate Professor, Department of Geological and Mining Engineering and Sciences, Michigan Technological University, Houghton, Michigan- 49931, U.S.A.

(2) Doctoral Candidate, Department of Geological and Mining Engineering and Sciences, Michigan Technological University, Houghton, Michigan- 49931, U.S.A.

Remote sensing and numerical modeling play critical role in geohazard characterization. In this study, we present the integrated application of these techniques to characterize and monitor slope instability in two challenging environments; volcanic edifice stability and slopes along transportation corridors. Remote sensing techniques are particularly advantageous for monitoring the deformation of active volcanos due to the logistical challenges involved in ground observation. For instance, Pacaya Volcano in Guatemala, a dominantly basaltic complex has been continually active since the 1960’s. Concerns over the stability of the edifice were investigated using a remote sensing technique known as Interferometric Synthetic Aperture Radar (InSAR) surrounding the 2010 eruption. Interferograms that were produced using ALOS PALSAR and UAVSAR data reveal that, the SW flank slid 3 m during this eruptive phase. This is the largest measured slope instability witnessed in a single event at a volcano that did not result in a catastrophic landslide. Numerical modeling indicates that the movement is due to NW-SE shallow magmatic intrusion, causing the edifice to slide along a weak basement layer.

Another challenging application where remote sensing could provide a viable solution is monitoring the condition of slope stability along the transportation corridor. Due to the vastness of the slopes, the current management practices are involved in restoring the slopes after the failure rather than identifying and remediating hazardous conditions before their occurrences. Computation of displacement and velocity, using InSAR and photogrammetry for slopes indicate that, the current condition and historic trends can be quantified using remote sensing. This information could be critical for the hazard characterization of slopes along transportation corridor.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Exploring Submarine Volcanoes along the Aegean Volcanic Arc

Paraskevi, NoMikou (1); Dimitris, Papanikolaou (1)

(1) Faculty of Geology and Geoenvironment, University of Athens, University Campus, Zografou, 15784 Athens, GREECE; email: evinom@geol.uoa.gr, dpapan@geol.uoa.gr

Submarine regions around active volcanoes are excellent locations for fostering multidisciplinary studies and targeting the development of proof-of-concept prototypes and of market-ready technological products. They offer the required challenging marine environment for validating a number of survey platform parameters, sensor capabilities in terms of observing fauna, habitats, minerals and morphology under a single Natural Laboratory. In particular, although submarine volcanoes pose significant threats to densely populated areas, their monitoring for inherent natural hazards is insufficiently developed, unlike land-based ones that are continuously monitored and host permanent infrastructure and instrumentation. Hazards relating to submarine volcanoes differ significantly from their subaerial counterparts, and therefore should be addressed separately in dedicated research efforts. Risk analysis for future catastrophic eruptions in submarine volcanoes is challenging and requires the most innovative and high-resolution mapping technologies to be developed and employed.

We focus on Greek offshore volcanoes, in the South Aegean Sea, which have demonstrated volcanic activity in recent times. From west to east these are: 1) Paphsanias submarine volcano in the Methana group; 2) three submarine domes to the east of Antimilos volcano and a hydrothermal vent field SE of Milos in the Milos group; 3) three volcanic domes east of Christiana, the growth of the Kamenes islands after the last catastrophic Late Bronze age eruption and a chain of about twenty submarine volcanic domes and craters in the Kolumbo zone northeast of Santorini in the Santorini group and 4) several volcanic domes and a volcanic caldera together with very deep slopes of several volcanic islands in the Nisyros group. All volcanic edifices are located within neotectonic grabens formed by normal faulting, sometimes overprinted by subvertical strike-slip structures.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Communicating risk in a highly complex environment: the Vesuvius Volcano-Phlegrean Fields area, southern Italy

Pasquaré, Mariotto F.A. (1)

(1) Department of Theoretical and Applied Sciences, Insubria University, Varese, ITALY

Vesuvius is a world-renowned volcano, a major touristic attraction but at the same time a source of significant volcanic hazard. Its latest major erupton in 1631 killed almost 4,000 people. The plinian eruption of 79 A.D. led to the emission of about 4 cubic km of ash and pumice, which buried the towns of Herculaneum and Pompeii. Vesuvius is also among the best-monitored volcanoes in the world; volcanologists are studying the deposits from past eruptions to gain further insights into the risks associated with future ones. It is foreseeen that more than 1 million people could be seriously affected by renewal of explosive activity. Another highly hazardous volcanic complex is the Phlegrean Fields Caldera, 5 km west-southwest of Naples, formed about 35,000 years ago with the eruption of 80 cubic km of ash (the Campanian Tuff). This presentation is firstly aimed at shedding light on public perception of volcanic risk in an urban area characterized by a high population density and affected by major social and economic problems. Secondly, volcanic risk communication efforts and science outreach activities are highlighted, as they have been increasingly carried out in recent years by the Civil Protection Agency and the several scientists that work to assess volcanic risk in this highly complex social and natural environment. The role of print and online media coverage of volcanic risk in the Naples area is also analysed: On one side, it has been instrumental in focusing public and political attention on the need to plan better volcanic crisis management stragegies; on the other side, the media have contributed to creating disproportionate alarmism in the local community. Suggestions are made on how to effectively raise public awareness of the local population about volcanic risk and help mitigate it, by strengthening and improving interaction between scientists, decision-makers and the media.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Circum-Arctic lithospheric transects from onshore to offshore

Pease V. (1), Coakley B. (2), Curtis M. (3), Faleide J. (4), Jokat W. (5), Meisling K. (6), Miller E. (6), Stephenson R. (7)

(1) Stockholm University, Department for Geology and Geochemistry, Stockholm, SWEDEN
(2) University of Fairbanks, Alaska, U.S.A.
(3) CASP, UNITED KINGDOM
(4) University of Oslo, NORWAY
(5) AWI Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, GERMANY
(6) Stanford University, School for Earth, Energy and Environmental Sciences, U.S.A.
(7) University of Aberdeen, School of Geosciences, Scotland, UNITED KINGDOM

Understanding the evolution of the lithosphere over time involves the integration and interpretation of geological and geophysical data, combined with good knowledge of the physical processes at work in the lithosphere giving rise to past and present structures. Tectonic activity related to the rifting process created the present-day structure of today's Arctic basins and bathymetric highs, and in the process modified older structures and architecture of the crust and lithosphere. The correlation of circum-Arctic terranes and orogens help to not only reconstruct paleogeography but to also define the role and determine the nature of the lithospheric processes that were active in the complex tectonic evolution of the Arctic.

CALE (Circum Arctic Lithosphere Evolution), an international and multidisciplinary effort involving c. 30 geologists and geophysicists from ten different countries working to link the onshore and offshore regions across the circum-Arctic region, is a scientific network in its final year. Crust to mantle cross-sections from onshore to offshore will be presented that integrate the latest scientific knowledge and data sets available for the Arctic. The principal Arctic transects include: Ellesmere-Canada Basin, Pacific Ocean-Lomonosov Ridge through the Bering Strait, across the Laptev Sea rift to the DeLong Islands, Barents and Kara regions across Timan-Pechora and Taimyr. These sections, the culmination of the CALE project, and their principle findings will be presented. The project concludes with a special publication focussed on these transects and the supporting investigations that made them possible.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Present-day stress and other geophysical parameters from deep well data

Pierdominici, Simona (1); Mariucci, Maria Teresa (2)

(1) GFZ German Research Centre for Geosciences, Telegrafenberg, 14473 Potsdam, GERMANY
(2) Istituto Nazionale di Geofisica e Vulcanologia, ITALY

A detailed knowledge of the stress orientation and magnitude in the earth crust allow estimating the active structure more favourable to move and the orientation of new ones, representing a fundamental contribution in defining the seismic hazard but is also a key point for many applicative researches (e.g. exploration and exploitation of underground resources, nuclear waste deep repositories, carbon dioxide sequestration etc.). Therefore new contemporary stress data from borehole breakouts, earthquake and fault data records have been collected, revised and analysed to obtain both an updated present-day stress map of Italy and a quantification of the spatial changes of the wavelength of the stress pattern by a statistical analysis. Nevertheless, there is lack of in situ data concerning stress magnitude and rock parameters in Italy. For this reason a detailed analysis on present-day stress field was performed to contribute to the knowledge of the shallow crust of the Venetian Plain (northeastern Italy) in terms of geophysical parameters of rocks and vertical stress magnitudes. Some deep wells in the area were selected and a detailed analysis of the sonic log data was carried out to obtain the values of the P-wave velocity in the different stratigraphic intervals for each well. Furthermore rock density for the single geological formation in each borehole was estimated following an empirical relationship between sonic velocity and density in sedimentary rocks. Magnitude of the vertical principal stress (Sv) was computed as the weight of the overburden in each well and the pore pressure was taken to be hydrostatic. These results are useful for crustal modeling but also input data for further studies.

Present-day stress field in Ross Sea (Antarctica) contribution of AND-2A Well (Antarctica)

Pierdominici, Simona (1); Montone, Paola (2), Schmitt, Douglas R. (3), Paulsen, Tim S. (4), Wilson, Terry J. (5), Jarrard, Richard D. (6), Wonik, Thomas (7), Handwerger, David (8)

(1) GFZ German Research Centre for Geosciences, Telegrafenberg, 14473 Potsdam, GERMANY
(2) Istituto Nazionale di Geofisica e Vulcanologia, ITALY
(3) University of Alberta, Edmonton, Alberta, CANADA
(4) University of Wisconsin, Oshkosh, Wisconsin, U.S.A.
(5) Ohio State University, Columbus, Ohio, U.S.A.
(6) University of Utah, Salt Lake City, Utah, U.S.A.
(7) Leibniz-Institute for Applied Geophysics, Hannover, GERMANY
(8) Schlumberger Research, Salt Lake City, Utah, U.S.A.

To define the present-day stress field in the upper crust and to understand the latest tectonic activity in the Ross Sea (Antarctica), borehole breakout and hydraulic fracturing test analyses were performed and compared to recent structural and geological investigations. The most essential objective of this work is (i) to identify the borehole breakouts along the 1137 m deep AND-2A well, (ii) to estimate the total length of breakouts and their orientation (i.e. the orientation of minimum horizontal stress), (iii) to correlate the borehole breakouts with existing structures in the boreholes (fractures and fractures zones) and (iv) to relate identified breakouts with the prevailing stress field at Ross Sea based on stress measurements performed in neighbour boreholes (i.e. CRP, AND-1A). The orientation of breakouts along the AND-2A well was measured using acoustic imaging (BHTV) and mechanical (Four-Arm Caliper) tools. The BHTV has shown a lot of interesting features such as many bedding planes, lamination and fractures (natural and induced) but few breakouts. The rare breakouts have also a small size (called proto-breakouts) but they are consistent with induced features. To better define the magnitude of the contemporary stress field in this area, a set of hydraulic fracturing stress measurements were carried out at depths of up to 1400 m below the rig floor at the bottom of the AND-2A borehole. The vertical stress was calculated by density log and it is between the maximum and minimum horizontal stresses. This result indicates a strike-slip stress regime at this location as also well constrained by the tectonic setting performed in this area of Antarctica. Finally, we believe that these results should be considered for future deep drilling in the Ross Sea.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

DynaM-Ice – Dynamics and Interaction of Mantle, Lithosphere and Ice Masses

Poutanen, Markku (1), Rogozhina, Irina (2) and the DynaM-Ice Team

(1) Finnish Geospatial Research Institute – FGI, FINLAND
(2) GFZ German Research Centre for Geosciences, Telegrafenberg, 14473 Potsdam, GERMANY

We propose a new project DynaM-Ice (Dynamics and Interaction of Mantle, Lithosphere and Ice Masses) as a task force of the International Lithosphere Program (ILP). It is a joint effort of two international projects, the former ILP co-coordination committee DynaQlim and the research initiative IceGeoHeat, designed to comprehensively study the history and present-day state of the continental regions subject to current and former glaciations. The broad aim of DynaM-Ice is to improve our understanding of the mechanisms driving the thermal and mechanical interactions between the Earth's interior and continental ice masses, with a particular focus on glacial isostatic adjustment and the effects of geothermal flux on ice dynamics. The integration of thermal and mechanical perspectives is necessary to better resolve the structure and rheology of the Earth's interior, especially beneath present day ice sheets. The key deliverables of this project will include new regional reconstructions of the thermal and rheological anomalies in the crust and mantle, glaciation history, sea level changes, and the thermodynamic state of the present-day ice sheets. These will derive from an interdisciplinary interpretation of seismic, magnetic, gravity and geomorphological data, reconstructions of absolute plate motion and paleoclimate alongside a large array of in-situ measurements and satellite observations. Especially in regions shielded by the present-day ice sheets, we expect to generate significantly improved constraints on regional lithospheric thickness and localized thermal and rheological anomalies in the underlying mantle. The DynaM-Ice network includes researchers from eighteen countries (and five continents) with complementary expertise in a wide range of geoscientific disciplines and detailed knowledge of the mechanisms underpinning the interaction between the solid Earth and surface processes.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Rift opening mechanisms revealed by episodic magma intrusion

Ruch, Joël (1); Wang, Teng (1); Xu, Wenbin (1); Hensch, Martin (2), Jónsson, Sigurjón (1)

(1) KAUST – King Abdullah University of Science and Technology, Thuwal, SAUDI ARABIA
(2) Icelandic Meteorological Office, IS-150 Reykjavik, ICELAND

During the past decade, rifting events and rifting episodes provide us new insights about the mechanisms that generate ground deformations, faulting and eruptions along divergent plate boundaries. However, our knowledge is still limited about, for example, the influence of pre-existing structures, the relations between intrusion and seismicity and the near field deformation. I will present two examples of episodic rift opening, in the southern Red Sea and in Iceland, with the aim to better understand how magma propagates and generates deformation and seismicity along divergent plate boundaries.

First, we studied the birth of two volcanic islands in the southern Red Sea that formed in 2011 and 2013. Using high-resolution remote sensing imagery and seismicity, we show that the intrusions are oriented oblique to the Red Sea opening at this latitude. We also found that the area is magmatically active since decades and is likely representing a rifting episode that was previously unnoticed. Second, we studied the collapse of a graben structure that was reactivated during a rifting event in 2014 originating from the Bárðarbunga caldera. This event led to the largest basaltic eruption in Iceland for more than 200 years. We use high-resolution radar imagery and seismicity to constrain the timing and the kinematics of the graben collapse in the near field. High-resolution radar amplitude image offsets show that left-lateral shear accompanied the opening across the graben, clearly supported by fault plane solutions over the same period.

These two examples of episodic magma intrusions along divergent plate boundaries suggest that pre-existing structures play a key role for magma propagation, with the influence of the regional stress field. We also show for the Icelandic case the first evidence of co-rifting shear opening and the direct influence of two centuries of far field strain accumulation fully released during a rifting event.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Active structural interactions at a rift-transform triple junction, NE Iceland

Rust, Derek (1)

(1) School of Earth and Environmental Sciences, University of Portsmouth, UNITED KINGDOM, email: derek.rust@port.ac.uk

The Northern Rift, part of the mid-Atlantic ridge system that crosses Iceland, is intersected by the right-lateral Husavik-Flatey transform fault, producing a remarkable subaerial exposure of structural features normally only seen in the oceanic realm. Moreover, the structures are developed in an extensive sheet of ~14 ka pahoehoe lavas, essentially forming a tabula rasa from which to record subsequent tectonics. These fortuitous circumstances, coupled with only minor vegetation development, create an area of <1 km2 containing innumerable fault features displayed in exquisite detail. From the ground the dominant faulting style is right-oblique normal, although linear 'teepee' compressional structures can also be recognised, possibly related to right-lateral crowding as the rift is approached, and compressional transfer zones are displayed between left-stepping en echelon faults. Piercing points can confidently be identified up to a separation of about one metre, and some
120 ground measurements were made, recording both slip vector and amount. Beyond this scale of observation, however, confidence diminishes, with piercing points at greater separations being more difficult to recognise, and uncertainty increasing over the possibility that some features may be related to lava inflation-deflation effects. Mapping these structures in the detail they merit presented an overwhelming task, which was only made possible through a return visit to carry out a drone survey (Malcolm Whitworth, this conference). The invaluable perspective gained from the resulting imagery enables such features as organised Riedel in Riedel structures to be recognised, as well as shedding light on an apparently systematic arrangement of depressions that at ground level appeared to be related to collapse of the pahoehoe surface as the result of lava drainage. Work to complete the mapping of all structures and opening vectors visible on the imagery continues.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Abiogenic hydrocarbons in the Tethyan serpentinite basement of southeastern Sicily (Italy): a xenolith perspective

Scribano, V. (1); Manuella, F.C. (1,*); Carbone, S. (1), Brancato, A. (2)

(1) Dipartimento di Scienze, Biologiche, Geologiche e Ambientali, Sezione di Scienze della Terra, Università di Catania, 95129 Catania, ITALY, *email: fmanuella@alice.it
(2) Istituto Nazionale di Geofisica e Vulcanologia-Osservatorio Etneo, 95123 Catania, ITALY

The most popular theory suggests that oils are generated by the alteration of biomass in sedimentary basins. Today, serpentinization and Fischer-Tropsch/Sabatier pathways are considered fundamental processes for the abiotic synthesis of organic molecules in slow/ultra-slow spreading oceanic ridges. Therefore, serpentinites may represent unconventional exploitable oil reservoirs (Szatmari et al., 2011).
A three decades study of deep-seated xenoliths found in the Hyblean tuff-breccia pipes (southeastern Sicily), along with recent geologic and geophysical investigations, brought to the conclusion that the basement of the Hyblean region and the Sicily Channel mostly consists of serpentinized peridotites belonging to the Permian Tethys Ocean (Manuella et al., 2015 and references therein). Some of the studied peridotite and gabbro xenoliths with a high degree of hydrothermal alteration bear abiotic organic matter, in form of alkane hydrocarbons (Ciliberto et al., 2009), asphaltenes (Scirè et al., 2011), and nanodiamonds (Simakov et al., 2015). Therefore we put forward the hypothesis that the Tethyan serpentinites beneath the Mesozoic–Cenozoic sedimentary sequence in Sicily and Sicily Channel (e.g., Pantelleria: Fiebig et al., 2015) host abiotic exploitable hydrocarbon reservoirs.

<u>References</u>

Ciliberto et al. (2009): Aliphatic hydrocarbons in metasomatized gabbroic xenoliths from Hyblean diatremes (Sicily): genesis in a serpentinite hydrothermal system. Chem. Geol., 258, 258–268.

Fiebig et al. (2015): Isotopic patterns of hydrothermal hydrocarbons emitted from Mediterranean volcanoes. Chem. Geol., 396, 152–163.

Manuella et al. (2015): The Hyblean xenolith suite (Sicily): an unexpected legacy of the Ionian–Tethys realm. Int. J. Earth Sci., 104, 1317–1336.

Scirè et al. (2011): Asphaltene-bearing mantle xenoliths from Hyblean diatremes, Sicily. Lithos, 125, 956–968.

Simakov et al. (2015): Nanodiamond finding in the Hyblean shallow mantle xenoliths. Sci. Rep., 5, doi: 10.1038/srep10765.

Szatmari et al. (2011): In: Closson (ed.) Tectonics, ISBN: 978-953-307-545-7, InTech, Available from: http://www.intechopen.com/books/tectonics/mantlelike-trace-element-composition-of-petroleum-contributions-from-serpentinizing-peridotites.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

How can dykes contribute volcano growth and eruption under the stress field?

Takada, Akira (1)

(1) Geological Survey of Japan, AIST, JAPAN

Magma partitioning through dikes is important process for crustal growth in the long-term, and volcanic hazard mitigation in the short-term. This paper treats mainly with basaltic dykes. (1) The three-dimensional model on the evolution of dyke system will be presented for the volcanic hazard mitigation. This paper discusses how dyke system evolves with volcano growth, interacting with the previous dyke system under the regional stress. The dyke system grows its dimension symmetrically with time. However, the adjacent stress sources, such as neighborhood faulting or volcanoes, and sector collapse, can change the dyke system asymmetrically. Some volcanoes develop circumference dikes at vertical growth or collapse. The time series data for fissure eruption sites with local faulting are presented: for example, Fuji, Hawaiian volcanoes, Etna, Hekla, Kliuchevskoi, and Galapagos volcanoes. The fissure eruption sites represent only dykes that can erupt. The data on concealed underground dykes are lacking. This study adds data on underground dykes along the sea cliff of an island volcano (Aogashima), the crater wall (Fuji), and the caldera wall (Tambora). (2) This paper reviews the various mechanisms how the ratio of erupted volume to supplied volume (E/S) is controlled using dyke theory. The erupted volume is important for volcanic hazard; the intruded volume can contribute to the crustal growth. The short-term E/S varies with time. The average E/S is compiled: ~0.3 for Hawaiian volcanoes, and ~0.15 for Iceland volcanoes. The long-term E/S is compiled using various crust section: ~0.1 for oceanic ridge, and ~0.75-0.9 for flood basalts. (3) Based on the field evidences on dyke system, I will show physical mechanisms on the evolution of dyke system controlled by the density difference, the regional and local stresses, and the supply rate, using analog experiments.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Craters of Elevation rise up again: classic geological ideas given new meaning though Geoheritage

van Wyk de Vries, Benjamin (1)

(1) Laboratoire Magmas et Volcans, CNRS / IRD, Observatoire du Physique du Globe, Université Blaise Pascal, Clermont-Ferrand, FRANCE

When Leopold van Buch created his Craters of Elevation theory after travelling to the Auvergne and Canary Islands volcanoes, these were already becoming classical sites for geological research. Von Buch's idea was thoroughly discredited through over zealous application to Etna, and through strong opposition from Craters of Eruption proponents. However, since the inception of the Chaîne des Puys - Limagne fault UNESCO World Heritage project, I have been motivated to restudy these old ideas, and we have found out that THERE ARE Craters of Elevation in the Chaîne and also at Teide. We have now found them all around the world, and have integrated them with modern basin research, where the Forced Fold is the structural geology equivalent. I shall talk through the parallel process of gaining geological knowledge and attempting to explain and characterise geoheritage that led us to reinstate von Buch's theory. We can learn important lessons from this example, especially: 1. how outreach and education can allow us to see our own science from the outside; 2. how to be careful about dogma and opposing ideas: 3. keeping an open mind, and accepting the evidence before us over the urge to defend pet theories. Now that Craters of Elevation is back in vogue, one of the main tasks for the above UNESCO project is to get the Limagne Fault to be as well understood by the general public as the Chaîne des Puys. Old Diluvian theories may not come back to bug us, but going through the ancient geosyncline ideas for the Limagne Rift, and the descriptions of Lyell and Co. we find them increasing reminiscent of more recent models of lithospheric large amplitude folding. We should apply newest ideas with the same regard for historical ones if we are going to provide the best science and Heritage outreach.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Volcano interactions: An overview on observations, statistical relevance, and models

Walter, Thomas R. (1)

(1) GFZ German Research Centre for Geosciences, Section "Physics of Earthquakes and Volcanoes", Telegrafenberg, 14473 Potsdam, GERMANY

Evidences are increasing that neighboring volcanoes are connected, and that tectonic earthquakes may trigger activity at volcano-fluid reservoirs. Some volcanoes erupt in chorus or erupt immediately after a tectonic earthquake occurred. Other volcanoes merely show signs of unrest, but no eruption. Still other volcanoes show no response, even though they are in a state of a generally high activity. The problem in volcano-earthquake interaction research is that the physical processes of the triggering are only poorly understood. Recent studies suggest a combination of (quasi)static and dynamic triggering, associated with permanent crustal strain or the short term passing of seismic waves, respectively. However, no consensus exists concerning the way how earthquakes are most effective for the triggering process, or about the time delays often observed between the passage of the seismic waves and unrest occurrence. Here the present state of knowledge on volcano interactions is outlined, and new directions to better understand the modes of interactions are discussed. In order to better understand the way earthquakes may trigger volcanoes, at GFZ Potsdam we designed laboratory experiments to simulate selected real scenarios as recorded by geophysical instruments. Our analog reservoir is situated on an earthquake simulator, constructed to allow systematic exploration and scenario simulation of empirical observables. The implications of the results are wide, and may not only apply to volcanoes triggered by earthquakes, but also to fluid reservoirs containing different fluids and/or gaseous phases.

DOI: http://doi.org/10.2312/GFZ.ILP.2015

Complex tectonics at the triple junction between the Husavik-Flatey fransform fault and the Gudfinnugja normal fault system, North Iceland: new insights from airborne unmanned vehicle (UAV) imagery

Whitworth, Malcolm (1); Rust, Derek (1); and Tibaldi, Alessandro (2)

(1) School of Earth and Environmental Sciences, University of Portsmouth, UNITED KINGDOM
(2) Department of Earth and Environmental Sciences, University of Milan Bicocca, Milan, ITALY

The Husavik-Flatey Fault is very well documented fault that forms part of the Tjornes transform fault zone in northern Iceland, striking NW-SE along the Tjornes peninsula. Here it intersects a set of approximately north-south trending normal faults of the Theystareykir fissure swarm, part of the North Volcanic Zone (NVZ). This triple junction between the Husavik-Flatey transform fault and the normal fault of the NVZ represents one of only a few locations where a transform-ridge intersection can be observed on land.

To document this unique zone, a team from the University of Portsmouth, UK undertook an aerial survey of the junction between the Husavik-Flatey fransform fault and the Gudfinnugja normal fault system in Northern Iceland using an unmanned aerial vehicle (UAV). From this survey, we were able to acquire imagery with a ground resolution of two centimeters and derive a digital surface model (DSM) with a resolution of ten centimeters.

This presentation will provide an overview of the UAV survey and present the results of the image and DSM analysis to map the triple junction in incredible detail; providing new insights into the tectonic processes operating a triple junctions including opening directions, fault locations and compressional and extensional tectonic structures.

Obituary for Evgenii Burov

1963 - 2015

It is with great sadness that we have to inform you today that our colleague and friend Evgenii Burov passed away Friday 9th October on his way to a meeting in Chile.

We lose one of our brightest scientists who inspired many of us with his innovative work.

Evgenii Burov was the initiator and leader of Task Force VIII - Lithosphere dynamics: interplays between models and data.

He is a recipient of the Edward A. Flinn-Pembroke J. Hart Award awarded to him by ILP in 1999 which was just one of the many distinctions Evgenii has received in the geoscientific community.

We lose a great colleague and teacher, an ERC Advanced Grant holder, a Stephan Müller Medalist of the European Geosciences Union, a member of the Academia Europaea.

Our thoughts are with his wife Katia and his son Alexei.

Sierd Cloetingh
President

Magdalena Scheck-Wenderoth
Secretary General

14 October 2015