International workshop

“The Geology of Eurasia”

Potsdam: 27-28 June 2019

Jointly organized by

The Helmholtz-Centre Potsdam German Centre for Geosciences GFZ

and

The Leibniz Society of Sciences at Berlin e.V.

ABSTRACTS

(PRELIMINARY VERSION

in alphabetical order)

Edited by Reimar Seltmann and Marco Bohnhoff

London / Potsdam, May 2019

The Leibniz Society of Sciences at Berlin e.V.

Workshop schedule I/II:

Thursday, June 27th:

10:00 Welcome addresses by the host organizations

Prof. Magdalena Scheck-Wenderoth, Director of GFZ Potsdam Department 'Geosystems'

Prof. Gerhard Banse, President of the Leibniz Society of Sciences at Berlin e.V.

10:20 Inauguration of Prof. Wenjiao Xiao as new member of the Leibniz Society

10:30 Inauguration lecture: Prof. Wenjiao Xiao, IGG CAS Beijing, China

New insights in the Altaids – Tethysides Amalgamation

11:30 L. Ratschbacher: *Steady-state plate tectonics – unsteady orogeny: a view form Pamir-Tibet*

D. Konopelko: *Neoproterozoic South Tianshan basement metamorphosed in the early Carboniferous*

T. Wang: *Orogenic Architecture and Crustal Growth from Accretion to Collision: Examples from the Central Asian Orogenic Belt and Kunlun-Qinling orogeny*

R. Seltmann, MLS: *Altaids metallogeny during 800 Ma and the jackpot at ~ 290 Ma*

12:50 Lunch, GFZ canteen building H

14:00 Keynote: Prof. A. M. Celal Sengör, MLS, Istanbul Technical University, Turkey

The Tectonics of the Altaids

14:50 M.R. Handy: *Subduction dynamics in the Alps-Mediterranean system seen from down under - the contribution of AlpArray*

15:10 Coffee break

15:30 M. Scheck-Wenderoth: *Present-day lithosphere configuration of the Alps and their forelands*

R. Kind, MLS: *Comparing the seismic structure of the mantle lithosphere of China, the USA and Central Europe*

P. Martinez-Garzon: *Contemporary stress and strain field in the Mediterranean from stress inversion, GPS data and shear-wave splitting*

S. Parolai: *The contribution of the Global Change Observatory Central Asia to seismic hazard assessment and risk mitigation*

17:00 General discussion

19:00 Workshop Dinner, Restaurant 'El Puerto' in Potsdam

Workshop schedule II/II:

Friday, June 28th:

09:00 Keynote: Prof. James Jackson, Cambridge University, UK

The role of lithospheric thickness variations in the active tectonics of Asia

09:50 J. Mechie: *Growing the Tibet plateau - the view from the deep crust, Moho and upper mantle*

I. Safonova: *Tectonic erosion in the Central Asian Orogenic Belt*

10:30 Coffee break

10:50 Keynote: Prof. Uwe Kroner, Technical University Bergakademie Freiberg, Germany

The assembly of Pangaea: the metallogeny of the orogens along the Rheic Suture

11:40 M.R. Strecker: *Neotectonics of the Pamir frontal thrust system: from earthquake ruptures to range-front segmentation*

E. Sobel: *A Triassic rift basin in the External Pamir - implications for Cenozoic intracontinental subduction*

A. Müller, MLS: *The geotectonic setting and genesis of the giant Oyu Tolgoi Cu-Au porphyry district, Mongolia: A rare example of an "ancient" (Devonian) porphyry-style deposit*

12:40 General discussion

13:30 End of workshop

Lunch, *GFZ canteen building H*

There is no fee to attend the workshop.

Please register by email to rha@gfz-potsdam.de

Workshop contact:

Prof. Dr. Marco Bohnhoff, MLS, GFZ Potsdam, bohnhoff@gfz-potsdam.de
Prof. Dr. Reimar Seltmann, MLS, NHM London, r.seltmann@nhm.ac.uk

MLS -Member of Leibniz Society of Sciences at Berlin e.V.

Lateral change from rollback subduction to oblique collision at the junction of the Dinarides and Hellenides

Mark R. Handy, Joerg Giese, Jan Pleuger, Eline Le Breton and many others

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The Dinarides-Hellenides orogen in the Western Balkans is a Late Cretaceous-Paleogene thrust-and-fold belt in the upper plate of the active Adria-Europe plate margin. The mode of convergence changes along strike, from roll-back subduction in the southern, Hellenic segment to highly oblique continental collision in the northern, Dinaric segment. The junction of these segments is marked by a 20° bend in the orogen and by a rotational normal fault trending at high angles to the orogen, the Skhoder-Peja Normal Fault. At depth, a ~150 km long NE-dipping slab anomaly representing the downgoing Adriatic Plate beneath the Dinarides lengthens across this junction and along strike to the SE, reaching ~900 km at the apex of the Hellenic arc. This slab is interpreted to have retreated from NE to SW as indicated in lithosphere-scale cross sections by the offset between the present plate interface and the Late Cretaceous Sava suture. Clockwise bending of the orogen began in Eo-Oligocene time, with accelerated rotation of the Hellenic segment since the middle Miocene. The Neogene component of bending is associated with an increase in shortening on a basal thrust running along the orogenic front, from only ~10 km north of the junction to at least 100 km south thereof. Higher in the nappe pile, bending is accommodated by orogen-parallel extension, clockwise block rotation and out-of-sequence thrusting. This Neogene thrusting is transferred to the Hellenic orogenic front via lateral ramps on dextral transfer zones.

The driver of Neogene tectonics has been enhanced rollback of the Hellenic segment of the Adriatic slab in the aftermath of Eo-Oligocene slab tearing beneath the Dinarides. The SW-retreating Hellenic slab segment induced clockwise bending of the southern Dinarides and northern Hellenides, including their Adriatic foreland, about a rotation pole in the vicinity of the Mid-Adriatic Ridge. This supports the idea that the Adriatic plate fragmented into two subplates (Adria s.str. and Apulia) and that the Apulian subplate, which is attached to the Ionian Sea and Nubia and is currently subducting beneath the Hellenic arc, has behaved non-rigidly. Future experiments invoking passive-array seismology may resolve the structures accommodating this behavior.

The role of lithospheric thickness variations in the active tectonics of Asia

James Jackson[1], Dan McKenzie[1], Keith Priestley[1], Alex Copley[1]

[1]*Bullard Laboratories, Department of Earth Sciences, University of Cambridge, UK, jaj2@cam.ac.uk*

Over the last decade advances in earthquake seismology have allowed us to make increasingly detailed maps of the variations in lithosphere (plate) thickness on the continents. The variations are dramatic, with some places up to 300 km thick, and clearly relate to the geological history of the continents as well as their present-day deformation. Though the horizontal resolution of the maps is currently about 200 km, that is still sufficient to show that many features which are apparently isolated in the middle of continents, such as intracratonic basins, intraplate earthquakes and volcanism, are in fact either within or on the edge of thick lithosphere, and correlate also with variations in plate strength that control the scale of geological structures and stratigraphy. Where the lithosphere thickness is about 120 km or less earthquakes are generally confined to upper crustal material that is colder than about 350°C. On the edge of thick lithosphere, the entire crust may be seismogenic, with earthquakes sometimes extending into the uppermost mantle if the Moho is colder than 600°C; but generally the continental mantle is aseismic. In such regions, earthquakes in the lower crust at 400-600°C require the crust to be anhydrous (granulite facies) and are a useful guide or proxy to both composition and strength. These correlations have important implications for the geological evolution of Eurasia. They can be seen to have influenced features as diverse as: the location of post-collisional rifting; intracratonic basin formation; the location, origin and timing of granulite metamorphism; and the formation, longevity and strength of cratons. In addition, they have important consequences for earthquake hazard assessment on the slowly deforming edges of continental shields or platforms, where the large seismogenic thickness can host very large earthquakes, as shown by historical and modern events and also by dramatic Holocene and late-Quaternary fault scarps (Fig. 1).

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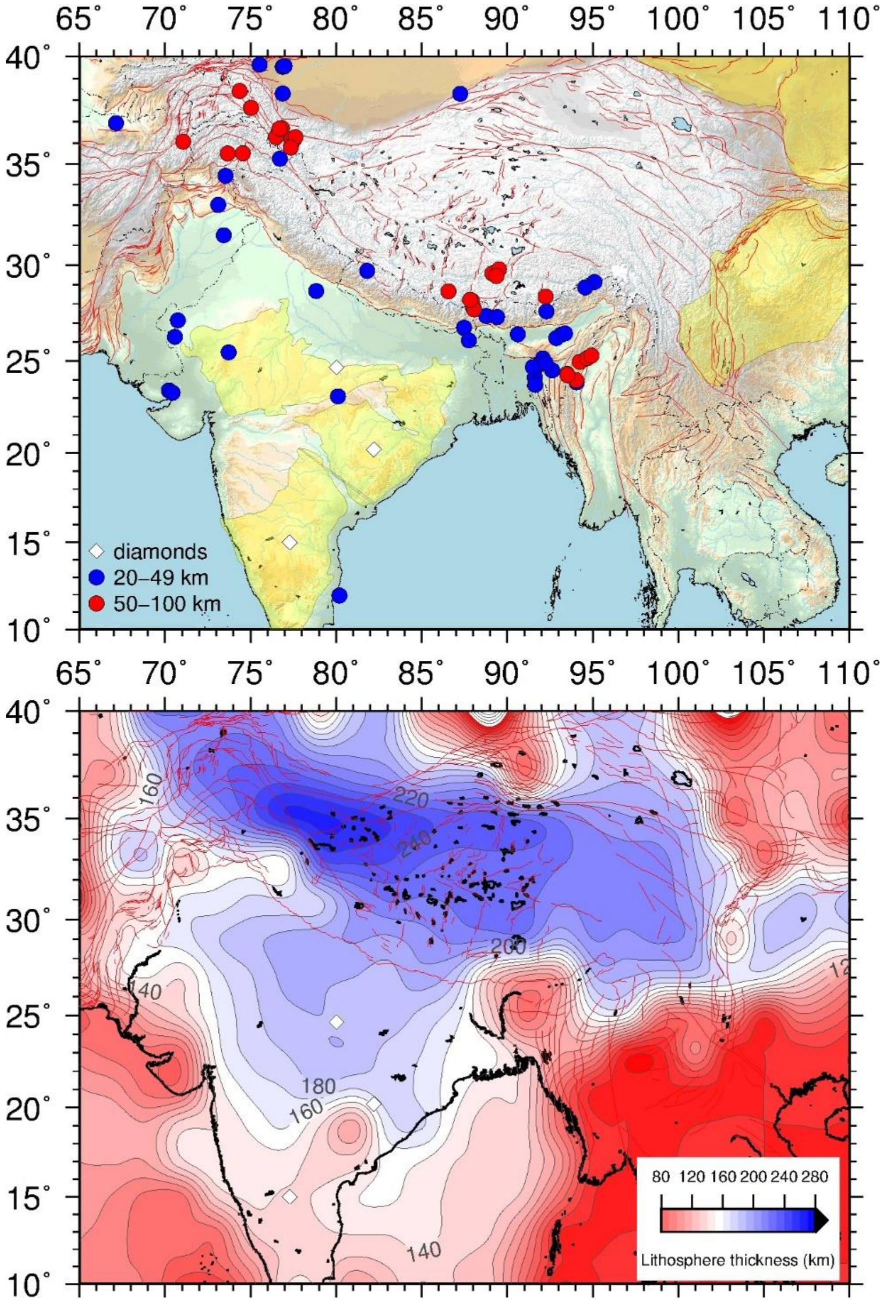

Figure 1. Top: Topography of the India-Tibet region showing outlines of ancient cratons (yellow), earthquakes of M_w >~5.4 whose depths have been confirmed by body-wave modelling as deeper than 20 km (see compilation of Craig et al 2012; but excluding deep earthquakes from the Hindu Kush and Indi-Burma subduction zone), diamond-bearing kimberlites, and active or Quaternary faults (Taylor & Yin 2009; Styron et al 2010). **Bottom:** Lithosphere thickness in the same region, from the April 2018 model of Priestley & McKenzie (see Priestley & McKenzie 2006 for the method used).

Comparing the seismic structure of the mantle lithosphere in China, the USA and Central Europe

Rainer Kind

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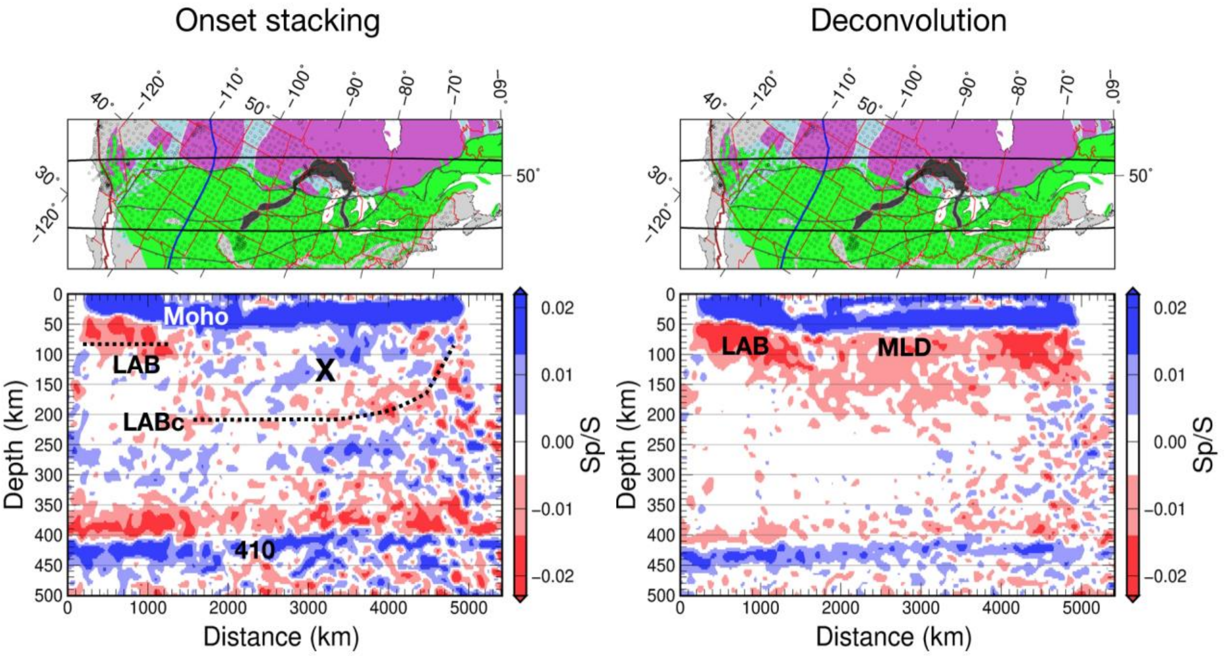
We address the question of a seismic velocity reduction in about 100 km depth which is observed in cratons and in younger continental regions. It is usually interpreted as lithosphere-asthenosphere boundary (LAB) in younger continental regions and as mid-lithospheric discontinuity (MLD) in cratons. Surface waves observe a low velocity zone in this depth and sharp higher resolution discontinuity is observed with the S-receiver function technique. The S-receiver function method uses S-to-P converted waves to image discontinuities in the upper mantle. However, the question if the negative precursors of the positive converted signal from the Moho (interpreted as LAB or MLD) could be an artefact of the processing technique (sidelobes due to the deconvolution) has never been thoroughly discussed. We modified the S-receiver function technique by skipping the deconvolution and obtained surprising results in the North American and Chinese cratons. The figure below compares a profile across the United States obtained with the new (marked Onset stacking) and the old (marked Deconvolution) receiver function technique. The LAB signal is observed in the tectonic active wester US with both techniques. The MLD below the craton is only observed with the old deconvolution technique. We conclude that the apparent MLD observation is an artefact of the processing and not a physical discontinuity. In the new method (Onset stacking) we see below the craton instead of the MLD a blue signal (meaning velocity increase) marked X. This signal could be interpreted as indication of old flat subduction below the entire Superior craton. With the new method we also see indications of the cratonic LABc near 200 km depth. More details are given in Kind et al. (2019).

We have done a similar study in China. There we confirmed the shallow LAB below the North China craton near 100 km depth. However, below the South China craton we also observe the LAB at the same depth, in apparent contrast to earlier observations. No indications of an expected cratonic LAB near 200 km depth are observed below the South China craton (Shen et al.; 2019). Earlier we had done a similar study in Central Europe (Kind et al.; 2017), however, still with the old method. At present we repeat this study with the new method and with the much increases data set of the AlpArray experiment.



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Neoproterozoic South Tien Shan basement metamorphosed in the early Carboniferous

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Paleozoic evolution of the western Tien Shan, which is built up on the basement of the Karakum continent, is poorly constrained compared to the better investigated Tien Shan terranes along the margin of the Tarim Craton. We present magmatic, metamorphic and detrital zircon ages for the regionally metamorphosed Baisun block and the metasediments comprising the Karakum basement in the westernmost parts of the South Tien Shan terrane. Age spectra of detrital zircon from metasediments of the Baisun metamorphic block and the western South Tien Shan show remarkable similarities over the vast area extending for ca. 500 km and are characterized by major Neoproterozoic peak at 1200 – 600 Ma and smaller peaks at 2300 - 1700 and 2700 - 2400 Ma. The 570 - 540 Ma ages of the youngest grains define late Neoproterozoic (Ediacaran) – early Cambrian maximum depositional ages of the metasediments. Comparison of the obtained age spectra with those published for the adjacent Tien Shan terranes indicate that the detrital zircon grains in the studied Ediacaran sediments were derived from the southern Precambrian continents of Karakum and Tarim while transport from the Northern Tien Shan was limited. The age of the Barrovian metamorphism in the Baisun block is constrained by ages of anatectic granites in the range 352 - 340 Ma, corresponding to early Carboniferous. These ages well match the 340 - 330 Ma ages, established for the adjacent Lolabulak and Garm metamorphic blocks. Based on the regional distribution of suture zones we suggest that during the Carboniferous the relatively small tectonic blocks of the South Gissar comprised an archipelago, located between the larger continents of Karakum and Tarim and possibly connected with the Paleotethys Ocean. The archipelago scenario can explain hot and rapid metamorphic and tectonic processes, documented in the South Gissar, similar to the ongoing collision along the Australia – SE Asia junction. The study was supported by the Ministry of Education and Science of the Russian Federation (project No 14.Y26.31.0018).

The assembly of Pangea: the metallogeny of orogens along the Rheic suture

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The Rheic suture is the result of the collision of Gondwana with Laurussia during the formation of western Pangea in the late Paleozoic. The Variscides of Europe / N-Africa and the North American Appalachians are directly related to the long-lasting convergence of both plates. The sedimentary, magmatic and metamorphic record within the orogenic belts provides evidence for recycling of Gondwana and Laurussia continental crust as well as the incorporation of juvenile material during supercontinent formation (Kroner et al., 2016). Another feature of these orogens is the occurrence of metallogenetic provinces along the plate boundary zone (Fig. 1). Here we focus on the distribution of Sn/W, Au, and U mineralization. We demonstrate, that the heterogeneously arranged mineralization along the Laurussia-Gondwana plate boundary zone resulted from the interplay of exogenic and endogenic processes during the entire supercontinent-cycle. This includes sedimentary accumulation of the ore elements during and subsequent to the initial continental break-up followed by tectonic accumulation during subduction-accretion and collisional tectonics. Recurrent heating during and after the formation of the supercontinent Pangea resulted in the mobilization of the metals and the formation of different mineral deposits.

Intense near-surface chemical alteration of sediments on stable mainland Gondwana in the early Paleozoic resulted in the residual enrichment of, e.g., Sn, W, Ta, and Au (locally forming placers), as well as Li, K, Rb, Cs that are incorporated into or adsorb on secondary minerals. Redox sensitive elements like U and Mo are lost along with the feldspar-bound elements Na, Ca, Sr, and Pb. Uplift and erosion of these sediments are causally related to the formation of the Rheic Ocean and the separation of Avalonia in the late Cambrian to Ordovician and resulted in the transport of this debris to the evolving passive margin of northern Peri-Gondwana. Avalonia received detritus from mainland Gondwana during the initial breakup stage and was completely decoupled from Gondwana during subsequent Ordovician seafloor spreading. Therefore, the late Ordovician Hirnantian glaciation affected exclusively mainland Gondwana and the Peri-Gondwana shelf to the south of the Rheic Ocean. Post-glacial sea-level rise resulted in global reducing conditions on shelf areas that acted as trap for U and other redox-sensitive elements. Only previously glaciated areas of Gondwana represent U sources and, therefore, Silurian black shales are U-rich on northern mainland Gondwana and Peri-Gondwana, but not on Avalonia and other parts of Laurussia that were separated from mainland Gondwana by the Rheic ocean. Most protoliths for Sn, Ta, W, Au, and U mineralization were part of the sedimentary pile on the extended Peri-Gondwana shelf. Although they follow different paths of enrichment, they occur in the same area as Silurian and Ordovician sediments have essentially the same spatial distribution. Tectonic accumulation at the active plate boundary includes the accretion of oceanic material at the active margin followed by pervasive thickening of the sedimentary accumulated protoliths. Early Paleozoic accretion of magmatic arcs and supra-subduction ophiolites is related to the formation of Laurussia, i.e., the Caledonian orogeny. Therefore, the distribution of some Au mineralization in the Appalachians is genetically not related to the shelf sediments of Peri-Gondwana, but to the tectonic accumulation of juvenile material.

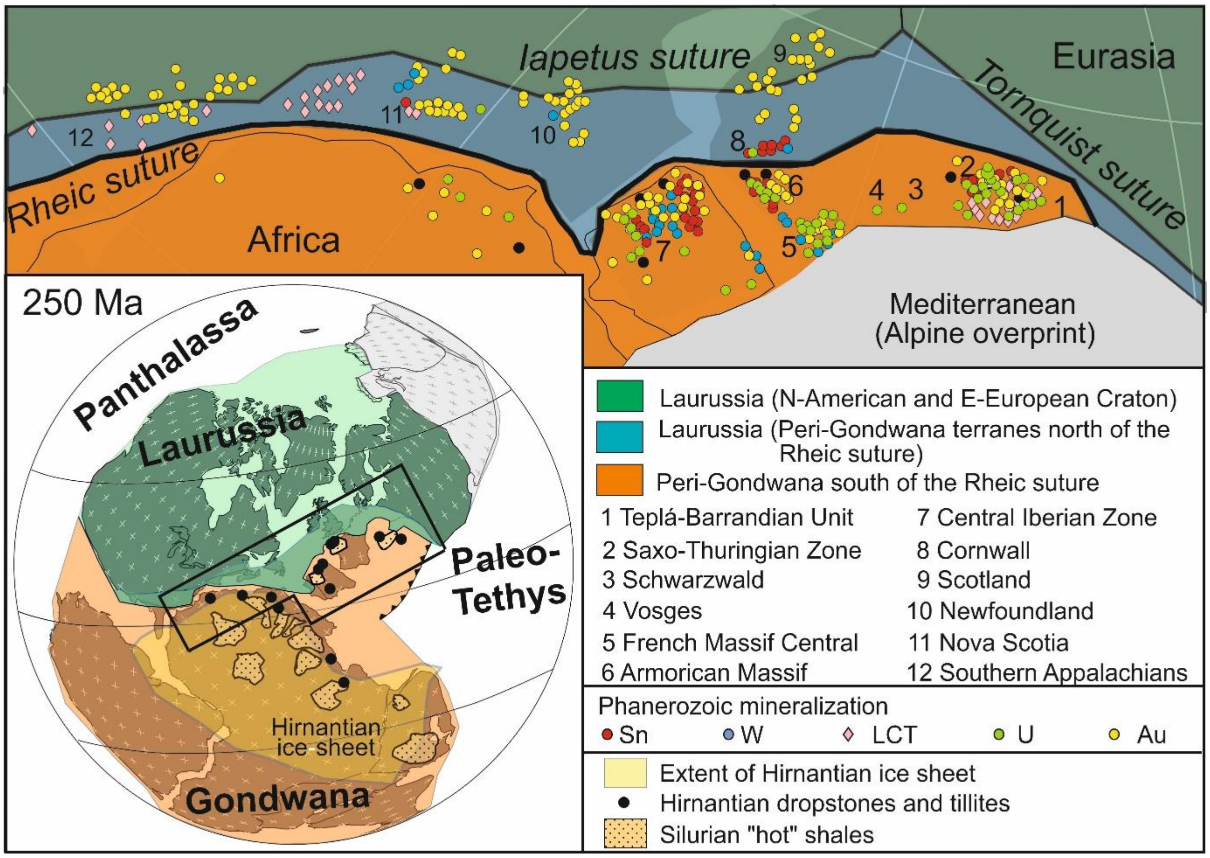

Fig. 1: Reconstruction of western Pangea for 250 Ma, showing the spatial distribution of Phanerozoic Sn, W, LCT (Li-Cs-Ta), Au, and U mineralization within the plate boundary zone between Laurussia and Gondwana. The distribution is controlled by protoliths rather than by tectonic setting; the timing of mineralization is controlled by tectonic processes (compiled from Romer and Kroner, 2016, 2018; Romer and Cuney, 2018).

Subduction accretion tectonics during the Variscan orogeny occurred in the Devonian and culminated in the early Carboniferous collision stage (Kroner and Romer, 2013). For example, pervasive nappe stacking affected the voluminous shelf sediments of the Armorican Spur, i.e., the extended promontory of thinned continental crust of the Gondwana plate, and led to initial metal mobilization exemplified by shear zone related orogenic gold deposits (Pochon et al. 2018) and synmetamorphic Sn/W enrichment inside the metasedimentary pile (Lefebvre et al., 2019).

Subsequent to the terminal intra-continental subduction event, rapid isothermal exhumation of (ultra) high pressure – (ultra) high temperature metamorphic rock volumes caused advective heat transfer to upper parts of the huge crustal pile introducing the final high temperature stage of the Variscan orogeny. The main characteristic of this stage is the formation of large granite batholiths, partly with world class Sn/W deposits.

Partial melting of Ordovician and Silurian sedimentary protoliths results in reduced melts with variable contents of Li, Cs, Ta, Sn, W, and U, largely depending on melting conditions and restite mineralogy. Different mobilization conditions, which are related to tectonic setting, result in regionally contrasting predominance of Li-Cs-Ta, W, and Sn(W) mineralization: Ta, Li, and Cs partition into the melt during muscovite-dehydration melting. In contrast, Sn partitions mostly in the restite during muscovite-dehydration melting and into the melt during biotite-dehydration melting. Multiple loss of partial melt results in Sn-rich restites and eventually Sn-rich late partial melts. The low-Ca, Na Ordovician sedimentary rocks are particularly suitable for such an enrichment process as metamorphism turns them into muscovite- and biotite-rich lithologies that allow for significant Sn enrichment during production and multiple loss of melt (Wolf et al., 2018). High-temperature melting processes are not restricted to syn-orogenic heat transfer but occur also during postorogenic intra-continental extension as exemplified by Cornwall, i.e., the most important European Sn/W district.

In contrast, Au is mobilized at much lower metamorphic conditions than necessary for partial melting. Thus, even though Au and Sn are enriched in the same Ordovician sedimentary protoliths, they are mobilized under different conditions and occur regionally separated along the Rheic suture zone.

Uranium mineralization is post-orogenic and is spatially related to late-(post) orogenic granitic and volcanic rocks, which show variable U enrichment if their source contained Silurian black shales deposited on the Gondwana shelf (high U contents). The formation of U mineralization is not related to the emplacement of these magmatic rocks, but to the leaching of readily mobilized U (mostly hosted in uraninite or volcanic glass) during multiple tectonic reactivation of fracture systems during the final formation of Pangea and the subsequent breakup of the supercontinent in the late Paleozoic and the Mesozoic/Cenozoic. In the European U-district, containing the world-class Ronneburg deposit (eastern Germany), recurrent reactivation of crustal-scale shear zones resulted in recurrent redistribution of U.

The metallogeny of the Gondwana-Laurussia plate boundary zone demonstrates the importance of weathering and glaciation prior and during sediment accumulation onto thinned continental crust of an evolving divergent plate boundary. These starting conditions are essential for later complex material enrichment paths at the convergent plate boundary zone. Tectono-thermal processes during subduction – accretion tectonics eventually followed by continent – continent collision are responsible for the initial formation of mineral deposits. Late to post-orogenic reactivation processes led to the recurrent metal mobilization.

Stable supercontinents can produce large volumes of weathered material. During the subsequent breakup stage they built vast passive continental margins accumulating giant volumes of shelf sediments. The sedimentary pile contains units that represent protoliths for a wide range of different metals. The formation of a new supercontinent includes the tectonothermal reworking of these lithologies at vast convergent plate boundaries. Recurrent intra-continental tectonics during the formation of a supercontinent and later during its initial breakup results in mineralization. Hence, the metallogeny on both sides of the Rheic suture represents a prime example for the causal link between the supercontinent cycle and the formation of mineral deposits.

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Contemporary stress and strain field in the Mediterranean from stress inversion of focal mechanisms, GPS data and shear-wave splitting

Patricia Martínez-Garzón[1], Oliver Heidbach[1], Marco Bohnhoff[1,2]

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Mapping the contemporary stress field of the Mediterranean provides fundamental insights on the complexity of plate tectonic forces in this region at different depths. Despite increased data availability and methodological improvements, most recent stress field characterization across the entire Mediterranean dates back to 1995. To extend the regional stress information, we use all earthquake focal mechanisms compiled in the World Stress Map database release 2016 for a formal stress inversion. Our main goals are (1) to improve the resolution of the stress field orientation, (2) to evaluate the performance of our stress inversion methodology in a tectonically complex region, (3) to test the hypotheses of similar stress orientations and heterogeneity with depth, and (4) to compare different types of stress and strain observations covering the entire depth range from GPS data at the surface to the mantle using shear-wave splitting data. The obtained stress orientations generally capture the main seismotectonic features of each area, including tectonically complex settings such as the Alpine Orogeny or the Ionian Sea. The orientation of maximum horizontal stress S_{Hmax} tends to be uniform with depth within uncertainties, but larger stress heterogeneity (quantified by means of the focal mechanism diversity and misfit angles) is resolved for the upper 1-10 km. Both, the orientation of the largest horizontal shortening axis of the strain field from potency tensors and horizontal GPS velocities are in general sub-parallel to the S_{Hmax}, indicating a linear stress/strain relationship and that the surface inelastic strain is consistent with the elastic strain accumulation. The Italian Peninsula displays largest discrepancies between stress and strain, potentially indicating changes with depth, a prominent role of aseismic deformation, and/or a non-linear relation between them. Increasing discrepancy between the S_{Hmax} orientation and fast shear-wave propagation is found from east (sub-parallel) to west (sub-perpendicular), eventually indicating that the stress from the crust and the mantle do not necessarily coincide.

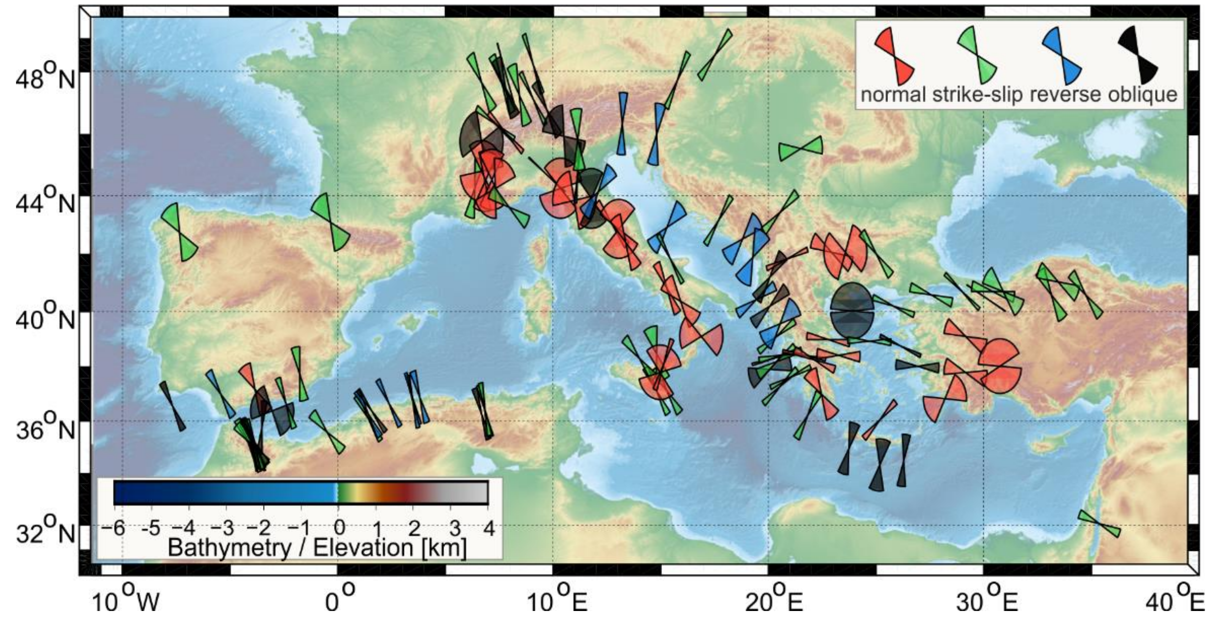

Figure 1. Obtained map of the orientation of maximum horizontal stress orientation and 95% confidence interval on different areas of the Mediterranean region.

Growing the Tibet plateau – the view from the deep crust, Moho and upper mantle

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The Tibet-Pamir plateau with an area of 2,500,000 km^2 and an average elevation of over 4500 m is the world's largest and highest plateau. Since 1994 the GFZ Potsdam has been involved in geophysical experiments on the Tibet-Pamir plateau. A seismic velocity cross-section down to 700 km depth beneath the Lhasa to Golmud transect across the Tibetan part of the plateau has been constructed. Beneath the cover layer, felsic rocks rich in α quartz exist down to 15-25 km depth. Beneath these depths, temperatures are probably high enough for ductile flow and partial melting to occur. The velocity increase across the boundary at 30-40 km depth marks the interface between felsic upper crust and more mafic lower crust. Crustal thickness is greatest (~74 km) south of ~31.5°N, where Indian lower crust forms the basal layer. Northwards, crustal thickness decreases to ~66 km around 33°N, before increasing to ~70 km beneath northern Tibet. Crossing the Kunlun, the crustal thickness change from ~70 km beneath the Songpan-Ganzi terrane and Kunlun mountains to ~54 km beneath the Qaidam basin is located about 100 km north of the Kunlun Fault and almost 45 km north of the North Kunlun Thrust. The Qaidam basin Moho is underlain by crustal velocity material for almost 45 km and the apparently overlapping crustal material may represent Songpan-Ganzi lower crust underthrusting or flowing northward beneath the Qaidam basin Moho. Thus the high Tibetan plateau may be thickening northward into south Qaidam as its weak, thickened lower crust is injected beneath stronger Qaidam crust. A similar situation is occurring at the eastern margin of the plateau across the Longmenshan. Here, the Moho occurs at 40-50 km depth below the Sichuan basin and deepens to the NW to 55-70 km depth under Tibet. However, whereas in the NE of the Longmenshan, the Moho deepening from SE to NW is smooth, in the middle and SW of the Longmenshan the Moho deepening is abrupt with, in some places, a possible overlap. In this case the high Tibetan plateau may be starting to thicken south-eastwards into the southwestern Sichuan basin as weak, thickened lower crust of the Songpan-Ganzi terrane is injected beneath the stronger crust of the Sichuan basin. Topographic loading of the high plateau and/or subduction of lithospheric mantle below the plateau may be driving and/or facilitating this mode of crustal thickening and plateau growth.

The geotectonic setting and genesis of the giant Oyu Tolgoi Cu-Au-Mo porphyry district, Mongolia: A rare example of an "ancient" (Devonian) porphyry-style deposit

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Porphyry deposits, the main source of Cu and significant amounts of Mo, Re and Au, are generally related to convergent plate margins in association with intermediate-felsic magmatism. Most porphyry deposits formed during the Phanerozoic but noticeably lesser amounts (<10%) in the Paleozoic and a very few are Proterozoic and Archean in age. If this pattern was due to erosion of older deposits (porphyry deposits form typically from 2 to 4 km depth) a general decrease of deposit size with increasing age would be expected to see but this is not the case. Thus, the decrease in porphyry productivity with increasing age has other reasons, like the evolutionary changes of plate tectonics. The largest Paleozoic porphyry mineralization is the Oyu Tolgoi district, which comprises of seven porphyry Cu-Au-Mo deposits in the southern Gobi Desert, Mongolia. The district defines a 12 km long, almost continuously mineralised trend, which contains in excess of 42 Mt of Cu and 1850 t of Au (Porter, 2016), and ranks among the largest high grade porphyry Cu-Au deposits in the world. The ~372 Ma old mineralization occurs within the Gurvansayhan island-arc terrane, which is located towards the southern margin of the Central Asian Orogenic Belt, a collage of magmatic arcs that were periodically active from the late Neoproterozoic to Permo-Triassic, extending from the Urals Mountains to the Pacific Ocean. Stratigraphic and U-Pb geochronologic data by Windley et al. (2007) indicate that the Oyu Tolgoi area in the Devonian was a primitive offshore island arc which did not interact significantly with ancient crust. However, the presence of sparse xenocrystic zircons, particularly in the intrusive rocks, and Nd isotopic data indicate that the arc was sufficiently close to a continental mass such that continentally derived material was encountered during magma genesis and emplacement. In traditional thinking, one of the favourable conditions for porphyry melt formation is the overriding of oceanic slabs by thick continental crust. This seems, however, not to be the case for the Oyu Tolgoi deposit. According to Solomon (1990) Tertiary-Quaternary porphyry deposits of the southwest Pacific Rim mostly formed after an arc reversal, which could be one circumstance which contributed to the formation of the Oyu Tolgoi mineralization. In this contribution we like to present our view on the formation of the giant Oyu Tolgoi Cu-Au porphyry district based on own data and reassessment of existing data.

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The contribution of the Global Change Observatory Central Asia to seismic hazard assessment and risk mitigation

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During the last few years several initiatives, coordinated by the GFZ German Research Center for Geosciences, are aiming at a harmonized seismic risk assessment and mitigation amongst the Central Asia countries.

In particular, the Earthquake Model Central Asia (EMCA) (Parolai, et al., 2015), the regional partnership of the Global Earthquake Model (GEM) and run in cooperation with local partners, allowed to obtain new probabilistic seismic hazard models calculated homogeneously for all the different Central Asian countries and compatible with those derived for the neighboring areas. Of major relevance during the EMCA project was the investigation of site effects via empirical and innovative methodologies in main target areas in each countries, therefore allowing deriving improved urban scenario accounting for the differences of ground motion due to the shallow geology effects.

EMCA, in synergy with other initiative like the EU financed SENSUM project or the World Bank project "Measuring seismic Risk in the Kyrgyz Republic", also addressed the problem of deriving new and updated exposure and vulnerability models for the whole area. These models are now allowing a multi-spatial and multi-resolution risk analysis that will facilitate local end-users in a quasi-real time accurate estimation of loss due to earthquake disasters.

In parallel to the EMCA initiatives, new projects were started aiming at the installation of new infrastructure in Central Asia mainly aiming at the collection of strong motion data in real time.

While the creation of an on-site early warning system in Bishkek already started (with the installation of 60 low cost SOSEWIN system in different buildings of the Kyrgyz capital) a large real-time strong motion network of already 18 real-time strong motion station was installed in the framework of the ACROSS initiative (Clinton et al., 2016). Note that this is the only real-time strong motion network existing in the whole Central Asia region.

These networks allow to collect the presently lacking strong motion data, necessary for improving seismic hazard and risk assessment, as well for improving the knowledge of the building behavior during weak and strong motion shaking. Last but not least they will offer the chance to implement a regional loss based earthquake early warning system for the main urban areas in the Central Asian countries. Software for real time loss assessment (CARAVAN) was developed and it is in a testing phase in cooperation with the Central Asia Institute for Applied Geosciences and the Kyrgyz Republic Ministry of Emergency.

Finally, the re-evaluation of information collected just after some of the large earthquakes occurred in the past, allowed to explain some of the co-seismic effect of the events in particular liquefaction and ground failure in Almaty.

In this talk, an overview of the activities carried out and scheduled in the next years will be provided as well as the major scientific and technical results obtained within these projects will be reported and highlighted.

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Deep lithospheric processes drive foreland inversion and the mountain building in the Pamir and Tian Shan

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The India-Asia convergence rates decreased from ~44 to 34 mm/yr at ~10 Ma (Molnar and Stock, 2009). Here, we relate mantle processes, the indentation of cratonic Indian lithosphere into cratonic Asian lithosphere beneath the Pamir and the ensuing rollback of Asian (Tajik-Tarim) lithosphere to processes in the Pamir, its foreland depression (the Tajik basin), and the Tian Shan. These processes have been active over the last 12-10 Myr.

Miocene granulite- and eclogite-facies xenoliths from the South Pamir provide a record of foundering of continental crust into the mantle. The xenoliths were derived from Asian (Gondwana-derived) crust like that exposed in gneiss domes exhumed from mid-deep crust. At 14-11 Ma, the xenoliths were heated 200–300 °C, buried to depths of 90 km – 20-40 km below the present Moho – and invaded by ultrapotassic/carbonatitic melts. This is interpreted to reflect crustal foundering synchronous with the onset of Indian cratonic lithosphere indentation and rollback of the Asian cratonic lithosphere as inferred from seismic imaging. Melting of the foundered crust and surrounding mantle produced the eastward migrating mid-Neogene – Recent Pamir/Tibet magmatism.

Tajik-basin inversion formed the thin-skinned Tajik-depression thrust-fold belt, outlined by westward convex anticlinoria and synclinoria underlain by a décollement in Jurassic evaporites. The belt's leading edge, the Uzbek and Tajik Tian Shan, constitutes the thick-skinned foreland buttress. Together, they form an asymmetric extruding-gliding-spreading nappe, connecting Pamir-plateau collapse with shortening in the Tajik-basin depression. In the thrust-fold belt and Tian Shan, apatite fission-track and (U-Th)/He data record shortening and erosion between ~12 and ~1 Ma, with exhumation to 2-3 km crustal depth within a few Myr after onset of shortening. The inversion, westward collapse, and shortening/transpression in the foreland buttresses was synchronous with and likely triggered by the indentation of cratonic Indian lithosphere into cratonic Asian lithosphere beneath the Pamir and the ensuing rollback of Asian lithosphere. Reviewing the modern mountain building in the central and western Tian Shan, we suggest that the deep lithospheric processes are also responsible for the onset of the rapid growth of the Tian Shan at 12-10 Ma, the reactivation of the Tallas-Ferghana fault, and the opposite rotation of the Ferghana and Tarim blocks.

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Tectonic erosion in Central Asian Orogenic Belt

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Subduction zones form and exist at Pacific-type convergent margins (PCM). PCM's are very important geological entities because on one hand they are major sites of juvenile crust formation on the Earth, but on the other hand they are places of strong crust destruction through tectonic erosion, which implies destruction of island arcs and accretionary prism by thrusting, oceanic floor relief, and fracturing. (e.g., Scholl, von Huene, 2007; Vanucchi et al., 2016). Accordingly, two contrast types of Pacific-type convergent margins – accreting or growing and eroding or narrowing - have been recognized so far. The accreting margins form accretionary complexes and grow oceanward. The eroding margins are characterized by shortening distance between arc and trench. The first evidence for the tectonic erosion at Pacific-type convergent margins was obtained from seismic reflection profiles made across the Tonga and Nankai trenches. The modern Pacific is surrounded by 75% of eroding convergent margins and 25% of accreting margins (Scholl, von Huene, 2007). As the present Western Pacific is a most probable analogue of the Central Asian Orogenic Belt (CAOB), processes of tectonic erosion could have been also active at the convergent margins of the Paleo-Asian Ocean (PAO), which suturing formed the CAOB (Safonova. 2017). Evidence for this comes from the Chatkal-Atbashi arc in the Kyrgyz Tienshan, the Itmurundy accretionary complex in central Kazakhstan and the Zharma and Char zones in eastern Kazakhstan. The Chatkal-Atbashi complex includes coeval and spatially adjacent Early Devonian arc granitoids, ophiolites and accretionary units. The Itmurundy and Zharma-Char zones host thick greywacke units but few outcrops of arc rocks; detrital zircons from those greywackes show unimodal U-Pb age curves and positive epsilon Hf suggesting intra-oceanic arcs once existed in the PAO, but later disappeared. Supported by megagrant of RF # 14.Y26/31/0018.

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Present-day lithosphere configuration of the Alps and their forelands

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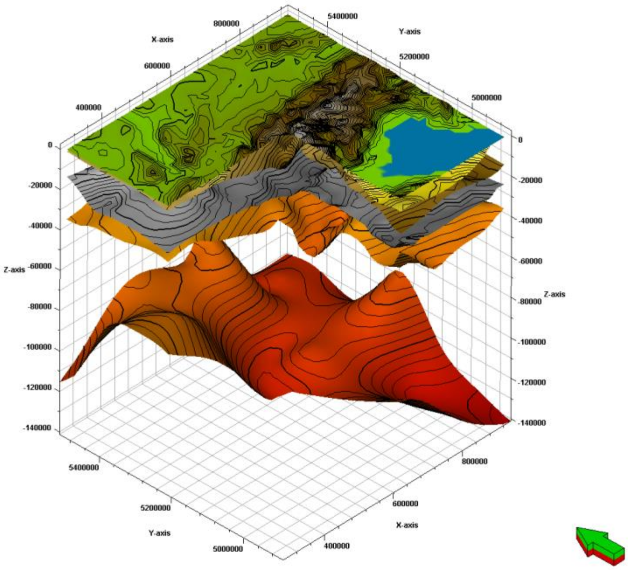
Mountain Building Processes in 4D

DFG Deutsche Forschungsgemeinschaft German Research Foundation



The European Alps developed in response to the continental collision of Europe and Africa in the Cenozoic that led to the formation of an orogen with adjacent foreland basins (Molasse and Po). As the amount of geological and geophysical observations in this region has steadily increased over the past few decades, the hypotheses put forward to explain the evolution of the system have also evolved. Within the DFG-priority program “Mountain building processes in 4D” we aim to derive a 3D description of the present-day physical state of the orogenic system through integration of numerous available geoscientific datasets including previous seismic and seismological experiments, observed gravity and existing 3D models. The generated model differentiates vertically between sedimentary layers (unconsolidated and consolidated), crystalline crustal layers (upper and lower) and mantle layers (lithospheric and asthenosphere). We find that the European crystalline crust is less dense and thicker (~2820 kg/m3, ~27.5 km) than the Adriatic crust (~2920 kg/m3, ~22.5 km). We find that lateral density contrasts within the crust of the two plates correspond to features expressed at the surface, such as faults but also boundaries between domains of different deformation intensity. Using the lithological interpretations derived from the seismically and gravity constrained 3D model, we assess the 3D conductive thermal field and related consequences for the deformation regime.

Altaids metallogeny during 800 Ma and the jackpot at ~ 290 Ma

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The Central Asian Orogenic Belt (CAOB, synonymously used to describe the Altaids orogenic collage) developed over 800 Ma from the Neoproterozoic to the Cretaceous.

It was a very busy place especially in the late Carboniferous to early Permian, with peak magmatism often described as granite flood and economic significant formation of mineral deposits. An extraordinary number of significant mineral deposits formed at ~290 Ma, including the Muruntau and Bakyrchik gold deposits, the Dhezkazgan copper deposit, and the Kalatongke-Maksut copper-nickel deposits, among many others. This contribution will explain why, how, and where these deposits formed and provide thoughts on where to explore next. It will kick-off with an overview of the tectonic setting and metallogeny of the region, include examples of specific deposits dated at ~290 Ma, and will wrap-up with highlighting the importance of the region.

The widespread, bimodal Early Permian magmatism of the CAOB, characterised by numerous A-type granites and mafic-ultramafic intrusions located in fault zones and suture shear zones, often of trans-lithospheric nature and commonly found also in the Permian rift basins, is considered to be essentially "post-collisional", but it occurs during a time when magmatism should be shutting down at the termination of a Wilson cycle. The collisional phase was northward underthrusting of the continental Tarim Block beneath the Tien Shan region of the CAOB, as evident from structural studies and deep seismic data. However, the tectonic regime is demonstrably extensional or transtensional.

Tectonic models have varied from ridge subduction to mantle "superplume" activity, but it is suggested that the magmatism was related to rapid retreat of the same long-term, W-dipping slab associated with accretionary development of the CAOB throughout the Paleozoic. As the Tarim and North China craton continental blocks approached the Siberian craton from the south in the Late Palaeozoic, the CAOB was trapped between these two blocks, and it folded to produce the characteristic E-W trending oroclines of the orogen. Synchronously, the underlying oceanic slab retreated eastward as the intervening cratons juxtaposed, producing a transtensional stress regime that induced melting of asthenospheric depleted mantle and refractory lower crust in a distal backarc setting, to produce the Permian A-type granites and coeval mafic rocks. This combined tectono-magmatic scenario set the stage for the mineralization peak taking place at around 290 Ma.

The Geology of the Altaids

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The Altaids are one of the largest superorogenic complexes in the world in which two genetically closely related orogenic complexes ended up generating much of northern Asia during the Palaeozoic and the early and medial Mesozoic. This immense superorogenic complex evolved as a consequence of the development of three large magmatic arc systems called the Kipchak and the Tuva-Mongol (Tuva-Mongol fragment housed two arcs) that were similar in size to the present-day Southwest Pacific arc chains. They both have rifted from the then combined (or close) Siberian and Russian cratons during the latest Neoproterozoic/earliest Cambrian following the Baykalide/Uralide orogeny. As a consequence of this rifting, the Khanty-Mansi Ocean opened behind them and they faced the Turkestan and the Khangai-Khantey Oceans, respectively. It is at the expense of these oceans that these two arc systems generated large subduction-accretion complexes. The Kipchak Arc was completely detached from the Siberian craton during the Neoproterozoic and it was reconnected with it along its trend by means of ensimatic arc systems that formed along its strike during the medial to late Cambrian. These ensimatic arcs also accumulated large amounts of subduction-accretion complexes in front of them during their migratory development throughout the Palaeozoic and, in Mongolia and in the Russian Far East, into the medial Mesozoic. As the accretionary complexes grew, magmatic fronts of their arcs migrated into them, turning them into arc massifs by magmatism and HT/LP metamorphism in arc cores. Especially near the Siberian Craton and in the Khangai-Khantey ocean, the subduction-accretion complexes were fed by turbidites shed from old continental crustal pieces. Where arc magmatic axes migrated into such accretionary complexes the material of which is of ancient continental provenance, they in places exhibit Proterozoic zircon ages and isotopic signatures inherited from their ancient source terrains leading to the mistaken conclusion of the presence of ancient continental crust under such arcs. It seems imperative to have proper field geological data together with the isotopic work to derive any reliable conclusions concerning crustal growth rates.

Şengör et al. (2014) compiled 1090 new, mostly zircon ages of magmatic and some metamorphic rocks from the literature for the whole of the Altaid supeororogenic complex. These ages show continuous arc activity from the Ediacaran into the early Cretaceous in the Altaids, although arc magmatism turned off already in the Triassic in the western Altaids. Much of the succeeding alkalic magmatism in the western moiety of the superorogenic complex was related to strike-slip activity opening the West Siberian basins such as the Nurol and Nadym and the large pull-apart basins of Alakol, Junggar and Turfan. There are numerous other smaller areas of extension related to the late Altaid strike-slip activity and they too have alkalic magmatism associated with them. Some of the alkalic granites not related to the late strike-slip activity may have been related to slab fall-off after terminal collisions, although this is now difficult to document with any confidence, although no Tibet-type collisional plateaux were ever produced as a consequence of Altaid collisions.

We have been able to find no evidence anywhere in the Altaids for independent trans-oceanic migrations of numerous 'terranes' tied to individual subduction zones. Only two major subduction zones were responsible for the entire Altaid evolution from the beginning to the end and this is consistent not only with the present tectonics of the earth where major subduction zones display great spatial continuity and temporal persistence, but also with the tomographic observations on well-imaged former subduction zones such as those associated with the Tethyan and the North American Cordilleran chains.

The entire Altaid collage now occupies some 8,745,000 km^2. At least half of this area represents juvenile addition to the continental crust during the Ediacaran to the earliest Cretaceous interval. That is more than 10% of the entire land area of the Asian continent. Similar events are now going on in the Nipponides in eastern Asia, in the Oceanian arc systems in the southwestern Pacific Ocean and in places around the Caribbean and the southern Antilles. Altaids were one of the main factories – if not *the* main factory – for the generation of the continental crustal during the earlier half of the Phanerozoic on our earth. This was not because the growth rate of the crust was unusual, but because so much of it was produced in such a huge area and in an interval of some half a billion years.

A Triassic rift basin in the External Pamir - implications for Cenozoic intracontinental subduction

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The Cenozoic Pamir consists of earlier accreted, east-west trending Mesozoic-Paleozoic terranes and intervening sutures broadly correlative with units exposed to the east, in Tibet, and to the west. The lateral offsets of sutures and the West Kunlun - North Pamir belt are thought to constrain the magnitude of Cenozoic Pamir indentation, which is typically assumed to be ~300 km. South of the narrow Alai foreland basin, the External Pamir (Trans-Alai range) comprises a thrust stack of Carboniferous to Neogene sedimentary rocks detached from the underthrusting Tien Shan-Alai crust, forming the Pamir Frontal Thrust system (PFT). The Northern Pamir is emplaced northwards over the External Pamir along the Main Pamir Thrust (MPT). The Northern Pamir comprises two major tectonic units separated by the Kunlun suture: (1) Paleozoic metasedimentary and (ultra)mafic igneous rocks equivalent to the Kunlun terrane (in the north) and (2) the Karakul-Mazar paleogeographic domain of Paleozoic metamorphic rocks intruded by Permian-Triassic plutons (in the south). The Karakul-Mazar terrane is bounded on the south by the Tanymas (Jinsha) suture, which represents the Triassic closure of the Paleo-Tethys Ocean following north-dipping subduction.

We have studied Paleozoic - Mesozoic sections of the External Pamir in the Qimgen, Gez and Oytag (Wuyitake) valleys, in NW China, the Altyn Darya valley, in the Kyrgyz Republic, and at Togde Past, in the Republic of Tajikistan. The Qimgen and Altyn Darya localities expose a clastic sequence with red sandstones that are offset by normal faults, pyroxene-bearing basalt dikes and flows, and rhyolites. Similar basalts can be found along-strike in Tajikistan. Both the structures and the bimodal volcanism suggest a rift setting; the size of the basin is not yet clear. We have constrained the latest Permian - Triassic age of both the volcanics and sedimentary deposits using Ar/Ar and zircon U/Pb dating. In particular, the major rhyolitic tuff is dated as ~240 Ma. In turn, the Triassic ages suggest that the basin formed in the back-arc of the Tanymas suture. We suggest that this extensional basin stretched along the rim of the entire Pamir; however, there is no evidence that this belt continued eastward into the Kunlun. It is not yet clear whether this basin closed during the Mesozoic or the Cenozoic.

The existence of this basin has important implications for the paleogeographic evolution of the Pamir region. When the basin opened, it would have offset the North Pamir southward with respect to Tarim, north of the Kunlun. In turn, this suggests that the North Pamir and the Kunlun may not have formed a linear belt in Mesozoic time or at the beginning of the Cenozoic. Since this alignment forms the basis for calculating the amount of northward indentation of the Pamir with respect to the Kunlun, existing geodynamic models may need to be reconsidered. Furthermore, if the rift basin only represents the margin of a broad oceanic basin which closed in the Cenozoic, the seismically-imaged south-dipping slab beneath the Pamir could represent the subduction of Triassic oceanic crust. Therefore, understanding the geodynamic evolution of this rift basin will help to constrain how the Pamir has deformed during the Cenozoic.

Orogenic architecture and crustal growth from accretion to collision: Examples from the Central Asian Orogenic Belt and Kunlun-Qinling-Dabie orogen

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Orogens can be generally grouped as: accretionary, collisional and intracratonic. However, how to define these types and to fingerprint differences on their architecture and crustal growth still remain to be answered. This paper conducts a comparative study between the Central Asian Orogenic Belt (CAOB), a typical and the world's largest Phanerozoic accretionary orogenic belt, and in the Kunlun-Qinling-Dabie Orogen, a typical composite and collisional belt and attempts to discuss these problems by juvenile compositions defined by Nd-Hf isotopic mapping of granitoids.

The CAOB, bounded by the Siberian Craton to the north and the Tarim-North China Craton, is the most important site of Phanerozoic continental growth on the Earth (e.g., Şengör et al., 1993; Jahn et al., 2000), even if the growth was probably overestimated (Kröner et al., 2017). Most granitoids in the CAOB have juvenile sources and can be classified into four types (e.g., Yang et al., 2017): (1) juvenile crust source, with juvenile Nd-model age (0.8-0.2 Ga) and positive εNd(t) value (0 to +8); (2) slightly-mixed source, slightly old Nd-model age (1.0-0.6Ga) and εNd(t) value around 0; (3) mixed source, characterized by large variation Nd-model age (1.6-1.0 Ga) and εNd(t) value (-10 to 0); (4) ancient source, characterized by very old Nd-model age (2.8-1.6 Ga) and very low εNd(t) value (-23 to -6).

The Kunlun-Qinling-Dabie Orogen, located in central China, is one of the main orogenic belts in Asia. It is the best suitable orogen to be compared to the CAOB, because (1) two belts formed during same times (Paleozoic-Mesozoic); and (2) they have the same craton (Tarim-North China craton) south to the CAOB and north to the Kunlun-Qinling-Dabie orogen. The granitoids in the Kunlun-Qinling-Dabie Orogen are different from those in the CAOB. They almost have negative εNd(t) values from -21.9 to -3 and old model ages of 2.3-1.2 Ga. Their values of εHf(t) are also mostly negative, and a few of lightly positive (e.g., Wang et al., 2015). Significantly, from the Kunlun-Qinling to the Dabie, i.e., from the composite orogen to collisional orogen, these εNd(t) become more negative and old model ages much older, suggesting juvenile composition decrease from a composite orogen to a collisional orogen.

All these signatures indicate that the granitoids in the CAOB have significant differences in Nd-Hf isotopic compositions from collisional orogens such as Kunlun-Qinling-Dabie Orogen, suggesting different deep crustal compositions for them. This study reveals that isotopic compositions of magmatic rocks can trace deep compositions of orogens and provide significant information for understanding orogenic composition, architecture and types (from juvenile accretionary, subductional to collisional) of orogens.

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New Insights into the Altaid-Tethyside Amalgamation

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The Altaids and Tethysides are two considerable orogenic systems in our planet (Şengör, 1987). In East Asia the Altaids and Tethysides contain key information about orogenic architecture and interactions, continental growth and metallogeny (Windley et al., 2007; Kröner et al., 2010; Seltmann & Porter, 2005). The closure of the Paleo-Asian Ocean (PAO) formed the Altaids, and the closure of the Tethyan Ocean (TSO), the Tethysides. Most previous reconstructions interpreted Tarim-Alxa-North China as a long Paleozoic continental chain that blocked the internal TSO ocean from the external PAO. However, it is controversial how and when the key continental blocks, including Tarim, Alxa and North China *inter alia*, were integrated into a continental chain. Paleogeographic and paleomagnetic data show that Kazakhstan, Tarim, Alxa and South China shared a similar Gondwana affinity, but North China was different (Song et al., 2017). In particular, recent paleomagnetic studies indicate that the Alxa block was not unified with North China until the late Permian (Yuan & Yang, 2015). In the late Paleozoic there were still wide oceans between Tarim, Alxa, and North China (Domeier & Torsvik, 2014). Therefore, an integrated Tarim-Alxa-North China blocking chain did not exist in the Early Paleozoic, because the major blocks of Kazakhstan, Tarim, Alxa, Qaidam, South China (SC) and Indochina (INC) were all mutually separated by extensive oceans. Detailed petrological and isotopic data of ophiolites in the western Altaids indicate that the ocean between West Tianshan and West Junggar belonged to the TSO (Liu et al., 2015) demonstrating that Tethys extended north of Tarim in the late Paleozoic. Therefore, in the Paleozoic there was likely a complicated archipelago system in which some intra-oceanic arcs provided links between all the major continental blocks, thus forming irregular boundaries between the so-called internal TSO and external PAO. In turn, this suggests there was considerable interaction between the Altaids and Tethysides in East Asia, in a manner comparable to the penetration of the Pacific plate into the Atlantic via the Caribbean Sea between the North and South American continents. So rather than an integrated Tarim-Alxa-North China continental blockage in the early Paleozoic, current evidence suggests that there was one larger, major composite continent composed of the Kazakhstan, Tarim, Alxa, Qaidam, North China, South China and Indochina blocks, called the KTANSI, which finally formed in the late Permian to Triassic. This configuration is based on the timing of final amalgamation of the intervening orogens situated between these major blocks, which all converged in the late Permian to Triassic. The South Tianshan was the major suture that welded the southern tip (Yili arc) of the Kazakhstan orocline with the passive margin of northern Tarim in the late Permian to mid-Triassic. The Tarim block was united with the Qaidam block by closure of the ocean within the Beishan and Eastern Kunlun orogens in the Permian. Since the Alxa block was not part of North China until the late Permian as deduced by paleomagnetic data, it is possible that a transform boundary separated these two independent blocks until the Triassic. Accordingly, in the Triassic there was a unified Kazakhstan-Tarim-Qaidam-Alxa-North China continental chain in northern East Asia, which was united with South China along the Qinling-Dabie-Sulu orogen, which in turn was amalgamated with Indochina along the Ailaoshan-Red River orogen in the Triassic. The suturing of these intervening orogens terminated in the Triassic, giving rise to a gigantic sigmoidal continental chain linked to another major sigmoidal complex composed of the Siberia craton and Tuva-Mongol orocline (Xiao et al., 2015; 2018). Complex continental mountain chains and multiple oroclines played important roles in the formation of orogens and continental growth of the East Asia continent.

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POSTER CONTRIBUTION:

Asian Gold Belt in western Tianshan and its Geodynamic setting, metallogenic control and exploration

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A lot of giant and world-class gold deposits, such as Muruntau, Zarmitan, Kalmakyr, Dal'neye, Unkurtash, Ishtanberdy, Taldybulak Levoberezhny, Kumtor, Sawayardun, Katebasu, concentrating along the centre Tianshan tectonic belt and the both sides of it, make up a famous gold metallogenic belt in the world, i.e. Asian Gold Belt, in western Tianshan which is located in the south-western region of the Central Asian Orogenic Belt from Uzbekistan through Kyrgyzstan to western Xinjiang, China (Yakubchuk et al., 2002; Xue et al., 2017). They build the second largest gold ore province in the world only after the Witwatersrand Basin in South Africa (Goldfarb et al., 2014). Why the Asian Gold Belt was able to form along a zonal region of about 3000 km long in W-E direction? What is the geodynamic setting and the key controls for the large-scale gold mineralization? Can the giant or world-class gold deposit be discovered in western Xinjiang Tianshan, China, just like that in Uzbekistan and Kyrgyzstan Tianshan? All of these significant geological and exploration problems are paid much more attention. The geodynamic setting and geological environments of the Asian Gold Belt, the elementary characteristics of the gold deposits in the belt, the metallogenic systems and their key controls, joint of the tectonic and metallogenic belts from western Xinjiang Tianshan, China, through Kyrgyzstan to Uzbekistan are reviewed based on the previous and our present researches. It is suggested that the originating, developing and closing of the Terskey and Turkestan-southern Tianshan oceans were the elementary geodynamic setting of the Asian Gold Belt (Yakubchuk et al., 2002; Seltmann et al., 2011; Xiao et al., 2013; Goldfarb et al., 2014; Xue et al., 2017; Alexeiev et al., 2019). The arc environment which is favorable to the formation of the porphyry copper-gold system developed during the ocean crust subductions (Yakubuchuk, et al., 2002; Xue et al., 2017), as well as the orogenic deformation environment which is profitable to the formation of the orogenic gold systems developed during the accretion and collision orogenic processes (Goldfarb et al., 2014; Xue et al., 2017). There are two types of gold systems, i.e. orogenic gold and porphyry copper-gold systems in the Asian Gold Belt. The older crust, deformation zones and overprinting hydrothermal alterations were the key controls for the orogenic gold mineralizations, yet the longer-developed matured arc, episodes of mantle-source magma and long-live mineralizations may be the key controls for the porphyry copper-gold mineralizations (Xue et al., 2017). The centre Tianshan tectonic belt is the core of the Asian Gold Belt and may be butted joint from Uzbekistan through Kyrgyzstan to western Xinjiang Tianshan, China. The Asian Gold Belt may enter into western Xinjiang Tianshan, China. It is hoped to discover giant or world-class gold deposits in the centre Tianshan tectonic belt and the both sides of it along the Nalati-Erbin belt in western Xinjiang Tianshan, China, which shows a complete orogenic gold mineralization factors and their perfect association (Xue et al., 2017).

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FURTHER CONTRIBUTIONS

(abstract not available yet) Status 14 May 2019

Neotectonics of the Pamir frontal thrust system: from earthquake ruptures to range-front segmentation

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