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Tethyan Dynamics I

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Session Title:

T026-I. Tethyan Dynamics I

Session Description:

Tethyan Realm is characterized by a series of mountain chains or plateaus along the equatorial zone over 15, 000 km, which has comparable size with the Cordilleran system at the eastern Pacific. The difference is that Tethyan evolution involved at least two completed Wilson Cycles (Paleo/Neo-Tethys) and an ongoing one (Indian Ocean) at its south. It includes various and complex processes like continent-rifting, ocean-spreading, oceanic subduction and continent-continent collision. The tropic positions of those mountain belts also significantly influenced the global climate and ecosystem. We welcome contributions from a range of areas, including but not limited to, geophysical imaging, geochemical/isotope studies, geodynamic modelling, and

geomorphological and paleo-environmental	Co-Organized:
studies to address the structural, composition, dynamic evolution and earth-surface processes of the Tethyan realm.	
Primary Section/Focus Group:	Abstract ID# 667652: Origin of the Kyrenia Terrane, Northern Cyprus: Results of Detrital
Tectonophysics	Zircon U-Pb Provenance Investigations in Triassic to Eocene Rock Units
SWIRL Theme:	Dominanted Duracentetian Comments Accienced by
Earth Processes	Program Committee (Oral, eLightning, or
Live Stream/On-Demand?:	Poster)
Νο	
Alternate Session Format:	

Туре:	
Oral	

Index Terms:

1031 Subduction zone processes [GEOCHEMISTRY] 7218 Lithosphere [SEISMOLOGY] 8104 Continental margins: convergent [TECTONOPHYSICS] 8120 Dynamics of lithosphere and mantle: general [TECTONOPHYSICS]

Sub Category:

Understanding the Dynamic Interactions among Earth-Surface Processes and Tectonics

Cross-Listing(s):

No

Co-Sponsor(s):

No

https://agu.confex.com/agu/fm20/t/sessions/index.cgi?username=107899&password=263857

No.

Adar Glazer¹, Dov Avigad¹, Navot Morag², Talip Güngör³ and Axel Gerdes⁴, (1)The Hebrew University of Jerusalem, Institute of Earth Sciences, Jerusalem, Israel, (2)Geological Survey of Israel, Jerusalem, Israel, (3)Dokuz Eylül University, Department of Geological Engineering, Izmir, Turkey, (4)Goethe University Frankfurt, Institute of Geosciences, Frankfurt am Main, Germany

Abstract Text:

Situated between Africa and Eurasia in the eastern Mediterranean, the island of Cyprus has developed on the northern margin of the southern Neo-Tethys by the accretion of three terrains, the Mamonia complex, the Troodos ophiolite, and the Kyrenia terrane. The latter comprises imbricated tectonic slices of Mezosoic-Cenozoic carbonate rocks, various clastic rock units and bimodal volcanic suites, alongside a thick Oligo-Miocene turbidite pile - the Kythrea flysch. This study was initiated with the aim of deciphering the provenance of Middle Triassic calcschist alongside Maastrichtian and Eocene sandstones of the Kyrenia terrane by detrital zircon U-Pb geochronology, in order to clarify its regional context. Our U-Pb geochronology data show that Precambrian-aged zircons in all three studied units cluster at the Neoproterozoic age interval (950-600 Ma). This Precambrian age profile resembles that of Paleozoic sandstone units of the Tauride block, as well as that of Paleozoic and Mesozoic sandstones found across North Africa. It is interpreted as reflecting the reworking of sand piles from the Taurides or any other peri-Gondwanan source. Phanerozoic-aged zircons cluster in four age groups: a small Silurian (~430 Ma) population appears in the Triassic and Maastrichtian units, Carboniferous (~300 Ma) and Triassic (~240 Ma) populations are conspicuous in all three units, and an Upper Cretaceous (~85 Ma) population significant in the Maastrichtian and Eocene units. Silurian and Carboniferous zircons are generally considered to represent north Paleo-Tethyan sources, although rare Carboniferous granitoids are recorded in the northern parts of the Anatolide-Tauride block, which resided at the southern margin of the Paleo-Tethys until the early Mesozoic. Possible sources for Triassic zircons are mainly found in the Aegean region with minor occurrences in the central Taurides, while sources for Upper Cretaceous zircons can be traced from the Pontides in the north to SE Anatolia in the south. Overall, while a provenance in the Taurides may account for the detrital zircon pattern of the Kyrenia, the presence of Paleozoic zircons points to an

unusual paleogeography whereby rock units of the Kyrenia, now amidst the Neo-Tethys, were fed from a Paleo-Tethyan source already in the Triassic.

Abstract ID# 718255: A sedimentary basin record of multi-phase continental collision in western Anatolia

Requested Presentation Format: Assigned by Program Committee (Oral, eLightning, or Poster)

Megan Mueller¹, Alexis Licht¹, Faruk Ocakglu², Clav Campbell³. Gui Aksit⁴. Kyle Lowery⁵. Michael H Taylor⁶, Gregorie Metais⁷, Pauline Coster⁸ and Kenneth Christopher Beard⁹, (1)University of Washington, Seattle, WA, United States, (2)Eskişehir Osmangazi University, Eskişehir, Turkey, (3)University of Kansas, Lawrence, KS, United States, (4)University of Oregon, Eugene, United States, (5)University of Washington, Seattle, United States, (6)Univ Kansas, Lawrence, KS, United States, (7)Centre de recherche sur la paleobiodiversite et les paleoenvironnements, Museum National d'Histoire Naturelle, Paris, France, (8) University of Kansas, Ecology & Evolutionary Biology, Lawrence, United States, (9) Ecology & Evolutionary Biology, University of Kansas, Lawrence, KS, United States

Abstract Text:

Determining the timing of intercontinental collisions can be a significant challenge in many orogens. Sedimentary, metamorphic, structural, magmatic and paleomagnetic estimates of collision can differ by 15-40 Myr. The timing of intercontinental collision along the >1,700-km long Izmir-Ankara suture zone (IAS) in Anatolia is no different: estimates span 20 Myr, from Maastrichtian to Ypresian. The collision age is debated between and within records of magmatism, deformation and exhumation, and metamorphism, and across geographical areas. To explain this range, various diachronous collision scenarios for the IAS are proposed, including a pre-collisional non-linear continental margin, an east-towest diachronous accretion of terranes, and an initial soft collision followed by a final hard collision. It remains unclear whether IAS closure is truly multi-phased or an artifact of comparing various records.

We investigate IAS evolution in western Anatolia by focusing on the evolution of one sedimentary basin, the Central Sakarya Basin. New geochronologic and sedimentary provenance proxy results, paired with previous stratigraphic work, reveal multiple phases of IAS evolution: Albian onset of an Andean-type margin, Campanian basement exhumation, a Paleocene magmatic lull, and earliest Eocene renewed magmatism and coeval basement involved shortening. Sedimentary provenance records therefore affirm multi-phased collision models for the IAS. We suggest that the ~20 Myr delay between initial intercontinental collision and the onset of significant upper plate deformation is related to either relict basin closure, or the switch from subducting thinned, passive margin continental lithosphere to full-thickness continental lithosphere.

Abstract ID# 723393: Temporal and spatial exhumation variations across the Talesh-Alborz Belt, Iran, reveal different responses to the Arabia-Eurasia collision Requested Presentation Format: Assigned by Program Committee (Oral, eLightning, or Poster)

Yang Chu¹, Mark Benedict Allen², Bo Wan¹, Ling Chen³, Wei Lin⁴ and Morteza Talebian⁵, (1)State Key Laboratory of Lithospheric Evolution, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China, (2)University of Durham, Durham, United Kingdom, (3)Institute of Geology and Geophysics, CAS, Beijing, China, (4)IGG Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China, (5)Research Institute for Earth Sciences, Geological Survey of Iran, Tehran, Iran

Abstract Text:

Accommodation of plate convergence during the Arabia-Eurasia collision is expressed in the exhumation record of the broad collision zone. In order to better constrain the spatial and temporal patterns of exhumation, this paper presents new geochronology (zircon U-Pb) and thermochronology (zircon and apatite (U-Th)/He) data for 18 samples from the Talesh Mountains of northwest Iran. The Talesh and the adjacent Alborz Mountains form the northern side of the Iranian Plateau. itself a first order feature of the collision zone. Zircon U-Pb ages record late Precambrian intrusion and metamorphism (~570 Ma), and a series of Jurassic, Cretaceous, and Oligocene intrusive events. Zircon U-Th/He ages are predominantly Mesozoic (150-90 Ma), whereas apatite (U-Th)/He ages are <20 Ma, peaking at ~7 Ma. When integrated with previous results, the combined data show more limited exhumation in the Talesh and northern Alborz than the southern Alborz, and a regional peak in exhumation in the Late Miocene (~7 Ma). We interpret the exhumation record to show that limited Cenozoic deformation and exhumation affected the Talesh and northern Alborz before the Late Miocene, at which time these areas were involved in significant deformation that persists to the present. Late Miocene onset of deformation may relate to a re-organization of plate convergence. The causes of this reorganization are debated, but could include elevation of the Iranian Plateau to a level at which it resisted further thickening, causing deformation to be accommodated in other regions.

Abstract ID# 700806: Tectonic transitions in the Tibetan plateau during India-Asia collision: Findings from scaled laboratory models

Requested Presentation Format: Assigned by Program Committee (Oral, eLightning, or Poster) Session Proposal Submission

Arnab Roy¹, Giridas Maiti², Joyjeet Sen² and Nibir Mandal², (1)Jadavpur University, Geological Sciences, Kolkata, India, (2)Jadavpur University, Department of Geological Sciences, Kolkata, India

Abstract Text:

The India-Asia continental collision, starting at ~50 Ma, has resulted in about 2000 km crustal shortening to build the Himalaya-Tibetan plateau, which is one of the landmark terrestrial features on the Earth. In this study, using a thin viscous sheet approximation we performed scaled laboratory model experiments to investigate the spatiotemporal variation in the Himalaya-Tibetan tectonics. The experiments allow us to constrain the Tibetan plateau topography as a function of the varying India-Asia convergence rates. Our results suggest two rigid crustal blocks: Tarim and Sichuan basins steered the growth pattern in the Tibetan plateau. Because of the resistance from the rigid Tarim block western Tibet uplifted first relative to eastern part, creating a topographic elevation difference, which directed the crustal flows grossly to NE. We show from experiments the elevated plateau topography underwent gravitational collapse when the indentation velocity dropped to present average of ~3.5 cm/yr at around 18 Ma. This event eventually led to a transition from contraction to extensional tectonics, dominated by east-directed crustal flows in response to the eastward topographic gradient developed during the early stage of fast collision. We compare the present day crustal flow velocity field, strain rates, and topographic variations in the model Tibet with the actual observations in the Himalaya-Tibet Mountain System.

Abstract ID# 711334: Paleocene Latitude of the Kohistan-Ladakh Arc Indicates Multi-Stage India-Eurasia Collision

Requested Presentation Format: Assigned by Program Committee (Oral, eLightning, or Poster) Craig Martin¹, Oliver E Jagoutz¹, Rajeev Upadhyay², Leigh Royden¹, Michael Patterson Eddy³, Elizabeth Bailey⁴, Claire I O Nichols⁵ and Benjamin P Weiss⁶, (1)Massachusetts Institute of Technology, Cambridge, MA, United States, (2)Kumaun University, Center for Advanced Study in Geology, Nainital, India, (3)Purdue University, West Lafayette, NJ, United States, (4)California Institute of Technology, Pasadena, CA, United States, (5)Massachusetts Institute of Technology, Earth, Atmospheric and Planetary Sciences, Cambridge, MA, United States

Abstract Text:

The nature of the collision events involved in the Himalayan orogeny offers insight into the role of convergent margins in plate reconfigurations, global climate, and the evolution of biodiversity. We report paleomagnetic data showing that an intraoceanic Trans-Tethyan subduction zone existed south of the Eurasian continent during Paleocene time. Our results demonstrate that this system was active at a paleolatitude of 8.1 ± 5.6 °N between 66 -62 Ma, located 600 - 2,300 km south of the contemporaneous Eurasian margin. The location of this system at the same time as the first ophiolite obduction event onto the northern Indian margin confirms that the collision was a multistage process involving at least two subduction systems. Collision began with docking between India and the Trans-Tethyan subduction zone in the Late Cretaceous and Early Paleocene, followed by the India-Eurasia collision in the mid-Eocene. Our results constrain the total postcollisional convergence accommodated by crustal deformation in the India-Eurasia system to 1,350 - 2,150 km, and the northsouth extent of the northwestern part of Greater India to < 900 km.

Abstract ID# 768285: The significance of Upper Jurassic felsic volcanic rocks within the incipient, intraoceanic Dras Arc, Ladakh, NW Himalaya Requested Presentation Format: Assigned by Program Committee (Oral, eLightning, or Poster)

Jessica Margaret June Walsh, University of Wollongong, GeoQuEST, School of Earth, Atmospheric and Life Sciences, Wollongong, NSW, Australia, Solomon Buckman, University of Wollongong, GeoQuEST, School of Earth & Environmental Sciences, Wollongong, Australia, Allen P. Nutman, University of Wollongong, GeoQuEST, School of Earth, Atmospheric and Life Sciences, Wollongong, Australia and Renjie Zhou, The University of Queensland, School of Earth and Environmental Sciences, St. Lucia, Australia

Abstract Text:

The Dras Arc is an island arc terrane located along the Indus Suture within the Ladakh Himalaya. To the north it is juxtaposed against the Eurasian Ladakh Batholith and to the south thrust over the Lamayuru Complex and Indian passive margin. Establishing the timing of inception and final collision of the Dras Arc is imperative to reconstructions of Neotethyan Ocean and timing of arccontinent collisions, prior to the terminal India-Asia continental collision. We describe and date felsic tuffs and adakitic felsic volcanic rock interbedded within the dominantly basaltic-andesitic Dras volcanic complex. These felsic volcanic units yield Upper Jurassic zircon U-Pb ages of 161 ± 1 and 152 ± 1 Ma respectively, making these the oldest reported units within the Dras Arc. We also report zircon U-Pb geochronologic and whole rock geochemical results for the Kargil Intrusive Suite which intrude the volcanic complex. Ages for the intrusives have been reproduced (102 ± 1 Ma and 101 ± 1 Ma), and a second, much younger phase (79 ± 1 Ma) has been identified as one of the youngest igneous phases within the Dras Arc. The presence of felsic, adakitic volcanism early in the evolution of the Dras Arc is consistent with the adolescent stages of island arc systems, in which dehydration melting of underplated arc or subducted oceanic crust generates small volumes of felsic magmas. Thus, the intraoceanic Dras Arc initiated in the Neotethyan Ocean during the Upper Jurassic, much earlier than previously reported, and possibly right up to collision during the late Paleocene between 60-50 Ma. It is likely that the Dras Arc developed together with the Spongtang **Ophiolite-Spong Arc complex and the** intraoceanic Zedong terrane of Tibet, first before colliding and accreting onto the passive margin of India prior to the terminal India-Asia continental collision.

Abstract ID# 709006: The bulk crustal structure of the Anatolian plate: evidence from H-K stacking of receiver functions Requested Presentation Format: Assigned by Program Committee (Oral, eLightning, or Poster)

Christopher Steven Steven Ogden, Imperial College London, Department of Earth Science and Engineering, London, United Kingdom and Ian D Bastow, Imperial College London, Department of Earth Science and Engineering, London, SW7, United Kingdom

Abstract Text:

The Anatolian Plate captures a broad range of tectonic processes from Aegean extension in the west to Arabian plate continental collision and in the east. The causes of Anatolia's uplift are debated, with dynamic support from a buoyant mantle, and crustal shortening both likely playing a role. Volcanism associated with subduction and lithospheric delamination/dripping has also affected Anatolia, but its impact on bulk crustal composition is poorly understood.

H-κ stacking is a widely used technique to glean crustal thickness (H) and bulk crustal Vp/Vs ratio (κ) from teleseismic earthquakes and has been employed by several studies on the Anatolian plate. When the crust is a simple layer above a halfspace approximation with a sharp Moho, H-κ stacking works well. However, Anatolia's complex tectonic and magmatic history likely renders this assumption invalid, at least in places, and this may explain why large discrepancies (up to 20km in Moho depth; up to 0.29 inκ) exist between studies with commonly analysed stations.

To address these issues, we use the modified H-k stacking approach of Ogden et al. (2019) to estimate crustal thickness and Vp/Vs ratio across Anatolia. Rather than using a single set of H-k stacking parameters (Vp, stacking weights etc), the Ogden et al., (2019) strategy explores the parameter space rigorously, including varying receiver function frequency content, as a means of understanding whether the Moho is an abrupt or gradational feature. We find that crustal thickness increases from 25km in western Anatolia to 47km in eastern Anatolia. In western Anatolia, H-κ stacking is reliable for many stations situated on the metamorphic Anatolide tectonic units, where the crust is ~30km thick. However, H-κ results are unreliable in the Eastern Anatolian Plateau where thick near-surface sedimentary and igneous strata disrupt the simple layer above a half-space assumption on which successful H-κ analysis hinges. Our frequency analysis reveals a gradational Moho is likely present across parts of central and eastern Anatolia, including the

Taurides and Pontides, perhaps as a relic of subduction processes. Vp/Vs ratios indicate a generally felsic crust, without evidence for widespread melt or mafic intrusion. We find that dynamic mantle support is required to explain Anatolia's high elevation.

Abstract ID# 766326: Receiver Function Mapping of Mantle Transition Zone Discontinuities Beneath Western Alps Using Scaled 3-D Velocity Corrections

Requested Presentation Format: Assigned by Program Committee (Oral, eLightning, or Poster)

Dongyang Liu^{1,2}, Liang Zhao², Huaiyu Yuan^{3,4} and Anne Paul⁵, (1)University of Chinese Academy of Sciences, College of Earth and Planetary Sciences, Beijing SHI, China, (2)Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China, (3)Centre for Exploration Targeting, University of Western Australia, Perth, Australia, (4)ARC Centre of Excellence for Core to Crust Fluid Systems, Macquarie University, North Ryde, Australia, (5)Univ. Grenoble Alpes, Univ. Savoie Mont Blanc, CNRS, IRD, IFSTTAR, ISTerre, Grenoble, France

Abstract Text:

The Alps orogenic belt resulted from continental collision between the Eurasian and Adriatic plates. The Western Alps orogenic belt has a complex tectonic history and the deformation in and around the Alps are significantly affected by several microplates and orogenic belts. The mantle transition zone is delineated by seismic velocity discontinuities around the depths of 410 and 660 km which are generally interpreted as polymorphic phase changes in the olivine system and garnet-pyroxene system. Previous tomographic models have revealed fast velocity anomalies localized deep in the mantle transition zone and piled up at 660km depth. Earlier seismic results however have not revealed the actual range extent of the subducting slab. In this study, we use P-to-S converted waves to study the 410 km and 660 km discontinuities beneath Western Alps.

This study uses data collected from 293 permanent and temporary broadband seismic stations (e.g., CIFALPS). Teleseismic events are selected from 30° to 90° epicentral distrance with magnitudes (Mw) between 5.3 and 8.5. Data are carefully checked by automated and manual procedures to give a total of 20514 receiver functions. Both 1D velocity model of the IASP91 and 3D velocity model of the EU60 are used for time-to-depth migration. The structure of the mantle transition zone revealed by the two velocity models has very similar characteristics but there are differences in the absolute depth of the discontinuity, suggesting large effects on the receiver functions caused by 3D velocity heterogeneities in the alps.

In the northern part of the study area, along the alpine orogenic belt, we find a localized arc-shaped thinning area with a depressed 410 discontinuity, which is attributed to hot mantle upwellings. The uplift is hardly seen on the 660 discontinuity, suggesting that the thermal material originates within transition zone. The depth of 410-discontinuity is found close to the global average depth in other regions. For the 660 discontinuity, the whole Alpine region has greater depth than global model predictions: the transition zone thickness in the western Alps is up to 40 km thicker than global model. This thickened mantle transition zone is likely attributed to the remnants from the oceanic mantle lithosphere that detached from the Eurasian plate after closure of the Alpine Tethys. **Primary Convener**

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