Imaging the subduction of continental crust and lithosphere beneath the northern margin of the Tibet-Pamir plateau

James Mechie[1], Rainer Kind[1], Xiaohui Yuan[1], Bernd Schurr[1], Felix Schneider[1], Christian Sippl[1], Wenjin Zhao[2], Mei Feng[3], Zhenhan Wu[2], Danian Shi[2], Heping Su[2], Guangqi Xue[2], Hui Qian[2], Prakash Kumar[4], Vlad Minaev[5], Mustafo Gadoev[5], Ilhomjon Oimahmadov[5], Ulan Abdybachaev[6], Bolot Moldobekov[6], Sagynbek Orunbaev[6], Sobit Negmatullaev[7]

[1] Deutsches GeoForschungsZentrum – GFZ, Telegrafenberg, 14473 Potsdam, Germany, jimmy@gfz-potsdam.de
[2] Chinese Academy of Geological Sciences, 26 Baiwanzhuang Road, Beijing, 100037, China
[3] Institute of Geomechanics, Chinese Academy of Geological Sciences, 11 Minzudaxuenan Road, Beijing, 100081, China
[4] National Geophysical Research Institute (CSIR), Hyderabad 500037, India
[5] Institute of Geology, Earthquake Engineering and Seismology, Academy of Sciences of the Republic of Tajikistan, Dushanbe 734063, Republic of Tajikistan
[6] Central Asian Institute for Applied Geosciences, 720027 Bishkek, Kyrgyz Republic
[7] PMP International, 59 Shevchenko St., Dushanbe 734025, Republic of Tajikistan

The main goal of this contribution will be to present recent results on the imaging of the subduction of continental crust and lithosphere from two seismological projects across the northern margin of the Tibet-Pamir plateau. The first project runs across the eastern end of the Qaidam basin and the Qilian Shan in the northeastern Tibetan plateau. The second project, the TIPAGE (TIen shan—PAmir GEodynamic program) project, is located in the Pamir and southern Tien Shan. The northern margin of the Tibet-Pamir plateau represents an important boundary as it is here that most of the outward growth of the plateau possibly occurs. Important faults occur here, such as the Kunlun fault which hosted the M8.1 Kokoxili earthquake in November 2001. Further, the large Qaidam basin in the northeastern part of the plateau is important for its mineral and hydrocarbon reserves.

For a period of about one year between the summers of 2010 and 2011, 25 broadband seismographs were deployed in a roughly linear array across the eastern end of the Qaidam basin and the Qilian Shan in the northeastern Tibetan plateau (Feng et al. 2014). This region is probably the most suitable place to study the ongoing convergence interaction between the high Tibetan plateau and the main Asian continental plate. Low-frequency *P* receiver function analysis of the data provides an image of the crust and mantle down to 700 km depth. In addition to the Moho at 45-65 km depth beneath the profile, the 410 and 660 km discontinuities bounding the mantle transition zone can be identified at 400-410 km and 650-660 km depths respectively. A possible increase in temperature in the upper mantle thought to exist beneath the northern part of the high Tibetan plateau is thus confined to this part of the plateau and lower upper mantle temperatures similar to those beneath southern Tibet occur beneath the Qaidam basin and Qilian Shan. When higher frequencies are included in the *P* receiver function analysis, a positive *Ps* converter dipping down to the south from 70-75 km depth at 37.9°N to about 110 km depth at 36°N is imaged. As this feature is only seen in high-frequency images and not in the low-frequency image, it is modelled as the positive *Ps* conversion from the base of an approximately 5 km thick anisotropic layer at the top of the Asian mantle lithosphere which is currently subducting. This south-dipping converter continues to the south on the INDEPTH IV profile (Zhao et al. 2011). *S* receiver function analysis completes the image of the structure below the Qilian Shan profile with the identification of the lithosphere-asthenosphere boundary (LAB). The LAB of the Asian plate is identified at 12-14 s (95-110 km depth) between 38 and 41°N below the northern part of the *S* receiver function profile. To the south it increases in depth such that it is at about 19 s (150 km depth) between 34 and 35°N at the southern end of the profile. The LAB of the Asian plate occurs at similar depths on the INDEPTH IV profile at the latitudes where the INDEPTH IV and Qilian Shan profiles overlap (Zhao et al. 2011). As on the INDEPTH IV profile to the south, between 34 and 35°N at the southern end of the Qilian Shan profile there is evidence from the *S* receiver functions for the LAB of a separate Tibetan plate (Zhao et al. 2011).

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The recent TIPAGE project in the Pamir and southern Tien Shan has produced new insights into this part of the Alpine-Himalayan orogenic belt (Mechie et al. 2012, Schneider et al. 2013, Sippl et al. 2013a, b, Schurr et al. 2014). Along the main seismic profile of the TIPAGE project, guided waves have been observed. These guided waves are associated with a south-dipping low-velocity channel in the upper mantle recognized from receiver function studies (Schneider et al. 2013). The low-velocity channel is coincident with the Pamir seismic zone and has been interpreted to represent Eurasian lower continental crust being subducted southwards beneath the Pamir (Schneider et al. 2013, Sippl et al. 2013a, b). Modelling of the guided waves should place further constraints on the average velocity within and the thickness of the low-velocity zone. Very preliminary results to date suggest that the low-velocity channel may have an average velocity as low as around 6.2 km/s and is on the order of about 10 km thick. This thickness is in agreement with the thickness of 10-15 km derived by Schneider et al. (2013). The low average velocity of 6.2 km/s would indicate either that upper crustal rocks are also being subducted to greater depths or that significant amounts of water are being transported to greater depths or that anisotropy with the slow axis oriented in the down-dip direction of the low-velocity channel exists.

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