Evidence for subduction of Asian continental lithosphere under the Pamir from lithospheric imaging

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Subduction of lithosphere is one way that shortening during continental collision may be accommodated. Although continental crust generally resists submergence due to its buoyancy, it may be pulled down intact by a leading oceanic plate during the last stage of the Wilson cycle or, alternatively, the lighter crust may be scraped off partly or entirely to allow the remnant lithosphere to sink into the mantle. The Pamir north of the western Himalayan syntaxis is arguably the best place to study this process, as an active Wadati-Benioff zone attests to subduction and xenoliths to deep burial of Eurasian crust. This is remarkable as, to the best of our knowledge, no oceanic plate is involved here. The intermediate depth earthquakes are an oddity too, because everywhere else on Earth deep seismicity (depth > 100 km) is exclusively occurring in active or closed oceanic subduction zones. However, it is these earthquakes that allow us to image deformation and structure at depths, where we are blind in other orogens.

We use seismological data from several temporal deployments between 2008 and 2012 [1] and a suite of passive seismic methods, i.e. high resolution earthquake locations, source mechanisms, tomography and receiver functions, to understand the processes acting at this unique setting. The relocated seismicity clearly defines two distinct planes below Pamir and Hindu Kush separated by a gap where strike and dip directions change abruptly [2]. The Pamir seismic zone forms a thin (~10 km width), curviplanar arc that strikes east-west and dips south at its eastern end and then progressively turns by 90° to reach a due eastward dip at its southwestern termination. Receiver functions (RF) reveal that the earthquakes are occurring inside a thin low velocity zone (LVZ), which can be tracked to at least 150 km depth [3]. We interpret this as subducted lower crust that is eclogitized along its descent. Local earthquake tomography images an arcuate high velocity region underlying the seismogenic plane, most probably representing cold Eurasian mantle lithosphere. On top of the LVZ imaged by RFs and just above the onset of deep seismicity, very low seismic velocities attest to probably middle crustal material that has been pulled down to depths locally exceeding 90 km before it is detached from the lower crust. We show that beneath the Pamir a big chunk of crust is pulled down by cold mantle lithosphere to depths between 80-100 km, where lower crust and mantle detach to continue subduction, and from where on earthquakes commence inside the lower crust probably due to metamorphic reactions.

[1] J. Mechie, X. Yuan, B. Schurr, F. Schneider, C. Sippl, L. Ratschbacher, V. Minaev, M. Gadoev, I. Oimahmadov, U. Abdybachaev, B. Moldobekov, S. Orunbaev and S. Negmatullaev, Geophys. J. Int., 188, 385 (2012).
[2] C. Sippl, B. Schurr, X. Yuan, J. Mechie, F.M. Schneider, M. Gadoev, S. Orunbaev, I. Oimahmadov, C. Haberland, U. Abdybachaev, V. Minaev, S. Negmatullaev and N. Radjabov, J. Geophys. Res., 118 (2013).

[3] F.M. Schneider, X. Yuan, B. Schurr, J. Mechie, C. Sippl, C. Haberland, V. Minaev, I. Oimahmadov, M. Gadoev, N. Radjabov, U. Abdybachaev, S. Orunbaev and S. Negmatullaev, Earth Planet. Sci. Lett., in press (2013).

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