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Seismic structure in the crust and upper mantle beneath the Hindu Kush and Pamir from Full Waveform Inversion

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The Hindu-Kush and Pamir are located north of the western syntaxis of the Himalaya, representing one of the most active continental collision zones involving a complicated lithosphere deformation history. Based on the increased seismic data coverage in this region we employ the Multi-Scale Full Waveform Inversion Scheme (MSFWI) to investigate the seismic structure of the crust and uppermost mantle using earthquake waveforms (12-100s) and cross-correlation Green's Function derived from ambient noise (10-80s). Through the MSFWI joint inversion, we provide high-resolution images for isotropic Vp and radial anisotropic Vs (Vsv and Vsh).

We image the subducting Hindu-Kush slab beneath the interaction zone of the Hindu-Kush and Tajik-Basin at depth and a thin and relatively low-velocity layer is detected on top of the subducting lithosphere, hosting the intense intermediate depth seismicity, indicating the subducting lower crust of the Hindu-Kush slab. The transition from relatively low-to-high velocity indicates the termination of eclogitization of the subducting crust accompanied by a gradual increase of negative buoyancy causing a slab break-off at a depth of around 150 km. This process is ongoing and accompanied by a deep seismicity cluster. Atop of the Hindu-Kush subducting system, low-velocities are imaged within the lower continental crust, dipping to the southeast. This gently dipping low-velocity layer connects the collision zone of the Hindu-Kush and Indian plate, hinting at a complicated lower crust subduction process, which is also accompanied by a very deep Moho up to 80 km.

Beneath the Central Pamir, a narrow low-velocity zone in the lower crust and uppermost mantle (down to 100 km) follows the curvature of the intermediate-depth seismicity and suture (and thrust faults), marking the active collision position of the Indian-Asian plates, which resulted in an exhumation and significant crustal thickening. The thin and southward dipping low-velocity zone in the uppermost mantle is also consistent with the intermediate seismicity, illuminating the subducting lower crust of the Asian plate while meeting the rigid Indian indentation.

Meanwhile, a strong sharp transition from high-to-low velocity coinciding the Talas-Ferghana fault at mantle lithospheric depth delineates the transition from the Ferghana basin into the Central Tien Shan, indicating the large scale lithosphere delamination beneath the whole Central Tien Shan with some lithospheric remnants existing beneath the central part of Central Tien Shan. This remnant high-velocity lithosphere possibly indicates that the deformation for the Central Tien Shan mainly concentrated on the south and north end due to the compression from the Tarim basin and Kazakh Shield, respectively.