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Seismic evidence of upper mantle melt caused by a subducted slab in the Indian-Eurasian continental subduction zone

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A low-velocity layer atop the mantle transition zone has been extensively observed worldwide, which may play an important role in mantle dynamics and Earth habitability. In subduction zones, this layer is widely explained as partial melting triggered by slab subduction on a regional or global scale. However, direct observational evidence is still absent, and the response of the layer to slab subduction is not well known. Here, we image the seismic velocity around the mantle transition zone by matching synthetic and observed triplicated seismic P and sP waveforms in the Indian–Eurasian continental subduction zone. Our observations reveal a laterally varied low-velocity layer atop the mantle transition zone beneath the Hindu Kush, where a subducted slab extends to the mantle transition zone. It is characterized by thickness of 56-94 km and P-wave velocity drop of -2.8~-4.7%. The geometric morphology of the low-velocity layer indicates that it is a partially molten layer induced by the subducted slab on a regional scale. Interestingly, our observations also support that the layer has a low viscosity. The decreased viscosity possibly facilitates slab motion in the deep domain; however, the buoyant continental crust in the shallow domain likely resists downwards movement of the slab. This differential movement is more likely to cause slab stretching, tearing and break-off in the middle region, which may contribute to explaining rare recurring large intermediate-depth earthquakes in an intracontinental setting.