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Anisotropic Mantle Lid in Young Subducted Slab underplating Central Mexico
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Tehru Alex Song[1*], YoungHee Kim[2]
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[1]IFREE, JAMSTEC, [2]Seismo Lab, Caltech
[1]IFREE, JAMSTEC, [2]Seismo Lab, Caltech

Modern plate tectonics involves several important ingredients such as seafloor spreading at mid-ocean ridges, generations of island arcs and subductions of plates. Although it is not clear exactly when plate tectonics started, seismic investigations of some of the oldest stable continental crust, the Slave craton and the Superior craton in North America, revealed multiple localized dipping anisotropic layers in the sub-cratonic lithospheric mantle that point towards the possibility of several shallow subduction episodes from late Archean (~2.6 Ga) to early Proterozoic (~ 1.8 Ga), which may form sub-cratonic lithospheric mantle by successive accretions and stacking. However, such seismic features have never been observed in modern subduction setting and it is extremely difficult to infer the state of plate tectonics such as plate velocities and spreading rates in early Earth. Here we model local converted S-to-P waves and teleseismic P-to-S converted waves to interrogate the interior of the young subducted Cocos plate beneath Central Mexico. We find a strong peak-to-peak P-wave (10 percent) and S-wave anisotropy (10 percent) localized within the topmost 2-6 km of the subducting oceanic mantle, with a fast symmetric axis dipping at about 40 degrees away from the East-Pacific Rise and orienting at about 30 degrees clockwise from the north, which is consistent with local plate motion direction. Such an anisotropic mantle lid is probably composed of dunites and depleted harzburgites assemblages that were originally synthesized and strained at the East Pacific Rise and later subducted. This provides a strong case that processes generating dipping anisotropic layers beneath the Slave craton and other ancient continents can be analogous to modern seafloor spreading at mid-ocean ridges, except they operate under a different thermal state of the mantle in the Earth's history. The analogy established here allows direct inferences of seafloor spreading rates back to the Archean, which has profound implications on the evolution of global heat flux and carbon cycle.

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