Seismic Image of a Thermo-Mechanical Channel at the base of Oceanic Lithosphere

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The plate tectonics theory is based on the existence of a rigid lithosphere floating over a ductile asthenosphere, forming the most prevalent plate boundary on earth, lithosphere asthenosphere boundary (LAB), but the nature of the LAB remains elusive. Surface wave tomography has been used to define the LAB but the vertical resolution is rather poor. Recently, receiver function methods have been used to image the LAB, but the resolution is still on 10 km with a very limited sub-surface sampling. Using ultra-deep seismic reflection technique, here we show the image of the LAB across the St Paul Fracture zone in the Equatorial Atlantic Ocean, consisting of two reflections. The depth of the upper reflector gradually increases from 70 km at 40 My to 80 km at 70 My, consistent with the plate cooling model of the lithosphere. It has a negative polarity with a velocity decrease of 7.5% and follows the 1150º Isotherm. The second reflector lies 15 to 10 km below, has a positive polarity, requiring an increase in velocity of 6.5%, and follows the 1250º isotherm. We suggest that these two reflectors define a thermo-mechanical channel (TMC), containing about 1.5% of melt with reduced viscosity, whose thickness decreases with age. The highly viscous TMC would decouple the tectonically driven lithosphere with the convecting mantle below.

Keywords: Plate Tectonics, Lithosphere Asthenosphere Boundary, Melt

