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The petrological control on the lithosphere-asthenosphere boundary (LAB) beneath ocean basins

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Abstract Text:

The oceanic lithosphere thickens with age by accreting asthenosphere material from below, and reaches its full thickness (L) of ~ 90 km at the age (t) of ~ 70 Ma. This lithospheric thickening fits the relation $L \propto t^{1/2}$, consistent with conductive cooling to the seafloor. A puzzling observation is that although conductive cooling continues, the oceanic lithosphere ceases to grow any thicker than ~ 90 km when t > 70 Ma. Small scale convection close beneath the lithosphere-asthenosphere boundary (LAB) has been generally invoked to explain this puzzle. Using the compositional systematics of global ocean island basalts and results of experimental petrology, we affirm that the LAB is a petrological boundary marking the intersection of the geotherm with the solidus of an amphibole (pargasite)-bearing lherzolite. The oceanic LAB is an isotherm of ~ 1100°C with $L \propto t^{1/2}$ for t < 70 Ma, and an isobar of ~ 3 GPa (~ 90 km) for t > 70 Ma. Small scale convection may take place, but it is not required to maintain the globally constant lithosphere thickness of ~ 90 km for t > 70.

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