



Heterogeneity and stratification of the mantle: what do we mean by 'layered'?

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The Earth's mantle is stratified in viscosity, mineralogy, chemistry and elastic properties. The mantle is also laterally heterogeneous: the upper mantle beneath continents and oceans have different compositions, rheologies and histories. Seismic tomography shows lateral variations throughout the mantle; some of these appear to be thermal, others appear to be compositional. Heterogeneities are prominent near the transition zone, and seem to indicate subducted material spreading out and also extending deeper. The increase in viscosity in the lower mantle may control deeper subduction.

Differentiation of the mantle to form the continents leaves behind depleted material. Melting beneath ridges samples the upper mantle preferentially; this would lead to vertical gradients in chemistry in the mantle. Deeper mixing would take place more slowly. Plumes sample the deeper mantle, and also enhance vertical mixing. Many of the observations that are interpreted in terms of a layered mantle are consistent with a relatively low viscosity upper mantle that is stirred by plate motions, and a more viscous and slowly convecting deeper mantle that still communicates with the upper mantle and the surface.