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A mechanism for ocean-floor spreading

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I wish to suggest a mechanism for ocean-floor spreading, other than deep mantle convection cells.

If the geotherm intersects the mantle solidus at the base of the upper mantle, a partly melted layer will result. It will be less dense than the overlying unmelted garnet peridotite lithosphere and the situation will be gravitationally unstable. It will be more voluminous than the overlying unmelted mantle and will distend the lithosphere which will break up into plates. It will have low rigidity and decouple those lithospheric plates from the underlying transition zone and lower mantle. Melted material, perhaps with crystals, will escape in two ways.

(*a*) General upward filtering takes the magma into colder regions where it chills and fractionates, depositing eclogite. An eclogite-enriched layer in the lithosphere is produced which enhances the gravitational instability. In this mechanism any liquid escaping to the surface has been greatly enriched in incompatible element contents by virtue of the eclogite fractionation, unlike the situation in (*b*) below.

(*b*) The instability forces liquid and crystals laterally towards and up the lines of easiest escape, which are the major fractures between lithospheric plates. The process is a continuing one because the exuded material is replaced by sinking of previously unmelted lithosphere into the zone of partial melting.

The fractures between lithospheric plates become the sites of mid-oceanic ridges as the plates are wedged apart. A ridge, or any part of it, may migrate laterally if one plate is preferentially obstructed; the fracture locates the ridge and is always the centre of spreading, untied to any hypothetical convection cell in the solid mantle. Away from the ridges the lithospheric plate is thinned by sinking, melting and lateral migration of melt. This may be expressed as 'topographic depression' or compensated by crustal and lithospheric shortening.

The continents, overlying old lithosphere, must on average show considerable crustal shortening. The return flow of material is integrated over huge areas in this model and does not require to be localized as in the convection cell hypothesis, removing anomalies such as the apparent lack of down flow under Africa etc. Atlantic and Pacific type continental margins are compatible with this model, as are ridge/trench convergences and gradual lateral extension of ridge systems.

A more complete development of this hypothesis will be presented elsewhere.