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Upper mantle mechanisms for the formation of melting anomalies

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The "Plate" hypothesis for melting anomalies postulates that volcanism that is unusual in the context of "normal" plate boundaries arises as a result of upper-mantle-based processes associated with plate tectonics. It is the inverse of the "Plume" hypothesis, which views melting anomalies as being bottom-driven, i.e. resulting from thermal diapirs rising from the deep mantle. The Plume hypothesis postulates that these diapirs penetrate the passive lithosphere and produce surface volcanism. The Plate hypothesis, in contrast, views lithosphere processes such as extension and delamination as engineering pathways that allow pre-existing melt to rise passively to the surface from the mantle beneath. Melting anomalies are extremely diverse, an observation readily accounted for by the diversity of the plate-related processes that permit volcanism. These may be categorized as: 1. continental breakup, 2. fertility at mid-ocean ridges, 3. plate-boundary junctions, 4. oceanic intraplate extension, 5. slab tearing and break-off, 6. continental intraplate extension, 7. catastrophic lithosphere thinning, and 8. sublithospheric melt ponding and draining. The Plate hypothesis incorporates a number of concepts that differ from some common assumptions. It requires that melt pre-exists in the mantle and it presumes that if pathways are opened through the lithosphere then this melt will rise to the surface. It requires a ubiquitous, shallow source for the "ocean island basalt" geochemical signature. It considers the mantle to be compositionally variable and the temperature of relevance to melting to be the homologous temperature, i.e. the temperature relative to the melting point of the source. Seismic tomography is not a direct measure of the temperature. This hypothesis offers a wide range of fresh research projects for students at all levels. Many melting anomalies have been little studied hitherto, and it is hoped that students will be enthused to take advantage of the plethora of new challenges presented in testing the Plate hypothesis.