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A novel way to grow continental crust: evidence from diamond-bearing granulite - garnet peridotite complexes

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All continental crust is ultimately derived from mantle-derived melts and a variety of subsequent fractionation, mixing and recycling processes. The exact number, timing and nature of these individual processes is recorded in cryptic form in the rocks forming the present-day crust. Unfortunately we have direct access to only a small part of the crust and for information from deeper parts must rely on xenoliths transported in extrusive magmas or bodies exhumed by tectonic episodes. The expected conditions of the deepest crust are those of the granulite facies and so studies of such granulite-facies rocks have contributed significantly to our understanding of the nature of the deep crust. An important growth mechanism derived from such studies is of magma underplating: mantle-derived melts intrude the crust, induce high grade metamorphism and partial melting in existing rocks, and through crystallisation, crystal accumulation and fractionation produce a lower crust of basic composition. This concept of magmatic underplating and granulite formation is well established but are other types of underplating also viable for crustal growth? Tectonically-exhumed bodies of the type-locality granulites from Saxony in Germany are unusual in that they are essentially granitic in composition, comprise mainly feldspar (mesoperthite) and quartz, and no primary orthopyroxene. Associated with Saxonian granulites, as well as with numerous other equivalent granulite bodies in Variscan Europe, are large bodies of mantle-derived garnet peridotite. Recent findings of microdiamond and coesite in Saxony-type granulites confirm long-suspected eclogite facies conditions for the formation of the "type" granulites which, combined with evidence from zircons of protolith ages considerably younger than those of surrounding non-metamorphic series, suggest a different process for granulitic lower crust formation. Proposed is deep continental subduction followed by rapid exhumation of partially-melted ultrahigh pressure felsic granulite along the subduction channel allowing entrapment of mantle slices. This hot material then spread laterally to underplate the crust before local up-doming and other tectonic processes locally exhumed the rocks at the surface. The result is a felsic lower crust formed by underplating (relamination) of former upper crust. Such welding together of continental slices via continental subduction is directly comparable to what is happening in the present-day Himalayan-Tibetan orogen.