Rheological Behaviour of Progressively Thickened Rifted Domains: Formation of Intracontinental Mountain Roots

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Deformation of previously thermally softened-rifted zones results in depression of the crust-mantle boundary (Moho) and development of an orogenic root system. Before shortening, crustal rocks and even the sub-rift mantle are softer than adjacent continents. Deformation of thermally softened rocks of rifted domains has a plane strain symmetry and results in growth of the orogenic root system. The root depth depends upon the rate of plate convergence, the distribution of rheological layering in the lower crust, thermal structure of previously rifted domains and the rheological evolution in the sub-Moho ultramafic mantle. At high rates of thickening-convergence the rifted domain is rapidly and almost passively transported downwards so that the mantle below the progressively thickened continental root (from 70 to ~100 km depth) becomes significantly colder and consequently stronger than adjacent mantle below the continental shoulders. At this time, the subroot mantle starts to function as a rigid obstacle for mountain root thickening and rocks become extruded vertically. Extrusion of the root may begin when the integrated strength of the root becomes weaker then the adjacent shoulder.

Rheological behaviour of thickened orogenic roots during extrusion depends again on the lithological distribution within the converging plates and thickening root, and variation of geotherms across the orogen. A comparison of stress values from steady state flow equations for given lithologies shows distinct changes in juxtaposition of rigid or ductile layers in the root with respect to neighbouring continents (shoulder) as temperature changes with time at constant strain rate of ~10-14 s^{-1}. The strain rate is controlled by the width of the deforming belt - slow for wide orogens, rapid for narrow ones and differences result for mafic (diabase, eclogite > 35 km) vs. quartzofeldspathic (QF, diorite) lower crustal lithologies

The internal rheological evolution within the thickened continental root compared to the shoulder, influences deep flake tectonics at early times in the orogenic history. In general the orogenic root is of similar strength to a colliding continent in the whole range of its thickness, apart from the region between 50 and 36 km where most flake and wedge tectonics occurs. During heating the strength profile changes with time so that the shoulder continental mantle and mafic crust gradually harden with respect to mafic and (QF) rocks. The rate of rheological root thermal weakening depends upon previous thermal history of the pre-orogen so that originally hot orogen is extruded rapidly and cold orogen after long time of thermal incubation.

A Model for an Obliquely Developed Continental Accretionary Wedge: NE Bohemian Massif

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Structural and metamorphic investigation of the northeastern margin of the Bohemian Massif has indicated four main sequential Variscan tectonic events: 1) Devonian rifting; 2) Early Carboniferous oblique underthrusting and formation of a continental accretionary wedge; 3) eduction of the wedge and 4) End Carboniferous late compression.

Devonian rifting of the Brunia continental margin resulted in the formation of two crustal-scale boudins associated with the development of two overlying synrift Devonian basins. It is argued that this extensional template strongly influenced the nature of the ensuing Variscan contractional deformation. Early Carboniferous (ca. 340-330 Ma), progressive, highly oblique underthrusting of the two crustal boudins beneath the Lugian terrane generated syn-deformational Barrovian metamorphism and the formation of a continental accretionary wedge. The wedge was further compressed by continued subduction of Brunia which resulted in the successive vertical extrusion of an upper and lower allochthon, derived from the more deeply underthrust crustal boudin. Compressional fabrics generated during this event were superimposed by extensional structures formed during the eduction of the wedge. The eduction was terminated by a transpressional event resulting from continued plate convergence. Release of mantle derived magma during late stage eduction thermally softened the transpressional zones in the more external parts of the wedge and gave rise to extensional unroofing of the internal part of the wedge.