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Can metamorphic core complexes develop within a previously non-thickened crust? Insights from the North China Late Mesozoic continental extension

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Structural style of deformed lithosphere primarily depends on its rheological profile type. Considering continental extension processes, narrow rifts develop for 'normal' thickness and thermal initial conditions in the lithosphere giving four-layer-type rheological profiles. Strength concentrates in both upper crust and uppermost mantle in that case yielding to narrow deformed areas (50 to maximum 100 km wide). In contrast, wide rifts correspond to very large deformed areas in the crust (several 100's of kilometres). They develop for two- (to three-) layer-type rheological profiles with a rather thin ($\sim$10 km) brittle upper crust on top of a thick pile of low viscous ductile rocks (including lower crust and overall lithospheric mantle) that can flow over large distances; this tectonic phenomenon locally yields to the development of Metamorphic Core Complexes (MCC) that can thus be regarded as a particular structure/component of a wide rift. After a thermal relaxation period, over-thickened orogenic domains display such two-layer lithospheric rheological profiles and, from this, development of metamorphic core complexes is often regarded as a witness of post-orogenic collapse process.

During Mesozoic to early Cenozoic times, a major E to ESE striking continental extensional affected the eastern part of Asia. The resulting structures cover now an area of 600 to 1000 Km wide, extending from East Gobi basin to Korea, parallel to the eastern coast of China. Numerous and various tectonic markers are preserved and include extensional sedimentary basins, synkinematics granitic intrusions and several MCC that have been identified over this extensional "band". Besides, tomographic studies show that this period is marked by an exceptional lithospheric thinning of $\sim$100 km. All these features well correspond to characteristics of a wide rift system forming during a post-orogenic stage. However, up to now, no trace of high pressure units of that age, and, thus, of crustal thickening has been documented there.

Lithospheric rheological profiles are computed for both pre-extension and Late Mesozoic extensional periods through Northeastern China. First order parameters controlling rheological profiles are (i) the tectonic regime, (ii) the lithologies composing the different lithospheric levels, (iii) the depth of the moho, (iv) the geothermal gradient and (v) the strain rate during extension. Common 'mean' lithologies are used for both crust and mantle. Paleogeotherms estimations for Early and Middle to Late Mesozoic come from available data on the vitrinite reflectance study within several sedimentary basins of the study area. Restoration of Mesozoic extensional structures is made along an E to ESE trending regional-scale section and finite strain amount is calculated. From this, one can deduce the depth of the Moho at that time and, if considering the age of the structures, the mean strain rate during extension. Resulting lithospheric rheological profiles show a two-layer-type during Mesozoic extensional period, with no strength peak localised just below the Moho and 8 to 10 km thick upper brittle crust which highly corresponds to the conditions required for developing wide rifts. On the other hand, finite strain computations show that extension of the crust was surprisingly limited during Late Mesozoic ($\sim$1,15 of stretching) and that tectonics can only partially account for lithospheric thinning (<20%). From this study, we pretend that Mesozoic metamorphic core complexes of Northeastern China may have developed without any strong previous thickening of the continental crust. Wide rift should better result from an extremely high geothermal gradient, during that period, combined with plate boundary conditions as driving extension. We propose that continuous slab retreat along the East Asia margin, during Mesozoic to Cenozoic times, may constitute the more plausible origin for this large-scale continental extension.