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Role of felsic vs. mafic lower crust in the rheological behaviour of crustal driven orogens

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Recent geophysical studies propose the possibility of extremely weak subcrustal mantle lithosphere with the main strength in overlying continental areas residing in upper and lower crust. Some geological observations e.g., Altaid or Proterozoic granulite belts show significant crustal shortening without any exhumation of deep high pressure rocks, indicating likelihood of weak lithsopheric mantle. In such situations with strong temperature dependence of deformation mechanisms particularly in quartz, feldspar and pyroxene, different lower crustal lithologies can develop quite contrasting deformational behaviour depending upon the depth location of the rock type, the transient geotherm and thickness of the crustal layers. The most noticeable differences in behaviour are expected from the quite contrasting lithologies of felsic (granitic, gneissic, pelitic) lower crust compared to mafic assemblages (amphibolite, granulite; eclogite in thickened crust). Transiently weak crustal layers are the likely locations of detachments, and transiently stiff layers can act as wedges into softer material. Convergence of crustal driven orogenies is numerically simulated using fully dynamical 2D thermomechanical model implemented in ANSYS finite element softwarepackage. The model uses constant convergence velocity applied at lateral boundaries, isostatic balance at the Moho and simple 1D surface erosion. Various scenarios have been examined; (1) where injection of opposing stiff lower crustal layers can result in thrust thickening of stronger lower crust downwards into weaker underlying mantle; (2) where compression of opposing soft lower crustal layers can result in homogenous thickening of stronger crust downwards into weaker underlying mantle; (3) where opposing layers of different strength, for collision of ocean-continent or two continental collision stages, result in wedging of stiff against stiff or stiff into softer rheologies, as

suggested by seismic interpretation of mountain roots.