Lithospheric deformation and continental crust recycling: The roles of rheology and eclogitization

Marie-Pierre Doin and Pierre Henry

[1] *Laboratoire de Géologie, École normale supérieure, 7, rue Lhomond, 75231 Paris Cedex, France*

A mechanical model with viscous (ductile) and plastic (brittle) rheologies is used to investigate the effect of eclogitization on the dynamics of convergence. Density increases by 300 to 600 km/m^3 during eclogitization of crustal rocks and continental lower crust and oceanic crust reach higher density than mantle. We explore cases of intracontinental deformation, subduction, and continental collision. We consider a wide range of parameters for friction, activation energy, and initial thermal state, and cases with or without eclogitization. The style of deformation appears to be primarily controlled by the presence or absence of weak zones. Simulations are run with a constant convergence velocity (1.5 or 4 cm/a) and the evolution of the compressive force through time is thus a critical test of the model viability. For intra-continental deformation, when the brittle crust is decoupled from the mantle, the mantle deforms by symmetrical bending or subduction, and a variable amount of lowermost crust is entrained with the sinking mantle. In these cases the compressive force remains in the (10^{12}-3×10^{13} N/m) acceptable range. Oceanic subduction only occurs if a low friction shear zone is specified in the brittle realm. During the transition from oceanic subduction to collision the oceanic crust in this shear zone remains trapped between colliding crusts. Eclogitization has no influence on the initial mode of deformation. In all simulations the influence of eclogitization increases progressively with time, in proportion of the amount of lower continental crust and oceanic crust entrained into the mantle. The structural evolution of the orogen model depends on eclogitization if initial decoupling occurs at mid crustal level. The simulations thus indicate that eclogitization promotes convergence and also, in some cases, enables the recycling of the whole continental lower crust into the mantle. We also suggest that eclogitization could regulate the long term convergence rate in orogens.