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Arc-continent collision: insight from self-consistent numerical modeling

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We performed 2D petrological-thermomechanical numerical modelling of oceanic-continental subduction followed by continental collision associated with closure of a backarc spreading center and accretion of a magmatic arc to the continent. The initial model setup represents two continents and an oceanic plate between them. The finite difference subduction/collision model includes spontaneous slab bending and retreat associated with backarc spreading, dehydration of the subducted crust, aqueous fluid transport, partial melting of both crustal and mantle rocks and melt extraction processes resulting in magmatic arc crust growth. Model development during oceanic-continental subduction stage reveals several realistic features characteristic for natural arcs. One is the construction of an accretionary wedge, including frontal and basal accretion, as well as subduction erosion. Growth of a new volcanic (mainly basaltic) layer atop the continental crust leads to subsidence and thinning of the underlaying continental crust. The lateral width of this magmatic arc is constricted to 40-60 km due to the limited extent of the melt extraction area in the hydrated mantle wedge atop the slab. Rapid slab retreat triggers the formation of a backarc basin with the new spreading center resulting in dry decompression melting of the mantle and building of new oceanic floor. The opening stops when the second continental plate comes to the trench that results in continent-arc-continent collision process associated with deep continental crust subduction (to depths of 90-160 km). Collision leads to a strong shortening of the previously formed backarc region which become buckled and displaced underneath the forming orogen.

We tested influences of (i) plate convergence regime and velocity and (ii) initial length of the oceanic plate onto the model development and found notable variations in resulting continental collision zone structures which share many similarities with natural orogens such as Alps and Bohemian Massif.