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Influence of Earth crust composition on continental collision style in Precambrian conditions: Results of supercomputer modelling

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A number of issues concerning Precambrian geodynamics still remain unsolved because of uncertainity of many physical (thermal regime, lithosphere thickness, crust thickness, etc.) and chemical (mantle composition, crust composition) parameters, which differed considerably comparing to the present day values. In this work, we show results of numerical supercomputations based on petrological and thermomechanical 2D model, which simulates the process of collision between two continental plates, each 80-160 km thick, with various convergence rates ranging from 5 to 15 cm/year. In the model, the upper mantle temperature is 150-200 ^{0}C higher than the modern value, while the continental crust radiogenic heat production is higher than the present value by the factor of 1.5. These settings correspond to Archean conditions. The present study investigates the dependence of collision style on various continental crust parameters, especially on crust composition. The 3 following archetypal settings of continental crust composition are examined: 1) completely felsic continental crust; 2) basic lower crust and felsic upper crust; 3) basic upper crust and felsic lower crust (hereinafter referred to as inverted crust). Modeling results show that collision with completely felsic crust is unlikely. In the case of basic lower crust, a continental subduction and subsequent continental rocks exhumation can take place. Therefore, formation of ultra-high pressure metamorphic rocks is possible. Continental subduction also occurs in the case of inverted continental crust. However, in the latter case, the exhumation of felsic rocks is blocked by upper basic layer and their subsequent interaction depends on their volume ratio. Thus, if the total inverted crust thickness is about 15 km and the thicknesses of the two layers are equal, felsic rocks cannot be exhumed. If the total thickness is 30 to 40 km and that of the felsic layer is 20 to 25 km, it breaks through the basic layer leading to formation of turbulent structure. These results suggest a new mechanism of continental collision evolution in Precambrian conditions.