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Continental rifting to seafloor spreading: 2D and 3D numerical modeling

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Two topics related with continental extension is studied by using numerical modeling methods: (1) Lithospheric mantle stratification changes dynamics of craton extension (2D modeling) and (2) Initial lithospheric rheological structure influences the incipient geometry of the seafloor spreading (3D modeling).

(Topic 1) Lithospheric mantle stratification is a common feature in cratonic areas which has been demonstrated by geophysical and geochemical studies. The influence of lithospheric mantle stratification during craton evolution remains poorly understood. We use a 2D thermo-mechanical coupled numerical model to study the influence of stratified lithospheric mantle on craton extension. A rheologically weak layer representing hydrated and/or metasomatized composition is implemented in the lithospheric mantle. Our results show that the weak mantle layer changes the dynamics of lithospheric extension by enhancing the deformation of the overlying mantle and crust and inhibiting deformation of the underlying mantle. Modeling results are compared with North China and North Atlantic cratons. Our work indicates that although the presence of a weak layer may not be sufficient to initiate craton deformation, it enhances deformation by lowering the required extensional plate boundary force.

(Topic 2) The process from continental rifting to seafloor spreading is an important step in the Wilson Cycle. Since the rifting to spreading is a continuous process, understanding the inheritance of continental rifting in seafloor spreading is crucial to study the incipient geometry (on a map view) of the oceanic ridge and remains a big challenge. Large extension strain is required to simulate the rifting and spreading processes. Oceanic ridge has a 3D geometry on a map view in nature, which requires 3D studies. Therefore, we employ the three-dimensional numerical modeling method to study this problem. The initial lithospheric rheological structure and the perturbation geometry are two key parameters that we investigated. The modeling results show that the continental rifting history affects the incipient geometry of the seafloor spreading, leading to (1) single straight oceanic ridge, (2) overlapping oceanic ridge and (3) curved oceanic ridge.