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Erosion controls on the metamorphic core complex dynamics and its relationship with syn-rift basin evolution

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The wide rifting evolves towards asymmetric extensional thinning of the entire crust and development of different characteristic features such as basins, half-grabens and metamorphic core complexes (MCC). In this context, formation of supra-detachment basins is also a common feature, along with the exhumation of metamorphic rocks and considerable displacements along the hanging wall. Initiation, geometry and mechanisms of metamorphic core complexes have been already largely debated on the basis field observations, analog and numerical models. For example, it has been well demonstrated that strain softening favors asymmetric deformation and accounts for different styles of brittle and ductile strain localization. However, the temporal and spatial relations between the dome formation and basin evolution are still poorly understood. In particular, most of the existing numerical models predict a topographical depression above the metamorphic dome, whereas in nature dome formation often corresponds to a topographical uplift. To explain these phenomena, we have integrated surface erosion, sedimentary processes and strain softening into a state-of-the-art 2-D numerical thermo-mechanical model of MCC development. In the numerical experiments, we first reproduce formation of a univergent MCC by implementing strain softening and testing a large spectrum of lithospheric structures. In the next series of experiments we apply erosion/sedimentation and test model sensitivity to different erosion parameters. The results show two distinctive stages of MCC dynamics and syn-rift basin development. One single broad basin forms above the dome and is divided onto an inactive basin located at the distal detachment and an active supradetachment basin that deepens with further extension, characterized by crustal necking and dome amplificationduring the MCC formation. It is noteworthy that without strain softening, erosion at of the rift flanks mayresult in complete burial of the dome below the sedimentary cover. The experiments also demonstrate strong dependence of the system evolution on the initial thermo-rheological structure. The geometry and topography of the rift system is largely controlled by syn-extensional erosion that also strongly affects vertical and lateral movements during the rifting phase. The predicted rift dynamics can be compared to the case of the wide rift system of the eastern part of North China Craton.