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# Impact of metamorphic reactions limited by water content on MCC formation and exhumation along detachment faults

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Metamorphic phase changes impact both the buoyancy (volume forces) and the rheology (surface forces) of rocks. As such, they play an important dynamic control on the tectonic processes. It is generally assumed that phase changes are mostly controlled by pressure and temperature conditions. Yet, this supposes some assumptions on the amount of water available in the system. In geodynamic community, it is systematically assumed that water is always available in sufficient quantities to minimize Gibbs energy for given P,T conditions and a constant chemical composition. So that, as a matter of fact, the influence of water on the system is completely neglected. Yet, many petrological studies point out that water, as a limiting reactant, is responsible for the lack of retrograde metamorphic reactions observed in the rocks exhumed in typical MCC contexts. In order to study the impact of fluid content on the structure of metamorphic core complexes, we have implemented fluid transport and water limited thermodynamic for phase transition, in a thermomechanical code. We describe a parametrisation of Darcy flow that is able to capture source/sink and transport aspects of fluids at the scale of the whole crust with a minimum of complexity. Using this model, phase transitions are controlled by pressure temperature and the local amount of free fluid that comes from both external meteoric and local dehydration sources. The numerical experiments imply a strong positive feedback between the asymmetry of the tectonic structures and the depth of penetration of meteoric fluid. Bending stress pattern in asymmetric detachment zone indeed drives the penetration of meteoric fluids to greater depth, where they can in turn lubricate the deep ductile part of the detachment. However, thermal weakening and/or slow re-equilibration of the protolith rocks at depth with time tends to decrease the asymmetry of structure, changing the orientation of the bending stress and to shut down the activity of asymmetric detachments in favor of spreading structures which forms double-domes.