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Role of Basement Faults on the Crustal Wedge Deformation of the Zagros fold-thrust belt, New Insights from 2-D Thermo-mechanical Numerical Models

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Geodetic measurements, earthquake distributions and analysis of topography imply simultaneous thin- and thick-skinned deformation in the Zagros fold-thrust belt. A series of 2-D thermomechanical numerical experiments with initial rectangular configuration of 300km by 30km were run to investigate crustal scale deformation during the development of the Zagros. The shortening experiments evaluate the possible interaction of pre-existing faults in Pre-Cambrian crystalline basement with the sedimentary cover in the presence of a 1-2 km thick intervening layer of weak Hurmuz salt. The experiments employ SOPALE, which is a geodynamic code based on the arbitrary Lagrangian-Eulerian (ALE) finite element method and capable of achieving large deformations with free surface behavior. In this modeling series we have addressed, 1, the degree to which the pre-existing basement faults can be reactivated due to brittle or ductile behavior of the lower crust (due to cold or hot geotherms), 2, the effects of initial spacing and location of basement faults on crustal deformation, 3, the degree of deformation decoupling between the cover and the basement rocks due to the weak Hormuz salt layer and 4, variation in deformation style and strain distribution.

Our preliminary results show that deformation of the cover sediments reach to the salt pinch out in the early stages. The wedge geometry, kinematics, and activity of pre-existing basement faults are strongly influenced by the Moho temperature and rheology of the basement rocks.

We infer that the Moho temperature, defining the geothermal gradient, plays a major role in how the basement in the Zagros fold-thrust belt accommodates and transfers deformation. In “hot” geotherm models (20°/km), cover and basement units deform simultaneously and deformation is transferred to the foreland in the basement at early stages of shortening. In contrast, for “cool” geotherm models (10°/km), basement deformation is focused at the back (hinterland) of the models where stacks of basement imbricates pile up. In intermediate geotherm models (15°/km) the basement faults are reactivated sequentially and deformation propagates serially to the foreland with progressive shortening. Although in our modeling approach we have focused on the Zagros fold-thrust belt, the results can be applied to any other fold-thrust belt with roughly similar configurations.