Geophysical Research Abstracts
Vol. 12, EGU2010-14414, 2010
EGU General Assembly 2010

Kinematic evolution of southern Hellenides (western Crete, Greece)

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Combined kinematic, structural and paleostress analyses were performed to reevaluate the tectonic evolution of the southern Hellenides in western Crete. Our work shows that the structural architecture of the study area was mainly established by two contractional deformation phases. SSW-directed thrusting from Oligocene to lower Miocene times (D1 phase) lead to brittle stacking of the upper thrust sheets and concomitant ductile exhumation-related imbrication of the lower HP tectonic units (Phyllite-Quartzite (PQ), Tripali and Plattenkalk units). Kinematic analysis in the PQ unit reveals a main southward ductile transport followed by late bulk coaxial deformation. The PQ unit rocks comprise the body of a crustal scale shear zone confined at its base by a major ductile thrust and in accordance with the proposed models we suggest that the exhumation process of the PQ unit involved S-directed ductile extrusion. Structural trends of ductile D1 thrusts define a salient bounded to the east by a NE-trending transverse zone situated in the western margin of the Lefka Ori window. At the eastern limb of the salient, the trajectories of L1 stretching lineation formed on a gently dipping S1 foliation in the PQ unit, show a clockwise rotation with proximity to the transverse zone. This suggests that the latter acted as an oblique buttress against the southward extruding PQ unit rocks causing their lateral escape. D2 phase was governed by regional NNW to NNE compression and involved significant folding and out-of-sequence with respect to D1 thrusting. The early D2a phase is related to the brittle-stage of exhumation of the HP-units and spans from middle to upper Miocene. D2a deformation involved thrust-related folding, tectonic imbrication and the formation of a middle Miocene thrust-top basin. The F2a folds are characterized by a predominant S(SE)-vergence and show a pronounced curvature of their hinge orientations from a regional E-W to a local NE-SW trend, the latter only present at the eastern limb of the salient. In the transverse zone, combined forward-directed imbricate thrusting and backthrusting lead to the development of a major pop-up structure and a triangle zone. Moreover, the trend of compression axes at the salient's eastern limb are deflected from the regional NNE to NNW orientation to a local NW orientation perpendicular to the transverse zone. These findings suggest that the transverse zone should have served as an oblique ramp to the southward transport of HP-rocks, while the steep dip of the ramp may has impeded displacement of the PQ unit rocks up the ramp acting as a buttress to their foreland propagation. The late D2b phase lasted from upper Miocene to Pleistocene and involved SW-directed thrust-related folding with synchronous sinistral strike-slip faulting and NE-striking normal faulting causing extension parallel to F2b fold hinges. The D2b-related paleostress field is characterized by local NE compression and NW extension orientations defining a transpressive to pure extensive regime. Where these coexist, the normal faults related to tension cut all previous structures suggesting that the extension postdates compression. This could possibly be attributed to a relaxation of the NE compression, which progressively evolved to the NW extension. The described kinematic evolution of southern Hellenides in western Crete reveals that the NE-trending transverse zone, which is possibly aligned with an inherited rift-related Mesozoic fault system, exerted significant control on the deformation pattern at progressively shallower structural levels within the crust.