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Frictional-viscous, low-angle normal faulting: a new tectono-stratigraphic map of NW Kea, W. Cyclades, Greece

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Within the overall context of the extensional regime in the Cyclades, new evidence is presented for bi-directional movement. Compared to the top-to-NNE transport direction which characterise the Eastern Cyclades, our new results place Kea, along with Kithnos and Serifos, in a row of islands having top-to-SSW shearing in the Western Cyclades.

The island of Kea represents an exhumed mid-upper crustal, SSE-directed extensional detachment system within the Western Cyclades, which has been dramatically thinned, probably due to slab-retreat at the Hellenic trench system. Along with subduction and back-arc basin evolution, this happened during ongoing convergence and collision between Eurasia and Africa/Arabia. Lithospheric failure in the region has a multiphase history: (1) multiple, low-angle dolomitic cataclastic fault zones formed at essentially the same time as, and (sub-) parallel to a regional mylonitic ductile foliation in calcitic marbles and chloritic schists and (2) a widespread system of (sub-) vertical cross-cutting steep faults.

Based on Quickbird imaging, high-precision GPS, kinematic, lithological and tectono-stratigraphic data, a detailed geological/structural map of NW Kea has been compiled. The island comprises a domed, low-angle normal fault system formed during low to very-low grade metamorphism. Within this, the Otzias Bay Detachment (OBD) in the northwest of the island is part of a higher strain shear-zone. In detail, the detachment comprises a several metre-thick cataclastic fault zone, with large breccia fragments in a broad grain-size distribution, interlayered with a few ultra fine-grained clay-rich gouge layers, several cm thick. The fault zone is associated with mega-boudins of protocataclastic dolomite (locally ankeritised) as well as serpentinite lenses. Phyllites are mainly observed around marble (mega-) boudins, representing higher strain zones within the greenschist unit. Ductilely folded calcitic (ultra-) mylonitic marbles and mylonitised cataclasite, chloritic and quartzitic schists represent the footwall.

The detachment dips at low angles towards the NNW. The mylonites have a pronounced stretching lineation. Stretching lineations have a strikingly consistent SSW-NNE orientation that shear criteria show formed during top-to-south sense movement.

The varying orientations of veins and faults indicate different generations and multiple reactivation periods. To initiate movement along the OBD fault, aseismic creep rather than seismic events probably occurred, since there are very few veins that cross-cut both the mylonites and the cataclasite together. There is also an absence of pseudotachylite.

Axis of non-cylindrical folds in the mylonites have rotated into the finite stretching direction, generating ductile sheath folds.

Gentle folding of the OBD and the structurally upper cataclastic zones about NNE-SSW oriented axes, suggests that a WNW-ESE shortening component accompanied deformation from ductile, through brittle/ductile to brittle conditions.