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Multidisciplinary monitoring of an active fault on the unstable flank of Mount Etna (Italy): radon, InSAR interferometry and geodetic data

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The emphasis in studies of flank instability at Etna has remained firmly on the northern part of the unstable sector where the conspicuously active Pernicana fault system (PFS) clearly links with the summit area of the volcano and defines the northern boundary of instability. The southern part of the sector, by comparison, has received scant attention and, most notably, its southern boundary remains poorly understood and controversial, hampering development of a clear overall picture of the instability. Our aim, accordingly, is to acquire new knowledge of the Ragalna fault system (RFS) on the southern flank, to better understand its geodynamic role. The methodology used comprises three type of data: i. radon and thoron measurements from soil and the potential significance of variations in these two decay products; ii. InSAR interferometry derived by radar images taken over Etna by the ERS-1 and ERS-2 satellites; and iii. electronic distance measurement (EDM) executed on the central part of the RFS. Valuable synergy developed between our differing data gathering techniques, producing consistent results and serving as a model for similar studies of partly obscured active fault systems. The RFS is revealed as a complex interlinked structure with continuity over a distance exceeding 14 km, most notably including extensions northwards from the conspicuous delta-shaped junction that marks the end of visible faulting, and north-eastwards, towards the summit craters of Etna. Linkage is confirmed in a transfer zone between two segments of the RFS separated at the surface by some 2 km. In a downslope direction continuity of the RFS is suggested at least as far as the transition between Etnean volcanic products and the surrounding non-volcanic bedrock. Dextral deformation rates across the RFS of about 7 mm a-1, derived from

InSAR, are complemented by EDM geodetic measurements at the main fault trace of 4 - 5 mm a-1, with both data sets indicating an extensional component of 3.5 - 4.0 mm a-1. More distributed simple shear deformation may explain the discrepancy in strike-slip values, an idea supported by ground fracturing and secondary peaks in measured radon flux from transects across the RFS. We also measured thoron (220Rn, half-life 56 secs); apparently, because of its limited diffusion range, a more sensitive but previously unexploited radon isotope for pinpointing active near-surface faults that has promise for future studies. The RFS is confirmed as the southern boundary of flank instability on Mt Etna and probably, via rifting in the summit crater area, links across to the well-known Pernicana fault system (PFS) that forms the northern boundary, thus encircling the unstable flank sector. A comparison of activity for these two fault systems reinforces proposals that the unstable sector is divided into at least three sub-sectors by intervening faults, while, in section, basal detachments associated with faults also form a nested pattern. Complex movement interactions in space and time are expected to take place between these structural components of the unstable sector.