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Comparative use of different methods for soil-gas radon detection on an active tectonic structure: the Pernicana fault on Mt. Etna volcano (Italy)

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The spatial distribution of soil gas radon activity was studied along the Pernicana Fault System (PFS) on Mt. Etna. The PFS is the longest and the most active on Mt. Etna: it runs for about 18 km on an approximate E-W direction in the NE flank of the volcano. At altitudes between 1000 and 1500 m a.s.l. the PFS is characterized by a near-vertical scarp max 70-80 m in height. At lower elevation (from 700-800 m a.s.l. till the Ionian Sea), the PFS is characterized by left-lateral faults with a dextral configuration. Shallow ($<$ 2-3 km) seismic activity ($2 < M < 3.5$) accompanies surface deformation along the central and western portion of the PFS. Aseismic creep occurs on this fault as well, especially on its central and eastern portions. The motion of the PFS has been interpreted as due to the lateral spreading affecting the unstable eastern-to-southwestern sectors of Mt. Etna. Three different methodologies were used to detect radon in soil gas along the PFS. The first one consisted in Solid State Nuclear Track Detectors (SSNTD), CR-39 type, and allowed for integrated measurements. The second one consisted in spot measurements carried out with a portable device (RAD7, Durridge Company Inc.), which also allowed for thoron measurements. The last one consisted in continuous measurements by means of monitoring devices (Barasol, Algade) remotely placed in selected sites. The amount of radionuclides in rocks from the studied area was measured using gamma ray spectrometry. The results indicate quite the same level of radionuclides in all of the collected rock samples. Two different horizontal profiles were investigated for soil gas radon, each consisting of ten

measurement points. The investigation period lasted from November 2006 till April 2007. In both profiles, significant differences in radon values were observed among the sampling sites, and the differences can be ascribed solely to differences in local soil permeability and different mechanisms of soil gas transport to the surface. In general, all methods used showed a good agreement in the spatial pattern of relative radon values, particularly if one looks at the time-averaged values at each sampling point. In detail, both SSNTD and RAD7 methods indicated higher radon values on the upthrown side of the PFS than on the downthrown side. This could be due to the greater structural instability, hence a greater fracturing, of the downthrown side of the fault, which would result in a higher degree of radon dispersion and/or air dilution. However, in both of the profiles the lowest radon values were recorded just on the fault plane, and relatively higher values were recorded a few tens of meters on both sides of it. This is a pattern already observed on other faults, such as the San Andreas fault, and it seems to be due to a dilution effect played by soil CO2 , whose efflux in the case of PFS is highest just along the fault plane. Time variations of radon activity were mostly linked to atmospheric influences and can be best studied with real-continuous monitoring devices. In conclusion, spot measurements of soil gas radon are useful for the quick recognition of high emission sites to be later monitored for radon variations in time. SSNTD allow for the time monitoring of a relatively large number of sites, but losing detail on the short-term changes due to their long integration time. Real continuous monitoring probes are optimal for detailed time monitoring, but are expensive and can thus be used to complete the information acquired with SSNTD in a network of monitored sites.