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The July 2006 eruption of Mount Etna (Italy) monitored through continuous soil radon measurements

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Radon (222Rn) is a short-lived decay product derived from 238U, with a half-life of only 3.8 days. This gas ascends towards the earth's surface mainly through cracks or faults. In recent decades radon has been used as a tool for predicting earthquakes and volcanic eruptions, because anomalous variations of its activity have often been reported before the occurrence of such geodynamic events. The recent eruptive activity of Mount Etna in Sicily (Italy) has been documented by multidisciplinary visual, geochemical, and instrumental observations. Here we describe the results obtained during the 10-day July 2006 Strombolian-effusive eruption of Mount Etna by using a radon probe installed near Torre del Filosofo (˜2950 m above sea level). This site is located ˜1 km south of the Southeast Crater, the youngest and most active of the four summit craters of the volcano, and the site of the July 2006 eruption. In order to better interpret the soil radon data we have compared them with simultaneously acquired volcanic tremor signals and a relative measurement of the thermal radiance emitted from the eruption area, derived from thermal camera measurements. During the month prior to the onset of the 2006 eruption, soil radon activity remained at low levels (˜1 x 103 Bq/m3); similar values persisted even when effusive activity started late on 14 July 2006. Only at ˜02:50 on the 15th July, radon activity showed a sharp increase (up to ˜50 x 103 Bq/m3) in a 20 minute interval, and a further increase to ˜20 x 106 Bq/m3 during the following hours. Explosive activity started at 04:30, 100 minutes after the initial rise in soil radon activity. High values in radon activity with numerous peaks persisted through the following four days, and were then followed

by a marked decline until early on 20th July, when an extremely sharp rise brought the levels of radon activity to unprecedented values of nearly 1.7 x 108 Bq/m3, and remained very high for the next ˜24 hours. The episode of lava fountaining of 20th July occurred during this interval, starting 10 hours after the maximum in radon activity. From then on through the end of the eruptive phase, the levels of radon activity fluctuated with values rarely exceeding 106 Bq/m3 and then gradually declined starting from around noon on 22nd July. At the end of the eruption, radon levels remained higher (10-100 x 103 Bq/m3) than those recorded before the eruption. In conclusion, the onset of the Strombolian activity (15 July) and the lava fountaining (20 July) were related to significant changes in the magma pressure within the conduit. These two events were preceded by some hours with increases in radon soil emission by 4-5 orders of magnitude. For this reason we can imagine in the future the use of this signal as a potential precursor of this type of volcanic activity. Minor changes in eruptive behaviour did not produce significant variations in the monitored parameters. We interpret peaks in radon activity as due primarily to microfracturing of uranium-bearing rock. These observations suggest that radon measurements in the summit area of Etna are strongly controlled by the state of stress within the volcano and demonstrate the usefulness of radon data acquisition before and during eruptions.