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Assessing volcanic and related hazards on islands: the Ischia (Italy) case study

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Hazards assessment of a given volcano is possible only if its past behaviour and present state are known. Furthermore, to forecast the eruption scenarios in case of renewal of volcanism in short-mid terms, it is necessary to know all the phenomenologies of eruptions and to reconstruct the structural conditions which have constrained the activity. It is also very important determine the chemical and physical parameters of the magmas erupted through time in order to reconstruct the evolution and present state of the magmatic feeding system. The main problems arising volcanic hazards assessment on islands, can be summarized as follows: a) volcanic islands are the emerged portion of usually much larger and complex edifices, with the consequence that only the deposits of a limited fraction of their history is accessible; b) the deposits of large explosive eruptions are only in part preserved; c) the deposits of effusive eruptions can be partially submerged as a consequence of both flowing of subaerial lavas into sea-water or sea-level fluctuations; d) even young volcanic vents can be below sea-level, due to original underwater location, dismantling of the volcanic edifice by erosion, deflation of the vent area, tectonic and/or volcano-tectonic displacement, sea-level fluctuation; e) the structural setting of the entire volcano could be only partially represented in its emerged portion; f) the relationships between deformation features and distribution of volcanic vents can be defined only in the emerged portion.

The obvious consequences of mentioned problems are: 1) the reconstruction of the volcanic and deformation history of the volcano, as well as the evolution and present state of the magmatic feeding system, could be incomplete, that is the reconstruction of the behavior law of the volcano could be not precise; 2) the areal distribution of both effusive and explosive eruption deposits could be only partially reconstructed;

3) isopachs and isopleths curves for pyroclastic deposits cannot be easy to reconstruct, and therefore the physical parameters of explosive eruptions, such as volume of erupted magmas, height of eruption columns and mass eruption rate (magnitude and intensity, VEI, etc.) are difficult to estimate.

To perform a volcanic hazards assessment at Ischia, the volcanic history subsequent to the last significant change in its behaviour has been taken in consideration. Such a change has occurred during the quiescence preceding the outburst of the last period of activity, at 10 ka. Periods of quiescence have alternated with periods of very intense volcanic activity. This behaviour could result from discontinuous refilling of a shallow magmatic system by poorly evolved magma batches arising from depth. As this volcanism has been related to the dynamics of a block resurgence, it is possible to speculate that renewal of volcanism will occur when resurgence will generate reactivation of faults through which magma can reach the surface. Effusive and explosive, both magmatic and phreatomagmatic, eruptions took place at Ischia in the past 10 ka. Effusive eruptions produced lava domes and coulées, and high aspect ratio lava flows. Magmatic explosions were mainly strombolian-to-violent strombolian, and only rarely they generated subplinian unstable eruption columns which in cases collapsed to produce small pyroclastic flows. Phreatomagmatic explosions produced pyroclastic density currents, usually confined in depressed areas, and only in one case were energetic enough to surmount significant topographic barriers. Length of the quiescence periods and characteristics of the following eruption are not linked by a constant relationship. In the past 10 ka volcanism was mainly confined in the portion of the resurgent block affected by extension, which corresponds to the eastern sector of the island.

The major hazard related to volcanism at Ischia is generation of landslides. Reactivation of faults and related volcanic activity, at least in the past 5.0 ka, have been accompanied by surface gravitational movements. These movements have generated roto-translational landslides and intermediate-to-large-volume mud- and debris-flow deposits, and subaerial debris-avalanche deposits. These deposits preceded and followed emplacement of volcanic products, suggesting that slope instability conditions were induced by both reactivation of vertical movements, likely related to the resurgence, and availability of large amount of loose material, rapidly accumulated during eruptions.