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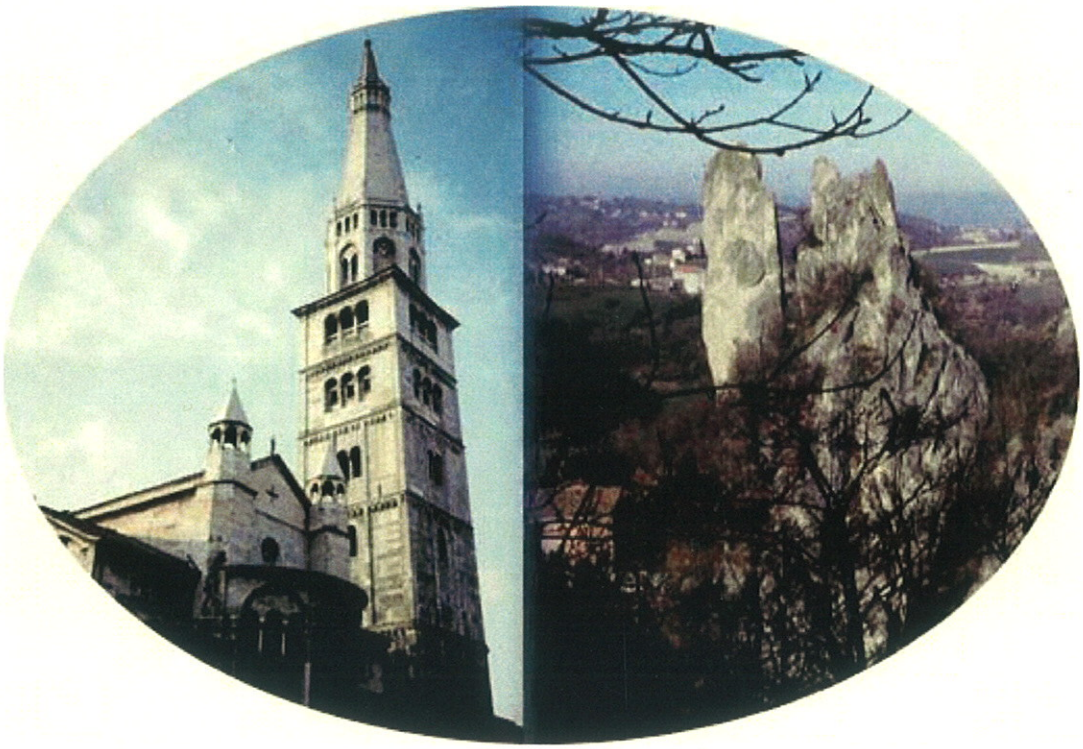
Workshop

Geomorphological Sites: research, assessment and improvement



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PROCEEDINGS

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The Mud Volcanoes of Salse di Nirano

The mud volcanoes (aka "macalubas") of Salse di Nirano are the most important and best developed pseudo-volcanic phenomenon found not only in the territory of Modena but in the whole of Italy (Ferrari and Vianello, 1985). They are situated on the bottom of a wide, sub-circular depression covering a surface of about 10 ha – where the Plio-Pleistocene "Argille Grigio-azzurre" Formation crops out – at an altitude of 208 to 220 m a.s.l. Many mud erupting bodies of various size and shape are found in the area. The caldera-like shape of this small valley may result from progressive ground subsidence owing to the continuous depletion of mud which, once ejected, flows into an underlying stream. All this mud volcano field is extremely active and mud emissions are more or less intense according to seasonal water availability. The arrangement of the erupting bodies along two contiguous alignments points to the existence of a considerable joint and fault system in the area (Bonazzi and Tosatti, 1999).

The Nirano mud volcanoes have always aroused great interest in travellers. They were first described by Pliny the Elder in his monumental work "Naturalis Historia", written around 60 AD, but only in the late 19th century was their real nature recognised, thanks to the accurate observations of the famous naturalist abbot Antonio Stoppani (1876) who laid down a complete and scientifically correct description of the phenomenon. These mud emissions are in fact caused by the presence in the subsoil of liquid and gaseous hydrocarbons which come to the surface through ground discontinuities, pushing up salty water and mud.

At present, the Nirano mud volcanoes are found over a surface of about 55,000 m2. Following the introduction of strict protection norms, the geomorphological situation of these mud volcanoes is in constant evolution, since with the passing of time new vents open and form new mud cones or pools, whereas others cease their activity.

The materials emitted by these vents are gases, liquids and solids. The gaseous phase, made up primarily of methane (87-96%) and secondarily of hydrogen sulphide, is the main conveyor of the liquid and solid components to the surface. The liquid phase is mainly constituted by superficial groundwater and vadose water, although deeper water is sometimes mixed with them. Occasionally the emission of water and fluid mud is accompanied by bituminous matter, clearly visible owing to the formation of concentric brown-blackish rings or iridescent films on the surface of the mud pools and craters. The solid phase is made up mainly of clayey materials

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dragged upwards by gases and water through the Plio-Pleistocene argillaceous formation cropping out in the area. Variable amounts of mineral salts are found in the water, such as sodium and potassium chlorides, which appear as whitish and powdery very thin levels on the surface of the mud crust during the dry hot season. All the emission products of the mud volcanoes are definitely alkaline, with pH always exceeding 8.5.

Various types of clay materials are pushed upwards by the gas; in some cases they are the final transformation product of other minerals, which have been subject to prolonged leaching action by the fluids characterising each mud volcano. The minerals identified by means of diffractometer analysis are: illite (53%), smectite (14%), interlaminated i/sm (14%), chlorite (11%), kaolinite (8%), whereas quartz and calcite are present in negligible amounts (Ferrari e Vianello, 1985).

As previously stated, in the past few years measurements of helium and radon Rn-222 isotope, present in the emission gases, were carried out, in order to record possible correlations with local seismicity. In fact, according to old literature data (Pantanelli, 1895), the eruptive activity of the mud volcanoes of the northern Apennine margin seemed to be influenced by seismic tremors. Observations carried out since 1986 on the Nirano mud volcanoes, confirmed that the eruptive activity of these pseudo-volcanic bodies is actually influenced by the release of seismic energy from focuses located in the mid-Apennine region. In particular, radon anomaly peaks were recorded almost systematically from some hours to some days before and after the main seismic shock in concomitance with medium-low intensity (3 to 4.5 magnitude) earthquakes (Gorgoni et al., 1988).

The Nirano mud volcanoes are interesting also on account of the ecological changes induced by the deposition of sodium chloride. The herbaceous plants which colonise the clayey soil erupted by the mud cones are the best example of halophilous (i.e., "salt lover") vegetation in the province of Modena. A salt-rich environment can in fact produce changes and particular adaptations in plants, such as bluish colour, dwarfism and early fall of the leaves. All this can be observed in the Nirano valley, where the halophilous character of the soil is shown by the presence of a plant usually growing along the sea coasts: the graminaceous Puccinellia borreri, which here grows only in the areas most affected by the salty mud flows. Another fairly common halophyte is Atriplex hastatum (Bertolani Marchetti, 1953). The salt-rich environment decreases progressively away from the eruptive vents where water impoundments host a typical ditch reed of this area: Phragmites australis, together with the graminaceous plant Agropyron pungens (Ferrari and Speranza, 1976).

Before the introduction of conservation norms, Man's interference in this area was very evident especially in constraining the natural diffusion of the

mud volcanoes. Indeed, for many years the mud cones were flattened in order to increase the surface available for farming. Furthermore, the most fluid mud was collected for therapeutic purposes (the nearby spa of Salvarola was supplied mainly with mud from these emissions). Finally, the area was also affected by the passage of numerous sheep and goat flocks which hindered the spontaneous growth of vegetation, especially in the mid-high sectors of the valley.

The Region's decree which in 1982 instituted the Natural Reserve of the Salse di Nirano, clearly identifies the aims of this protected area, which are: 1) to safeguard and preserve the natural (geomorphological features, vegetation and wildlife) and environmental characteristics of the site; 2) to organise the territory for fruition with scientific, cultural, educational and recreational purposes; 3) to reconstruct the landscape unity of the whole area.

The considerable reduction of anthropogenetic disturbances following the institution of the Reserve has allowed the increase of the eruptive phenomena which can now develop with no constraints. Even the environmental conditions of the surrounding areas are now upgraded, with a marked expansion of wild plants. In particular, the valley slopes which up to some 20 years ago were bare, with gully erosion and badland morphology, as witnessed by various photographs of the time, are now subject to the widespread growth of grass and shrubs, thus contributing to limit the intense erosion processes typical of this low-Apennine belt, mainly made up of argillaceous formations. This fact, which is probably due to the abandonment of practices such as wood cutting and sheep farming, might demonstrate that the onset of badland morphology on these hills resulted not so much from climate changes but rather from deforestation and intense grazing.

Giovanni TOSATTI

When Pliny the Elder described the eruption of a mud volcano in the district of Modena (was it one from Nirano? Or perhaps the extinct mud volcano near Sassuolo?) with the much exaggerated terms of "*crepitu maximo...flamma fumoque*" perhaps he was already foretelling what was going to happen to him some years later. In fact, his scientific curiosity led him to observe from far too close a position, another much greater eruption, i.e. the famous Vesuvius eruption of 24 August 79 AD whose ashes eventually killed him.