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Understanding the origin of magnetic znomalies in Monte San Vincenzo (Southern Italy) archaeological Site: susceptibility measurements, PXRD, XRF and optical analysis

M. Ciminale *, D. Gallo *, M. Pallara ** and R. Laviano **

Key words: Magnetic survey, Archaeological sites, Susceptibility, Magnetic minerals, X-ray and optical analysis.

In the 2002 a multidisciplinary research project began studying the ancient landscapes of Tavoliere, an agricultural area located in Southern Italy that, as shown by historical and archaeological documentations, has been intensively populated from the Neolithic until the Middle Ages (e.g. Bradford, 1949; Jones, 1987; Volpe, 2001). Since the number and extent of the sites (villages, villas, farms, necropolis, etc.) render the planning of a systematic programme of excavations very difficult, a non-invasive investigation combining aerial photography and high-resolution magnetic surveys has been carried out in order to locate and identify buried archaeological features over wide areas (Ciminale *et al.*, 2007), obtaining information useful for a synoptic reconstruction of the deep transformations that occurred in this territory (landscape archaeology).

One of the surveyed sites is a vast Neolithic settlement placed on a hill top (Monte San Vincenzo) along the Celone river valley. Both crop marks and magnetic anomalies (Fig. 1) appeared very intense and were sharply defined allowing a detailed recognition of the buried structures. Subsequent targeted excavations brought to light part of a C-shaped compound (Fig. 2) providing, in addition, the complete

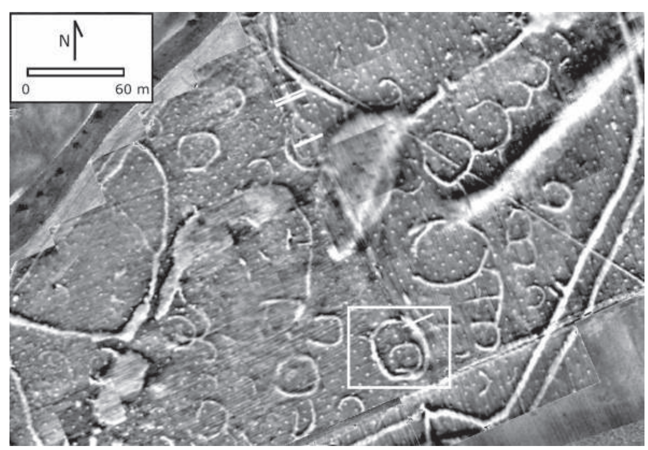

Figure 1: Final result of the integrated survey in Monte San Vincenzo Site: part of the processed magnetogram ([-18, 18] nT black/white). Intense magnetic anomalies outline precisely shape and position of the buried structures. Apart from the general plan of the Neolithic village, a pattern of regularly spaced spot features is clearly identifiable. These define the layout of an ancient olive grove whose orientation is in agreement with the roman land subdivision. The white rectangle delimits signals chosen for the targeted excavation.

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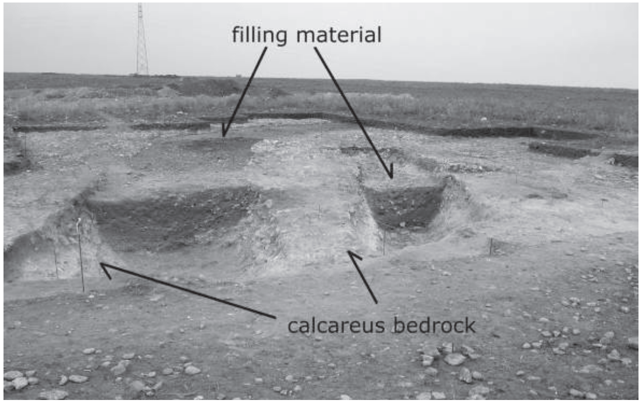

Figure 2: Photo of the excavated ditches.

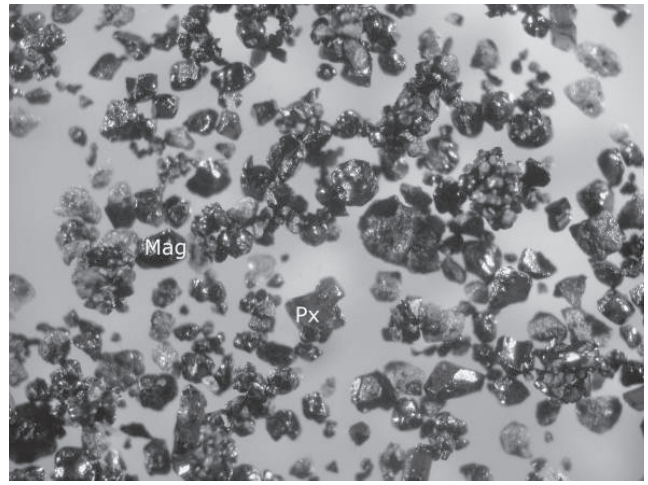

Figure 3: Microphotograph showing magnetic fraction of the filling material. Fragments of magnetite (Mag) and some pyroxenes (Px) can be clearly identified.

information on the geometry and location of the sources of recorded remotely sensed data.

In order to understand the origin of the relevant magnetic anomalies, susceptibility measurements were also performed; the detected contrast between the filling material and the calcareous bedrock was used to create synthetic models of the archaeological sources. Theoretical and experimental data were subsequently compared.

Following this the material filling the ditches was sampled for Powder X-ray Diffraction (PXRD), X-ray Fluorescence (XRF) and optical analysis. PXRD quantitative analyses showed a variable presence of clay minerals, quartz, feldspars and calcite. Among the clay minerals, illite plus muscovite are more abundant than smectite. XRF analysis data displayed SiO2, CaO, Al2O3, Fe2O3 and K2O as main oxides as in the "tout venant" samples as in the clay fraction (Φ<2µm) (tab. 1). Optical microscope observations showed many crystals of pyroxenes, amphiboles, melanite garnets, magnetite, hematite and amorphous Fe-oxide-hydroxides (Fig. 3). Furthermore microscope optical analyses indicated the presence of volcanic rock pumices and lava fragments.

All these interesting results, let us hypothesize that the provenance of the material filling the ditches, and thus its magnetic properties, can be ascribed to the nearby (55 km) Vulture volcano complex.

Eventually, since the presence of magnetic minerals in clayey materials indicates the occurrence of alluvial and colluvial process, a spatial distribution of the igneous products could be inferred from geomorphological studies (Eramo *et al.*, 2004; Laviano & Muntoni 2006) and therefore it could be used to analyze magnetic data recorded in other sites surveyed in the same territory.

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	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	LOI
Tout venant	35,31	0,49	10,24	4,22	0,14	1,60	22,76	0,45	2,28	0,26	22,25
Φ<2µm	37,44	0,60	14,32	5,89	0,16	2,08	14,83	0,21	2,48	0,33	21,66

Table 1: Average chemical composition of (1) "tout venant" samples and (2) clay fraction samples.

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