The Roman area natural environment: geomorphological features and lithic resources

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SUMMARY: The landscape of the region surrounding Rome - of which the volcanic complexes of the Monti Sabatini and Alban Hills make part. The landscape of this region is the result of the combined action of volcanism and exogenous agents. The morphological aspect of these volcanic complexes is quite similar in the peripheral areas and rather different in their central parts. Denudational processes are mainly due to channelled running waters that show different drainage patterns. The resulting landforms consist of different shaped valleys often controlled by structural factors. A more detailed description is given for a particularly interesting sector of the Monti Sabatini. Flint resources for lithic tool production on pebble are scarse in the Roman area. They are limited to Pliocene and Quaternary fluvial and marine deposits. In a study of 1995, four gravel "flint provinces" were differentiated for central Latium, each characterized by a specific composition in flint types and percentages. The provenance of the chert material used in the two lower Paleolithic sites of La Polledrara di Cecanibbio and Rebibbia-Casal de'Pazzi could be related to these provinces.

1. Geomorphological Features

This paper describes the main morphological features of the region surrounding Rome, which extends as far as the foot of the Latian Subapennines. This region includes a good part of the Campagna Romana (or Agro Romano), a term traditionally used to indicate the area, having no well-defined boundaries, which surrounds the Eternal City (Almagià 1976). It is a generally hilly region with altitudes gradually decreasing from a top level of about 1000 m toward the sea and also characterized by more or less wide coastal plains among which the deltaic plain of the Tiber river stands out.

The present morphological aspect of this region is the result of the combined action of the Middle and Late Quaternary volcanism and of the exogenous agents. The most important landforms encountered are volcanic, due to the activity of the Monti Sabatini and Alban Hills complexes.

The volcanic activity of the Monti Sabatini complex was mainly of areal kind. The volcanic products were ejected from numerous centres widespread over an area of about 1500 km^2; a main central edifice originated only in the eastern sector, where the Sacrofano Volcano developed. The volcanic activity started at the margins of the main graben and then migrated to its centre, following tectonic dislocations of regional importance. It caused the emplacement of a large amount of products (about 180 km^3) prevailingly made up of pyroclastic flows, hydromagmatic products, lava sheets and pyroclastic fall products. As a consequence of its mainly areal activity, the Monti Sabatini complex generally shows a very smooth morphology characterized by low relief and structural surfaces originated by the emplacement of volcanites (Biasini *et al.* 1993).

The Alban Hills volcanic complex is characterized by an important central edifice, which erupted most of the volcanic products. The activity of this volcano had three main phases. The first phase occurred between 0.5 – 0.36 Ma BP; about 34 km^3 of products were erupted and at least four huge pyroclastic flows were emplaced; these products extended regularly around the central edifice and were the last to reach as far as the periphery of the Roman area. This first phase ended with the summit caldera collapse. The second phase was very similar to the previous one; the volcanic activity concentrated again in the central area where a second smaller central edifice grew up inside the collapsed area. During this phase the most important lava flows were erupted (e.g. the Capo di Bove flow on which the famous Appian Way partially winds). The third, final phase was characterized by violent hydromagmatic activity from several eccentric craters, located in the southwestern sector of the volcanic complex; at present the largest of these craters hold the Lake Albano and the Lake of Nemi (Caputo *et al.* 1993).

In spite of the similarity of their eruptive cycle, the Monti Sabatini and Alban Hills volcanic complexes are morphologically different, at least for their central parts.

The Monti Sabatini landscape is marked by the contrast between the composite aspect of the central sector, where most of the positive and negative volcanic forms are present, and the smooth and regular trend of the peripheral sectors. The positive volcanic forms (mainly scoria cones) are responsible for the greatest elevation in the northern part of the central sector where, at Monte Rocca Romana, to the North of Lago di Bracciano, the maximum elevation is reached (612 m a.s.l.). The wide subcircular depression, occupied by the Lago di Bracciano is the most striking negative form of the whole complex. Other important subcircular or ellipsoidal depressions are those of Martignano, Baccano and Sacrofano, all to the East of Bracciano. The origin and evolution of these four depressions followed different paths. The former had an essentially volcano-tectonic origin, while the others have the typical features of volcanic centres with predominantly explosive activity.

On the contrary, the existence of the central edifice makes the Alban Hills landscape much sharper, at least in the central area where the emission centres are concentrated. In fact this volcanic complex has the shape of a large edifice with rather gentle slopes, slightly convex and cut by many small valleys. The summit area is characterized by two walls with very steep slopes; the outer wall is the remnant of the Tuscolano-Artemisio edifice and it has a horseshoe shape, being open to the West; the inner wall is the remnant of the Faete edifice and it rises from the flat plain that occurs inside the outer wall.

The morphological features of the peripheral sectors of the Alban Hills and of the Monti Sabatini are quite similar. The repeated pyroclastic and lava flows caused the formation of surfaces slightly inclined from the eruptive centres outward; on these surfaces the erosive action of the exogenous agents has produced its modelling effects.

The drainage networks of the Alban Hills area is affected by channelled running waters that form drainage networks, which change in density and pattern (centrifugal, centripetal, annular and parallel) according to different factors. The watercourses flowing on northern and northwestern slopes join the Aniene river; drainage networks have a centrifugal radial pattern at the headwaters, then they assume an overall parallel pattern, mainly NW-SE oriented. Streams draining the western slopes join the Tiber river downvalley of its junction with the Aniene river. On these slopes streams mainly flow in a SE-NW direction and the drainage network geometry becomes similar to a subparallel pattern. The southwestern slopes include also numerous small catchments, which drain directly into the sea, from the mouth of the Tiber river to Anzio.

Denudational processes, which affect the Alban Hills area, are mainly due to surface running water. Landforms resulting from the action of channelled waters are definitely the most important; they consist of differently shaped valleys, often controlled by structural factors and partly by microclimatic conditions that change with altitude. The trough-floored valleys – generally of small extent - are the most widespread landforms along the slopes of the inner volcanic edifice and along the upper slopes of the outer edifice. The V-shaped valleys locally represent a landform change being the continuation, interruption, or beginning of trough- and flat-floored valleys. In general they are not frequent and at present they often show deepening riverbed erosion. The flat-floored valleys, frequently being covered by alluvial deposits on their bottom, are very widespread in the western and southwestern sectors, as well as in the northern one near the Monti Prenestini.

The drainage network of the Monti Sabatini volcanic complex seems to be influenced only by the wide and low relief surfaces originated by volcanite emplacement and by the large depressions of Bracciano, Baccano and Sacrofano. The drainage network varies in density from zone to zone and tends to show a centrifugal pattern on the whole. In this general drainage pattern, several configurations can be easily isolated and broadly classified into different types: centripetal, centrifugal, annular, parallel and dendritic. The morphological evolution and the present arrangement of the Monti Sabatini volcanic complex are the result of both the cited volcanic events and the exogenous processes. The most evident exogenous processes are due to channelled running waters that dissected the volcanic plateau into large shelves, which are separated by deep valleys drawing a drainage network with different characteristics from zone to zone. However a great role had also the strong control by recent tectonics, as various morphotectonic studies show (Biasini *et al.* 1993; Ciccacci *et al*. 1988, 1989).

The Sacrofano-Baccano volcano is described in detail; it represents the only central edifice of the whole Monti Sabatini complex and its evolution may have been similar to that of the Alban Hills. The Sacrofano-Baccano area, located in the eastern sector, had a morphological evolution markedly affected by both volcanic and tectonic events, which involved the same valley of the Tiber river. Such evolution took place through four main phases (Fig. 1).

In the first phase the products of the volcanic centre of Sacrofano built up the central volcanic edifice, while many scoria cones originated in the peripheral zones of the main volcano. On the newly created relief a radial centrifugal drainage developed, which cut deep valleys mainly developed on the northern slope of the volcano (Fig. 1.1). The emplacement of the Sacrofano lower pyroclastic flow, in particular, was strongly controlled by the preexisting topography and was responsible for the morphological changes also in the most marginal areas.

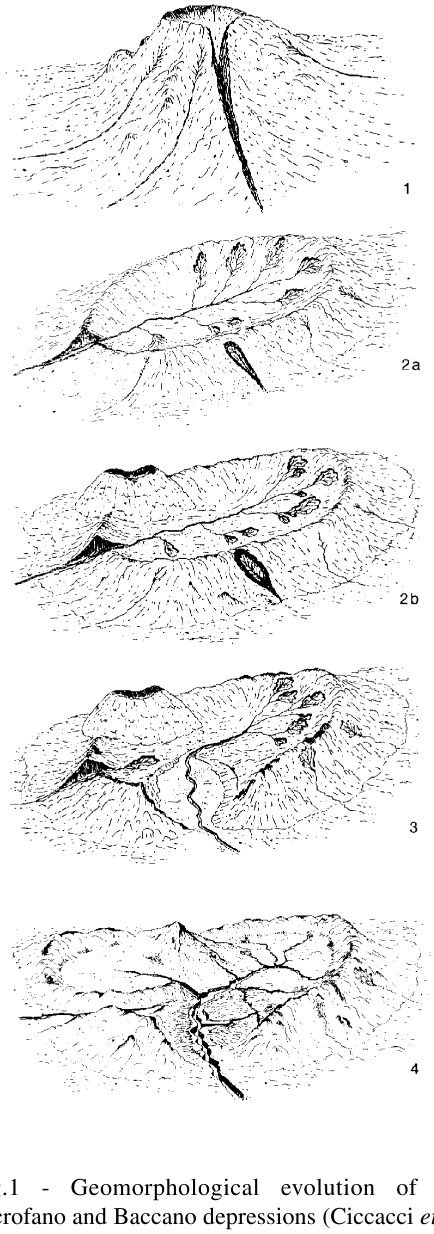

Fig.1 - Geomorphological evolution of the Sacrofano and Baccano depressions (Ciccacci *et al.* 1988, modified).

To the North of the Sacrofano volcano, in fact, this flow was channelled in the ancient valley of the Tiber river which was dammed and forced to flow in the present and more eastern position (Alvarez 1973). At the end of this first phase, the volcano summit collapsed and consequently a large elliptical caldera formed, with its major axis NE-SW oriented, a tectonic direction of regional importance; in fact it clearly controlled the morphological evolution of the eastern sector of the Monti Sabatini volcanic complex as well as its volcanic history.

The presence of the Sacrofano caldera dominates the second phase (Fig. 1.2a). The collapse of the volcano summit cut off the radial valley headwaters, while the valleys themselves were partially filled with the pyroclastic flow. Within the caldera a new centripetal drainage network was emplaced which joined the main trunk flowing from NE to SW, following the caldera major axis and breaking the depression edge southwestward. At the end of this phase a hydromagmatic activity developed at an uncertain centre. The products of this activity crop out on the northern and eastern rim of the caldera; the same kind of activity is responsible for the building up of a tuff-cone (Monte Razzano) on the western edge of the Sacrofano caldera (Fig. 1.2b).

The third phase is marked by consistent modifications of surface drainage. The main trunk of the intracalderic drainage network, NE-SW oriented, is forced to flow southward inside the valley in connection with the crater since the first evolutive phase. This deviation was probably due to the headward erosion of a river channel (Rio Cremera), which breached the southern rim of the caldera depression and captured the intracalderic drainage network (Fig. 1.3). This piracy was probably made easier by a volcanic event, which would have interrupted the southern edge of the Sacrofano caldera.

The fourth phase of the evolution of this area started with the beginning of the Baccano eruptive centre activity. The volcanic events of this phase deeply changed the previous landscape. The western edge of the Sacrofano caldera was firstly buried by the Baccano lower hydromagmatic unit and finally interrupted by the main collapse of the Baccano caldera (Fig. 1.4), which was accompanied by the faulting of the Monte Razzano tuff cone. The Baccano products caused the progressive filling up of the Sacrofano depression; as consequence, subhorizontal structural surfaces originated that raised the caldera bottom and caused the drainage network rejuvenation.

2. Lithic Resources

In the following text, attention is concentrated on the siliceous resources for lower paleolithic tool production, although other provenance studies for this period have been done in the Campagna Romana, e.g. on the origin of the leucitite blocks encountered at the La Polledrara site (Anzidei *et al.* 1995).

The Roman area is characterized by both volcanic and continental depositional environments (Conato *et al.* 1980; De Rita *et al.* 1988; Di Filippo 1993; Marra & Rosa 1995). Generally, the area is poor in siliceous resources for tool production: the volcanic deposits do not contain chert at all, whereas the continental formations contain chert veins only locally. In this area, pebbles made up of chert and siliceous limestone are essentially limited to Pliocene and Quaternary fluvial and marine deposits. And therein, unweathered flint pebbles are not abundant.

In 1995 a research was carried out for the Soprintendenza Archeologica di Roma to establish the provenance of the pebbles used for the production of the lithic tools encountered at the lower-Paleolithic sites of “Casal de’ Pazzi” and “La Polledrara di Cecanibbio” (for the geological and paleoenvironmental aspects of these sites, see Anzidei *et al.* 1984, 1988, 1989; Anzidei & Arnoldus-Huyzendveld 1992; Arnoldus-Huyzendveld & Anzidei 1993).

At the La Polledrara site, the flint is mainly of one type: medium grained, dark grey, unweathered and with a black or grey, thick cortex. The lithic industry encountered at the Casal de' Pazzi site is basically derived from two types of material: predominantly unweathered, fine and medium textured flint with light colors (yellowish, greyish, rarely brown or reddish), and, more rarely, a second type: a greyish flint with many inclusions. Up to now only two tools were found to be derived from flint similar to that of La Polledrara (dark-grey). The first type of the Casal de' Pazzi site seems at first sight identical to what was used in the roman and pontinian area during the middle Palaeolithic.

The procedure for the provenance study has been first to identify on the geological maps the sediments containing siliceous veins and pebbles in a large part of the coastal area of central Latium. Successively, the lithological composition of various Pliocene and Pleistocene pebble formations has been verified in the field. The choice to limit the field research to gravelly deposits is justified by the exclusive use of tools on pebbles during the Lower Paleolithic. Samples were collected at ten geological sites, considered to represent sufficiently the variability of central Latium. On all the sites, at least of 100 pebbles larger than 3 cm, the lithological composition, the degree of weathering and the color were determined in the field. The results of the counting are given in table 1.

The differences in flint percentage and composition between the various sample turned out to be remarkable. On the basis of the data collected, four "flint provinces" for the central area of Latium were proposed, intended to serve as a tool for further research in this field (Fig. 2, from Anzidei *et al.* 1995):

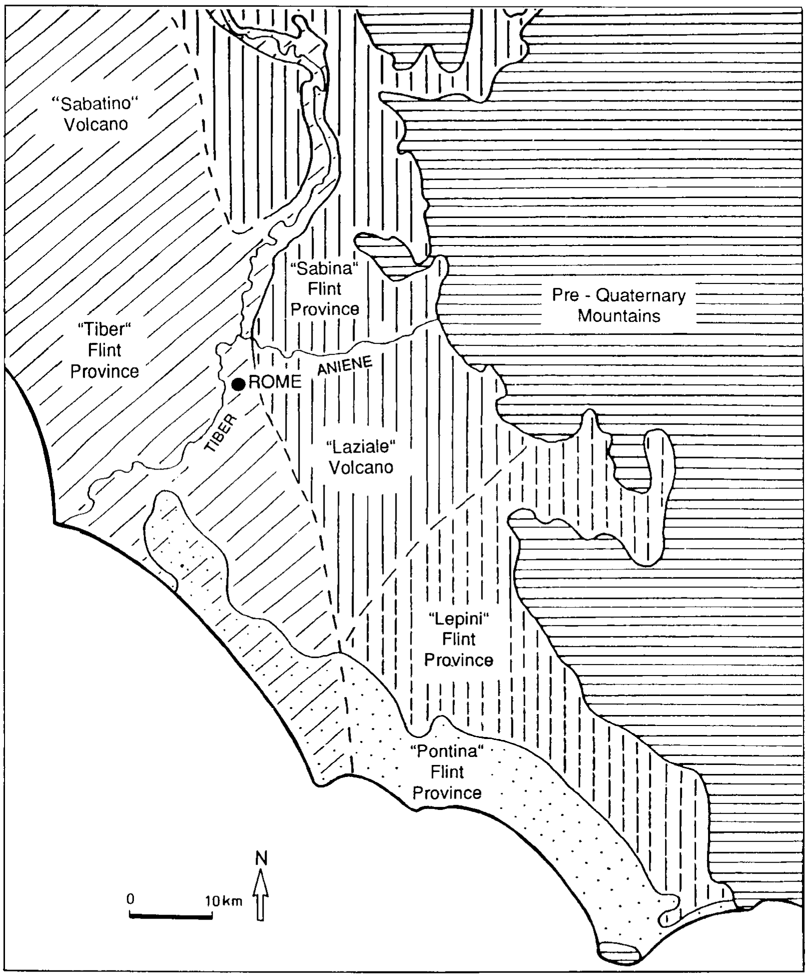

Fig.2 - Proposal for the “flint provinces” of the area around Rome: “Tiber” province, “Sabina” province, “Pontina” province, “Lepini” province.

T: "Tiber" province (fluvial-deltaic and coastal facies)
S: "Sabina" province (fluvial-deltaic facies)
P: "Pontina" province (coastal facies)
L: "Lepini" province (fluvial facies).

The Tiber and Pontina flint province overlap partially in space. This must be due to the activity of the Latium volcano (Alban Hills) in the Midde Pleistocene, which forced the limit of the Tiber province to the northwest.

As far as the flint type of the La Polledrara site, the geological study showed that they must have been derived from a formation belonging to the Tiber province. In fact, flint pebbles of similar size, colour and texture, occur in a part of the "Ponte Galeria Formation" (belonging to the lower Middle Pleistocene "Sicilian", age 0,8-0,6 Ma; Conato *et al.* 1980), presently exposed about 3 km to the south of La Polledrara, about 40 m below the site level, along the Galeria and Magliana valleys. Also other formations containing the same dark-grey flint occur in the area, i. e.: part of the S. Cosimato and Aurelia formations, correlated respectively to isotopic stages 11 (0,48-0.37 Ma) and 9 (0.37-0.27 Ma; De Rita *et al.* 1991). However, considering the limited extension of the S. Cosimato formation, only the pebbly part of the Aurelia formation, representing a contemporaneous river bed downstream from the site, seems to be a reasonable alternative hypothetical source for the dark-grey flint.

Since all three formations identified contain pebbly layers only downstream from the site, the presence of the flint pebbles at the La Polledrara site must be assigned in any case to human transport.

The two flint types of Casal de' Pazzi do not derive from any of the Tiber flint province. In the scheme proposed, the source of the dominant type of flint found at Casal de' Pazzi (type I, light colored, unweathered) must have been the pebbly formations of the Pontina flint province. Instead, the source of the subordinate type (type II, grey with inclusions) must have been the pebbly formations of the Sabina flint province, probably the local river bed of the paleo-Aniene.

Up to now, no provenance studies for the lithic material have been done for the other lower paleolithic sites of the Roman area. The present identification of the flint provinces could direct this research.

Tab.1 - Flint types of the samples collected around Rome.

FLINT PROVINCE	Nr. sample	Code sample	Geological formation of sample	total % flint	% dark grey unweathered flint	% light coloured unweathered flint	% red unweathered flint	% grey weathered flint	% light coloured or red weathered flint
Tiber	1	GAL	Ponte Galeria formation (middle Pleistocene)	11	3 *	0		8	0
	2	COS	San Cosimato formation (middle Pleistocene)	36	6 *	1		19	10
	3	AUR	Aurelia formation (middle Pleist.)	30	2 *	1		17	10
	4	CAL	Tor Caldara –Anzio ("qsm", middle Pleistocene)	37	32 *	5		0	0
Sabina	5	ACQ	Acquaviva ("Q2p", Plio-Pleistocene)	2	2 ***	0		0	0
	6	ARC	Casino d'Arce ("Q2-1", Plio-Pleistocene)	0	0	0		0	0
Pontina	7	LAT	Latina quarry (Pleistocene)	56	1	45 **	8	1	
	8	CIR	Parco Circeo – Sabaudia (Pleist.)	72	4	55 **	10	3	
	9	IEM	Campo Iemini –Torvaianica (Pleistocene)	73	2	56 **	0	15	
Lepini	10	NOR	Norma – Mt. Lepini (Pleistocene - Holocene)	0	0	0		0	0

* La Polledrara flint type
** Casal De' Pazzi flint type I
*** Casal De' Pazzi flint type II.

4. References

Almagià, R. 1976. *Le Regioni d'Italia. XI: Lazio*. Torino: U.T.E.T.

Alvarez, W. 1973. Ancient course of Tevere river near Rome: an introduction to the Middle Pleistocene volcanic stratigraphy of Central Italy. *Geol. Soc. Am. Bull.* 84: 749-758.

Anzidei, A.P. & Arnoldus-Huyzendveld, A. 1992. The middle Pleistocene site of La Polledrara di Cecanibbio (Rome, Italy). *Fourth Conference of Italian Archaeology, B.A.R., I.S.*: 141-153.

Anzidei, A.P., Angelelli, F., Arnoldus-Huyzendveld, A., Caloi, L., Palombo, M.P. & Segre, A.G. 1989. Le gisement Pleistocène de la Polledrara di Cecanibbio (Rome, Italie). *L'Anthropologie* XCIII, 3: 749-781.

Anzidei, A.P., Angelelli, F., Caloi, L., Damiani, I., Pacciarelli, M., Palombo, M.R. & Segre, A.G. 1988. Il giacimento pleistocenico de "La Polledrara" di Cecanibbio (Roma) - Relazione preliminare. *Archeologia Laziale* 9: 361-368.

Anzidei, A.P., Arnoldus-Huyzendveld, A., Lemorini, L., Caloi, L. & Palombo, M.R. 1999. Two Middle Pleistocene sites near Rome (Italy): La Polledrara di Cecanibbio and Rebibbia - Casal de' Pazzi. In *The role of early humans in the accumulation of European Lower and Middle Palaeolithic bone assemblages*. Monographien des Römisch-Germanischen Zentralmuseums 42. Mainz: 173-195.

Anzidei, A.P., Cassoli, P.F., Ruffo, M. & Segre, A.G. 1984.Risultati preliminari dello scavo di un deposito pleistocenico in località Rebibbia-Casal de' Pazzi. *Atti del XXIV Convegno dell'Istituto Italiano di Preistoria e Protostoria.*

Arnoldus-Huyzendveld, A & Anzidei, A.P. 1993. Ricostruzione di un ambiente fluvio-lacustre nella regione vulcanica di Roma (la Polledrara di Cecanibbio). *Atti XXX Riunione Scientifica Istituto Italiano di Preistoria e Protostoria, Firenze*: 151-165.

Biasini, A., Buonasorte, G., Ciccacci, S., Fredi, P. & Lupia Palmieri, E. 1993. Geomorphological characteristics. In: Sabatini Volcanic Complex. *Quad. Ric. Scien. C.N.R* 11: 80-94.

Caputo, C., Ciccacci, S., De Rita, D., Fredi, P., Lupia Palmieri, E. & Salvini, F. 1993. Drainage Pattern and Tectonics in some volcanic Areas of Latium (Italy). *Geologica Romana* 29: 1-13.

Ciccacci, S., De Rita, D. & Fredi, P. 1988. Studio geomorfologico delle depressioni vulcaniche di Sacrofano e Baccano nei Monti Sabatini (Lazio). *Mem. Soc. Geol. It.* 35: 833-845.

Ciccacci, S., De Rita, D. & Fredi, P. 1989. Geomorfologia quantitativa e morfotettonica dell'area di Morlupo-Castelnuovo di Porto nei Monti Sabatini (Lazio). *Geogr. Fis. Dinam. Quat. Suppl.* 1: 197-206.

Conato, V., Esu, D., Malatesta, A. & Zarlenga, F. 1980. New data on the Pleistocene of Rome. *Quaternaria* 21: 131-176.

De Rita, D., Funiciello, R. & Parotto, M., 1988. *Carta geologica del Complesso Vulcanico dei Colli Albani (Vulcano Laziale). Scale 1:50.000. C.N.R., P.F.G.* Roma: Gruppo Nazionale per la Vulcanologia.

De Rita, D., Rosa, C. & Zarlenga, F. 1991. Un'ipotesi di correlazione tra la sedimentazione lungo la costa tirrenica della Campagna Romana e l'attività vulcanica dei Colli Albani (Pleistocene medio-superiore). Prog. Strategico Crosta Profonda, Sottoprogetto CROP 11. *Studi Geol. Camerti. Vol. Spec.* 1991/2: 343-350.

Di Filippo, M. (ed.) 1993. *Sabatini Volcanic Complex; scale 1:50.000.* Roma: C.N.R.

Marra, F. & Rosa, C., 1995. Stratigrafia e assetto geologico dell'area romana, In Funiciello, R. (ed.), *La geologia di Roma. Il centro storico*: 49-118. Roma: Istituto Nazionale di Geofisica, Dipartimento di Scienze Geologiche, Servizio Geologico Nazionale.