Middle Pleistocene geology of the "Bassa Campagna Romana"

D. De Rita[1], F. Zarlenga[2]

[1]*Dipartimento di Scienze Geologiche, Università degli Studi di Roma Tre, Roma, Italia* - derita@uniroma3.it

[2]*Divisione ambiente e Caratterizzazione territoriale, ENEA-Cr-Casaccia, Roma, Italia* - zarlenga@casaccia.enea.it

SUMMARY: This paper describes the main geological characters of the "Bassa Campagna Romana" during the Middle Pleistocene. In this period the "Bassa Campagna Romana", comprised between the city of Rome and the Tyrrhenian sea, has been interested by complex geological processes including extensional tectonism related to the development of the Tyrrhenian basin back arc, volcanism, and the glacio-eustatic variations of the sea level related to global climatic changes. The Tiber river is one of the most important geological element present in the area; most of the deposits outcropping in the area are, in fact, alluvial sediments of the Tiber and its tributaries, often interbedded with volcanic deposits from the Colli Albani and the Sabatini volcanic districts. The successions, which sometimes contain Palaeolithic industry, has been subdivided, by the presence of unconformities, in several orders or cycles of alluvial fills interbedded with volcanic deposits.

1. Stratigraphy of the area*

During the Middle Pleistocene to the recent, Central Italy has been interested by complex geological processes including:

- general uplifting of the area due to hysosthatic re-equilibration, after the Apennine orogeny, and to extensional tectonism of the Tyrrhenian margin related to the development of the Tyrrhenian back arc basin;
- extensive alkali-potassic volcanism from mainly explosive volcanoes forming a NW-trending elongated belt, parallel to the Tyrrhenian sea coast;
- glacio-eustatic variations of the sea level.

The interplay among these processes are responsible for the morphological setting of Central Italy and, in particular, of the "Bassa Campagna Romana". The geometry and the facies characteristics of the volcanoclastic succession of the Tiber valley indicate that its morphology was modified many times during the Middle Pleistocene, both for the effects of local tectonics, the emplacement of large-volume ignimbrites and oscillations of the sea level.

In this paper we present a synthesis of the geological studies that have been made in the last ten years on this area, with emphasis to a new interpretation that has been possible by the data collected during the recent field survey for the new 1:50.000 geological map of Italy.

Most of the Middle Pleistocene deposits outcropping in the "Bassa Campagna Romana" are alluvial sediments of the Tiber river and of its tributaries, which represent several orders or

* The new data reported in this section were obtained during the survey of the "Roma" and the "Albano" geological maps (originally at the 1:10000 scale) of which the field operators have been Alessandra Esposito and Marina Fabbri. Guido Giordano has been the field research Director and Renato Funiciello and Donatella de Rita have been the Chief Supervisors. Francesco Zarlenga has been the Responsible for the survey of sedimentary Quaternary units.

cycles of alluvial fills. In some cases and at the top of the sequence, they show brackish and marine facies as at the Torre del Pagliaccetto, San Cosimato and Vitinia sections (Conato *et al.* 1980). This succession of sediments, interbedded with volcanic deposits from the Colli Albani (also known as Alban Hills), almost 20 km south-east of Roma, and the Sabatini volcanic Districts, more than 30 km north of Roma, lie unconformably on Lower Middle Pleistocene (P. Galeria Formation) and older pre-volcanic sediments.

The Sabatini volcanic district is a large volcanic area with many craters and calderas located around a central collapsed area at the present infilled by the Bracciano lake. Volcanic activity started around 600 ka ago from craters located in the eastern sector. Here, the Sacrofano volcano, the most active of the sector, had mainly explosive activity erupting fall scoriae and pumices and huge pyroclastic flows. The fall levels and some of the pyroclastic flow units reached the Bassa Campagna Romana: the "Tufo giallo della Via Tiberina" (549 ka), the "Prima Porta" unit (514 ka) and the "Tufo giallo di Sacrofano" (333 ka). Volcanism was contemporaneously active in the central sector of the volcanic district where fracture systems erupting lava flows and explosive craters developed around the central volcano-tectonic depression of the Bracciano lake. From the Vigna di Valle crater, south of the Bracciano lake, was erupted the "Tufo rosso a scorie nere" ignimbrite (430 ka).

The Colli Albani volcanic district is a central volcano whose activity can be subdivided in three main Epoch (*sensu* Fisher & Schmincke 1984). During the first Epoch, from 600 ka to 300 ka, the central Tuscolano-Artemisio volcano was active, which erupted several pyroclastic flow units, largely reaching the Bassa Campagna Romana. After the collapse of the edifice and the setting of the Tuscolano-Artemisio caldera, volcanic activity was located within the smaller Le Faete central edifice, grew inside the collapsed area. Final hydromagmatic explosions from eccentric craters ended the volcanism less than 30 ka ago.

The base of the volcanoclastic succession of the "Bassa Campagna Romana" is the Ponte Galeria Formation. It is made of interbedded conglomerates, sands and clays interpreted as the deposits of the ancient Tiber river and its delta in the medium-higher part, named Paleotiber.

The geometry, the facies characteristics and the thickness of the Ponte Galeria formation indicate that, before the beginning of the alkali potassic volcanism, about 600 ka ago, the Paleotiber was in an easternmost position with respect to the present and its delta was in the area of Ponte Galeria. Ponte Galeria formation has been studied by many Authors and several interpretations of its sequence have been proposed (Conato *et al.* 1980; Malatesta & Zarlenga 1986; Milli 1992, 1997; Marra & Rosa 1995; Marra *et al.* 1994).

On top of this sequence, the "Tor de Cenci" unit is present. The "Tor de Cenci" unit is the deposit of pyroclastic flows erupted from the central Tuscolano-Artemisio volcano in the Colli Albani volcanic district.

The "Tor de Cenci" unit has been dated by Karner *et al.* (1994) 561 ka. It is one of the four ignimbrites, separated by paleosoils, recognized during the recent field research as belonging to the deposits generally known as "Tufi pisolitici".

Almost contemporaneously to the "Tor de Cenci" unit, interbedded with synvolcanic sediments, is another ignimbrite unit erupted by the Sacrofano volcano in the Sabatini volcanic District. This ignimbrite, named the "Tufo giallo della Via Tiberina" was erupted 549 ka ago.

These eruptions had a strong impact on the sedimentary environment of the Roman area. Many minor river valleys were completly infilled and the Tiber, North of Rome, had its course moved westward. Enormous volumes of sediments were rapidly transported by mass flow and high sediments-concentration flow processes. Thick volcanoclastic deposits, both interbedded and on top of the ignimbrites are the products of this sineruption phase.

The volcanic and volcanoclastic sediments are cut by an important erosion surface that we consider as due to the oscillation of the sea level related to the OIS 14.

On this surface, fluvial sediments interbedded with several volcanic units are present.

The fluvial sediments are conglomerates, sands and clays rich in volcanic component and locally interested by travertine deposits. The volcanoclastic deposits are also known as "Valle Giulia" unit as defined in the Roman urban area (Marra & Rosa 1994).

The volcanic units come from both the Sabatini and the Colli Albani volcanic Districts. They are the "Palatino unit" dated 533 ka and the "Casale del Cavaliere unit" from the Tuscolano-Artemisio volcano, the "Prima Porta" unit, dated 514 ka years and fall deposits from the Sacrofano volcano in the Sabatini volcanic district.

This complex sedimentary cycle is closed by a strong uplift of 20-30 m, started during the first volcanic eruptions and by a contemporaneous low stand of the sea level, due to the glacio eustatism, which produced an erosion surface, that we relate to the isotope stage 12, which cut all older sediments.

After this phase a new chapter in the geology of Bassa Campagna Romana begins, in fact erosion and sedimentation in the palaeovalleys have been strongly affected by the eustatic cycles, during the low standing of the sea level large regional erosion surfaces and during high stand of the sea level the sedimentation in the palaeovalley were produced; these sedimentary cycles represent "fourth order depositional sequences" (De Rita *et al.* 1993).

This first surface is filled by complex volcanics or by sediments. The volcanic unit are lava flows, "Pozzolane rosse" and "Pozzolane nere" units from the Colli Albani volcano that are interbedded with syneruption pebble-sandy fluvial sediments.

The sediments related to the oxygen isotope stage 11 are characterised by the absence of black scoriae coming from the "Tufo rosso a scorie nere". They constitute the S. Cosimato Formation (Conato *et al.* 1980; Malatesta & Zarlenga 1986) and, from a palaeontological point of view, they could be correlated to the Fontana Ranuccio Faunistic Units (FU) (Caloi & Palombo 1995).

Probably at the end of this cycle, or during the higher part the "Tufo rosso a scorie nere" ignimbrite, dated 430 ka, from the Vigna di Valle crater and fall deposits from Sacrofano volcano both in the Sabatini volcanic districts were put in place. The volcanoclastic sediments are known in the literature as San Paolo formation, "Conglomerato giallo" unit.

An erosion surface that we relate to isotope stage 10 cuts these sediments. The volcanoclastic and volcanic sequence on it is constituted by fluvial and lagoon sediments interbedded with the "Villa Senni" eruption deposits which include the deposits of two ignimbrites, the "Tufo lionato" and the "Tufo di Villa Senni" ignimbrites, dated at 336 ka, the "Tufo giallo di Sacrofano" from the Sacrofano volcano dated at 333 ka. Toward the top the Capo di Bove lava flow has been recognized. This important lava flow was erupted from the Le Faete edifice, the youngest central volcano of the Colli Albani volcanic District, which grew up inside the collapsed area of the Tuscolano-Artemisio.

The alluvial sediments related to isotope stage 9 are well known as Aurelia Formation (Caloi *et al.* 1998; Conato *et al.* 1980; Malatesta 1978; Malatesta & Zarlenga 1988) and, from a palaeontological point of view, are related to the Torre in Pietra Faunistic Units (F.U.) (Caloi & Palombo 1995), defined in the type section of Torre in Pietra.

Also this succession is closed by an erosion surface related to isotope stage 8 and the following alluvial infill, related to isotope stage 7, is named Vitinia Formation (Conato *et al.* 1980; Caloi *et al.* 1998), which, from a palaeontological point of view, are related to the Vitinia Faunistic Units (FU) (Caloi & Palombo 1995), defined in the type section of Vitinia.

Also this sedimentary cycle is closed by an erosion surface due to the uplift and to the lowering of sea level, on which marine sediments (Tyrrhenian s.s related to the 5e isotope stage, Hearty & Dai Pra 1986; Milli & Zarlenga 1991) are embanked.

After the Tyrrhenian cycle, an unnamed alluvial formation was deposited the Bassa Campagna Romana (with an age corresponding to 0,09 and/or 0,08 and/or 0,05 Ma; Arnoldus-Huyzendveld *et al.* 1993) and lastly the present

alluvial bottom valleys, correlated to the Versilian transgression, were formed.

All the volcanoclastic succession, following the Ponte Galeria Formation (l.s.), shows a geometry of overlapping alluvial fills, sensu Leopold *et al.* (1964), that have been interpreted as due to the lack of uplift phase until the Tyrrhenian stage. The sediments of the Tyrrhenian, instead, are embanked at 30-35 m a.s.l. to the older. The rate of this uplift has been calculated to be 10-15m. A second uplift phase of 30 m occurred after the Tyrrhenian, the sediments of the unnamed unit lie at 10-15 m a.s.l. The third and the last uplift phase occurred after the deposition of this and it has been calculated to be of 10 m. This is the cause of the presence of only three main Middle Pleistocene terraces in the "Bassa Campagna Romana".

2. Industry and Stratigraphy

During the last thirty years of research the relationships between stratigraphy and human industry has been clarified: In fact we can find Bifacial Acheulean industry in the sediments of the Aurelia Formation, Mousterian in the Vitinia Formation and in the Tyrrhenian or probably younger formations (Saccopastore). This presence, with Mammal fauna and volcanic layers, allow us to define a very good stratigraphy in an area where the outcrops are not so particularly abundant. Lastly it is very important to underline that the sediments which constitute the alluvial fills, represent only a little part of an interglacial stage; in fact, if we observe the present alluvial bottom valleys, we can understand that they were formed during the last arising of the sea level, starting from 12 ka and concluded 8 ka ago c.a.

3. Conclusions

Several sedimentary cycles were recognized in the "Bassa Campagna Romana" whose age is comprised between oxygen isotope stages 11 and 1. Volcanic deposits from the Tuscolano-Artemisio volcano in the Colli Albani volcanic District and from craters located in the Sabatini volcanic District are interbedded, allowing a correlation between volcanism and sedimentation along the coast. The lack of uplift until the Tyrrhenian stage caused the absence of alluvial terraces and the deposits are instead, alluvial fills insides.

4. References

Arnoldus-Huyzendveld, A., Gioia, P., Mussi, M., Toniutti, P., Zampetti, D. & Zarlenga, F. 1993. Paleosuperficie esposta, concentrazione di industria litica e stratigrafia nella piana costiera di Maccarese (Roma). *Il Quaternario*, 6 (2): 213-226.

Caloi, L. & Palombo, M.R. 1994. Biostratigrafia e Paleoecologia delle mammalofaune del Pleistocene medio dell'Italia Centrale. *Studi Geol. Camerti*, B, 503-514.

Caloi, L., Palombo, M.R. & Zarlenga, F. 1998. Late-Middle Pleistocene mammal faunas of Latium (Central Italy): Stratigraphy and environment. *Quaternary International*, 47/48: 77-86.

Conato, V., Esu, D., Malatesta, A. & Zarlenga, F. 1980. New data on the Pleistocene of Rome. *Quaternaria*, 22: 131-176.

De Rita, D., Milli, S., Rosa, C., Zarlenga, F. & Cavinato, G.P. 1993. Catastrophic eruptions and glacioeustatic episodes in Latium. *Intern. Conf.: "Large explosive eruptions". Accademia Nazionale dei Lincei, 25/5/93, Rome*.

Fisher, R.V. & Schmincke, H.U. 1984. *Pyroclastic rocks*. Berlin: Springer-Verlag.

Hearty, P.J. & Dai Pra, G. 1986. Amino-stratigraphy of Quaternary Marine deposits in the Lazio Region of Central Italy. *Zeit.Geomrph.N.F.*, 62: 131-140.

Karner, D.B., Marra, F., Renne, P., Alvarez, W. & Ammerman, A.J. 1994. $^{40}Ar/^{39}Ar$ dating of complex coastal deposits in Italy : a radiometric calibration of Pleistocene climate cycles. *Congr. Geol. Am. Soc., 20-22 Oct., Seattle*.

Leopold, L.B., Wollman, M.G. and Miller, J.P. 1964. *Fluvial processes in geomorphology*. San Francisco and London: Freeman W.H.

& Company.
Malatesta, A. 1978. Torre in Pietra. Roma. *Quaternaria* 20: 203-577.
Malatesta, A. & Zarlenga, F. 1988. Evidence of Middle Pleistocene transgression along Mediterranean Coast. *Palaeogeogr., Paleoclim., Paleoecol.* 68: 311-315.
Marra, F. & Rosa, C. 1995. Stratigrafia e assetto geologico dell'area romana. *Mem. Descr. Carta Geol. d'It.* 50: 49-118.
Milli, S. 1992. Analisi di facies e ciclostratigrafia in depositi di piana costiera e marina marginali. Un esempio nel Pleistocene del Bacino Romano. *Tesi di dottorato di Ricerca, IV ciclo*, Università degli Studi di Roma "La Sapienza", Roma.
Milli, S. & Zarlenga, F. 1991. Analisi di facies dei depositi tirreniani (Duna Rossa) affioranti nell'area di Castelporziano (Roma). Una revisione ambientale. *Il Quaternario* 4 (1b): 233-248.