# Distribution in space and time and analysis of preservation factors of Pleistocene deposits in the Roman area

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SUMMARY: An overview is given of the distribution of the 12 major Lower Palaeolithic sites around Rome with both bones and artefacts. Regularities in their spatial distribution are traced, and the preservation and discovery conditions of the sites are analysed. Generally, the formation of the embedding sediments is recognised as a principal site-forming condition. It is stressed that in the "Campagna Romana", sedimentary conditions have been present only during very short periods of the Quaternary geological evolution. Also other factors for site "formation" -favourable living conditions, burial, fossilisation, and discovery- are analysed for this specific area. It is concluded that the present distribution of Lower Palaeolithic sites near Rome may be mainly due to events related to the local and regional geological and morphological evolution. It is remarked that, in order to gain insight in the real areas of frequentation of the "Campagna Romana", one should take into account all the factors relevant to site formation, in particular the existence of favourable depositional conditions only during short time spans, the Quaternary landscape evolution characterised by several intertwined cycles of erosion and sedimentation, and the spatial distribution of stratigraphies containing remains and their apparently similar empty counterparts.

## 1. Spatial Distribution of the Sites

The aim of the present contribution is to offer a general overview of the distribution of the Lower Palaeolithic sites - with both bones and artefacts- of the surroundings of Rome (Fig. 1), moreover to trace some regularities in their spatial distribution and to analyse some of the factors that may have played a role in their preservation and discovery. Geological characteristics and discovery conditions of 12 major sites are given in table I (a, b).

According to the site distribution in relation to the geological context, the older sites (age about 300,000 years) are predominantly related to the fluvio-lacustrine environment existing towards the end of the main volcanic activity of the Albano and Sabatino districts (Middle Pleistocene, between about 500,000 and 300,000 years BP). Instead, the younger sites (age 200,000 - 125,000 years) are related predominantly to a plainly alluvial environment. In the older group, present altitudes are higher than in the younger group (60 to 70 m a.s.l. – with Torre in Pietra "m" as an exception - versus 30 to 50 m a.s.l.). One notices that half of the sites were discovered after 1970 (mainly those belonging to the older group).

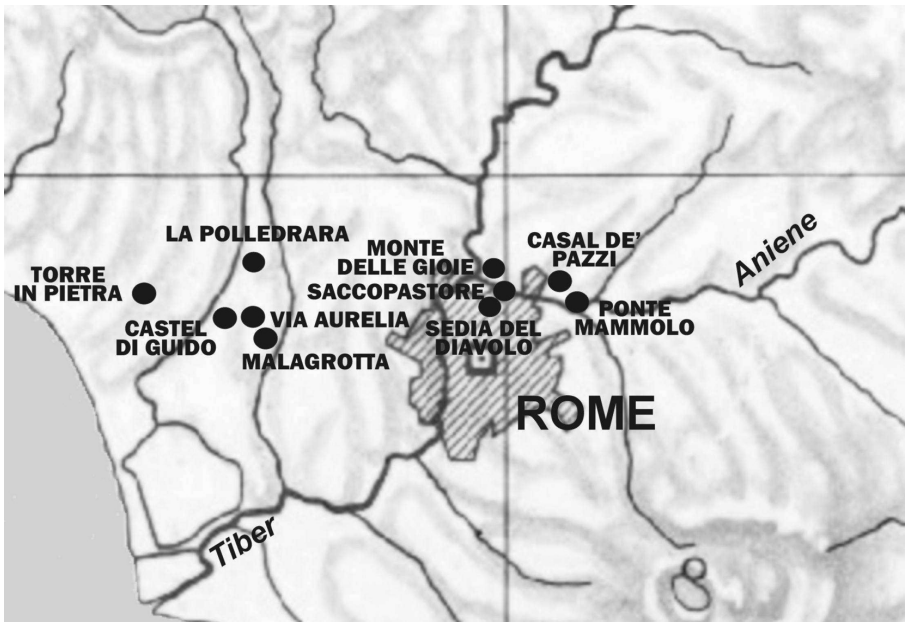


Fig.1 - Distribution of the major Lower Paleolithic sites around Rome.

## 2. A Condition for Site-Formation: Embedding in Sediments

An essential site forming condition is the formation of the embedding sediment. From the viewpoint of landscape development, to survive in time, the remains should be embedded in the most recent cycle of deposition, or in relicts from older cycles that escaped later erosion. Moreover, the deposit should be located in such a position in the present landscape that the depth below the surface allows for discovery (Arnoldus-Huyzendveld 1995).

The sediments of the Middle Pleistocene (middle and late) of the "Bassa Campagna Romana", represented by the alluvial sediments of the Tiber river and its complex tributary system, are clearly related to the eustatic rise of the sea level at the moment of deglaciation and represent complete sedimentary cycles (Malatesta & Zarlenga 1986, 1986a, 1988). Their position, at least concerning the three oldest cycles (formations of San Cosimato, Aurelia and Vitinia; Conato *et al.* 1980), did not give rise to alluvial terraces in the stricter sense, since no uplift phases occurred during their deposition. Being the later fills inset in the trenches cut in the earlier fills, these sediments can be identified as "alluvial fills inset" (Leopold *et al.* 1964). They are separated by erosion surfaces of global character, related to the eustatic lowering of the sea level in coincidence with glacial phases (Caloi *et al.* 1998).

Examining the most recent sedimentary cycle, represented by the present Tiber floodplain deposits, with a thickness variable between 100 m near the sea and about 50-60 m near the city of Rome, we observe that these layers were deposited between 12000 and 8000 years ago. This means that an alluvial infill was produced in only 4000 years; this value can be enlarged when admitting a reasonable margin of error, but anyway a very short time stands out.

Reflecting upon the fact that, in the past, alluvial infills of this type have been considered to coincide with the entire interglacial part of a glacial-interglacial cycle (the whole cycle lasting on average about 100,000 years), one notices that from the record of the interglacial phase a large part of possible information contained within the sediments is lacking. Therefore, a fluvial sedimentary cycle in areas close to the river outlet, like the "Bassa Campagna Romana", does not represent else then a small part of a much longer story.

Tab.1a - Discovery- and site characteristics of the principal Lower Palaeolithic sites around Rome.

| Site | Altitude m. a.s.l. | Year of discovery | Conditions of discovery | Motive of discovery | Period excavation / study | Geological formation | Isotopic stage | Geological facies |
|---|---|---|---|---|---|---|---|---|
| Torre in Pietra "d" | 44 | 1954 | quarry outcrop | survey | 1954-1964 | Vitinia formation | 7 | alluvial |
| La Polledrara di Cecanibbio | 83 | 1984 | surface outcrop | systematic survey | 1985-2001 | Aurelia formation | 9 | fluvio-lacustrine |
| Castel di Guido | 71 | 1970 | quarry outcrop | survey | 1980-1990 | Aurelia formation | 9 | fluvio-lacustrine |
| Casal de' Pazzi - Rebibbia | 28 | 1981 | road enlargement | public works | 1981-1986 | Aniene middle terrace | 7 | alluvial |
| Sedia del Diavolo | 44 | 1882 | roadside outcrop | quarry | 1935-1938 | Aniene middle terrace | 7 | alluvial |
| Monte delle Gioie | 49 | 1869 | surface outcrop | quarry and railroad construction | 1938 | Aniene middle terrace | 7 | alluvial |
| Saccopastore | 23 | 1929 | surface outcrop | quarry | 1935 | Aniene lower terrace | 5e | alluvial |
| Ponte Mammolo | 30 | 1837 | surface outcrop | survey | 1866-1867 | Aniene middle terrace | 7 | alluvial |
| Malagrotta | 57 | 1970 | surface outcrop | survey | 1975-1978 | Aurelia formation | 9 | fluvio-lacustrine |
| Torre in Pietra "m" | 34 | 1954 | surface outcrop | survey | 1954-1964 | Aurelia formation | 9 | alluvial |
| Via Aurelia km 19.3 | 60 | 1970 | roadside outcrop | survey | 1981-1984 | Aurelia formation | 9 | fluvio-lacustrine |
| Via Aurelia km 18.9 | 65 | 1990 | surface outcrop | survey / public works | 1990 | Aurelia formation | 9 | fluvio-lacustrine |

Tab.1b - Discovery and site characteristics of the principal Lower Palaeolithic sites around Rome (continued)

| Site | Stratigraphy | Present landform | Paleo-environment | Burying layers | Fossilisation process | Bone preservation |
|---|---|---|---|---|---|---|
| Torre in Pietra "d" | sandy-gravelly river infill | hill slope / terrace | river channel | alluvial deposits | probably calcification | various |
| La Polledrara di Cecanibbio | clayey tufitic sediments | hill slope | fluvio-lacustrine basin / ephemeral river channel | fluvio-lacustrine and pyroclastic deposits | fluoritisation | excellent |
| Castel di Guido | clayey tufitic sediments | hill summit | fluvio-lacustrine basin / ephemeral river channel | fluvio-lacustrine deposits | probably fluoritisation | good |
| Casal de' Pazzi - Rebibbia | sandy-gravelly river infill overlying "tufo lionato" | terrace | main river channel | alluvial deposits | probably calcification | various |
| Sedia del Diavolo | sandy-gravelly river infill | terrace | main river channel | fluvio-lacustrine and pyroclastic deposits | probably calcification | various |
| Monte delle Gioie | sandy-gravelly river infill | terrace | main river channel | fluvio-lacustrine and pyroclastic deposits | probably calcification | various |
| Saccopastore | sandy-gravelly river infill | terrace | main river channel | alluvial deposits | probably calcification | various |
| Ponte Mammolo | sandy-gravelly river infill overlying "tufo lionato" | valley side, terrace | main river channel | alluvial deposits | probably calcification | various |
| Malagrotta | clayey tufitic sediments | hill slope | fluvio-lacustrine basin | fluvio-lacustrine deposits | probably calcification | various |
| Torre in Pietra "m" | erosion surface | hill slope / terrace | land surface | alluvial and fluvio-lacustrine deposits | probably calcification | various |
| Via Aurelia km 19.3 | clayey and sandy tufitic sediments | hill slope | fluvio-lacustrine basin / ephemeral river channel | fluvio-lacustrine deposits | probably fluoritisation | good |
| Via Aurelia km 18.9 | clayey and sandy tufitic sediments | hill slope | fluvio-lacustrine basin / land surface | fluvio-lacustrine and pyroclastic deposits | probably fluoritisation | good |

And moreover, that part is limited to interglacial climatic conditions, since the eventually existing remains refering to glacial periods are now covered by the sea.

There occur also sediments, mainly lacustrine, but also alluvial, e.g. alluvial flooding deposits, which are detached from this specific evolutionary context, i.e. detached from the outcrops of the "alluvial fill inset", and for which it has been possible to reconstruct a detailed evolution. Frequently, just in these contexts paleontological and palethnological differences of a certain extent are observed, and sensible differences between the industries of various outcrops or differences in the faunas are evaluated. Here the request arises to refine the geological time scale. But from the geological viewpoint it is not possible to define a different reference period since the event is the same, i.e. the rising and highstand of the sea level, and almost never one succeeds in understanding the exact point on the time line of the events.

A particular limitation of the "Campagna Romana" is moreover the absence of limestone outcrops and the consequential lack of caves with archaeological and faunal remains.

Volcanic layers represent precious markers for the regional stratigraphical reconstruction, but neither the volcanic activity of the Albano and Sabatino districts has been continuous (De Rita *et al.* 1991; 1993; De Rita & Zarlenga, this volume). The activity started about 500,000 years ago and lasted until about 25,000 years ago, with very long periods of inactivity. Therefore, also the information contained in volcanic products, or in the sediments derived from them, are limited to precise moments of the regional evolution. For instance, one should consider (De Rita *et al*. 1993) that the major part of the activity and the products of the "Tuscolano-Artemisio" period of the Albano volcanic district seems to be deposited during phases of low sea level.

One must conclude that the information contained in sediments, and thus it paleontological and palethnological content, does not evidence anything else than particular moments of much longer lasting geological events, about which we have no, or very few, information. Certainly, once cleared up this limitation of geology it is possible, by integrating the various information, to succeed more or less correctly in determining the point on the time line of a specific site.

## 3. Other Conditions for Site Formation

### *3.1 Favourable living conditions*

We may presume that the peculiar environmental conditions of the Rome area, surrounded by volcanoes that were during the Lower Palaeolithic in their "afterlife", must have exercised a general attraction on the mammal fauna. One could mention the abundant vegetation on fertile soils, the abundance of springs and water courses, the complex pattern of environmental conditions, the ease of tracking from one area to another caused by the levelling effect of the pyroclastic deposits – absence of steeply dissected valleys-, the presumable dominance of intermittent parallel river channels (of the "braided" type) related to the high sediment load of the water courses, and the frequent occurrence of stagnant waters so typically for a "young" geomorphology.

### *3.2 Burial and fossilisation*

Taphonomy analysis provide a convenient tool to detect how fossils form and why they are found where they are (Andrews 1997; AA.VV. 1999; Martin 1999). As already known, the possibility to have bone–bearing deposits depend on nature of the organism, way and place of life and manner and cause of death, nature of biotic and physical processes operating during transport, burial and fossilisation, nature of deposit, processes of accumulation and of diagenesis of remains. Consequently, the bone-bearing deposit formation is not an usual phenomenon and a bone record rarely samples more than a very small and more or less poorly representative selection of an animal community (Behrensmeyer 1991). Any way, bones, made by complex matrix of proteinaceous materials (collagen and others),

highly mineralised and reinforced with hydroxyapatite ($Ca_{10}[PO_4]_6[OH]_2$ ) are usually the last part of the vertebrate body to decompose and are often robust enough to survive and fossilise. Preservation is aided by the relative resilience of bone, which provides improved opportunities for chemical alteration and fossilisation (Trueman & Benton 1997). However, bones are subject to destruction through breakage due to transport, trampling, scavenging, digestive process, weathering, wetting and drying, acid conditions etc.

Rapid burial is a near essential for bone preservation. This is usually accomplished in fluvial, lacustrine or marine environments though there can preservation in terrestrial sites under suitable chemical conditions. Caves, ash originating from volcanic eruptions and vulcanoclastic deposits can also offer conditions in order to a potential preservation. Fluvial conditions notably affect by selective transport the composition of bone-bearing. In fact, the transport of bone to sites of deposition are governed by the same rules which control movement of other sedimentary particles. In many instances, bone beds develop on river bends or other sites where clasts accumulate. This is the pattern of many deposits of the "Campagna Romana".

In the "Campagna Romana", bone fossilisation has presumably occurred in most cases through calcification. Although few analysis on the chemical composition of the bones are published, one could infer this from the composition of the circulating groundwater, which is frequently calcareous through the influence of the sandy calcareous layers interbedded between the clayey Pliocene substrate and the volcanic deposits.

A special case of fossilisation is present at the La Polledrara site, i.e. evidently through fluoritisation (Arnoldus-Huyzendveld & Anzidei 1993; Anzidei *et al*. in press). The composition of the bones has been determined by diffractometric analysis as fluoroapatite, a resistant and hard material. The bone remains are frequently associated with small fluoritic aggregates and more rarely, with large imprints of radial gypsum crystals. The local lacustrine sediments are made up mainly of ashy tuffites. Within these sediments there occur occasionally whitish layers, composed mainly of fluorite (also barite and halite are present as minerals).

The origin of these layers has been related to the rise along fractures of mineralised fluids causing fumaroles at the surface. Volcanic gas may mix with ash, and fluorine may link to the ash particles. The process of fossilisation may have occurred by indirect contact of the bones with ashes and fluorine-containing water. The chemical transformation must have been of this type: hydroxyapatite + F <—> fluoroapatite + OH. The gypsum ($CaSO_4$) could be a result of the interaction of the bone calcium with the sulphur contained in the fluids or gasses.

The distribution of fluorite layers in the local geological context turned out to be limited to a narrow N-S belt with a length of more than 10 km, crossing the site. Therefore, this kind of fossilisation may have occurred as well in other sites situated on this belt (Castel di Guido, Via Aurelia, Boschian 1993). The fluorite deposits of the Rome area are a rather rare phenomenon if seen on a world scale, so probably also this way of bone fossilisation.

### *3.3 Discovery of the sites*

Urban or suburban conditions do evidently contribute to the discovery of archaeological sites. The discovery conditions of the sites of the "Campagna Romana" were essentially of two kinds: or in relation to intensive surface transformation through quarries or public works or to more or less systematic surveys. The two types of discovery tend to concentrate in two different sectors of Rome: the former in the north-eastern area (Casal de' Pazzi, Sedia del Diavolo, Monte delle Gioie, Saccopastore, Ponte Mammolo) and the latter in the area to the west of the town, close to the Via Aurelia (Torre in Pietra, Castel di Guido, Malagrotta, La Polledrara di Cecanibbio, Via Aurelia km. 19,3). This distribution is related to the recent development of these areas. From the end of the 19$^{th}$ century on, the eastern zone has been subject to urbanisation, with the gradual substitution of the existing gravel and sand quarries by urban quarters. On the contrary, a vast area

to the west was composed by large estates belonging to the "Pio Istituto di S. Spirito" and the "Ospedali Riuniti di Roma", which were used as agricultural estates and farms for supplying the Roman hospitals. These properties passed in 1978 to the Rome Municipality and were from then on protected by the Urban Development Plan, thus maintaining their agricultural vocation.

Another aspect typical of the Rome area is the presence of many Institutions related to the archaeological heritage. We should mention research Institutes like the "Istituto Italiano di Paleontologia Umana", the University of Pisa and particularly the survey activity and capillary archaeological research and protection activity of the Rome territory by the "Soprintendenza Archeologica" of Rome. So it has been possible to exercise a control on the territory and to verify constantly the stratigraphical situations and the archaeological presences put to light during the expansion of the city. The result of this policy has been the identification, excavation and preservation, of two of the most interesting late Middle Pleistocene deposits in Italy: the La Polledrara and the Casal de' Pazzi sites, as well as the acquisition of many data useful for a detailed geomorphological and palaeo-environmental reconstruction of the Rome territory.

## 4. Conclusions

Referring to the present distribution of the early Palaeolithic sites in the Rome territory, one notices that a few stratigraphical situations are dominant, i.e. alluvial and volcanic-lacustrine.

From the geological considerations exposed it follows that sedimentary conditions must have dominated only during a small portion of time, i.e. the phase of sea level rising. Moreover, natural caves that eventual could fill some of the gaps in our knowledge are lacking in the "Campagna Romana". And finally, the known data are limited to interglacial climatic conditions, since the eventually existing remains refering to the glacial periods are now covered by the sea or have been removed by surface erosione. Considering moreover the other conditions necessary for becoming a site (frequentation, burial, fossilisation and discovery), it may be justified to conclude that the present distribution of Lower Palaeolithic sites near Rome is probably due mainly to fortunate sequences of events related to the local and regional geological and morphological evolution. In particular one could refer to the conditions that the top of the volcanic-lacustrine sediment layers (with locally favourable fossilisation conditions for the faunal remains) became exposed through the late Pleistocene and Holocene surface erosion, and that in the lower tract of the Aniene River, the terraces were locally well preserved trough the combined influence of lateral river displacement (sea level highstand) and linear dissection (last sealevel lowstand).

It must be stressed that, due to the intensive urbanisation and the constant presence of the institutions, in the "Campagna romana" many potential "containers" have been observed, i.e. those stratigraphies that may have had the potential to embed and preserve the paleontological and associated archaeological remains. But almost never these turned out to be present.

Taking into account the existence of favourable local depositional conditions only during short time spans and the (complementary) huge gaps in time and space, moreover a Quaternary landscape evolution characterised by several intertwined cycles of erosion and sedimentation, and finally the spatial distribution of "empty" stratigraphies and of stratigraphies containing remains, it should well be possible to gain insight into the real areas of frequentation.

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