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IMPLICATIONS OF RIVER SYSTEM ON RECENT TIBER RIVER ALLUVIUM

Anna Chiara Giacomi
Università di Roma "Sapienza", Roma
Corresponding author: A.C. Giacomi <annachiara.giacomi@uniroma1.it>

ABSTRACT: Giacomi A.C., *Implications of river system on recent Tiber River alluvium.* (IT ISSN 0394-3356, 2011)
The study shows a geological/geotechnical model of the filling of the buried Tiber River valley in the area of historical centre of Rome. The stratigrafic reconstruction of the Holocenic alluvial deposits, obtained by a 3D detailed engineering -geology model reconstructed by the observation of 78 geotechnical boreholes. Starting from the model, it was possible to explain the river system evolution during Pliocene-Pleistocene.

RIASSUNTO: Giacomi A.C., Implicazioni del sistema fluviale sui depositi alluvionali recenti tiberini. (IT ISSN 0394-3356, 2011)
Il lavoro propone un modello geologico/geotecnico delle alluvioni del Tevere nell'area urbana di Roma. La ricostruzione stratigrafica è stata ottenuta attraverso 78 stratigrafie di sondaggio. Dal modello è stato possibile poi interpretare l'evoluzione della sedimentazione fluviale nel Pliocene-Pleistocene.

Key words: Tiber River Valley, Lythotipes, Geometrical relationships, Geological and geotechnical model.

Parole chiave: Valle Tiberina, Litotipi, Relazioni geometriche, Modello geologico e geotecnico.

1.INTRODUCTION: GEOLOGICAL SETTING OF THE CITY OF ROME

The area of Rome was characterized by marine sedimentary conditions from Pliocene through early Pleistocene times (4.5-1.0 Myr).
This Plio-Pleistocene succession consists of alternating, decimetre-thick levels of clay and sand (BOZZANO *et al.,* 1997).

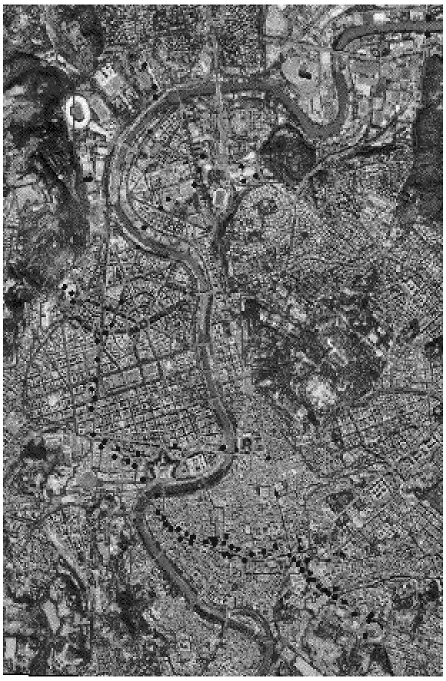

Fig.1 Boundary of the alluvial deposits in correspondence with the historical center of Rome and location of 78 boreholes.
Fig.1 Limiti dei depositi alluvionali nel centro storico di Roma e ubicazione dei 78 sondaggi.

During middle-late Pleistocene and Holocene times, sedimentary processes were confined to fluvial channels and coastal plains and strongly controlled by glacio-eustatic sea-level changes (BOZZANO *et al*., 1997). In the same time, the region also experienced strong volcanic activity, causing the emplacement of a thick pyroclastic cover that became intercalated into the continental sedimentary deposits.
The present-day hydrographic network of the Tiber valley and its tributaries originated from the Würm glacial (18 Kyr) period result from re-incision and deepening of the valleys which resulted from previous glacial-interglacial phases.
The sediments filling the Holocene incisions are generally characterised by a fining-upward succession, with a relatively thin level of gravel at the base grading into a thick pack of sand and clay (BOZZANO *et al*., 2000). This fine-grained portion of the deposit is represented by normal to weak overconsolidated clayey and sandy silt, (BOZZANO *et al.,* 2000).

2.THE CREATION OF THE MODEL

The originality of the ricostruction is in the correlation in 3D of the filling of the Tiber River valley in the area of the hystorical center of the city, adding some new elements in respect of that in BOZZANO *et al.* (2000, 2008).
The geological reconstruction of this model was based on data stored from 78 continuously cored boreholes which were uniformly distributed within the belt delimited in Fig. 1, from the Tiber Island to

the Tor di Quinto quarter. These boreholes, which range in depth from 30 to 67 m b.g.l., penetrate through the sediments filling the Tiber River valley and, in numerous cases, terminate in the Pliocene substratum (i.e. the *Monte Vaticano Unit*). Alluvial deposits have been classified by BOZZANO *et al.*, (2000), like CORAZZA *et al.,* (1999).
It was possible to construct a DEM relative to the ancient erosional Pleistocenic surface, using the AUTOCAD Map3D software, to define spatial limits. The upper limit, between alluvial deposits and bedrock, has been traced according to the Carta Geologica di Roma 1:10000 (FUNICIELLO R. & GIORDANO G., 2008), and it was construed as the upper limits of the ancient Tiber River Valley currently contains Holocenic alluvial deposits of the river.
To construct a geological/geotechnical 3D model it was necessary to correlate the boreholes according to layers every 5m. In each layer physiographic, morphology and sedimentology criteria were used to the correlation, to extrapolate the point data in a bigger area.
The operations shown above have been repeated for each deep investigation, for a total of 13 layers,

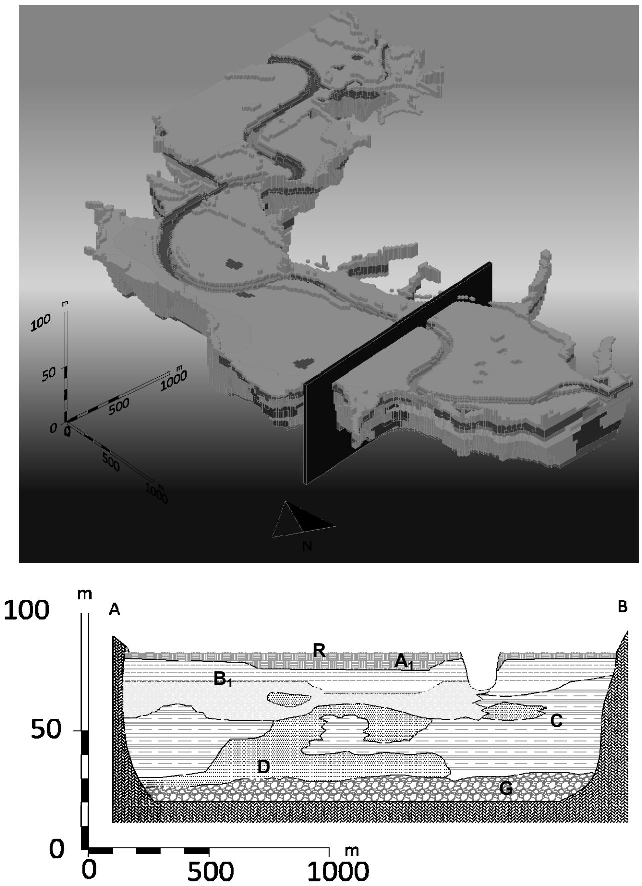

Fig.2 3D engineering geology model and location of the section (down).
Fig.2 Modello geologico-geotecnico 3D e ubicazione della sezione (sotto).

from -45 m to +15 m. b.g.l..
Thanks to an automatic process of extrusion, it was possible to transform the data from flat graphic sketches to a volumetric one. In this way all layers are joined together. Fig.2 shows the 3D reconstruction of the Tiber Valley alluvial deposits.
You can see a regular morphology of the valley, with a width of 2,5 km and a depth of about 60 m b.g.l.; the valley is characterized by steep vertical slopes, dug out of the *Monte Vaticano Unit*. Landslides and falling rocks could have happened during the aerial exposition. This is confirmed by the analysis of some boreholes situated near the banks of the Tiber River.
A probable interpretation could be that fragments of the landslides from the walls of the valley fell, while the Pleistocenic-Holocenic fluvial sedimentation was going on.
The morphology of the Valley is a possible result of an intense erosive process, due to a marine regression associated to the last glacial maximum dated at around 18.000 years ago.
This event was responsible for the incision of hydrographic networks of the Tiber River; Tiber River cut a channel into the Pliocene substratum to a depth of –50 m relative to the modern sea level, forming a wide valley of more than 60 m deep with sloping river banks and a flat *thalweg*.

3. GEOLOGICAL INTERPRETATION OF ALLUVIAL SETTING.

The occurrence of gravel deposits (lithotype G) at the base of the alluvial succession for a constant thickness (10m) implies that the Tiber River was initially a braided stream, whereas the transition to the finer sediments of lithotypes D and C indicates that it progressively became more meandering with the presence of vast palustrine areas (Fig.2).
At -45m b.g.l. there are some lenses of Unit G in Unit D that indicated erosional events: sand of D Unit could be deposited where the Tiber River has cut gravel alluvium, leaving isolated body of Unit G near the river bank. The D bodies, sandy and sandy silt, may represent the principal riverbed, designed in central part of the valley: an upright river-bed, which with the passing of time became a meandering course, opposite to the actual one (see the D body in fig.2).
Clay and silty clay (lithotype C) are deposited on this basal gravel and form the major part of the alluvial fill. The Unit C occurs as an almost continuous unit on the left bank of the present Tiber River and has a total thickness of around 50 m (Venezia Square, Popolo Square, Tor di Quinto, Campi Sportivi Street): it is due to the increase of sinuosity index and fine-grained overbank deposits were developed.
The lateral heteropic relation between the

alternating silty-sandy, sandy-silt and clay levels of lithotypes D and C indicates the almost continual presence of tributaries between 18,000 b.p. and the present, defining an alluvial floodplain which was formed not only by the main Tiber River but also by its right bank tributaries. Between 13.000 and 8.000 years, the main tributaries Valle dell'Inferno and Balduina streams, deposited two lateral bodies on the right bank (BOZZANO *et al*., 2000). The absence on the left bank of coarse alluvium indicates the lack of tributaries: it could be because of the ancient affluents witch dispersed to the wetlands (Unit C). Sandy and silty sandy (lithotype B_1), interpreted like the main Tiber River, indicates a more central position of the main channel in the valley than the present one. It is possible that about 3000 years ago there was a new erosive activity, with a bigger energy transport (ALESSIO *et al*., 1992).It has also been confirmed by an erosional surface between C and B bodies (see section in Fig.2). As lithotype B_1 has a larger grain size than B_2, it is likely that currents along the principal channel had a higher energy than those in the tributaries. The fact that the present course of the Tiber River in the Rome area is not centred in respect of the main B_1 body suggests that it had a different trend. It could be anticipated that this would have been more rectilinear during the period of change described above, subsequently becoming more meandering in response to the rapidly decreasing rate of sea level rise and eventual stabilisation. However, the good correspondence on the northern side of lithotype C filled by B_1–B_2 sediments and the trace of the Valle dell'Inferno stream implies that the position of the right bank tributaries has remained nearly stable from the erosive event to recent times. On the river banks there are the ancient bodies of tributary B_2: they are the bodies of Valle dell'Inferno and Balduina streams from Mt. Mario - Mt. Vaticano - Gianicolo on the right bank and Spinon stream (at South) and Aniene River (at North) on the left bank. The high thickness of Unit C, in heteropic contact with B_2 on the river banks, indicated that the wetlands around the Tiber River and its tributaries were periodically flooded. The historical alluvium A_1-A_2 are finer-grained than B_1-B_2, showing a decrease in the transport capacity of both the principal river and its tributaries. The lithological variation between lithotype A_1 (located around the principal riverbed) and A_2 (further away) is probably due to the same reason on postulated for the difference between lithotypes B_1 and B_2: B_1 body is central in the valley as A_1 covers the actual Tiber channel; B_2 is only in some confluence areas, while A_2 is everywhere, getting to the slopes of the valley.

The thickness of both Unit A and the anthropic fill material Unit R on the left bank is similar to the one on right bank: it is possible that during the growth of ancient city of Rome, and with this the anthropic fill deposition, on the right bank (Prati quarter) frequently floods happened. Here the Unit A alluvium is more thick and continue.

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