Subsurface stratigraphy and urban archaeology in the Bologna area

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Abstract

Reconstructing subsurface stratigraphic architecture of Late Quaternary deposits is of paramount importance in the context of resource management and hazard reduction in alluvial and coastal plains. Urban areas, in particular, represent peculiar regions where high density of subsurface stratigraphic data may enable the construction of predictive sequence-stratigraphic models with high temporal resolution. As a part of a project involving University of Bologna, Regione Emilia-Romagna and Superintendence to Archaeological Properties of Emilia-Romagna, this study shows how an integrated sedimentological and archaeological approach to high-resolution subsurface stratigraphy in the Bologna urban area may provide the basis for refined reconstruction of the palaeoenvironmental evolution during the late Holocene.

The subsurface of Bologna hosts an abundance of stratigraphic data stored in the Emilia-Romagna Geological Survey database. Over the last two decades, the realization of the Geological Map of Italy imposed the organization of stratigraphic information into georeferenced datasets. At present, more than 3000 stratigraphic data are available for the Bologna urban area, with average density of about 30 data/km^2. For this study we also used 34 continuously cored boreholes and 9 outcrops (quarries and excavations) as reference points for facies characterization. Stratigraphic correlations were ensured by 35 radiocarbon dates, whereas archaeological data were used to characterize the late Holocene portion of the study succession.

The subsurface stratigraphy of the Bologna area, which forms the southern portion of the Po Basin, displays a peculiar facies architecture that was strongly influenced by the evolution of two major river systems (Reno, west of the old town, and Savena to the east). These river courses form two distally coalescing alluvial fan gravel systems that radiate out from their outlets into the alluvial plain. During the Last Glacial Maximum, up to the early Holocene, the north-western and eastern parts of the town were periodically affected by lateral migration of Reno and Savena rivers, as documented by the presence of thick sheet-like, fluvial gravel bodies at various depths. The more ancient part of the town, instead, acted invariably as a triangle-shaped interchannel sector comprised between the Reno and Savena outlets. For this reason, subsurface stratigraphy beneath the centre of the old town consists almost entirely of fine-grained (silt-clay) material, with subordinate lens-shaped sand intercalations supplied by the minor drainage network.

Within this monotonous alluvial succession, this study led for the first time to identification of five vertically stacked palaeosols that can be tracked continuously across the study area. These palaeosols represent the only significant stratigraphic marker within the alluvial succession. The older, Pleistocene palaeosols exhibit complex, overprinted profiles, whereas the Holocene palaeosols are characterized by single profiles. In sequence-stratigraphic terms, these paleosol are correlative with the erosional surfaces at the base of the most laterally extensive fluvial bodies and are interpreted to represent interfluvial sequence boundaries of millennial-scale depositional cycles.

The uppermost two palaeosols, assigned to the Eneolitic Age and the Etruscan/Roman culture, respectively, were additionally investigated on an archaeological basis, since they contain ample indications of human activity. The Roman presence, in particular, was pervasive and had direct influence on the geology of the area by digging discharge areas and ditches, filling topographic depressions and modifying and controlling the river network.

The Eneolitic and Roman palaeosols are closely spaced in the urban area, whereas they are separated by an increasing thickness of alluvial deposits, up to 5 meters, in the metropolitan area. Through integration of core

analysis, stratigraphic correlations, archaeological excavation results, and historical sources we reconstructed a map that depicts the distribution of Roman settlement in the Bologna area and its relationship with the surrounding fluvial palaeoenvironment. The Roman palaeosol, which is identified to a maximum depth of 6 m, is buried beneath a variable thickness of either alluvial or anthropogenic deposits. These impart to the subsoil peculiar geotechnical and petrophysical characteristics.

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