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Paleo-surfaces of glacio-eustatically forced aggradational successions in the coastal area of Rome: Assessing interplay between tectonics and sea-level during the last ten interglacials

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ABSTRACT

Recently acquired geochronological and stratigraphic data provide new information on the sedimentary successions deposited by the Paleo-Tiber River in the coastal and near-coastal area of Rome in consequence of the glacio-eustatic changes, allowing to better define their inner geometry and palaeogeographic spatial distribution. In the present work we use this revised sedimentary dataset to provide a geochronologically constrained and tectonically adjusted record of paleo sea-level indicators. Aimed at this scope, we review literature data acquired in the last 35 years and using the new geochronological constraints we pinpoint the coastal-to-fluvial terraces of MIS 5 and MIS 7, mapping their relic surfaces in an area of 30 km along the coast north and south of the Tiber River mouth, and 20 km inland of the fluvial valleys of Tiber and Aniene rivers. The geometry of these paleo-surfaces provides constraints on the relative elevation of the sea-level during the last interglacials and on the uplift rates in this region during the last 200 ka. In particular, we recognize the previously undetected terraces of MIS 5.3 and MIS 5.1 interstadials, and we assess their spatial relationship with respect to MIS 5.5, providing important information on sea-level oscillations during this time span. Comparison with sea-level indicators provided by previous aggradational successions deposited during past interglacials spanning MIS 9 through MIS 21 in the coastal area of Rome, also allows us to reconstruct the tectonic history and investigate its relationships with the Middle-Pleistocene volcanic activity of the Roman Comagmatic Region along the Tyrrhenian Sea margin of Italy in the last 900 ka.

1. Introduction

1.1. The aggradational successions of the Paleo-Tiber River

The strict link between sedimentation and sea-level changes in the area of Rome (Fig. 1) has been evidenced in the last two decades by a series of studies that, using $^{40}Ar/^{39}Ar$ ages of pyroclastic layers intercalated within the sedimentary deposits, have correlated a series of aggradational successions with as many sea-level rises associated to the glacial terminations occurred since 800 ka (Karner and Renne, 1998; Karner and Marra, 1998; Marra et al., 1998, 2008; Florindo et al., 2007; Marra et al., 2008).

An aggradational succession typically comprises the stratigraphic record of each complete glacially forced sea-level oscillation in a coastal area, which is represented by a basal erosive surface, progressively excavated in consequence of coastline regression and lowering of sea level during glacial periods, filled up by a fining-upward sequence of clastic sediments, rapidly deposited during the deglaciation-induced sea-level rise. The aggradational successions in the area of Rome are represented by the alluvial sediments of the Paleo Tiber River and its tributaries. These deposited within the fluvial incisions and in the coastal plain, and have been designated by formal Formation names (Fig. 2), newly conceived or based upon previous literature (Karner and Marra, 1998, and references therein). Each one of these sedimentary units comprises a basal, coarse-grained section deposited during the final stages of a lowstand at the onset of the glacial termination, and an upper, fine-grained section, deposited during the highstand. They represent a discontinuous stratigraphic record, constituted by a succession of ten major aggradational units deposited during periods of sea-level rise corresponding to MIS 21 thorough MIS 1, plus several minor successions corresponding to the more pronounced δ^{18} record sub-stages, representing the physical remnant

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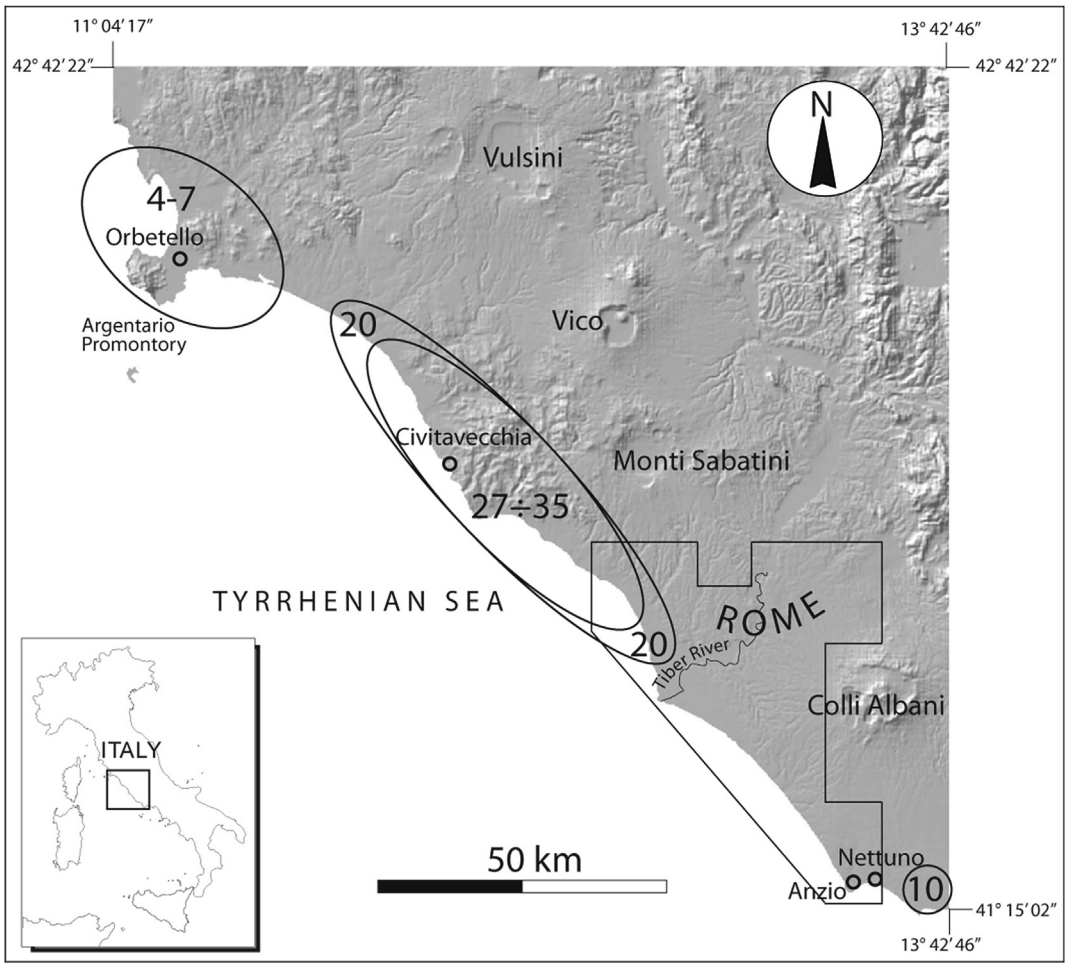

Fig. 1. Digital Elevation Map of Latium showing location of the volcanic districts of the Roman Province (Peccerillo, 2005, and references therein), and the elevation (in m) of the coastal terrace of MIS 5.5 (Ferranti et al., 2006). The direct, spatial relationship between the coastal uplifted sector, comprised between the towns of Orbetello and Anzio, and the volcanic area is apparent (Karner et al., 2001a).

of as many glacio-eustatic cycles in this time span (Marra et al., 2008, Fig. 2).

The sedimentary features of these aggradational successions encompass fluvial to lacustrine and lagoon to coastal facies (Conato et al., 1980, and references therein). A detailed facies analysis of the deposits cropping out in the coastal area of Rome is provided in several papers (e.g. Milli et al., 2008, and references therein) describing a suite of fourth-order depositional sequences. The correlation of deposits defined based on sequence stratigraphic approach with the glacio-eustatically controlled aggradational successions of the Paleo-Tiber River can be found in Marra et al. (2014a). Based on the revised definition of stratigraphic sequence by Zecchin and Catuneanu (2013), all the recognized aggradational successions represent the innermost part of high-frequency sequences in relation with glacio-eustasy. These sedimentary deposits have been exposed by continuous uplift affecting the area of the delta (Fig. 1; Ferranti et al., 2006, and references therein). In contrast to other worldwide evidence of terraces formation in response to erosional/sedimentary isostasy (e.g. Bridgland and Westaway, 2008), Karner et al. (2001a) have suggested a main tectonic origin for the coastal uplift in the area of Rome, based on the identification of two early pulses of uplift around 800 and 600 ka, coincident with the beginning of the main eruptive phases at the Monti Sabatini and Colli Albani districts (Fig. 1), suggesting a link with the back-arc geodynamic context (Faccenna et al., 1996) of this region. Consistent to this interpretation, a third uplift phase since 250 ka has been interpreted as preluding to the rejuvenation of the volcanic activity that occurred at the Albano crater since 70 ka (Freda et al., 2006; Giaccio et al., 2009; Marra et al., 2009). This last phase of uplift was evaluated in ca. 45 m, based on elevation of the terraced marine deposits of MIS 7 and MIS 5 at ca. 40 and ca. 25 m a.s.l., respectively, previously estimated along the Tyrrhenian Sea coast of Latium (Hearty and Dai-Pra, 1986; Bordoni and Valensise, 1998; Karner et al., 2001a; Ferranti et al., 2006) (Fig. 1). However, new geochronologic and stratigraphic data collected at Cava Rinaldi in the Fosso Galeria valley (Fig. 3b) have evidenced the occurrence of the MIS 5 aggradational succession forming a fluvial terrace ca. 37 m a.s.l., revising previous attribution by Karner et al. (2001a) of the paleo-surface around 40 m a.s.l. to MIS 7 (Marra et al., 2015).

The geochronologically constrained terraced deposit of Cava Rinaldi is used in the present work as a pinpoint to re-assess the chronologic relationships among the different terraced surfaces correlated to highstands of MIS 5 and MIS 7. We have reconstructed these paleo-surfaces through a dedicated geomorphologic study of the coastal area and of the alluvial plains of the Tiber River and its main tributaries as far as 20 km inland from the coast.

1.2. MIS 5 – Epi-Tyrrhenian Formation

Different names were used in the local literature to designate the deposits of the sedimentary cycle correlated to sea-level rise