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Research paper

Biodetrital carbonates on the Adriatic continental shelf imprinted by oxidation of seeping hydrocarbons

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ABSTRACT

The gas-productive Bonaccia area located at ca. 80–90 m below sea level offshore Ancona (Central Adriatic Sea) is site of hydrocarbon-derived carbonate production. The carbonates include large dm-sized slabs (bryozoan limestone), smaller concretionary aggregates, mudstones and pipes. The mudstones and botryoidal aragonite cements within limestones show $\delta^{13}C$ values as low as −47.8‰ VPDB, consistent with seepage of isotopically light hydrocarbons (e.g. methane). These hydrocarbon-derived carbonates commonly incorporate abundant shell remains, deriving from the prevalently coarse bioclastic-rich muddy deposits from post-glacial transgressive units. It is, therefore, hypothesized that hydrocarbon-rich fluids permeated the post-glacial sediments, resulting in seafloor seeps that were inhabited by chemosymbiotic lucinid bivalves and burrowing callianassid shrimps; fossils and traces of which have been found in the Bonaccia carbonates. Microbial oxidation of the reduced compounds contained in the seep fluids led to a locally patchy carbonate cementation of the sediments at the seep sites. The pipes are interpreted as decapod burrows that subsequently served as conduits for hydrocarbon leakage. Seepage is probably still active at present as testified by gas production at the study site. Interestingly, seep carbonates exhumed by erosion served as hard substrate for fouling benthos (i.e., bryozoans, oysters and red algae) in the Holocene. The main products of the processes at the Bonaccia study site are composite bryozoan-dominated limestones, whose multi-step and complex history was unfold thank to radiocarbon dating of key components and precise stratigraphic control. The Bonaccia case-study can serve as a model for the interpretation of ancient analogs, such as bryozoan dominated limestones and mudstones of Paleozoic to Mesozoic age, which are not uncommon in the geological record. It further calls for caution in assuming that the presence of dominant macrobenthic fossil in old hydrocarbon-derived limestones implies its ecological connection to active seepage.

1. Introduction

The northern Adriatic Sea extends for more than 300 km with a dip of about 0.02° and represents the widest epicontinental shelf in the Mediterranean region (Fig. 1). The impact of the post-glacial sea level rise was recorded in the Adriatic basin by a set of backstepping barrier-island-lagoon deposits, slightly modified through transgressive reworking (Trincardi et al., 1994, 1996; Correggiari et al., 1996; Cattaneo and Steel, 2003; Storms et al., 2008; Maselli et al., 2011). Recent deposition following the attainment of modern sea level at ca. 5.5 kyr BP (Asioli, 1996) is focused in a narrow shore-parallel area on the western side of the Adriatic margin, where a 30-m-thick highstand system tract clinoform has developed (Cattaneo et al., 2003). This sediment distribution leaves the axial and eastern portions of the Adriatic shelf sediment starved, and

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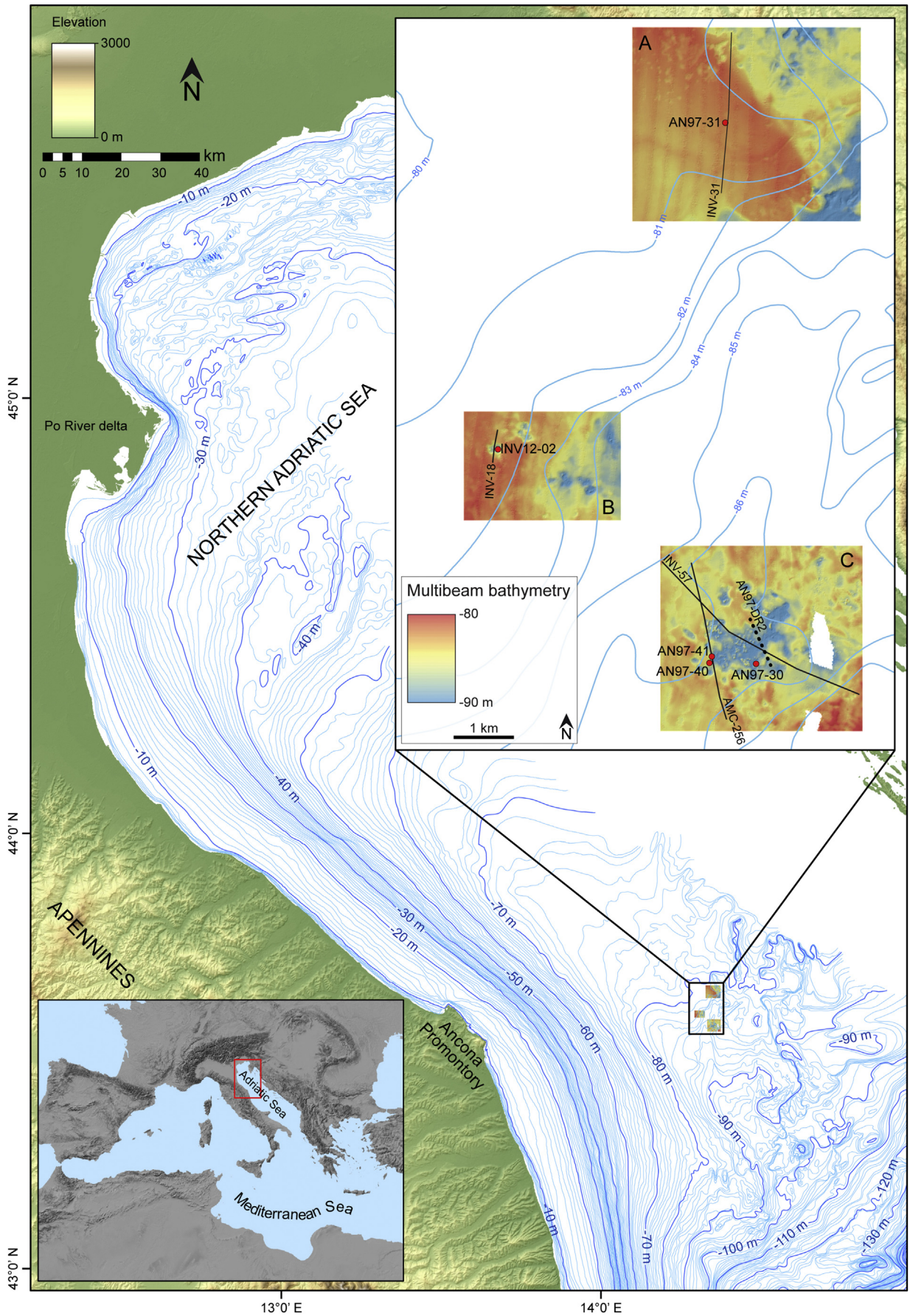

Figure 1. Northern Adriatic Sea bathymetry (1-m-spaced contours from Trincardi et al., 2014) with the study area shown in the inset map (A, B, C refer to the 3D bathymetric views and seismic lines of Fig. 2). Multibeam bathymetries are presented with 10 m of horizontal resolution. Dotted line represents dredge track, red circles represent sediment cores and grabs. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article).