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Late Aptian palaeoclimatic turnovers and volcanism: Insights from a shallow-marine and continental succession of the Apennine carbonate platform, southern Italy

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ABSTRACT

This study reports an integrated facies analysis carried out on a new section from the Upper Aptian of the SE Matese Mts. (Civitella Licinio, northern Campania, S. Italy), which includes several decimeter-to-meter scale lacustrine intervals straddling a meter-scale plant-rich Plattenkalk. These intervals are assigned to the late Gargasian–early Clansayesian by their stratigraphic relationship with the upper *Salpingoporella dinarica* acme as well as lithologic and biostratigraphic supra-regional key-markers found in the Apennine Carbonate Platform (ApCP), including the *Orbitolina* Level. We infer that the monogeneric parautochthonous plant remains (*Frenelopsis* sp.) were deposited in a supratidal-to-paralic coastal mudflat close to a restricted, shallow-marine lagoon, at the verge of an arid–semiarid climatic phase. The Plattenkalk was rapidly replaced by persistent lacustrine lithofacies at the onset of a major climatic turnover (Glacial Trigger). The overlying shallow-marine deposits are capped by a deeply incised palaeokarstic surface and, in turn, by unconformable middle Clansayesian transgressive shallow-marine deposits.

Interlayering of reliable lithologic indicators of palaeoclimate and High-Resolution Event Stratigraphic (HIRES) correlation of the Civitella Licinio succession with the astrochronologically tuned Mt. Faito reference section of the ApCP bring evidence of rapidly fluctuating hydroclimatic conditions (wet and arid phases) in the short (100 ky) and long (400 ky) eccentricity time band. HIRES and astrochronological age assignment to crucial key markers and humid/arid phases at Civitella Licinio permit to further refine the detailed stratigraphy of the Mt. Faito reference section and to assign the upper *S. dinarica* acme of the ApCP to a numerical age of 118.55–118.50 My. SEM and EDS analyses document common to abundant windblown volcanic particles (glass shards and sanidine crystals) throughout the *Frenelopsis*-rich Plattenkalk (~118.3 to ~118.2 My) and the encasing units, especially in the overlying brackish–lacustrine deposits. Palaeogeographic and palaeoclimatic reconstructions suggest that the pyroclastic material was probably transported by northeasterly trade winds from orogenic volcanic centers located within the Dinaridic–Carpatho-Balkan arc–trench system and have been supplied to the ApCP for a time span of ~3 My during the Late Aptian. A preliminary tephrostratigraphic correlation of the Upper Aptian volcaniclastic levels of the ApCP with the bentonite levels of the Vocontian Basin is proposed.

1. Introduction

The spatial and temporal patterns of middle-Cretaceous palaeoclimate evolution are far from being fully understood despite remarkable results (Hay, 2008, 2009; Hay and Floegel, 2012; Chaboureau et al., 2012). Crucial pitfalls in current palaeoclimatic studies are generally represented by: A) paucity of reliable biotic, sedimentary, mineralogical and geochemical indicators of palaeohydrologic conditions; B) incomplete palaeogeographic distribution of data sets; C) lack of suitable, chronostratigraphical calibration of shallow- and deep-water records; and D) only partial comprehension of the global palaeoclimate system during rapid phases of greenhouse–icehouse transitions (*cf.* Hay, 2009; Hasegawa et al., 2012). These problems generally bias the overall predictivity and reliability of General Circulation Models (GCMs) for the Mesozoic as these latter require precise information on a complex set of surface boundary conditions, including the distribution and evolution of vegetation types in specific time intervals (see Sewall et al., 2007). This is the case for the Aptian, an interval of rapid and significant changes of atmospheric pCO_2 (Retallack, 2002; Royer, 2006; Li et al., 2014; Wang et al., 2014), temperature (Steuber et al., 2005; Mutterlose et al., 2009; McAnena et al., 2013; Bodin et al., 2015), sea level (Al-Husseini, 2013; Maurer et al., 2013; Bover-Arnal et al., 2014; Haq, 2014), and ocean

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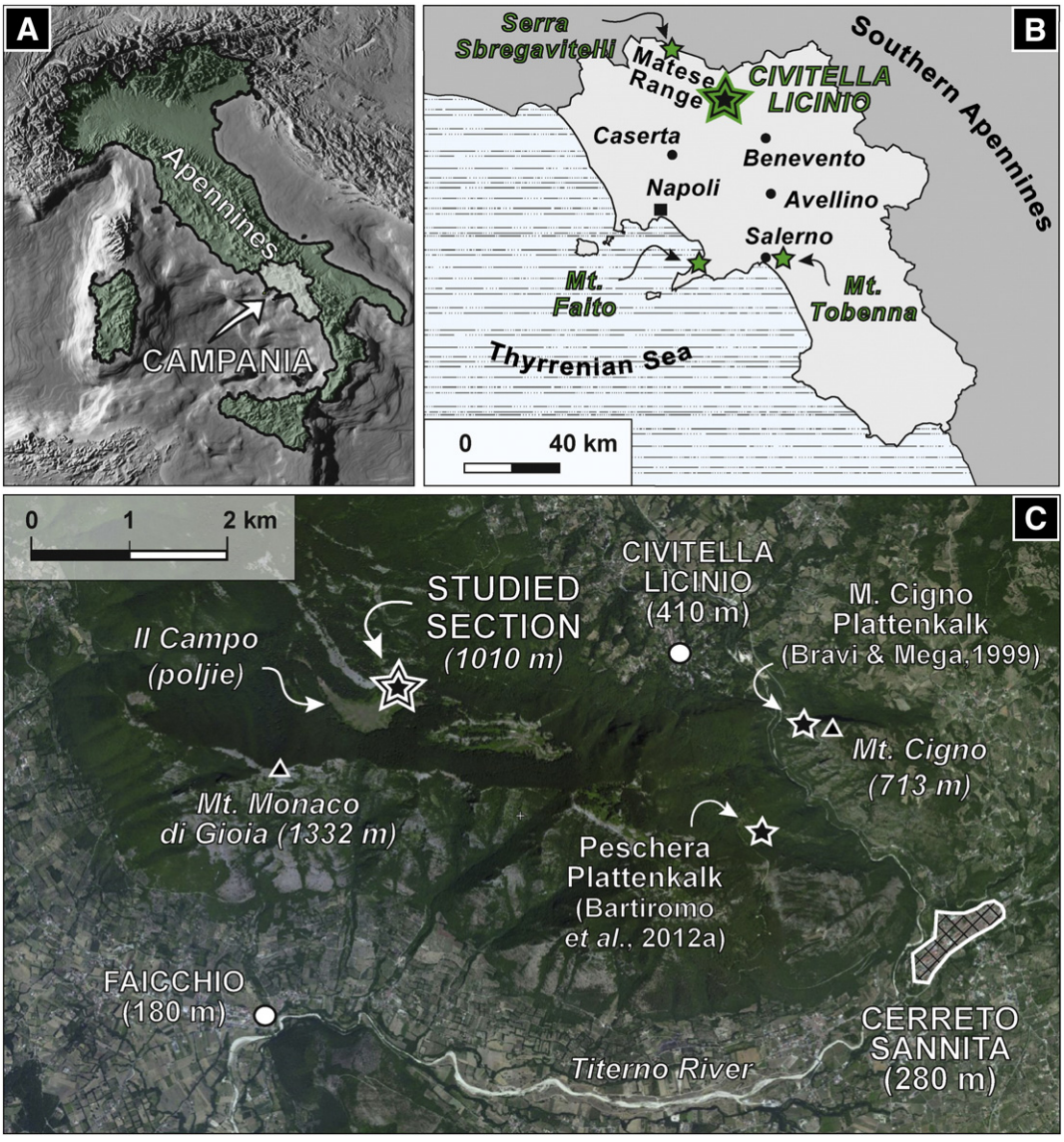

Fig. 1. Geographical maps illustrating the position of the Campania region (A), the Matese Mountains (B) and the Civitella Licinio section relative to the principal topographic features (C). The position of other localities and sections discussed in the text is also reported.

geochemistry (Puceat et al., 2005; Wortmann and Chernyavsky, 2007), which all induced towering palaeoclimatic and palaeoceanographic events (Jenkyns, 2010; Föllmi, 2012; Bottini et al., 2015) as well as drastic biotic and geochemical forcings in the marine (Skelton and Gili, 2012; Erba et al., 2015; Pascual-Cebrian et al., 2016) and continental (Jahren et al., 2001; Suarez et al., 2014) realms. Consistent with these changes, and based on the Upper Aptian continental and shallow-marine deposits of the Apennine Carbonate Platform (ApCP) (southern Italy), Graziano and Raspini (2015) have recently documented repeated shrinkings and expansions of the intertropical, arid and humid palaeoclimatic belts with a well-defined orbital control in the short (100 ky)- and long (400 ky)-eccentricity time bands. These hydroclimatic shifts have been correlated also in a Tethyan framework and provided with numerical ages according to integrated stratigraphic procedures constrained by an astrochronological tuning with Tethyan pelagic reference sections.

Continental deposits of the Aptian are increasingly evaluated as reliable recorders of regional to global palaeoclimatic turnovers and represent useful proxies for investigating the evolution of pCO_2, palaeotemperature and water cycle (Heimhofer et al., 2003; Suarez et al., 2011; Rodríguez-López et al., 2012; Li et al., 2013; Ludvigson et al., 2015; Du et al., 2016). In addition, they concur to upbuild the archive of the Cretaceous continental record, which is the only well-founded indicator for establishing the worldwide palaeogeographic distribution of climatic belts and their evolution through time (Chumakov et al., 1995; Ziegler et al., 2003; Sewall et al., 2007; Boucot et al., 2013) over a fundamental interval of the Mesozoic greenhouse Earth. Aptian continental deposits of southern Italy represent a valuable source of information for defining the palaeogeography (*e.g.* Dalla Vecchia, 2008; Zarcone et al., 2010) and palaeoclimatology (Graziano and Raspini, 2015) of the peri-Adriatic area. Furthermore, owing to their peculiar fossiliferous record which includes dinosaurs (*e.g.* Petti et al., 2008; Sacchi et al., 2009; Citton et al., 2015) and plants (*e.g.* Bartiromo et al., 2009, 2012a) they bear significant, supra-regional palaeobiogeographical implications.

Recent investigation has emphasized the crucial role of the Aptian terrestrial, shallow- and deep-water fossil record as possible analogs to derive the current and future climate changes (Hay, 2011; Skelton and Gili, 2012; Graziano, 2013; Bottini et al., 2015; Graziano and Raspini, 2015). However, these results augment the need of refining available techniques for high-resolution stratigraphic correlations with which to complement precise palaeoclimatic information in a