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Carbon and strontium isotope stratigraphy of the Upper Cretaceous (Cenomanian-Campanian) shallow-water carbonates of southern Italy: Chronostratigraphic calibration of larger foraminifera biostratigraphy

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ABSTRACT

Shallow-water carbonates are invaluable archives of past global change. They hold the record of how neritic biologic communities reacted to palaeoenvironmental changes. However, attempts to decipher these geological archives are often severely hampered by the low stratigraphic resolution attained by biostratigraphy. This is particularly the case for the Upper Cretaceous carbonate platforms of the central Tethyan realm: their biostratigraphy suffers from very low resolution and poor correlation with the standard biochronologic scales based on ammonites, planktic foraminifers and calcareous nannoplankton.

In this paper we show how this problem can be tackled by integrating biostratigraphy with isotope stratigraphy. We present a detailed record of the benthic foraminiferal biostratigraphy and carbon and strontium isotope stratigraphy of three upper Cenomanian-middle Campanian sections belonging to the Apennine Carbonate Platform of southern Italy. For the upper Cenomanian-Turonian interval, the carbon isotope curves of the studied sections are easily correlated to the reference curve of the English Chalk. The correlation is facilitated by the matching of the prominent positive excursion corresponding to the Oceanic Anoxic Event 2. For the Coniacian-middle Campanian interval, the correlation is mainly based on strontium isotope stratigraphy. We use the $^{87}Sr/^{86}Sr$ ratios of the low-Mg calcite of well preserved rudist shells to obtain accurate chronostratigraphic ages for many levels of the three studied sections. The ages obtained by Sr isotope stratigraphy are then used to better constrain the matching of the carbon isotope curves.

From the high-resolution chronostratigraphic age-model stablished by isotope stratigraphy, we derive the chronostratigraphic calibration of benthic foraminiferal biostratigraphic events. For the first time the benthic foraminiferal biozones of the Apennine Carbonate Platform can be accurately correlated to the standard ammonite biozonation. This result is of great relevance because the biostratigraphic schemes of other carbonate platforms in the central and southern Tethyan realm are largely based on the same biostratigraphic events.

1. Introduction

Carbonate platforms were widespread in the Tethyan region during the Cretaceous (Kiessling et al., 2003; Philip, 2003; Skelton, 2003). These complex sedimentary systems responded to changing environmental conditions with changes in the relative abundance of the main carbonate producers and with repeated phases of inception, growth, retreat and demise. Therefore, they potentially

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preserve a detailed record of how neritic biologic communities reacted to changes in climatic and oceanographic conditions and sea-level changes. However, the study of this invaluable palaeoenvironmental and palaeobiological archive is often severely hampered by the low stratigraphic resolution of biostratigraphy of Cretaceous carbonate platforms and by the lack of precise correlation with coeval hemipelagic and pelagic successions. Most of what we know on the Cretaceous climate and oceans has been derived from the study of deep-water successions, which are generally accurately dated by means of chronostratigraphically significant macro- and microfossils (ammonites, calcareous plankton and nannoplankton), sometimes supplemented by other high-resolution stratigraphic tools, like chemo-, magneto- and cyclostratigraphy. On the contrary, biozonations of Cretaceous carbonate platforms, mainly based on calcareous algae and larger foraminifers, usually have a much coarser resolution and, generally, a poorly constrained chronostratigraphic calibration. Some notable exceptions include the biostratigraphic scheme of orbitolinid foraminifers in the Lower Cretaceous French-Swiss Urgonian Platform and Arabian Platform, for which chronostratigraphic calibrations, albeit controversial, have been proposed (Arnaud et al., 1998; Arnaud, 2005; Clavel et al., 2009, 2010; Schroeder et al., 2010), and the biozonation of orbitoidal foraminifers for Campanian-Maastrichtian peri-Mediterranean carbonate platforms, which is reasonably well calibrated to calcareous plankton (van Gorsel et al., 1978; Caus et al., 1996), but only applicable to open platform settings. Finally, Steuber and Schlüter (2012) proposed recently a chronostratigraphical calibration of rudist bivalve biozones using Sr-isotopes stratigraphy.

The problem of low resolution is particularly acute for the Upper Cretaceous carbonate platforms of the central and southern Tethyan area, as shown by the most widely used biostratigraphic schemes (De Castro, 1991, southern Apennines; Chiocchini et al., 2008, central Apennines; Fleury, 1980, Greece; Velic, 2007, Adriatic platform; see Fig. 1). With a few exceptions, each biozone covers a time-interval >4 Myr. The most recent biozonation of the Adriatic platform (Velic, 2007) presents a slightly higher resolution, at least in the Cenomanian-Santonian interval (average resolution is about 2 Myr per biozone, see Fig. 1). However, this biozonation makes use of virtually any available biostratigraphic event and it is highly improbable that all these events can be used outside of the Adriatic platform. Even more critical than their low resolution, is the problem posed by the chronostratigraphic calibration of these biozonal schemes. Ammonites, calcareous plankton and nannoplankton are virtually absent in these carbonate platforms and direct correlation to deep-water successions has not been established. As a result, the chronostratigraphic age of the biozones is poorly constrained. This is explicitly acknowledged in De Castro (1991) and Chiocchini et al. (2008). No evidence is cited in Velic (2007, p. 2) for the calibration of the Turonian-Maastrichtian

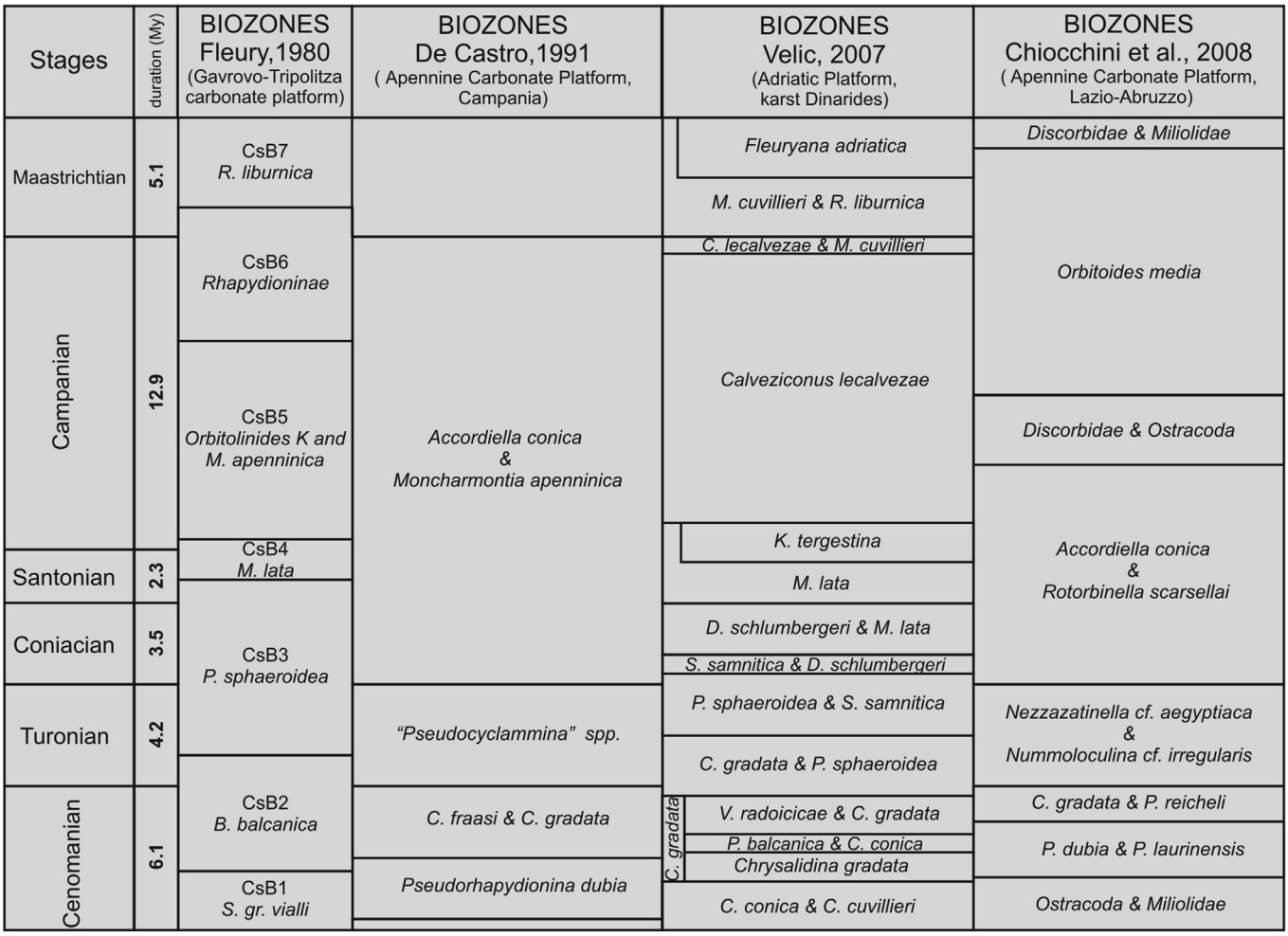

Fig. 1. Late Cenomanian-Maastrichtian biostratigraphy of central Tethyan carbonate platforms. All these schemes suffer of low resolution and poorly constrained chronostratigraphic calibration. Substage duration is after Gradstein et al. (2004).