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A new high-resolution $\delta^{13}C$ record for the Early Triassic: Insights from the Arabian Platform

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ABSTRACT

A new carbon isotope record with conodont biostratigraphy is presented for the entire Early Triassic from the Musandam Peninsula, United Arab Emirates (UAE). This is a near-continuous and exclusively shallow marine carbonate succession that allows analysis of a high-resolution primary carbon cycling signature in the absence of significant depth-dependent or lithologic controls. The Musandam carbon isotope record can be broadly correlated with global isotopic events but also resolves additional features, including the presence of significant negative events during the previously identified positive excursions at both the Dienerian/Smithian and Smithian/Spathian boundaries. A further positive event is revealed during the development of the mid-Spathian negative excursion, a feature not previously reported in any other section. These new short-lived events are probably related to the occurrence of the more widely recognized Early Triassic excursions, and may represent fluctuations in the driving mechanisms superimposed on the continued instability of the global carbon cycle in the aftermath of the end-Permian extinction. Together, these features highlight additional complexities to the Early Triassic carbon cycle perturbations than previously documented.

1. Introduction

Carbon cycle disturbance, as recorded in $\delta^{13}C$ records, is a well-established feature for the Permian–Triassic Boundary (PTB) extinction (Korte and Kozur, 2010) and a number of studies have also demonstrated continued unstable behavior for the entire Early Triassic (e.g., Atudorei, 1999; Korte et al., 2004; Payne et al., 2004; Richoz, 2006; Horacek et al., 2007a, 2007b, 2009). Such carbon isotope records have provided valuable data for formulating and testing both kill-mechanism hypotheses and carbon cycle scenarios (Rampino and Caldeira, 2005; Payne and Kump, 2007; Korte and Kozur, 2010). Quantifying how the isotope record varies with paleogeography and paleodepth is particularly important for understanding the chemical structure of the Tethys and Panthalassa oceans, enabling insight into the driving mechanisms of both the Early Triassic carbon isotope excursions (CIEs) and the prolonged biotic recovery from the end-Permian extinction (Stanley, 2009; Algeo et al., 2010; Meyer et al., 2011).

Interpretation of the carbon isotope records within this framework, however, relies on the accurate expression of the $\delta^{13}C$ record which is controlled by many factors, including data resolution, sedimentation rate, chronological control and diagenesis. Separating lithologic, depositional and diagenetic effects from the primary signature in $\delta^{13}C$ data is particularly problematic. Many published $\delta^{13}C$ curves are derived from mixed clastic–carbonate sequences which contain major facies changes reflecting the deposition of sediments at varied water depths, so potentially masking or exaggerating the global secular ocean chemistry signature. Furthermore, diagenetic alteration can cause the $\delta^{13}C$ signal to vary with lithology, such as in the widely observed PTB clay which shows overly depleted $\delta^{13}C$ values as a result of decarbonation (see Korte and Kozur, 2010 for review). One of the strongest arguments for published $\delta^{13}C$ records being a reflection of a primary signature is the correlation of broad trends between geographically widespread records. Overprinting these broad trends, however, are interesting fluctuations, data scatter and differences in excursion magnitudes, which may be of regional importance if a primary signature can be assured.

Here we present a new high-resolution carbon isotope record from an exclusively shallow carbonate platform that shows only minor facies changes, so removing major water depth or lithology-related biases. The Musandam Peninsula PTB and Early Triassic section of the United Arab Emirates (UAE) was originally situated in the southwestern Neo-Tethys (Fig. 1A) and is one of the thickest Lower Triassic carbonate

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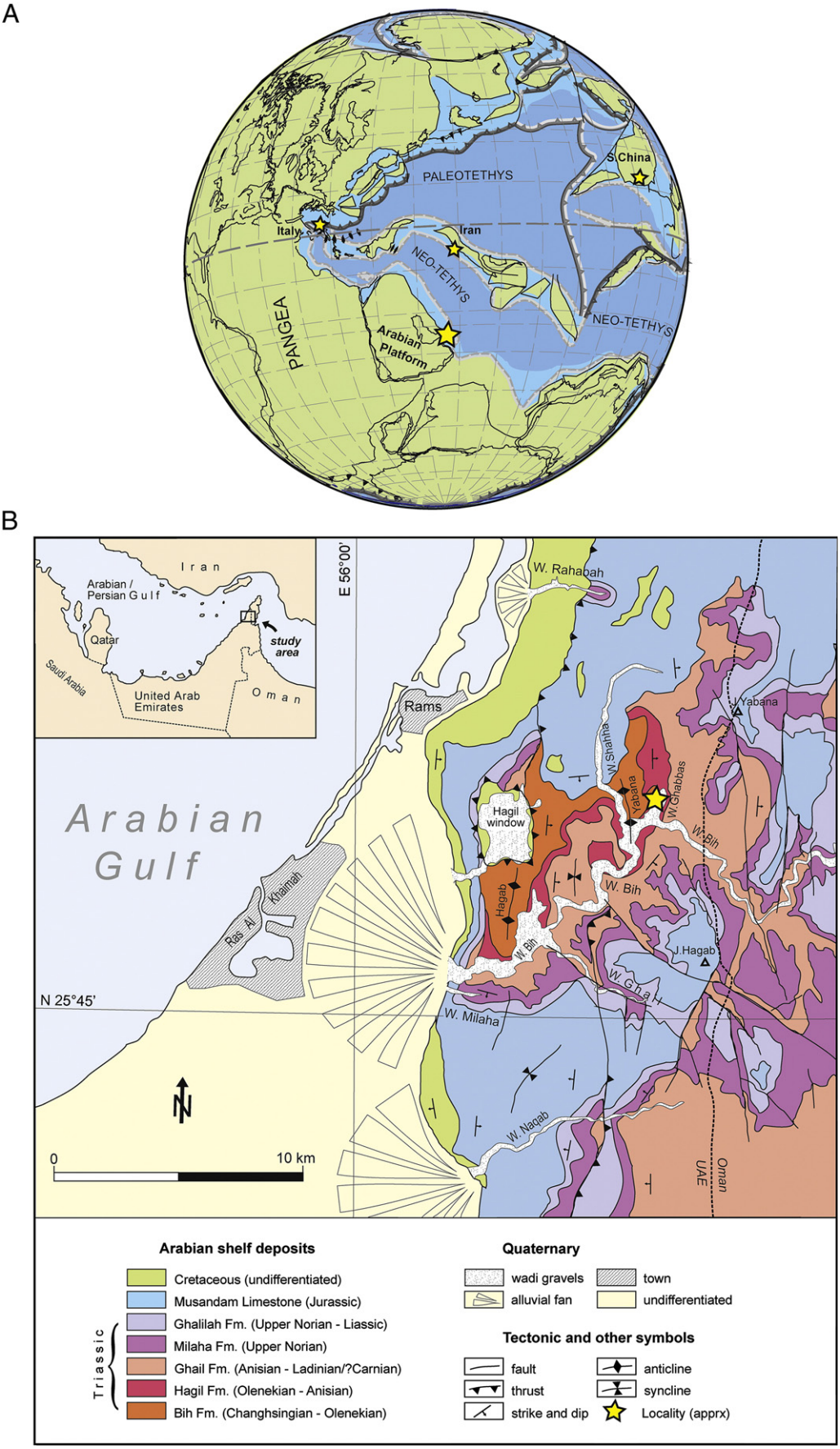

Fig. 1. A: Paleogeographic reconstruction of the Late Permian continental configuration showing approximate position of the Arabian Platform, modified from Stampfli and Borel (2002). Locations of published Early Triassic carbon isotope curves presented in Fig. 4 are also shown. B: Geological map of the Musandam Mountains showing the section location, modified from Maurer et al. (2008). GPS co-ordinate for main transect in Wadi Shahha: N 025° 50′ 31.7″, E 056° 06′ 41.7″.