Global and Planetary Change 154 (2017) 44–60

Contents lists available at ScienceDirect

Global and Planetary Change

journal homepage: www.elsevier.com/locate/gloplacha

The role of land-marine teleconnections in the tropical proximal Permian-Triassic Marine Zone, Levant Basin, Israel: Insights from stable isotope pairing

D. Korngreen*, T. Zilberman

Geological Survey of Israel, Israel

A B S T R A C T

Three Late Permian – early Middle Triassic successions (Avdat 1, Pleshet 1 and David 1 boreholes, Levant Basin, Israel), located in relatively proximal and distal order from land within a broad tropical mixed carbonate/siliciclastic open marine zone, were studied using carbonate and organic matter contents (organic and inorganic carbon) in order to demonstrate the degree of effect of the land-marine teleconnection on the isotopic signatures at the depositional environment. The $\delta^{13}C_{carb}$ profiles exhibit sequential negative/positive fluctuations, which are correlatable with the reported worldwide sequential negative-shift events, enabled further stratigraphic division of the successions to stages and sub-stages. The successions changed their relative siliciclastic content relative to the degree of influence of each terrestrial influx source (eastern or southern), an outcome of humid up to extreme aridization hinterland exchanges, actually recording the expansion or contraction of the paleo-ITCZ. The $\delta^{18}O$ profiles exhibited a range of values (− 5‰ to − 7.5‰ on average) typical to the western NeoTethys and similar to the reported worldwide climate trends with three major warming periods: (I) Late Permian to the PTB; (II) Late Dienerian - most of the Smithian; (III) early-mid Anisian, and two relatively cool periods: Griesbachian-Dienerian and Late Smithian – Spathian, but each of the three periods exhibiting short respites with the opposite trend. The $\delta^{13}C_{carb}$, $\delta^{18}O_{carb}$ and the $\delta^{13}C_{org}$ profiles of the proximal position consistently differ in magnitude from the distal ones, assuming a high contribution and involvement of meteoric water rich in terrestrial OM derived from the nearby supercontinent and affecting also the original water $\delta^{18}O_{seawater}$ value (calculated to about − 3‰),which seemingly should be applied on the entire western Tethys seaway. During times of associations with maximum ITCZ contraction, the $\delta^{13}C_{org}$ values of − 31‰ to − 33‰ in the distal succession exhibit the end member values of the regional marine OM, while values of − 22.5‰ to − 25‰ of the proximal succession are considered representing the regional terrestrial signature. Our data show good correlation between warming trends, the proximal/distal location of succession and the disparity of $\delta^{13}C_{carb+org}$ values that may explain the differences in reported worldwide values.

1. Introduction

1.1. Permian-Triassic transition

The Paleozoic - Mesozoic Earth- life transition has been described by a plethora of works, and those involving geochemical proxies became the forefront of research in the last three decades, well establishing the global synchronous nature of the ecological perturbations, the climate changes, the major biotic extinctions during the Permian – Triassic (P-T) transition, and the recovery attempts that followed during the Early Triassic.

The sedimentary succession inventory of life remains is the reflection of the sum total of depositional conditions at the accumulation site, e.g. latitude (temperature), water depth, light penetration, and nutrient supply (oligotrophic versus eutrophic). Depositional environments of detached or isolated carbonate platforms are relatively poor in inorganic nutrient supply (meso-oligo-trophic), hence leaving the related ecosystems open to be ruled by algae-symbiotic carbonate-secreting organisms and optimising the grounds for larger benthic foraminifera, algal/coral-dominated banks and other carbonate-secreting fauna, augmenting the total carbonate precipitation (Lee and Hallock, 1987; Kiessling et al., 1999; Immenhauser et al., 2000; Flügel, 2002; Erez, 2003; Baud et al., 2007; Hohenegger, 2011; Schmidt et al., 2011). These sites therefore become very attractive for scientific research

* Corresponding author.
E-mail address: doritk@gsi.gov.il (D. Korngreen).

http://dx.doi.org/10.1016/j.gloplacha.2017.05.009
Received 27 November 2016; Received in revised form 25 April 2017; Accepted 29 May 2017
Available online 31 May 2017

although their representativeness of the worldwide life is actually limited. However, proximal marginal marine environments attached to large continents are under incessant terrestrial influxes rich in nutrients (eutrophic conditions), induced flowering of algae and water plants, developing stressed conditions to the symbiotic organisms and oppressing the carbonate secretion, hence, the two end-member ecological systems themselves laying the foundation to differential biostratigraphic division between sections.

For the P-T period, the conodont fossil group becomes the main biostratigraphic tool (e.g. Zhao et al., 1981; Yin et al., 2001; Lehrmann et al., 2003; Jin et al., 2006; Jiang et al., 2007). The P-T conodont zonation is summarized and discussed in detail in Korte and Kozur (2010), Yuan et al. (2014) and in Brosse et al. (2016), but many P-T successions were characterized by low recovery, different species occurrences, or even absence of conodonts due to limited distribution and endemism. The lack of conodonts and other index-fossil groups from a record not only magnifies the correlation difficulties with remote successions or with global events, but also misleads regional attempts of paleo-geo-reconstruction.

The last stages of the supercontinent Pangea convergence was during the Permian – Triassic time (Stampfli et al., 2013), forming a supercontinent that stretched longitudinally almost from pole to pole (Fig. 1a), establishing proximal marginal marine belts under tremendous terrestrial influxes. The degree of influence of these influxes was evaluated by their mineralogical compositions (Clarke, 1988; Robertson and Searle, 1990; Golonka and Ford, 2000; Sharland et al., 2004; Weidlich and Bernecker, 2003; Golonka, 2007; Algeo and Twitchett, 2010), but despite their extensive influence, their ecological parameters and proxies and the land-sea reciprocal relations were scantly studied (e.g. Hermann et al., 2010; Grasby et al., 2013).

Fig. 1a shows the global schematic distribution of reported marine P-T key sections, grouped according to their paleo-latitude locations, their marine association, and their paleo-geographic teleconnection with land masses. The different sections were grouped into three main categories (Fig. 1b; not including non-marine group 1sections; following Corsetti et al., 2005; Korte and Kozur, 2010 and reference therein). Groups 4–6, 7–10, and 12 (e.g. S. China including the GSSP, Tibet, S. Alps; Japan; Iran, Turkey, Greenland, Svalbard, Russia, NW USA), which were located on isolated or detached platforms from large continents, show a wide range of paleo-latitude settings (low, low-mid, mid and mid-high latitudes). Those that were connected to large continents and were affected by their terrestrial influxes are assembled by two attributions: 1. Groups 11 and 13 are of those connected to the Am-Euro-Asia continent (north Pangea) and were located from paleo- mid-low to mid latitudes (e.g. N Canada, N Alps, and Hungary). 2. Groups 2 and 3 are the successions located in the paleo-mid and mid-high latitudes assigned to the Gondwana margins - Neotethys association (south Pangea; e.g. India, Pakistan, Australia and Oman). The P-T successions of low latitudes (tropical) of marginal depositional setting, proximal and affected by a large continental hinterland are not represented to date.

1.2. The sequential global $\delta^{13}C_{carb}$ excursions and events of the Permian – Triassic transition

The global carbon-cycle perturbations and $\delta^{13}C_{carb}$ excursions during the Late Permian–Early Triassic transition display distinct shifts in the $\delta^{13}C_{carb}$ values, accentuating a sequential pattern of distinguishable events (Algeo et al., 2007 and references therein) that preceded, followed, and corresponded to the Permian-Triassic boundary (PTB):

The late Permian event (LPE): The LPE exhibiting a drop of 1.5–2‰ in the $\delta^{13}C_{carb}$ values preceded the P-T boundary (Holser et al., 1989; Yin et al., 2001, 2007; Xie et al., 2007; Cao et al., 2009; Luo et al., 2011; Korte and Kozur, 2010; Shen et al., 2013).

The Permian-Triassic Boundary event (The PTB): The PTB is characterized by a sequence of sharp decreasing values of $\delta^{13}C_{carb}$, of at least 4‰ up to a 7‰ from positive values as + 4‰ to 0‰ dropped to − 3‰; − 4‰;-5‰; (e.g. Magaritz et al., 1988; Holser et al., 1989; Cao et al., 2002, 2009; Payne et al., 2004; Corsetti et al., 2005; Haas et al., 2006; Algeo et al., 2007; Yin et al., 2007; Tong et al., 2007; Luo et al., 2011; Horacek et al., 2010; Korte and Kozur, 2010; Brandner et al., 2011; Shen et al., 2013; Song et al., 2013; Zhang et al., 2014) but a drop from − 5‰ to − 20‰ was also reported (Nabbefeld et al., 2010). The minimum peak was found to be in compliance with the biostratigraphic conodont zonation defining the P-T boundary in up to 1 m deviation, bellow the *H. parvus* biozone (e.g. Cao et al., 2002, 2009; Korte and Kozur, 2010; Shen et al., 2013; Burgess et al., 2014).

The Griesbachian event (GE): The GE is linked to the second negative peak of the $\delta^{13}C_{carb}$ values following the PTB (Corsetti et al., 2005; Horacek et al., 2007; Xie et al., 2007; Korte and Kozur, 2010; Richoz et al., 2010; Joachimski et al., 2012; Burgess et al., 2014), and without the attribution to the GE (Holser et al., 1989).

The Griesbachian-Dienerian boundary event (GDBE): A distinguished negative shift in the profile, comprising a drop of 1–1.5‰ in the $\delta^{13}C_{carb}$ values, followed by a steep increase of $\delta^{13}C_{carb}$ values (up to + 4‰), attributed to a stage just below the Griesbachian-Dienerian boundary (Payne et al., 2004; Korte et al., 2005; Galfetti et al., 2007).

The Dienerian-Smithian boundary event (DSBE): was ascribed to a peak of prominent increase of about + 2‰ of $\delta^{13}C_{carb}$ values (Payne et al., 2004; Korte et al., 2005; Galfetti et al., 2007).

The Late Smithian event (LSmE): A drop of 4–6‰ at the upper part of the Smithian was assigned to this event (Payne et al., 2004; Corsetti et al., 2005; Korte et al., 2005; Galfetti et al., 2007; Horacek et al., 2007).

The Late Spathian event (LSpE): The last Early Triassic negative shift exhibiting a drop of 2‰ (Payne et al., 2004; Corsetti et al., 2005).

The Early–Middle Triassic transition: An increase in $\delta^{13}C_{carb}$ values after the Late Spathian event was observed during the transition into the early Anisian (Aegean and Bithynian; Payne et al., 2004; Corsetti et al., 2005; Galfetti et al., 2007; Horacek et al., 2007).

1.3. $\delta^{18}O_{carb}$ excursions

Global warming during the P-T transition and the Early Triassic, considered as the hottest record of marine temperatures (~ 40 °C in Sun et al., 2012; see also Payne and Clapham, 2012), was associated with extension of the desert-belts into the mid latitudes, and the paleo-mid-high latitudes (50°–55°) were characterized by temperate/warm multi-exchanges of climates (Péron et al., 2005; Sellwood and Valdes, 2006). Two warming and two cooling periods were observed during the Late Permian – Early Triassic time interval deduced from the excursions of $\delta^{18}O$ values analyzed from intra-basin sediments (Sun et al., 2012):

The first warming period interpreted from $\delta^{18}O_{carb}$ profiles was indicated by the continued decline in values, a drop of 1.5‰ up to 5‰ in the different worldwide successions during the LPE, PTB and the Greisbachian (Holser et al., 1989; Heydari et al., 2000; Rampino et al., 2000; Haas et al., 2006; Horacek et al., 2010; Richoz et al., 2010; Joachimski et al., 2012; Chen et al., 2013; Chen et al., 2016).

The first cooling development of the Early Triassic also interpreted from $\delta^{18}O_{carb}$ profiles was indicated at the uppermost part of the Griesbachian and along the whole Dienerian (Haas et al., 2006; Richoz et al., 2010).

The second global warming in the Early Triassic began at the Dienerian/Smithian boundary, lasted the whole Smithian, and peaked at the Smithian/Spathian boundary (Galfetti et al., 2007; named “Late Smithian Thermal Maximum” by Sun et al., 2012).

The second cooling period of the Early Triassic was recognized by Sun et al. (2012) and Romano et al. (2013) at the early Spathian, which was followed by climate stabilization along most of the Spathian (see also Galfetti et al., 2007; Hochuli and Vigran, 2010; Stefani et al., 2010; Hermann et al., 2011). The uppermost Spathian was considered by Sun