SHIFTING BIOGEOCHEMICAL DYNAMICS DURING THE LATE TRIASSIC AND EARLY JURASSIC: INSIGHT FROM STABLE CARBON AND NITROGEN RECORDS

Joyce Yager1, William Berelson1, Frank Corsetti1, Joshua West1, Silvia Rosas2, David Bottjer1

1Department of Earth Sciences, University of Southern California, Los Angeles, CA 90089, USA, joyceyag@usc.edu
2Especialidad de Ingeniería Geológica, Pontificia Universidad Católica del Perú, Av. Universitaria 1801 San Miguel, Lima, Perú

1. Introduction

The end-Triassic mass extinction was one of the largest mass extinctions of the Phanerozoic. The causes of the extinction and associated environmental changes have largely been hypothesized to be from the contemporaneous emplacement of the Central Atlantic magmatic province (CAMP), a large igneous province that injected climatically significant volatiles into the atmosphere during its geologically rapid emplacement (e.g. Marzoli et al., 2004).

The stable carbon isotope composition of marine carbonate (δ13C_carb) and organic carbon (δ13C_org) changed during the end-Triassic mass extinction and the emplacement of CAMP (e.g. Ward et al., 2001; Hesselbo et al., 2002; Palfy et al., 2001; Guex et al., 2004). Interpretations of the C isotope records across the Triassic-Jurassic boundary vary widely, particularly in terms of what these records tell us about CAMP and associated C cycle change. Hypotheses range from ocean acidification to changes in nutrient cycles, and are typically invoked as products of increased atmospheric CO₂ (e.g. Greene et al., 2012; van de Schootbrugge et al., 2007).

2. Levanto Section

Within the framework of our ongoing sedimentological, biostratigraphic, and geochemical analyses across the Triassic-Jurassic boundary in selected localities from Nevada (USA) and Morococha and Chachapoyas (Peru) (Ritterbush et al., 2014; 2015; Yager et al., In review), we discuss our stable carbon and nitrogen (δ15N) analyses from the Levanto section (Chachapoyas), The Late Triassic and Early Jurassic outcrop at the Levanto section as the Aramachay formation, part of the Pucara group (Rosas et al., 2007), consisting of carbonate-rich shales. U-Pb ash bed dating and ammonite biostratigraphy (Schaltegger et al., 2008; Schoene et al., 2010; Guex et al., 2012; Wotzlaw et al., 2014) from the Levanto section enable assessment of changes in isotope measurements through time and global correlation, respectively.

We will discuss changes in paired δ13C_org and δ13C_carb and δ15N measurements from the Levanto section to evaluate possible changes in biogeochemical cycling across the end-Triassic extinction and emplacement of CAMP.

3. δ13C

δ13C_org and δ13C_carb both exhibit broad first order positive excursions. δ13C_org is consistent near -30‰ for much of the Rhaetian, until an abrupt shift to -27.5‰, followed by a shift to -28.5‰ coincident with the end-Triassic mass extinction. A second positive shift follows, and then values slowly return to -30‰ until the top of the section. δ13C_carb is near -2‰ and shifts towards 1.5‰ during the entirety of the measured Rhaetian. δ13C_carb shifts back towards -2‰ while δ13C_org shifts back towards -30‰ during the Hettangian. These records are consistent with other measured sections from the Triassic-Jurassic (e.g. Hesselbo et al., 2002; Ward et al., 2001; Williford et al., 2007; Bachan et al., 2012).
4. $\delta^{15}$N

Our ~four million year record is the first high-resolution $\delta^{15}$N study spanning much of the Rhaetian through much of the Hettangian. $\delta^{15}$N values shift systematically through the Rhaetian at the Levanto section, from ~9‰ (early mid Rhaetian) to ~3‰ (late Rhaetian). Rhaetian values exhibit cyclicity within this trend, with a variability of about 3‰. We speculate these changes may be related to Milankovitch cycles. $\delta^{15}$N values stabilize near 2.5‰ in association with the end-Triassic extinction and Triassic-Jurassic boundary, with very little variability seen through the Hettangian (< ±0.5 ‰). The shift from Milankovitch-driven cycling towards low variability and accompanying shift from more positive to low $\delta^{15}$N values could be explained by several potential hypotheses related to the cycling of organic matter, paleo-redox, and nutrient dynamics leading up to the end-Triassic mass extinction. We will discuss possible scenarios (e.g. change in nutrient supply, water column oxygenation) leading to these changes and the plausibility of each in light of other data (e.g. C:N, %TOC) in an attempt to better understand changes in biogeochemical cycling prior to the end-Triassic mass extinction.

References

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