Carbon Isotopic Excursion Below CAMP Basalts

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The Triassic-Jurassic (Tr-J) boundary marks one of the most severe Phanerozoic mass extinctions. With a turnover of at least 50% of continental biodiversity, the event set the ecological stage for the ascent of dinosaur-dominated ecosystems. Our previous work on the Tr-J boundary in eastern North American continental rift basins and work by others in marine and continental deposits demonstrate an associated modest Ir anomaly, a "fern spike," a stomatal density (CO2) anomaly, and a pair of negative d13Corg excursions separated by a positive excursion. While these observations have been interpreted as condign with an extraterrestrial impact, much if not all of this evidence is also consonant with the temporally proximate voluminous flood basalts of the Central Atlantic magmatic province (CAMP). However, data from eastern North America suggest that all CAMP flows post-date the extinction level by tens of thousands of years, making causation difficult to support. Nonetheless, Marzoli et al. (2004) and Knight et al. (2004) interpret magnetic reversals within the Central High Atlas basalts of Morocco as indicating that most of the lavas predate or were synchronous with the Tr-J boundary, making a plausible case for the CAMP as the cause of the extinction.

A predictive corollary of the Marzoli-Knight hypothesis is that the initial d13C excursion seen globally should be within or above the Moroccan CAMP but not below it. To test this prediction, we examined the carbon isotopic composition of bulk organic material (d13Corg) through palyniferous strata below the lower basalt sequence of the Central High Atlas. While the Triassic index species Patinasporites densus does appear in the highest palyniferous sample as reported by Marzoli et al. (2004), our isotopic data suggests the presence of a pronounced isotopic excursion below the oldest basalt, consistent with profiles from the Fundy basin of Canada and the Newark basin of the USA. These results are: 1) inconsistent with the hypothesis of Marzoli et al. (2004) and Knight (2004) that the lower Central High Atlas basalts predate the Triassic-Jurassic boundary; and 2) consistent with some reworking of Triassic palynomorphs at least locally into the first few 10s of centimeters of Early Jurassic strata.

The isotopic excursion seen in Morocco, eastern North America, and indeed globally is the signature of the massive carbon cycle disruption that occurred at the Tr-J boundary. Should the Central High Atlas basalts post-date that excursion, as suggested by our preliminary d13Corg results, there would be no known examples of CAMP basalts contemporaneous with or predating the Tr-J boundary and direct causation of the mass extinction by the CAMP will be difficult to support. We are in the process of examining other sections in the Argana basin and as well as reexamining the Central High Atlas sections using compound specific d13C of biomarkers, to test the generality and meaning of the pre-basalt patterns.

Knight, K.B., Nomade, S., Renne, P.R., Marzoli, A., Betrand, H., and Youbi, N., 2004, The Central Atlantic Magmatic Province at the Triassic-Jurassic boundary: paleomagnetic and 40Ar/30Ar evidence from Morocco for brief, episodic volcanism. Earth and Planetary Science Letters, v. 228, p. 143-160.

Marzoli, A., Bertrand, H., Knight, K.B., Cirilli, S., Buratti, N., Vérati, C., Nomade, S., Renne, P.R., Youbi, N., Martini, R., Allenbach, K., Neuwerth, R., Rapaille, C., Zaninetti, L., and Bellieni, G., 2004, Synchrony of the Central Atlantic magmatic province and the Triassic-Jurassic boundary climatic and biotic crisis. Geology, v. 32, p. 973–976.