Dinosaur track and subaerial exposure surfaces in the Albian Glen Rose Formation of Central Texas

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Dinosaur tracks and trackways are well known and documented in the Albian (Early Cretaceous) Glen Rose Formation of Central Texas. They were deposited in very shallow marine environments, as inferred from sedimentologic evidence such as the dinosaur tracks themselves, the presence of mudcraks and of microbial structures developed in a tidal flat environment, where exposure to atmospheric conditions likely happened during periods of low sea-level. To confirm the subaerial exposure of track layers and its role in the preservation of trace fossils, an isotopic and elemental geochemical study was performed at three locations: South San Gabriel Creek near Austin, Blanco River, and Starzville.

First, isotope data show that not all track-bearing layers are associated with a negative-upward trend in carbon and oxygen stable isotope composition ($\delta^{13}C$ and $\delta^{18}O$, respectively). At Starzville, a 2 and 1 ‰ drop in $\delta^{13}C$ and $\delta^{18}O$ values, respectively, in the 70 cm below the track-bearing layer results from the subaerial exposure of the track layer deposited in a shallow marine environment and altered by meteoric fluids; this is confirmed by the strongly negative $\delta^{13}C$ and $\delta^{18}O$ values measured in the marly infill of burrows from the track layer. Such a trend is not seen at other study locations: at Blanco River, a 1.5 ‰ decrease in $\delta^{18}O$ values and no significant change in $\delta^{13}C$ values is recorded from the start of the measured section up to the track layer, and an increasing trend in both $\delta^{13}C$ and $\delta^{18}O$ values characterizes the 1 m-thick interval underneath the tracklayer at San Gabriel.

Second, Chemical Index of Alteration values calculated from elemental geochemistry are above 80 in all study locations, suggesting a moderate to intense alteration of landmasses under greenhouse conditions. The absence of a strong negative $\delta^{13}C$ excursion associated with track layers suggests either a lack of well-developed vegetation on land that would constitute a source of soil-respired CO_2, or the preferential preservation of undertrack layers. In the latter case, negative $\delta^{13}C$ values associated with the track layer would have been eroded during a subsequent sea-level rise, resulting in a stratigraphic hiatus. This observation could serve as a tool to differentiate true track from undertrack layers developed under greenhouse climate conditions.