Identifying geologically meaningful U-Pb ages in fossil teeth

S Nichols[a]

[a] *Earth and Atmospheric Sciences, University of Alberta, AB, Canada*

Age dating attempts on fossil material have thus far yielded mixed results. While successes have been reported on single specimens, most fossils are thought to have experienced a complex history that obscure a simple determination of age. For this study, transects along the cross-section of 13 fossil alligorid teeth from the Arroyo Chijuillita Member (ACM) of the Nacimiento Formation, New Mexico, and tyrannosaur and crocodilian teeth from the Dinosaur Park Formation (DPF), Alberta were analysed for trace elements and U-Pb isotopes using laser ablation ICP-MS. The reliability of this method was supported by good agreement in the TIMS (61.5±1.6 Ma) and laser ablation ICP-MS (64.9±3.6 Ma) ages for a targeted tooth region.

The cross-sectional profile of Y in fossil teeth was found to be a good indicator of the extent of post-fossilization alteration. Four gradational Y patterns were identified; 1) Concentrations 2-3 orders of magnitude greater in the center of the sample than the edges, 2) Concentrations 2-3 orders of magnitude greater at the edges of the sample than the center, 3) Profile and concentrations intermediate between Pattern 1 or 2 and Pattern 4, 4) Flat Y profile at very low (DPF) or high (ACM) concentrations. Patterns 1 and 2 samples preserve fossilization-age signatures in some portions of the teeth, while Patterns 3 and 4 samples are associated with progressive disturbance of the fossilization-age signature and preservation of secondary age dates.

In the ACM, the U-Pb system preserved in the fossil teeth analyzed can be considered a mixing between the fossilization-age, low-Y center of a Pattern 2 sample (64.2±5.4 Ma) and a Pattern 4 sample preserving an alteration age (25.7±2.1 Ma) corresponding to the end of large-scale volcanic activity in the Four Corners region. In the DPF, the U-Pb data is defined by an age of 71.8±9.4 Ma from a Pattern 1 sample at low $^{238}U/^{206}Pb$ and altered analyses skewing towards higher $^{238}U/^{206}Pb$ values. Alteration ages are ~49 Ma and ~33 Ma, but have not been tied to a known geological event. Presented here is a simple geochemical screen to determine the extent of post-fossilization alteration a fossil has experienced, such that samples most likely to preserve a fossilization U-Pb signature can be identified. Furthermore, teeth that do not preserve a fossilization-age signature are used to elucidate the nature and timing of post-fossilization alteration events.

Corresponding author: sm@ualberta.ca