Evidence for natural, non-thermal annealing of fission tracks in apatite

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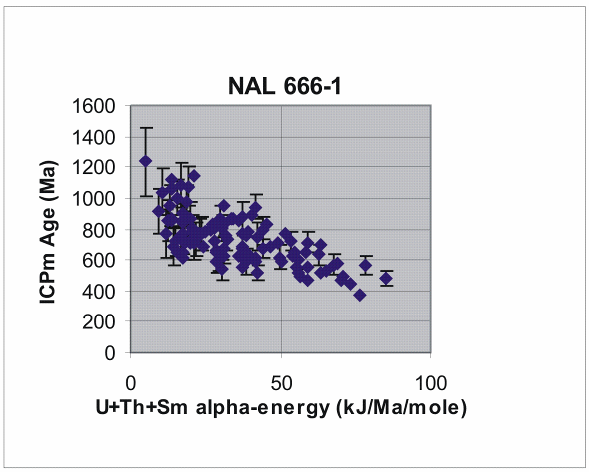
Apatite fission-track (AFT) analyses using a LA-ICP-MS based approach on samples from Finland and Canada provide evidence for a non-thermal AFT annealing process that is dependent on the present-day concentration of alpha-emitter actinides (U,Th,Sm) within grains. In one example, 118 grains were dated from a sample from central Finland (see below).



Because all of the dated grains are from a single hand sample, the inverse correlation between the concentrations of alpha-emitter actinides and AFT age cannot be explained simply by intra-grain variations in temperature history. Electron microprobe analysis of the dated grains indicates that chemical elements that are known to control the annealing rates in apatite (Cl, Mn, Fe, REE, etc.) do not show a similar correlation.

Electron beam induced annealing of fission tracks in apatite (Paul and Fitzgerald 1992) and studies of phosphates as nuclear waste forms (e.g. Ewing and Wang 2002) indicate that processes other than thermal annealing can cause fading of fission tracks under laboratory conditions. The above example from Finland represents a natural example of non-thermal, radiation-induced annealing.

Modelling of AFT data from cratonic settings with annealing models that do not incorporate non-thermal annealing processes will lead to overestimation of paleotemperatures.

References

Paul and Fitzgerald 1992, *American Mineralogist* **77**.
Ewing and Wang 2002, Phosphates, *Reviews in Mineralogy and Geochemistry* **48**

Trace element distributions and coral skeleton micromorphology following a bleaching event

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The massive tropical corals commonly used as palaeoclimate archives, such as *Porites* sp;, contain zooxanthellae (symbiotic photosynthesizing algae). Coral bleaching occurs when these pigmented zooxanthellae are expelled from the coral tissue. In this study we investigate how the biomineralization process and trace element distribution within the coral skeleton are impacted by zooxanthellae population dynamics following a bleaching event. The non-destructive, high resolution in-situ mapping capabilities of synchrotron μ-XRF is an ideal tool to investigate differences in trace element partitioning that correspond to the fine-scale architecture of coral skeleton.

A healthy ~30 year old *Porites australensis* colony was collected 2 ½ years after the February 1998 mass coral bleaching event from the inshore central Great Barrier Reef, Australia (18.48°S, 146.26°E). During the 1998 coral reef bleaching event ~80% of coral to a depth of 10m bleached at this reef, and bleaching mortality subsequently reduced coral cover by ~20%. At the time of collection (August 2000) there were no signs that the specimen had bleached, however, x-ray images show a marked and sustained skeletal growth response with lower extension and calcification rates and higher skeletal density.

Synchrotron μ-XRF mapping was carried out at Beamline X26A (NSLS, BNL) with the beam set at 16.5 keV to target elements up to Sr and a 10μm spot size. Sr, Ca, Br, Zn, Ni, Cu, Fe Pb and Ba were mapped in 20μm steps (equivalent to daily growth rate) down the width of a single corallite for a 4-year period of skeleton growth including the 1998 bleaching event. Skeletal structures are compositionally zoned, with a strong response 6 months after the start of the bleaching event. An adjacent CT-X-ray microtomography scan recorded the contemporary morphological changes in skeleton micro-architecture. Bulk analyses of Sr/Ca, Mg/Ca, $\delta^{13}C$, $\delta^{18}O$ were measured on a parallel milled transect. To isolate the role of tissue smoothing on the seasonal signal μ-XRF elemental maps were also collected across the most recent skeleton deposited within the tissue zone of specimens collected in both summer and winter seasons.