EGU2020-20017
https://doi.org/10.5194/egusphere-egu2020-20017
EGU General Assembly 2020

U-Pb dating of carbonate-fluorapatite: a potential chronological tool for ancient marine sediments

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Carbonate-fluorapatite (CFA) is a common early diagenetic component of marine sedimentary sequences. Nodules, laminae and shell overgrowths or infills composed of CFA are relatively common features in phosphorites, carbonates and other marine sediments (e.g., Datillo et al., 2016). CFA U-Pb dating thus has potential application as a chronometer in a wide variety of ancient marine sediments, particularly in those marine sections lacking diagnostic faunal and/or floral assemblages, or well-dated volcanogenic horizons.

In order to test empirically whether accurate and precise U-Pb ages can be obtained from CFA using LA-ICPMS we have analysed CFA from a several marine sediment samples. These include samples of Cretaceous phosphatic chalk from southern England, phosphatic nodules from the Cretaceous of northern Ireland and western Scotland, and a sample from a laterally extensive Carboniferous phosphorite in western Ireland. Ages obtained from CFA in these rocks can be precise (as low as c. 0.55% 2SE error in one sample), and are all unimodal. U-Pb ages of CFA, however, range from stratigraphically-consistent ages to ages that record much younger events than their host rock stratigraphic ages.

While ‘ages’ obtained from CFA may be precise, what each of these ages represents geologically requires further study. The genetic relationship between phosphate and its host rock must be petrographically studied to understand the correspondence between the phosphatic and other components of these rocks in terms of their depositional and diagenetic histories. It is apparent that in some cases CFA will record deposition or early diagenesis, but that the U-Pb system in CFA can be overprinted by later tectonic events in other cases. In addition, whilst LA-ICPMS U-Pb dating of apatite (i.e. fluorapatite and chlorapatite) in crystalline rocks is now routine, the crystal structure and composition of CFA differs from apatite derived from igneous and metamorphic rocks, including the established fluorapatite U-Pb standards (e.g. Madagascar apatite, Thomson et al., 2012). Thus, assessment of matrix-matching effects will have to be undertaken to fully establish the CFA U-Pb chronometer.

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