

Factors affecting detrital zircon age distribution – Natural samples and experimental approach

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We have investigated some of the factors that affect the accuracy of detrital zircon age provenance studies. The main goal was to quantify the effects of individual factors in the deviation of the measured detrital age spectra from the real zircon age distribution in the sediment and in the sediment source. The analysis has been carried out in a natural catchment in the Scottish Highlands representing simple two-component source system and on samples of synthetic sediment prepared on purpose for this study using zircon-free quartz sand and known number of zircon grains of known age distribution. Our results suggest that the zircon fertility of the source rocks and physical parameters of zircon grains represent the most important factors affecting the distribution of zircon age populations in the stream sediments. It can account for a several-fold difference between the ratio of the rocks in the source area and abundance of zircon in the sediment. Additional age biases can be introduced during sample preparation and data processing. The sample preparation and selection of zircons from the mineral concentrate may result in preferential loss of small grains and enhancement of the age component represented by larger grains. This can, together with the preference for larger grains during handpicking, cause several-fold difference compared to the real age distribution in the sediment sample. These factors appear to be more important for the reproducibility of zircon age spectra than is the number of zircon grains analyzed per sample. Even the most abundant age population in the sample may deviate by tens of percent from its real content in the sediment after hundred or more analyses have been done. The complex relations between proportion of zircon age populations in the source, sediment and analyzed sample make it difficult to relate the peak intensity in the age spectra to the sediment quantity contributed from different sources. At all times, the analytical limits of the dating techniques must be considered when evaluating potential overlap of zircon populations that are closely spaced in time. Although the visualization of U-Pb data in probability density plots is commonly used for comparison between samples, the detrital zircon age spectra must always be interpreted relative to the volume of individual age populations, not to the intensities of the age peaks.

Fluoride removal by calcite – Stirring rate/temperature effects

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Fluoride contamination of groundwater due to anthropogenic activities remains a major concern for many industries worldwide. The effects of stirring rate and temperature on the removal of fluoride by calcite have been studied in order to determine the most efficient and cost effective method of remediating such contamination.

The kinetics of calcite dissolution and precipitation in aqueous solution has been the subject of numerous investigations. However, little study has been undertaken on heterogeneous systems where mass transport processes and surface reactions determine rates. Aleksey, *et al.* [1] have noted that traditional thermodynamic approaches to determine equilibrium are problematic and there is a need for a kinetic approach to solving these problems. The effects of stirring and temperature on the heterogeneous calcite/F systems are the focus of this study.

A series of free drift experiments were conducted in a controlled temperature (CT) room at 20°C, 30°C and 40°C, with P_{CO_2} in equilibrium with the atmosphere ($P_{CO_2} \approx 10^{-3.5}$). Calcite was added to potassium fluoride solutions and stirred at 0, 200 and 300rpm using an overhead stirrer. The results in Table 1 have been determined by fitting the experimental data to the non-linear Hill 1 function ($r^2 > 0.98$).

RPM	Temp	Minutes	RPM	Temp	Minutes
300	40°C	5,143	0	40°C	13,224
300	30°C	9,196	0	30°C	24,250
200	40°C	11,287	0	20°C	138,169
200	30°C	22,330			

Table 1: Time (min) to reach equilibrium F removal

The results clearly demonstrate that a greater rate (dF/dt) of fluoride removal is possible with increased stirring rate and temperature. Early in the reaction <200 minutes dissolution is largely a function of a surface reaction as mixing has little effect on the rate [2]. In the latter part of the reaction, stirring rate has a significant effect, consequently hydrodynamic transport effects dominate [2].

[1] Alekseyev *et al.* (1997) *Geochimica et Cosmochimica Acta*. **61**, 1125–1142. [2] Plummer & Parkhurst (1979) *Chemical Modelling in Aqueous Systems*.