Relating U-Th-Pb ages of accessory minerals to metamorphism: A case study from the Barrovian sequence of the Central Alps, Switzerland

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Accessory minerals allanite, monazite and rutile from amphibolite facies rocks across the Barrovian sequence of the Central Alps (Switzerland) were investigated for composition and U-Th-Pb ages. The growth ages of these minerals record stages of prograde and peak metamorphism.

Allanite formed during the prograde path at 26-33 Ma. It occurs aligned along an early foliation that is overprinted by later generations of mica. In some cases, the foliation along which allanite is aligned is only preserved in garnet. Rutile from one metapelite in the central region also records a ~33 Ma age. Zr-in-rutile thermometry yields a temperature of 550±20°C, which is lower than the 620°C peak temperature deduced from the main mineral assemblage [1], indicating that rutile crystallised under prograde conditions. We interpret this early age as the time when the rocks reached peak pressure conditions.

The timing of peak temperature conditions is recorded in monazite, rutile and, in one sample, allanite rims. Monazite yields an age of 22 Ma and grew at the expense of allanite and after the first stage of garnet growth. In monazite-bearing samples, allanite is preserved as inclusions in garnet, whereas monazite is part of the matrix. Zr-in-rutile thermometry suggests that 23 Ma rutile in a calcschist records the timing of peak temperature conditions. 20 Ma allanite rims in one metapelite crystallised on older (27 Ma) cores, and are also interpreted to reflect the timing of peak to retrograde conditions.

Through multi-mineral geochronology a prograde metamorphic history, spanning some 10 Ma, can be reconstructed: from prograde greenschist facies to peak amphibolite facies conditions. The observation that 33 Ma prograde rutile is preserved despite the later temperature peak at 22 Ma suggests a closure temperature of Pb in rutile in excess of 620°C.

[1] Todd & Engi (1997) *J. metamorphic Geol.* **15**, 513-530

A multi-isotope (H, O, C, S, B, Mg, Ca, Ba) approach to study diagenesis in Black Sea-type sediments

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Like The Black Sea, The Baltic Sea Has Switched Between Fresh Water And Brackish Water Modes. The Changes In Paleo-Environmental Conditions Caused Downcore Gradients In The Concentrations Of Dissolved Species In The Pore-Waters With Consequences For Microbial Activity And Physicochemical Water-Solid Interactions Associated With Multiple Stable Isotope Fractionation Processes. Here, We Introduce A New Combined Multi-Isotope And Trace Element Approach To Investigate Diagenesis In These Non-Steady State Systems.

In a Gotland Basin core, it is found that concentrations of conservative elements and the pore water H-2 and 18-O contents decrease with depth due to diffusion from brackish waters into underlying fresh waters. A downward increase and decrease of Ca and Mg concentrations, respectively, is associated with decreasing Ca-44 and Mg-26 isotope values. B-11 isotope values decrease in the limnic part. An increase in Ba concentrations with depth is associated with a slight increase in Ba-137/134 isotope values. Microbial activities lead to an increase in DIC, but a decrease in SO4 concentrations and in C-13 contents of DIC with depth. Desorption of Ba from glacial sediments due to downward diffusing ions is responsible for the formation of sedimentary barites. S-34 and O-18 isotope values of barites suggest that these were formed in glacial sediments from pore waters strongly depleted in O-18. Impacts of diagenetic processes on multi-isotope signals in pore waters and authigenic phases are discussed. Mixing between brackish and fresh waters, solid-liquid interactions, and transport reactions explain most of the observed isotope variations along the vertical pore water profile.

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