

Trace elements in Quartz: Experimental constraints on Al, Ti, Fe and P saturation

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Quartz is a characteristic mineral of the continental crust and is present within a broad range of geological environments. This relatively simple trigonal mineral is known to host a number of elements at trace concentrations, including Al, Ti, Fe, P, Li, K, Na and H⁺.

It has been demonstrated [1] that the Ti content of quartz can be used to estimate the temperature of crystallization, assuming growth under specific conditions. Here we report on-going research into a broader range of elements (Al, Fe, P and H) in an effort to better understand how quartz composition changes as a function of temperature, pressure and system composition. In other words, this experimental research is aimed at increasing the potential use of natural quartz as a geological indicator. Experiments were carried out in an end-loaded piston-cylinder apparatus, with starting material contained in cold-sealed 6.8 mm Ag capsules. Experiments were run at 650-900 °C and 10-20 kbar for 4-7 days at vapour saturated (H₂O) conditions.

Our results vary depending on P-T-X, but a number of systematic trends are present. Experiments containing co-existing quartz and kyanite, for example, indicate that the Al content of quartz decreases from ~1200 to ~450 ppm when pressure is increased from 10 to 15 kbar at 900 °C.

[1] Wark & Watson. (2006) *Contrib. Mineral. Petrol.* **152**, 743–754.

Effect of Arsenic on microbial Iron reduction and Arsenic speciation in an Iron-rich freshwater sediment

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Depth profiles in the sediment porewaters of the Chattahoochee River (Georgia, USA) show that iron oxides scavenge arsenate in the water column and settle to the sediment-water-interface (SWI) where they are reduced by iron-reducing bacteria. During their reduction, these particles seem to release arsenic to the porewaters in the form of arsenate only.

Sediment slurry incubations were conducted to determine the effect of low concentrations of arsenic (< 10 µM) on biogeochemical processes in these sediments. Experiments confirm that any arsenate (As (V)) added to these sediments is immediately adsorbed in oxic conditions and released in anoxic conditions during the microbial reduction of authigenic iron oxides. Incubations in the presence of ≤ 1 µM As (V) reveal that arsenate is released but not concomitantly reduced during this process. Simultaneously, microbial iron reduction is enhanced significantly when exposed to 1 µM As (V), spurring the simultaneous release of arsenate into porewaters and secondary formation of crystalline iron oxides. Above 1 µM As (V), however, the microbial reductive dissolution of iron oxides appears inhibited by arsenate, and arsenite is produced in excess in the porewaters. The large effect of such low arsenic concentrations on iron reduction suggests arsenic is involved in a catalytic cycle that is detrimental to iron-reducing bacteria. Possible mechanisms for such effects on iron reduction are proposed and tested using *Shewanella* species as model iron-reducing microorganisms.

Overall, these incubations reveal that investigations with natural sediments may provide new insights on the tight coupling between both geochemical and biological processes in sediments that could not be assessed in well-defined systems. They show that even low inputs of arsenic to riverine sediments may affect microbial processes, the stability of iron oxides and, indirectly, the cycling of arsenic.