Arsenic distribution in an unconformity related hydrothermal vein system

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Many active geothermal systems discharge large amounts of arsenic, contributing significantly to geogenic arsenic contamination. This study aims at a better understanding of the physicochemical controls that favor transport or fixation of arsenic in geothermal environments. The unconformity related hydrothermal vein system at Sailauf (Germany) provides a well suited natural field laboratory, with As enriched mineral assemblages exposed immediately below the Permian unconformity. Hydrothermal minerals of the rhyolite hosted veins comprise mainly Ca-Mn carbonates, which are intergrown with braunite, hematite, hausmannite and manganite. Arsenate minerals are present as late vug fillings, intergrown with late stage carbonates, and fracture fillings of native arsenic. The textural features suggest a significant mobility of As in the hydrothermal fluids, in particular during late-stage low-temperature fluid-mineral reactions.

As a first step towards a quantitative As budget of the system, we determined the distribution of arsenic and other trace elements in cogenetic gangue and ore minerals by combination of EPMA and LA-ICPMS. The work is complemented by fluid inclusion studies that involve As analysis by LA-ICPMS of single fluid inclusions. While early primary calcites are virtually devoid of As, cogenetic main stage braunites were found to contain arsenic in oscillatory zoning patterns. Concentrations range from 100 ppm in the As-poor to 6000 ppm within the As rich growth zones. Primary tabular hematite exhibits variable As contents of 100 to 1000 ppm, whereas late stage carbonates can have as much as 1000 ppm As. The trace element distribution, in conjunction with fluid inclusion and stable isotope data, will be used as input for geochemical modeling of the As mineralization processes. The modeling will look at the competing effects of precipitation of As phases as a consequence of fluid boiling or mixing processes, and As incorporation into oxide minerals controlled by surface complexation.

Irreducible uncertainty in estimates of silicate mineral weathering rates

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The notion that precise estimates of silicate mineral weathering rates are possible is a key assumption behind many environmental policies. Earlier, we showed that an ensemble of published silicate mineral weathering rate estimates was insufficiently precise to evaluate sustainability of forest harvest at a single site [1]. Here, we extend this analysis with a comprehensive dataset from 82 different sites on 3 continents where 3 or more published weathering rate estimates were available. The range (max/min) of published weathering rate estimates at a single site (below) had a median value of 6 and a maximum of 52.

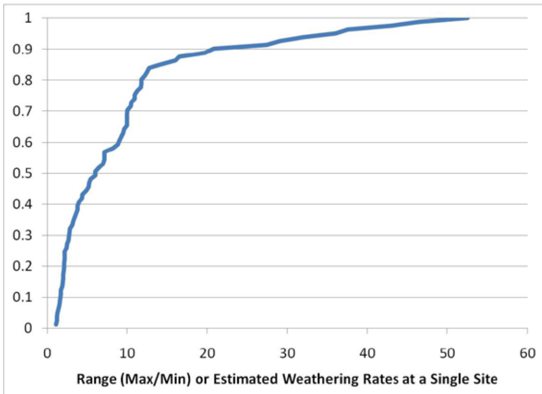

Figure 1: Cumulative distribution plot of range (max/min) or published weathering rate estimates for single sites.

While the weathering rate uncertainty can be partitioned into model structural, weathering zone depth, parameter and data terms, there is an irreducible factor of 2 uncertainty in rate estimates. Failure to consider this uncertainty can have profound consequences for critical load estimates, sustainable forest harvesting or assessing the feasibility of geo-engineering projects for climate change mitigation.

[1] Klaminder *et al*. (2011) *For. Ecol. & Mgmt*. **261** 1-9.