Fluoride in groundwaters of regolith and bedrock (0-900 meters depth) in a granitoidic setting, SE Sweden

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Parts of Scandinavia show elevated fluoride in groundwaters which can be linked to the igneous host bedrocks of the Baltic Schield [1]. We investigated fluoride in groundwaters down to 900 meters depth in a small area located in southeastern Sweden. Just north and south of the study area intrusions of fluorine-rich (average 0.43 wt%) 1.45 Ga old granites are situated [2, 3]. Fluoride in private excavated wells are approximately five times higher here compared to Sweden in general [4]. Groundwaters in regolith (boreholes with plastic-casings; 0.3 mm slot screens) and fractures in the bedrock (boreholes with packed-off sections) were monitored for several years and were evaluated with respect to fluoride hydrogeochemistry. In addition, fluorine content in the host rock minerals have been investigated using wavelength dispersive spectrometry.

Fluoride in the regolith groundwaters ranged from below level of detection (LOD, <0.2 mg/L) to 5.1 mg/L (median 1.4 mg/L) and were overall stable over time. In the bedrock groundwaters, concentrations ranged from below LOD to 7.4 mg/L (median 2.7 mg/L). The area closest to the Götemar granite showed the highest fluoride concentrations in both water types, which suggests presence of F-rich secondary mineral coatings on fracture walls (fluorite is overrepresented here) and F-rich glacial deposits originating from the intrusion of the Götemar granite as major sources.

This granite and associated greisen contain higher amounts of F-rich fluorite and apatite, than surrounding rocks and in addition, biotite, muscovite and apatite are much more F-rich. Further on, the fluoride concentrations in the bedrock groundwaters increased closer to the surface in waters classified as of meteoric origin [5]. This pattern may indicate a downward transport of fluoride from the regolith into the bedrock fracture system.

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Carbonate clumped isotope thermometry in the subsurface

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The carbonate clumped isotope thermometer potentially can be used to reconstruct the temperature and d18O of the ocean in the distant past. However, there is considerable uncertainty regarding how the thermodynamically controlled, temperature dependent abundance of carbonate groups containing both ^{13}C and ^{18}O, is affected during burial. There is evidence that both recrystallization and solid state diffusion within the crystal lattice are important processes. There is likely a time-depth dependence to these processes, though the details of these dependencies are currently poorly constrained. This study explores how the burial and exhumation history modifies the primary distribution of isotopes in host carbonates from the subsurface and surface of Oman. The study includes rocks of Eocene to Neoproterozoic age that sit at current burial depths of 360 m to 5850 m. Additionally, we analyzed exhumed carbonates from the same formations, estimated to have been buried from 1-2 km up to 8-10 km.

Results from this work suggest two dominant modes of diagenesis: 1) Texturally well preserved carbonates measured from the subsurface yield seawater compositions similar to today of around 0‰ with Phanerozoic samples yielding temperatures <40°C and Neoproterozoic samples yielding temperatures <60°C. 2) Highly recrystallized carbonates affected by low-water-to-rock diagenesis sit close to the current geothermal gradient. Samples exhumed from depths >8km yield higher temperatures (120-150°C) and very enriched fluid compositions (~8‰) and also indicate low water-to-rock diagenesis.

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