Björklund and Pleutajokk (Sweden)

Description: Mineralised areas in the Fennoscandian Shield characterising the Arjeplog-Arvisdjaur-Sorsele uranium province in northern Sweden are believed to have been emplaced at the peak of metamorphism around 1750 Ma (Figure 1).

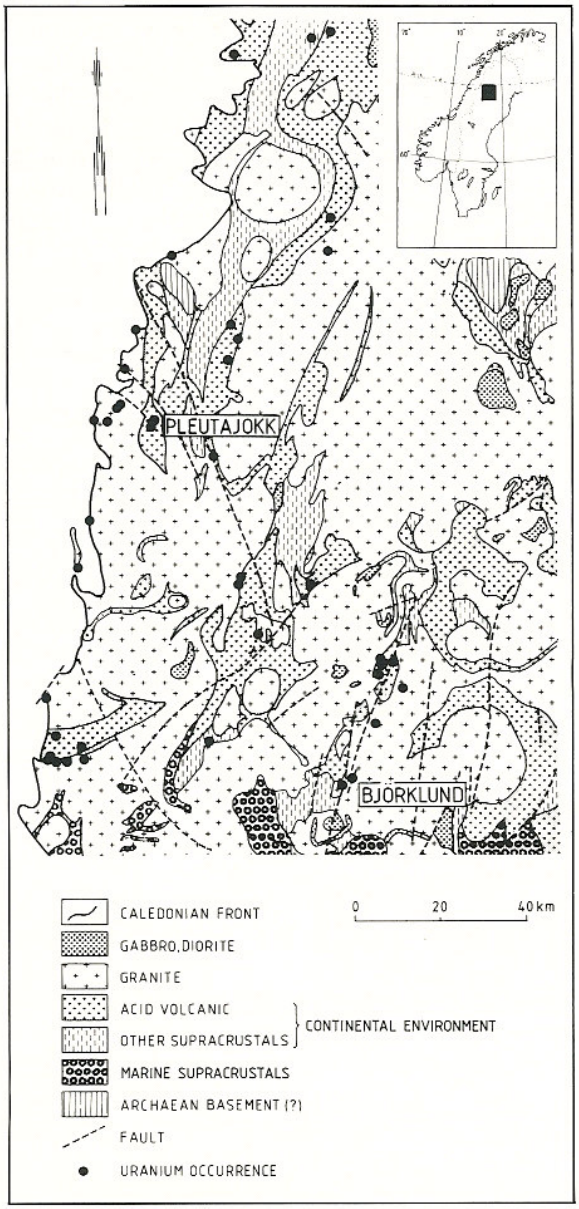

Figure 1: Geology of the Arjeplog-Arvidsjaur-Sorsele uranium province, northern Sweden, showing the location of the Björklund and Pleutajokk uranium mineralisations (after Smellie and Rosholt, 1984).

Two of these epigenetic mineralisations, Björklund (in granite) and Pleutajokk (in metamorphosed rhyolitic acid volcanics), have been studied in detail as part of a regional documentation of uranium occurrences (Hålenius and Smellie, 1983). In both cases the uranium (as uraninite) has been mobilised as a result of hydrothermal activity following the metamorphic stage and concentrated along younger fracture systems. Whilst many of these fractures have been sealed during mineralisation, some have remained open to later groundwater circulation.

The objective of the study was to sample open mineralised fractures (considered hydraulically active) at both localities and to determine using U-decay series measurements whether the

uraninite has remained stable since emplacement, i.e. an analogue of spent fuel stability under *in-situ* geosphere conditions (Smellie and Rosholt, 1984).

Relevance: The study is of most relevance to spent fuel disposal concepts, but also offers more general implications of uranium mobilisation and transport in the geosphere.

Position(s) in the matrix tables: This study illustrates the spent fuel stability box in the near-field matrix table.

Limitations: Although naturally occurring uraninite is closely analogous to spent nuclear fuel, both being dominantly UO_2 in composition, uraninite does not contain any concentrations of fission products and the maximum temperatures reached in a modern reactor far exceed those experienced by the uraninite at Björklund and Pleutajokk. Furthermore, uraninite may contain substantial amounts of lead (radiogenic) not present in spent nuclear fuel.

Quantitative information: Mineralogically, the uraninite at depths ranging from 55-130 m has escaped major oxidation and dissolution since its emplacement despite being presently close to the surface. Isotopic disequilibrium (i.e. potential water/rock interaction processes) is evident from the U-decay series measurements. However, this can be explained by ^{234}U recoil-induced loss or gain and that no oxidative bulk leaching has occurred during the last 0.5 Ma. In other words, even though water/rock interaction is occurring, the physico-chemical environment at the sampled depths has been, and probably still is, non-oxidative. By analogy, these results would tend to support, at least at the depths investigated, that the more harmful actinides, which are of similar chemical properties to uranium and are present in spent nuclear fuel, would also have been stable in this environment for similar periods of time.

Uncertainties: On a scale of low-medium-high, the uncertainties associated with this semi-quantitative study are assessed as medium. Since no groundwater samples could be collected (and the absence of hydraulic data), the hydrochemical boundary conditions are unknown and could be extrapolated only.

If the data from this study are to be related to the geosphere, it is important to bear in mind that such data are fracture-specific (i.e. hydraulically-specific) and should not be applied indiscriminately.

Time-scale: The time-scale addressed by the study is geological, both Quaternary (<2 Ma) and beyond (>2Ma).

PA/safety case applications: There are no examples of its use in published PAs.

Communication applications: There are no examples of its use in communication and dialogue material.

References:

Hålenius, U. and Smellie, J.A.T., 1983. Mineralisations of the Arjeplog-Arvisdjaur-Sorsele uranium province: mineralogical studies of selected uranium occurrences. Neues Jahrb. Mineral., 147, 229-252.

Smellie, J.A.T. and Rosholt, J.N., 1984. Radioactive disequilibria in mineralised fracture samples from two uranium occurrences in northern Sweden. Lithos, 17, 215-225.

Added value comments: The analogue could be better used if more localities could be included and each accompanied by quantitative hydraulic and hydrochemical data. This would improve the conceptualisation and also model development. As it is, the data are most useful in confidence building (with respect to certain FEPs) and also in scenario development. The conclusions to the

study could be used more in communication – at least as support to similar conclusions from the Cigar Lake study related to spent-fuel stability.

Potential follow-up work: More field measurements and sampling could be undertaken at different mineralised localities to extend the value of the data from fracture-specific scale to, for example, spent fuel deposition borehole scale.

Keywords: Uranium mineralisation, uraninite, radionuclides, U-decay series.

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