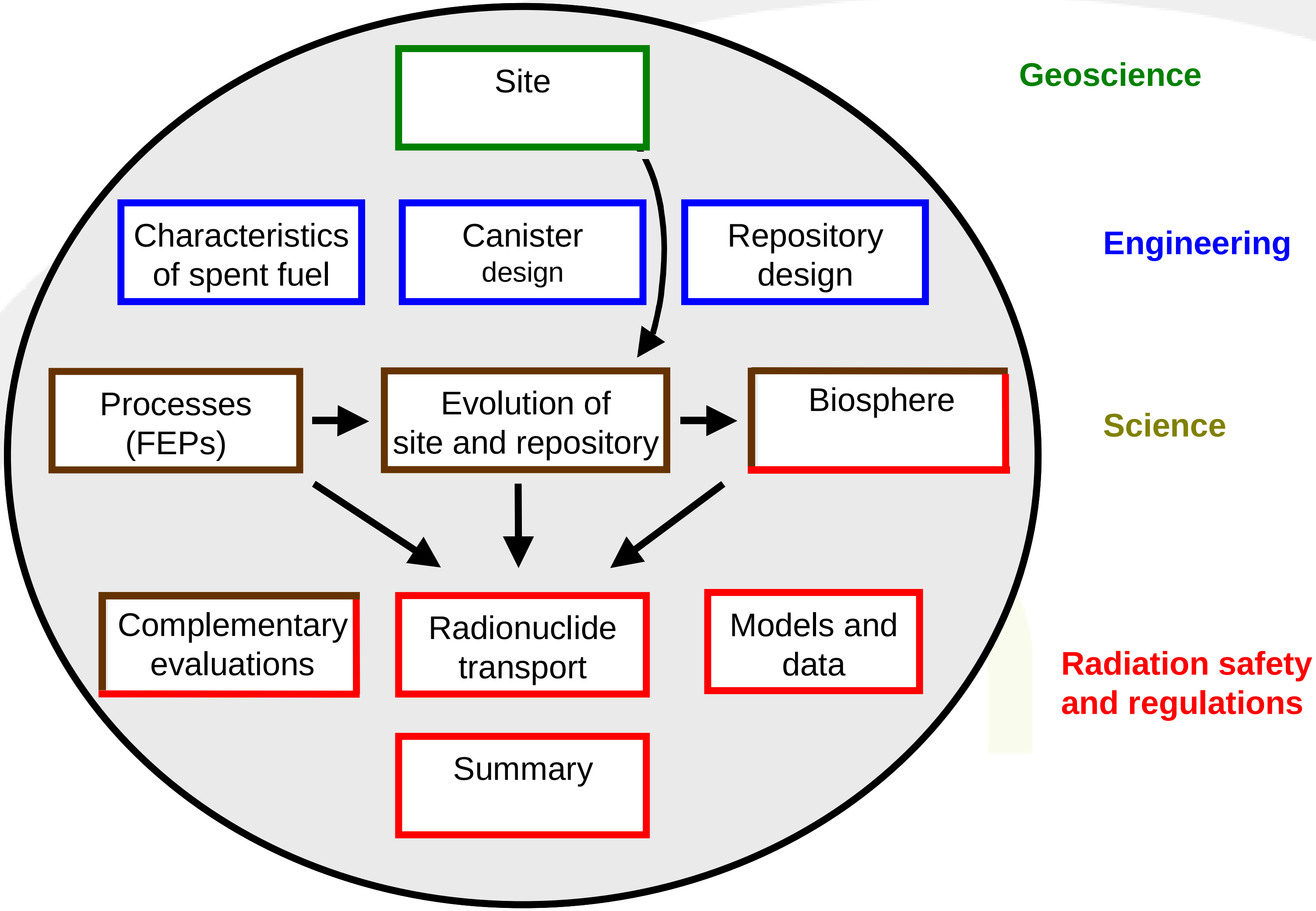
NATURALS ANALOGUES IN THE FINNISH SAFETY CASE

OVERVIEW:

1. THE SAFETY CASE PORTFOLIO
2. SAFETY CASE AND PERFORMANCE ASSESSMENT
3. USE OF OBSERVATIONS OF NATURAL SYSTEMS IN COMPONENTS OF THE SAFETY CASE PORTFOLIO
   - UNDERSTANDING, SUPPORT AND CONFIDENCE
4. EXAMPLES

1 THE SAFETY CASE PORTFOLIO



2 SAFETY CASE / PERFORMANCE ASSESSMENT

2.1 SAFETY CASE (SC) is a broader concept than PERFORMANCE ASSESSMENT (PA) (radionuclide transport report) now included in the SC and allows the use of natural analogues to understand the behaviour of the system components and interactions between them.

3 USE OF OBSERVATIONS OF NATURAL SYSTEMS IN THE SAFETY CASE PORTFOLIO (I)

- Natural analogues are mostly use to add confidence to the safety of geological disposal with respect to
  - **Design, materials, and processes**

- Site – understanding the long term behaviour of the site with respect to past internal and external processes; methodology in N.A. and Site studies is similar.

- Evolution – definition of climatic scenarios based on the imprints (several proxies) of the last glacial cycle. Understanding and predicting the behaviour of the bedrock/groundwater (e.g. <u>salinity</u>) system during permafrost from studies at Lupin mine in Canada and other publications.

3 USE OF OBSERVATIONS OF NATURAL SYSTEMS IN THE SAFETY CASE PORTFOLIO (II)

PROCESSES AND INTERACTIONS

- Radionuclide release, transport, and retention

NATURAL ANALOGUES

- Cigar Lake, Canada
- Oklo, Gabon
- Palmottu, Finland: U-Th orebody in crystalline rock similar to the rocks at Olkiluoto. Low U concentration in deep reducing groundwater. Precipitation of U(VI) minerals in the upper parts control U concentration in oxidising groundwaters (500 ppb max).

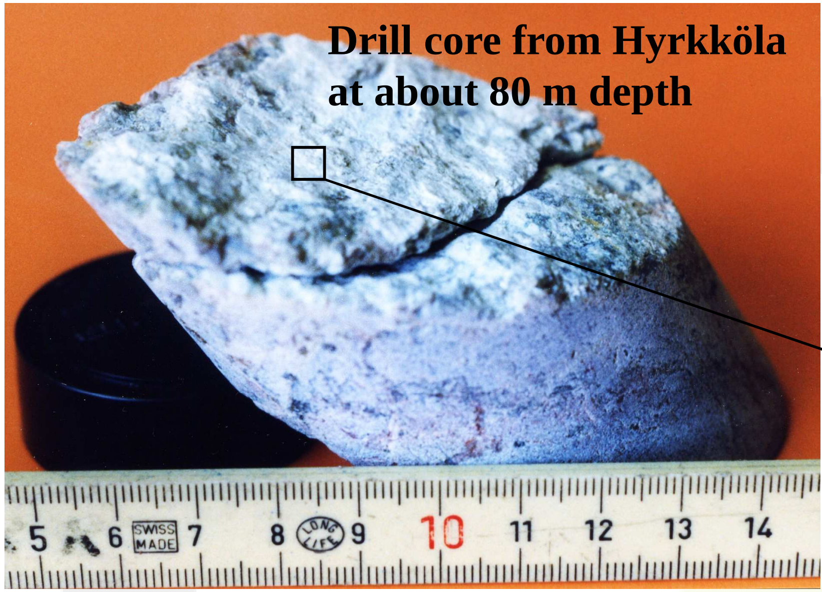
- Copper corrosion
- Íron (steel) corrosion
- Bentonite alteration, cement degradation, and bentonite/cement interactions

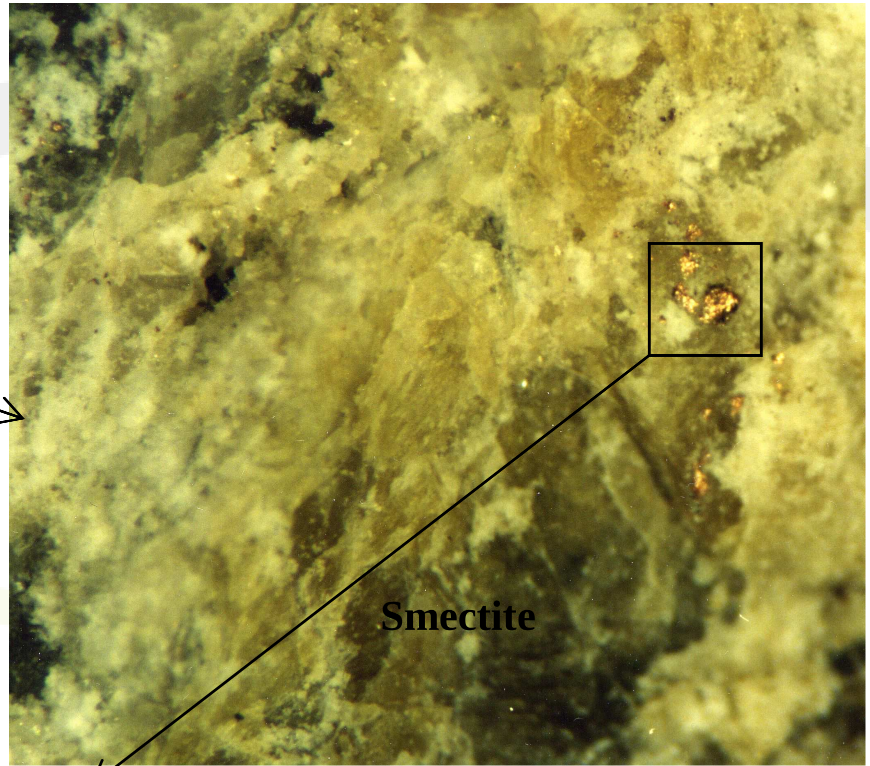
- Hykkölä, Finland: **Native copper durability in oxidising and in reducing conditions. Minor corrosion to Cu-sulphides and oxides. Interaction of copper sulphides and uranium: sulphides immobilise U.**
- Littleham Cove, Devon, UK
- Kronan cannon, Sweden
- Bühl, Germany
- Inchtuthil, Scotland
- Kinnekulle, Sweden
- Maqarin, Jordan

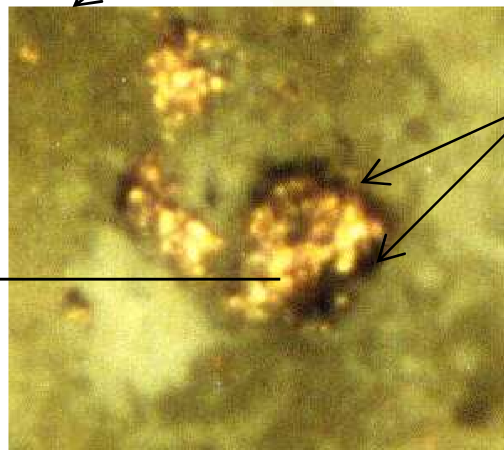
4 Examples

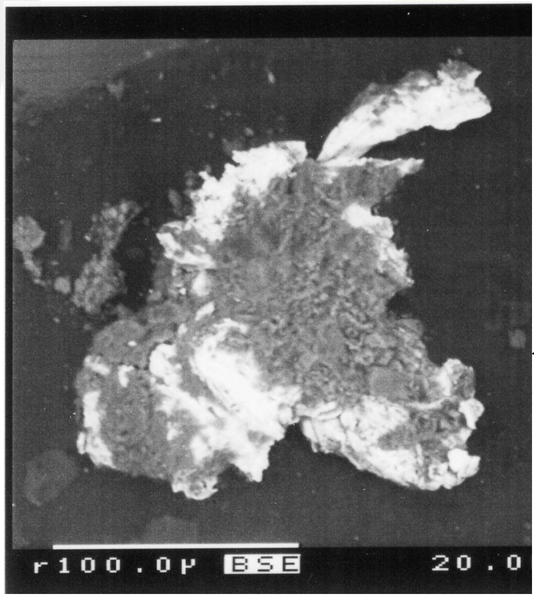
- Erosion rates during ice ages
  - largest boulders ice have release and move are well below 20 m.
  - 25 glacial cycles would be needed to erode in this fashion 500 m of bedrock. During the last million year about 8-9 glacial cycles are known to have occurred.

Boulder, Sulkavalla, Finland (www.jukola.com/jukola/kuvat/hiidenkivi)









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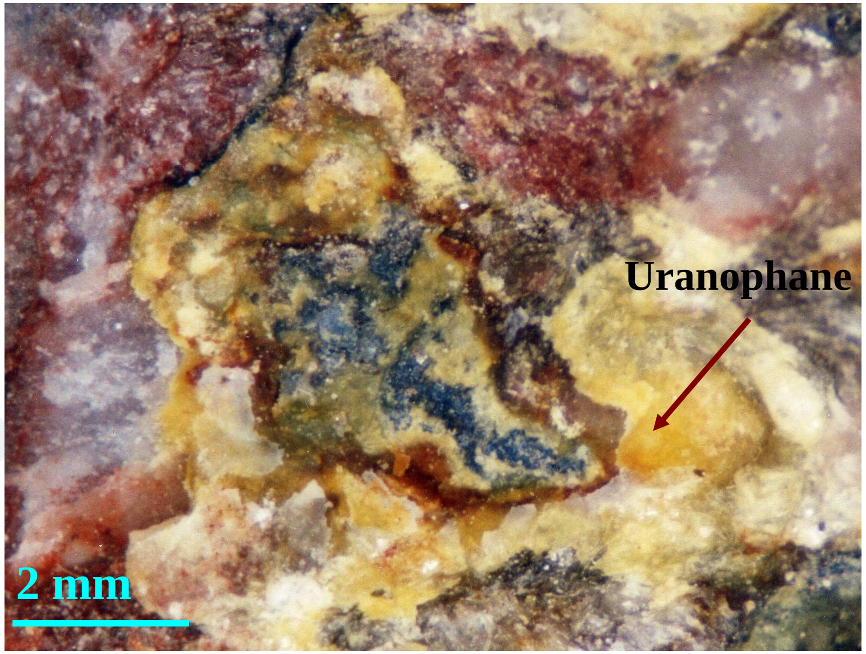
- Glaciation related issues (groundwater stability, glacial meltwater intrusion) and uranophane age (e.g. Hyrkkölä)

- Uranium is indeed released and transported from reducing environment to oxidising conditions near the surface.
- U precipitated in open fractures between 70-100 ka ago.
- During the last 70 000 years, even the area has been under ice/water, no major events have affected U in these fractures.



Marcos 2002, Read et al. 2007

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