

# Exploring uranium mineral systems: challenges and opportunities

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The objective of exploration, for all natural georesources including uranium, is the discovery of a mineral resource that is a concentration or occurrence of solid material of economic interest in or on the Earth's crust in such form, grade or quality and quantity that there are reasonable prospects for eventual economic extraction. The evaluation of uranium resources is a question that raises regularly according to the expected development of the nuclear energy in the energy mix. Like other commodities considered as critical, uranium is also linked to changes in political situations and possible threads on the supply chain. From a scientific and technical point of view, the knowledge of the uranium mineral system and return of experience from recent discoveries and mining innovation have also major implications on possible assessment of potential resources at the regional scale.

Mineralization processes leading to the formation of economic deposits require the assessment of the main components defining uranium mineral systems (Wyborn et al. 1994). Translating the mineral systems approach into an effective exploration targeting system can be a challenge (McCuaig et al 2010). At the regional and district scale, project generation addresses some critical aspects related to geodynamic setting and major metals enrichment within the different lithological horizons that may correspond to specific structural pathways or chemical fronts. Based on this analysis, a deposit type among the 15 ones defined by the IAEA (2022) can be targeted and used to build up an exploration program including geophysical, geological and geochemical surveys. Presently, Proterozoic unconformity and sandstone deposits are considered as the most promising targets to be explored in terms of tonnage and economy. At the camp scale, proxies and footprints corresponding to each type of deposit, like alteration haloes, syn sedimentary features or redox front, can be identified and used to refine targeting and definition of the drilling program. At the prospect scale, qualification of the metallogenic model and quantification of the mineable resources will be the priority to prepare a scoping study.

Nordic countries have experienced uranium exploration and assessed reasonably assured resources in particular in Finland (Pohjola 2015) and Greenland/Denmark (Thrane and Steenfelt 2018) that have recently published an evaluation of the potential for uranium deposits. In Sweden, large resources of uranium are identified as by-products of molybdenum and vanadium hosted in the Lower Paleozoic Alum Shale of Scandinavia.

While uranium exploration and mining are banned since 2018 in Sweden and 2021 in Greenland, strategies to face global warming and greenhouse gas emission may lead to the launching of a new generation of nuclear plants, implying a new assessment of uranium resources. A parallel can be done with the rare earth supply chain in Europe, transition to CO<sub>2</sub> free energy requiring a significant amount of critical metals that implied new exploration projects and new discoveries.

## References

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- Wyborn, L.A.I., Heinrich, C.A., Jaques, A.L., 1994: Australian Proterozoic mineral systems: Essential ingredients and mappable criteria. *Proceedings of the Australasian Institute of Mining and Metallurgy Annual Conference, Darwin*, 109-115.

SGA-sponsored keynote speaker invited for a specific session: Session 8, Economic geology, Metallogeny of the Nordic countries and beyond