Model Number A-25: Pegmatite-hosted Uranium-(Thorium–Molybdenum–Rare Earth Element)

Concise Description: Granite pegmatite dykes and sills, formed from anatexis in high metamorphic grade environments, which contain uranium ± thorium, molybdenum, and rare earth elements. Thomas (1983) is the principal reference for this model.

Geological Environment

Host Rock Types: Granite pegmatite dykes and sills. White to pink to red granite pegmatite dykes which consist of microcline, plagioclase, and quartz, with up to 25% biotite. Minor hornblende and/or diopside are common. Accessory minerals may include muscovite, sericite, saussurite, apatite, monazite, zircon, sphene, tourmaline, magnetite, pyrite, pyrrhotite, molybdenite, chalcopyrite, uraninite, and secondary uranium minerals such as gummite and uranophane. Thomas (1983) found that 80% of the recorded uraniferous granite pegmatites of the Hearne Province are associated with Paleoproterozoic metasedimentary rocks, principally pelites, with relatively minor meta-arkose and calc-silicates. The remaining 20% are associated with Archean granitic gneisses. Migmatitic fabrics in the associated rock types are common.

Rock Textures: Pegmatite dykes, sills, and *lit-par-lit* injections. The principal minerals consist of anhedral to euhedral crystals, with an average grain size that ranges from 1 to 30 mm, but occasionally much coarser. Accessory minerals are typically fine-grained (<1 mm) and occur as the groundmass between the coarser crystals or as microcrystalline inclusions within the major phases. Textural and compositional zoning is variable and appears to be partially related to the associated rocks. Pegmatite contacts range from sharp to gradational with the surrounding rock.

Ages of the Host Rocks and Mineralization: The pegmatites and associated mineralization in the Hearne Province are thought to have formed from anatectic melts of Archean granitic gneisses and Paleoproterozic sedimentary rocks, related to upper amphibolite facies metamorphism associated with orogenic activity (Thomas, 1983). The principal locations in Saskatchewan are in the Wollaston and Mudjatik domains and are thought to be related to peak 1.82 to 1.80 Ga metamorphism associated with the Trans-Hudson Orogen.

Depositional Environment: Granite pegmatites formed from anatectic melts and local remobilization in the presence of available water, in response to upper amphibolite to granulite facies metamorphism, related to orogenic activity. The source rocks for the pegmatites and metals are the enclosing rocks that mainly consist of Paleoproterozoic metasedimentary rocks and subordinate Archean granitic gneisses. Pelites were the dominant sedimentary source rock with minor arkoses and calc-silicates. The source of the uranium and other metals is believed to be primary content in the source rocks. Anatexis acted to concentrate these elements in the residual pegmatites. The pelites have the highest metal values which may explain why the majority of the uraniferous pegmatites have that association. The pegmatites primarily occur in the lower portions of the supracrustal sequence, typically close to the unconformable contact with the underlying basement granitic gneisses.

Tectonic Setting: Original Paleoproterozoic sedimentary basin development on Archean granitic basement. Compressional deformation, burial and high-grade metamorphism associated with the Trans-Hudson Orogen. Later erosion exposed the deep structural-metamorphic levels.

Associated Deposit Types: In the Wollaston Domain, some of the sedimentary-hosted Cu ± polymetallic deposit type locations have significant uranium contents (*e.g.*, Duddridge Lake). There are also interpreted sedimentary-hosted U locations in both the Wollaston and Mudjatik domains.

Deposit Description

Mineralogy: Uraninite (UO_2) is the principal economic mineral, with a variety of yellow to green secondary minerals that include gummite minerals and uranophane. Accessory minerals may include apatite, monazite, zircon, sphene, magnetite, pyrite, pyrrhotite, molybdenite, chalcopyrite, and allanite.

Textures and Styles of Mineralization: Pegmatite dykes, sills, and *lit-par-lit* injections that may be stratabound within the enclosing rocks. Typically occur as irregular, lens-like bodies that can form intricate injections into enclosing rocks. Pinch and swell of the dykes is common. May be concordant with or crosscut the structural fabric. Dyke swarms may consist of dykes in parallel, *en echelon*, or as coalescing crosscutting dykes. Individual dykes may range from a few centimetres to several metres in width, with lengths that can range in excess of 100 m. The uraninite occurs as fine-grained (<1 mm), anhedral to subhedral grains that exist as individual grains or trains of grains along cleavage traces, grain boundaries, fractures, and as microcrystalline inclusions in major rock forming minerals. The uraninite is commonly found within or in contact with biotite. Accessory minerals generally occur as fine-grained (<1 mm) groundmass or as microcrystalline inclusions.

Alteration: Development of secondary, yellow-green uranium minerals such as gummite and uranophane.

Geological Ore Controls: 1) Paleoproterozoic erosion of Archean crust and development of a sedimentary basin; 2) *ca*. 1.8 Ga Trans-Hudson Orogen with associated deformation, burial, and high-grade metamorphism; 3) formation of uraniferous pegmatites by anatectic melting of associated basement granitic gneisses and Paleoproterozoic metasedimentary rocks; 4) lower portions of the metasedimentary succession are favourable; 5) pelitic rocks are especially favourable; and 6) later erosion to expose the deep structural-metamorphic levels of the pegmatites.

Geochemical Signature: 1) uraniferous granite pegmatites in the Hearne Province have mean U contents of 691 ppm (Thomas, 1983); 2) pegmatites are characterized by high U:Th ratios (Thomas, 1983); and 3) the principal associated elements include Th, Mo, and occasionally REE.

Geophysical Signature: 1) airborne, ground, and borehole radiometric surveying; 2) as graphite is commonly associated with the favourable, associated, basal pelitic sequences, airborne and ground electromagnetic surveys should prove useful; and 3) airborne and ground magnetic surveys as an aid to geological mapping.

Examples (with grades and tonnages)

Locations are found in most domains with high metamorphic grade supracrustal assemblages. However, the Wollaston and Mudjatik domains of the Hearne Province contain the largest number and most significant locations. Examples in the various domains include: Glennie (SMDI 0805 and 0720), Kisseynew (SMDI 0500), Peter Lake (SMDI 1892), Wollaston (Pipewrench North, SMDI 0941, 1145, and 2027), Mudjatik (Charlebois Lake, Mozzie Lake), Train Lake (SMDI 1599 to 1602), Tantato (SMDI 1588 and 1593), Beaverlodge (SMDI 1559), Zemlak (SMDI 2125), and Virgin River (SMDI 2061).

Some of the locations have historical reserve figures. These include Pipewrench North: 54 500 tons grading 0.087% U_3O_8 (1970 reserve figure from SMDI 0940a); Charlebois Lake: 2 000 000 tons grading 0.05% U_3O_8 (1975 reserve figure from SMDI 1666); and Mozzie Lake: 204 000 tons grading 0.119% U_3O_8 (1968 reserve figure from SMDI 1670). In 1954, 65 tons were produced from the La Ronge Uranium mine but the grade was uneconomic (SMDI 0805).

Selected Bibliography

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