

**VERSATILE MONAZITE: RESOLVING GEOLOGICAL RECORDS AND SOLVING CHALLENGES IN MATERIALS SCIENCE**

**Petrogenesis of the Kulyk Lake monazite-apatite-Fe(Ti)-oxide occurrence revealed using in-situ LA-(MC)-ICP-MS trace element mapping, U-Pb dating, and Sm-Nd isotope systematics on monazite†**

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**ABSTRACT**

The high-grade metamorphic metasedimentary rocks that comprise the Wollaston Domain, northern Saskatchewan, are host to numerous REE-mineralized pegmatite bodies, including the Kulyk Lake monazite-apatite-Fe(Ti)-oxide occurrence. This occurrence, which is defined by a 3–5 cm wide sinuous zone of granoblastic monazite, apatite, and titanomagnetite, is enclosed within aplitic monzonite and granitic pegmatite dikes. Monazite in this dike was studied in detail using in situ laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) and LA-multi-collector (MC)-ICP-MS. A combination of in situ LA-ICP-MS trace element mapping, trace-element quantification, and U-Pb dating were used to identify a significant volume of partial resorbed xenocrystic monazite and zircon cores within the monazite-apatite-Fe(Ti)-oxide zone. This xenocrystic monazite is locally characterized by anomalously high As, V, Mo, and Eu concentrations and high  $(La/Yb)_{CN}$  (i.e.,  $>1000$ ) consistent with their derivation from metalliferous black shales. The U-Pb age distribution of the inherited monazite and zircon populations matches that of the middle- to upper-Wollaston Group sedimentary succession. The latter was confirmed by in situ Sm-Nd isotope systematics measured by LA-MC-ICP-MS that yielded  $\epsilon Nd_{(1830Ma)}$  between  $-5.0$  and  $-5.7$  consistent with derivation from Wollaston Group metasediment. The crystallization of  $\sim 1830$  Ma anatectic overgrowths on xenocrystic cores is indistinguishable from monazite crystallization in the aplitic monzonite dike hosting the monazite-apatite-Fe(Ti)-oxide bodies. This study reveals the potential importance of metalliferous monazite-rich lithologies in the anatectic zone to these pegmatite-hosted REE occurrences and suggests that entrainment and magmatic segregation mechanisms may have helped to concentrate monazite, apatite, and Fe(Ti)-oxide prior to final emplacement of the aplite-pegmatite dikes. Similar processes may have occurred regionally and in other high-grade metamorphic terrains worldwide that are endowed with metalliferous metasedimentary protoliths.

**Keywords:** Monazite, LA-ICP-MS, monazite-apatite-Fe(Ti)-oxide, Trans-Hudson, detrital monazite, in situ geochronology