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## GRENVILLE SKARN TITANITE: POTENTIAL REFERENCE MATERIAL FOR SIMS U–Th–Pb ANALYSIS

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### ABSTRACT

We have investigated the homogeneity, chemical composition, structure, degree of radiation damage, and post-formation evolution of titanite crystals from skarns of the Grenville Province of the Canadian Shield using SHRIMP, TIMS, Raman and PL spectroscopy, EBSD, and EPMA–WDS. These results are used to assess the potential of the titanite as Reference Material (RM) for micro-analytical U–Th–Pb age dating. The SHRIMP data show that these megacrysts (5–31 g) have concordant U–Pb isotope systematics, 60 to 500 ppm U, 120 to 1200 ppm Th, <sup>206</sup>Pb/<sup>204</sup>Pb between 500 and 2500, ages of ~1 Ga, and excellent homogeneity at the scale of the analytical volume of the ion probe. The ID–TIMS titanite data for OLT1, OLT2 and TCB show that these crystals are essentially concordant. Data for OLT1 and OLT2 show slight scatter (*i.e.*, in excess of that expected from the uncertainty in an individual analysis). For OLT1, one of seven analyses shows Pb loss or, possibly, a younger period of growth. Crystals OLT1 and OLT2 have respective TIMS concordia ages of 1014.8 ± 2.0 Ma (2σ, *n* = 6, MSWD = 1.8) and 998.0 ± 4.5 Ma (2σ, *n* = 3, MSWD = 3.3) for domains that have not lost Pb. The TIMS analyses of TCB are tightly clustered and give a concordia age of 1018.1 ± 1.7 Ma (2σ, *n* = 4, MSWD = 0.92). Raman and PL spectra show a low to moderate degree of accumulated radiation-induced damage in the Grenville Skarn Titanite crystals and uniform internal distributions of this damage. The EDSB contrast images indicate little or no crystallographic misorientation. The EMPA–WDS data show that the outer 50–100 μm of the OLT1 and TCB crystals are enriched in Al and F, and depleted in Fe and Nb, when compared with the interior. In spite of the variation in composition and degree of radiation damage amongst samples, there are no identifiable matrix effects in our SHRIMP data. Some Grenville skarn titanite (GST) crystals have potential as RM for micro-analytical U–Th–Pb age dating. Crystal TCB has excellent homogeneity of U–Th–Pb isotopic composition. Crystals OLT1 and OLT2 have minor TIMS age heterogeneity. However, this heterogeneity is smaller than that of the Khan titanite, our current in-house titanite standard. Careful selection of analysis areas during SIMS, and of chips for TIMS analysis, allows high-quality isotopic data to be obtained from these large crystals of titanite.

**Keywords:** titanite, reference material, Grenville Province, skarn, SHRIMP, TIMS, Raman, EBSD, geochronology.

### SOMMAIRE

Nous avons caractérisé l'homogénéité, la composition chimique, la structure, le degré de dommage dû à la radiation, et l'évolution post-formation de mégacristsaux de titanite prélevés de skarns dans la Province de Grenville du Bouclier Canadien au moyen d'analyses SHRIMP, TIMS, spectroscopie Raman et Photoluminescence (PL), EBSD, et EPMA–WDS. Ces résultats

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