Preliminary Results of the 2002-2003 Saskatchewan Industry and Resources Geochronology Program

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Abstract

Conventional ID-TIMS U-Pb analyses have provided preliminary results for four samples collected from northern Saskatchewan. A probable volcaniclastic rock from the base of the Murmac Bay Group in the Beaverlodge Domain has yielded a 2327 ±14 Ma date, indicating that part or all of the succession may be much younger than the Archean age previously inferred. An 1898 ±3 Ma date obtained from an upper amphibolite facies gabbro suggests that the high-grade metamorphic event overprinting the adjoining Zemlak Domain to the west is synchronous with previously determined 1.91 to 1.90 Ga thermotectonism in the Beaverlodge Domain. A 1751 ±2 Ma date from a pink fluorite-bearing porphyritic granite in the northern Mudjatik Domain implies southward extension of the Nueltin Granite suite into northern Saskatchewan. A megacrystic monzonite from the southern Peter Lake Domain has yielded a 2540 ±1 Ma date, providing a minimum age for the Warner Lake gabbroic suite, migmatitic supracrustal rocks, and the regional upper amphibolite facies metamorphic overprint.

Keywords: geochronology, U-Pb, Murmac Bay Group, Beaverlodge Domain, Zemlak Domain, fluorite-bearing granite, northern Mudjatik Domain, Nueltin Granite, Warner Lake gabbroic suite, Peter Lake Domain, age of metamorphism.

1. Introduction

Geochronological analysis using conventional Isotope Dilution–Thermal Ionization Mass Spectrometry (ID-TIMS) U-Pb techniques was initiated on 10 bedrock samples during 2003 at the University of Alberta. Six of these will require more work before meaningful results can be reported. The remaining four include: 1) a probable volcaniclastic rock from the base of the Murmac Bay Group in the Beaverlodge Domain, 2) a gabbro sampled for the age of metamorphism in the Zemlak Domain (Uranium City Project), 3) a fluorite-bearing, porphyritic granite from the northern Mudjatik Domain (Phelps Lake Project), and 4) a megacrystic monzonite from the Peter Lake Domain (Peter Lake Domain Project).

2. Quartz-phyric Volcaniclastic(?) Rock (4701-765) from the Base of the Murmac Bay Group, Beaverlodge Domain, Rae Province

A 'basal polymictic conglomerate' originally identified at the unconformity between the Elliot Bay Granite and the basal quartzite of the Murmac Bay Group (Macdonald, 1984) was re-discovered in 2001 (Ashton *et al.*, 2001). Subsequent petrographic study showed that a majority of the clasts were derived from volcanic and/or hypabyssal quartz porphyries and that the matrix is either a crystal tuff or an epiclastic rock derived by reworking of the felsic centre from which the clasts were derived (Niebergall, 2003; Ashton and Hunter, this volume). The remaining clasts include minor quartzite and few, if any, obvious basement clasts. Since this finding inferred a previously unrecognized period of felsic volcanism at the base of the Murmac Bay Group, a sample of the volcaniclastic rock was collected (UTM 629322E, 6585407N, NAD27) for geochronological study.

A 10 kg sample of quartz-phyric volcaniclastic(?) rock contained abundant colourless, euhedral, zircon prisms (2:1 length to width ratio) and abundant prism fragments, both of which display numerous fractures. All five analyzed single zircon crystals had moderate to low uranium contents (133 to 269 ppm) and similar high Th/U ratios (0.51 to 0.74). Four of the grains have similar $^{207}Pb/^{206}Pb$ dates (2319 to 2329 Ma), and define a discordia line with an upper intercept date of 2327 ±14 Ma (MSWD=2.6). The fifth analyzed zircon grain is morphologically similar to the others but is somewhat older with a $^{207}Pb/^{206}Pb$ date of 2488 Ma. The 2327 ±14 Ma upper intercept date is considered a best estimate for the age of the clasts in this unit.

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Because this finding is inconsistent with the Archean age previously inferred for the Murmac Bay Group (e.g. Hartlaub *et al.*, 2002; Ashton *et al.*, 2002), another visit was made to the outcrop in 2003 and more samples were collected to test its validity. One additional relationship that was confirmed is that the volcaniclastic(?) rock is interbedded with the basal quartzite over several metres (Ashton and Hunter, this volume). Thus, its age should also represent the age of the basal Murmac Bay Group.

Petrographic work has shown that similar quartz porphyries outcrop along the newly inferred Murmac Bay Group basal unconformity extending through Peebles Lake and Nunim Channel on the eastern Crackingstone Peninsula (Ashton *et al.*, 2000; Ashton and Hunter, this volume). In addition, quartz porphyry dykes intrude the Cornwall Bay Granite near the northwestern corner of Cornwall Bay, and very similar rocks are known to form a phase of the 2311 ±34 Ma (R. Hartlaub, pers. comm., 2003) Gunnar Granite at the southwestern corner of the Crackingstone Peninsula (Ashton *et al.*, 2000).

3. Gabbro (4700-0320) from the Eastern Zemlak Domain, Rae Province

A ca. 1910 to 1900 Ma age has been established for the dominant high-grade metamorphic event east of the Black Bay Fault in the Beaverlodge Domain, based on a titanite date from a basalt in the Elliot Bay (Lake Athabasca) area and two zircon dates from intermediate to mafic rocks in the Reed Bay area (R. Hartlaub, pers. comm., 2002). However, the grade of metamorphism west of the Black Bay Fault is generally higher than that of the western Beaverlodge Domain and, given the long and complex history of the Rae Craton, it was considered important to determine whether both areas were recording a single but varied metamorphic event or two different ones. A metamorphosed hornblende-plagioclase mafic dyke several metres thick from about 2 km west of Bushell Inlet along the northern shore of Lake Athabasca (UTM 624400E, 6598400N, NAD27) was sampled in order to directly assess the age of metamorphism. The dyke is situated within the Black Bay structural straight belt and has been subjected to northeast-trending F3 folding along with a brittle-ductile deformational overprint (Ashton *et al.*, 2001). It is geochemically similar to a suite of diabase dykes that intrude the 2311 ±34 Ma (R. Hartlaub, pers. comm., 2003) Gunnar Granite east of the Black Bay Fault at the southern end of the Crackingstone Peninsula.

The least magnetic heavy mineral fraction in this sample consists primarily of apatite, lesser zircon and trace pyrite. The more magnetic fractions are dominated by pyrite. Two populations of zircon were identified: 1) large (>100 microns) colourless to tan, subhedral prisms with 3:1 aspect ratios, some of which are fragmented and 2) tiny (30 to 40 microns) colourless, spherical to elliptical grains, similar to those generally attributed to a metamorphic origin. All four of the single zircons analyzed have moderate to low uranium contents (175 to 392 ppm) and similar Th/U ratios (0.23 to 0.47). Three have nearly identical $^{207}Pb/^{206}Pb$ dates (1886 to 1896 Ma) and define a discordia line with an upper intercept age of 1898 ±3 Ma (MSWD=0.28). Based on the zircon morphology and low Th/U ratios (i.e., primary mafic magmatic zircon typically has a Th/U ratio >1), this age is considered a preliminary best estimate for the age of metamorphism. Since this result is nearly identical to the 1910 to 1900 Ma dates obtained east of the Black Bay Fault, it is assumed that the metamorphic assemblages in both areas are recording a single thermotectonic event, which is tentatively attributed to the Thelon-Taltson Orogeny.

4. Fluorite-bearing Porphyritic Granite (0233-053) from the Northern Mudjatik Domain, Hearne Province

The fluoritic granite sample (UTM 667431E, 6606059N, NAD83) is from one of several small stocks that intrude migmatites of the northern Mudjatik Domain at Spratt Lake in northeast Saskatchewan (Munday, 1973; Harper *et al.*, 2002; MacDougall, 2002). The rocks are massive, pink to red on fresh and weathered surfaces, coarse grained, and have two well-developed vertical joint systems. They contain 10 to 15% biotite, up to 25% K-feldspar phenocrysts that are up to 2 cm long by 1 cm thick, and trace amounts of interstitial fluorite. The granite was believed to belong to the Nueltin suite of late Trans-Hudson intrusions (Harper *et al.*, 2002; MacDougall, 2002), dated elsewhere in the Northwest Territories and Nunavut at 1.765 to 1.75 Ga (Peterson *et al.*, 2000). Unlike many of the Nueltin suite granites, the Spratt Lake intrusions do not display rapakivi texture.

The least-magnetic mineral fraction recovered from the fluorite-bearing porphyritic granite contains predominantly fluorite, apatite and graphite, with minor zircon. The more magnetic fractions contain significantly more zircon. The zircon appears to represent a single population of tan, subhedral to euhedral prisms and derived fragments. Although a high proportion consists of good quality crystals, many zircon grains have mineral inclusions and fractures. The three crystals selected to represent the range of grain types present include a colourless equant fragment, a broken long subhedral prism, and a tan euhedral prism. They have moderate to low uranium contents (128 to 470 ppm), quite variable and generally high Th/U ratios (0.69 to 1.27), and similar $^{207}Pb/^{206}Pb$ dates of between 1689 Ma for the most discordant analysis (20.7% discordant) to 1753 Ma for the most concordant (0.4% negatively discordant). All three analyses are collinear and define a discordia line with an upper intercept of 1751±2 Ma (MSWD=0.09), which is interpreted to be a good estimate for the emplacement age of the granite. This

age indicates that the Spratt Lake fluoritic porphyritic granites are part of the Nueltin suite of post-orogenic intrusions and extends their known distribution into northeastern Saskatchewan.

5. Megacrystic Monzonite (RM0201-182) from the Peter Lake Domain, Hearne Province

A widespread monzonitic suite, which is dominated by monzonite with gradational variation into quartz monzonite, monzodiorite, and syenite, is exposed in the southern half of the Peter Lake Domain (Maxeiner and Hunter, 2002). The pink to grey, coarse-grained and commonly megacrystic rocks, may be massive, weakly foliated, or locally mylonitic. Their mafic mineral content varies between 10 and 20%, and is dominated by biotite with minor amounts of epidote, hornblende, and titanite. Megacrystic components are characterized by up to 3 cm long pink K-feldspar phenocrysts, composing up to 30% of the rock and generally defining a tectonic foliation. The megacrystic varieties compositionally and texturally resemble rocks of the ca. 1.86 Ga Wathaman Batholith, but were interpreted as Archean (Maxeiner and Hunter, 2002). The monzonitic suite intrudes the Warner Lake gabbroic suite of the ca. 2.56 Ga Swan River Complex (Corrigan *et al.*, 2001) as well as upper amphibolite facies migmatitic supracrustal rocks. It appears to have escaped the main regional high-grade metamorphic overprint, but has been affected by a weaker 1.8 Ga thermotectonic overprint attributed to the Trans-Hudson Orogeny. The suite is post-dated by pink to brick-red syenogranite to alkali feldspar granite, as well as minor mafic dykes. A sample of the monzonite was collected from an outcrop located at kilometre 114 of Highway 905 (UTM 568233E, 6331842N, NAD83) in order to better constrain the ages of the Warner Lake gabbroic suite, the migmatitic supracrustal rocks, and the upper amphibolite facies metamorphic event.

Abundant tan to pink zircon was recovered in the least-magnetic fraction of this sample. The majority of crystals are equant to prismatic and many have turbid regions (alteration?) and fractures. There is a large range of grain size. Core/overgrowth relationships were not observed. Two small multi-grain fractions and one single-zircon fraction have moderate to low uranium contents (160 to 260 ppm) and similar Th/U ratios (0.38 to 0.44), typical of zircon that crystallizes directly from felsic magma. The $^{207}Pb/^{206}Pb$ dates are similar (2539 to 2544 Ma) and all three analyses are nearly concordant (i.e., less than 0.7% discordant). One fraction has a slightly older $^{207}Pb/^{206}Pb$ date and was not used in the age calculation. A best-fit reference line constructed to pass through the other two zircon analyses yields an upper intercept date of 2540 ±1 Ma, which is interpreted as the best estimate for the emplacement age of the monzonite. This age confirms the presence of a widespread Archean monzonitic suite within the Peter Lake Domain and provides a minimum age for the Warner Lake gabbroic suite, migmatitic supracrustal rocks, and for the upper amphibolite facies metamorphic event.

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