Geofile 2014-3

Southern Nicola Arc Project 2013: Geochronological data

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Geofile 2014-3 synopsis

Geofile 2014-3 contains the results, methodology and quality control data from geochronological analyses of samples collected during fieldwork conducted as part of the Southern Nicola Arc Project (SNAP, Mihalynuk et al., 2014; Mihalynuk and Logan 2013a), which is a component of the BC Porphyry Deposit Initiative (Hickin et al., 2014). In 2014, SNAP focused on systematic quadrangle mapping of ~1000km^2 centered on Allison Creek, in the Princeton area. The area is north of the Copper Mountain mine site and includes developed porphyry Cu±Au-Ag prospects with published resources: Miner Mountain (see Mihalynuk and Logan, 2013a), Axe (see Preto, 1979), and Primer (Dillard Lake, see Mihalynuk and Logan, 2013b). For a province-wide overview of the prolific Late Triassic – Early Jurassic porphyry copper-gold deposit epoch, see Logan and Mihalynuk (2014). The geological context of the samples dated is provided in Mihalynuk et al. (2014) and sample descriptions and implications of the age dating are paraphrased from that report below.

Geochron samples:

U-Pb Thermal Ionization Mass Spectroscopy

Sample # MMI12-3-15

UTM coordinates: 682955mE 5483506m N (NAD 83, UTM zone 10).

Sample MMI12-3-15 was collected from a rusty diorite dyke in the Southwest zone at Miner Mountain. Descriptions of the dyke, its major and trace element geochemistry, and mineralization are presented in Mihalynuk and Logan (2013a). Five zircons were analyzed: three whole crystals which were anhedral, oblate, pitted, and up to ~200 μm long; two were crystal fragments about ~100 μm and ~70 μm in longest dimension (Sheet 5 in *Geofile2014-3 SNAP2013GeochronFriedmanU-PbTIMS.xls*). All but the smallest grain provided adequate material for analysis, resulting in the four data points on Sheet 2. Two grains fall slightly below concordia, and two grains that overlap concordia providing a best interpreted age calculated as 155.8 ±0.14Ma.

Mineralization at Miner Mountain has long been considered a product of the Late Triassic Nicola Arc magmatism, but based upon the ages above, now extending into the Early Jurassic (~188 Ma). Nevertheless, a ~156 Ma magmatic age for mineralization is much younger than any known or suspected Nicola Group and we consider 3 explanations for this mineralization:

1. The sulphide mineralization is remobilized from a deeper, probable Late Triassic source.
2. The age is in error; another U-Pb age determination from a sample of drill core that intersected the mineralized intrusion is currently in progress to test this option.
3. There exists a ~156 magmatic suite with previously unappreciated copper endowment.

Intrusions emplaced around 156 Ma occur in great volumes across southern British Columbia. The adjacent Osprey Lake batholith occupies much of the eastern third of the area mapped by Mihalynuk et al. (2014) and has returned K-Ar cooling ages from biotite of 149 ±2 Ma, and from hornblende of 154 ±3Ma (Hunt and Roddick, 1988), but a U-Pb crystallization age of 166 ±1Ma (Parrish and Monger, 1992).

U-Pb Laser Ablation-Inductively-Coupled Plasma Mass Spectroscopy

Sample # MMI13-10-8

UTM coordinates: 676762m E 5499696m N (NAD 83, UTM zone 10).

Sample MMI13-10-8 was collected from a tuffaceous polymictic conglomerate section that sits on, and interfingers with, flow-banded rhyolite. Clasts include limestone, granitoid intrusives, altered mafic volcanic and clasts of the immediately underlying units (Spences Bridge Group). Twenty-seven grains were selected from the zircon separate for analysis, and all but two of these were inspected for evidence of growth zoning and xenocrystic cores before analysis by laser ablation (see images of 11 representative zircon grains on Sheet 5 of *Geofile2014-3 SNAP2013GeochronFriedmanU-PbLA.xls*). All LA-ICPMS analyses fall into two age clusters comprised of 2σ error envelopes from most grains that overlap concordia (Sheet 3) and these have age distribution peaks at ~103 and ~220 Ma (Sheet 4). Subsidiary peaks in the older cluster are at ~190 and ~205 Ma.

All age distribution peaks can be easily linked to probable protoliths. A lack of grains younger than 103Ma and a dense cluster at 103 Ma, which is the age of the Spences Bridge Group (Diakow and Barrios, 2009), confirms geological observations which point to synvolcanic (tuffaceous) sedimentation interfingered with rhyolite mapped as Spences Bridge Group. All older grains can reasonably be expected to be derived from the underlying Allison Lake pluton or nearby Nicola Group volcanic arc rocks. From a similar polymictic conglomerate near Dry Lake, Preto (1979) extracted a block lithologically identical to the Allison Lake pluton, and from it obtained a K/Ar (muscovite) age of 207 ±10 Ma (originally 203 ±5Ma, recalculated with new decay constants and error estimates by Breitsprecher and Mortensen, 2004), confirming derivation from the plutonic roots of the underlying arc. Importantly, the ~190Ma sub-peak supports our interpretation of 188 Ma cooling age of sample MMI12-5-8 (see Hornblende and biotite $^{40}Ar/^{39}Ar$, below) as a crystallization age, and indicates its exposure and erosion during Spences Bridge deposition.

40Ar/39Ar by laser step heating

Sample # MMI12-5-8 hornblende

UTM coordinates: 683045m E 5514796m N (NAD 83, UTM zone 10).

Sample MMI12-5-8 was collected from a mineralized hornblende diorite at the Primer South prospect (see Mihalynuk and Logan, 2013b, for a description). A plateau is formed by six steps that include 98.7% of the ^{39}Ar released (Sheet 3 in *Geofile2014-3 SNAP2013GeochronGabites5-8Ar.xls)*. There is no obvious sign of thermal disturbance and the sample analyzed is relatively fresh and unlikely to have been completely reset. Thus, the plateau age, 188.2 ±2.5 Ma is interpreted as recording the post magmatic crystallization age.

This intrusion has been assumed correlative with the Late Triassic Copper Mountain suite (~205-200Ma) by Mihalynuk and Logan (2013b) and previous workers, but if interpreted correctly, the new age requires emplacement in the Early Jurassic. Intrusions of this age are known in the Nicola arc to the north where young mafic-dominated phases of the Takomkane batholith are dated at 187.7 ±1.1 Ma ($^{40}Ar/^{39}Ar$ hornblende, Schiarizza et al., 2009), and from southern BC, the Bromley Batholith has returned a K/Ar hornblende cooling age of 186 ±3Ma (Hunt and Roddick, 1988), and the Skwel Peken Formation age is reported as ~187 ±9Ma on the basis of 3 discordant zircon fractions (Ray and Dawson, 1994).

Sample # MMI12-7-4 biotite

UTM coordinates: 682952m E 5508591m N (NAD 83, UTM zone 10).

Sample MMI12-7-4 was collected near the northern boundary of the 2013 study area, from an oxyhornblende and biotite-phyric rhyolite breccia interpreted as part of a series of coalescing flow domes (Mihalynuk and Logan, 2013b). A release spectrum with a strong plateau comprising 78.6% of the ^{39}Ar yields a calculated age of 50.2 ±0.6Ma (Sheet 3 in *Geofile2014-3 SNAP2013GeochronGabites7-4Ar.xls).*

Mihalynuk and Logan (2013b) included these rocks with the Early Cretaceous Spences Bridge Group, the closest previously mapped felsic volcanic rocks (Monger, 1989). However, they also noted lithological similarity with volcanic units in the Princeton Group as described by (Church, 1973), and collected a sample for geochronological age determination in order to resolve the ambiguity. The Early Eocene, 50 Ma age is typical of the late stage of Eocene magmatism that swept across southern British Columbia (Bordet et al., 2014), and about the midpoint in the Princeton Group magmatic epoch which lasted from 53 – 47 Ma, according to isotopic age compilation of Ickert et al. (2009).

Sample # MMI12-8-6 hornblende

UTM coordinates: 682272m E 5516277m N (NAD 83, UTM zone 10).

Sample MMI12-8-6 was collected from a hornblende-pyroxene porphyritic volcanic breccia that interrupts sedimentation of a thick epiclastic succession (Mihalynuk and Logan, 2013b) above the main, augite porphyry breccias and flows that are the defining feature of the Late Triassic Nicola arc. Fresh euhedral hornblende from this unit yields a stable plateau with 94.3% of ^{39}Ar released in 9 of 11 steps from which an age of 182.1 ± 2.3 Ma is calculated (first and last steps omitted from age calculation, Sheet 3 in *Geofile2014-3 SNAP2013GeochronGabites8-6Ar.xls*).

Lack of any fabric or alteration of the hornblende (see Fig. 6 of Mihalynuk and Logan, 2013b) is incompatible with complete resetting of this sample and the age is interpreted as recording crystallization at the time of eruption. In addition, intercalation of this unit with epiclastic strata which contain clasts lithologically identical to sample MMI12-5-8 is consistent with an age younger than ~188 Ma. Early Jurassic magmatic ages such as these are important as they show that Nicola arc volcanism extended into the Jurassic, and is not limited to the Late Triassic as has been widely assumed.

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