# U-Pb age and geochemical studies of Mississippian and Cretaceous plutonic rocks in south-central McQuesten map area, Yukon

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## ABSTRACT

The Reid Lakes batholith (RLB) in southwestern McQuesten map area (115P) has previously been tentatively assigned a mid-Cretaceous age, although two K-Ar ages from the northwestern part of the batholith indicated that at least part of the body must be late Paleozoic or older. U-Pb dating of two lithologically distinct samples from the southeastern part of the RLB yields Early Mississippian crystallization ages (341.5 ± 0.7 Ma and 355.7 ± 0.9 Ma). A sample of the Moose Creek pluton, which is on the northeast side of the Tintina fault zone, but was previously interpreted to be part of the RLB, yielded a U-Pb age of 92.0 ± 0.3 Ma. The Moose Creek pluton is therefore correlated with the mainly 95-93 Ma South Lansing plutonic suite which intrudes rock units of Ancestral North America, whereas the RLB is a multi-phase, Early Mississippian intrusion into metamorphic rocks of the Yukon-Tanana terrane.

## RÉSUMÉ

Antérieurement, un âge du Crétacé moyen avait été provisoirement attribué au Batholite de Reid Lakes (BRL), dans le sud-ouest de la région de la carte McQuesten (115P), bien que deux âges obtenus par datation K-Ar dans la partie nord-ouest du batholite indiquaient qu'au moins une partie du corps plutonique devait être du Paléozoïque tardif ou plus ancien. La datation U-Pb de deux échantillons différents sur le plan lithologique, prélevés dans la partie sud-est du BRL, livre des âges de cristallisation du Mississippien précoce (341,5 ± 0,7 Ma et 355,7 ± 0,9 Ma). Nous avons obtenu un âge U-Pb de 92,0 ± 0,3 Ma pour un échantillon du Pluton de Moose Creek qui se situe du côté nord-est de la zone de failles de Tintina, mais que des interprétations antérieures avaient associé au BRL. Par conséquent, nous pouvons établir une corrélation entre le Pluton de Moose Creek et la suite plutonique de South Lansing qui date essentiellement de 95 à 93 Ma et pénètre dans les unités lithostratigraphiques du protocontinent nord-américain, tandis que le BRL est une intrusion multiphasée du Mississippien précoce dans les roches métamorphiques du terrane de Yukon-Tanana.

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## INTRODUCTION

Plutonic rocks underlie a substantial portion of the southern McQuesten map area (115P) in west-central Yukon. On most previous geological maps (e.g., Bostock, 1942; Wheeler and McFeeley, 1991; Gordey and Makepeace, 2003), one large body in the south-central part of the map area (here termed the Reid Lakes batholith) has been shown to straddle the Tintina fault zone (TFZ), which transects the McQuesten map area (Fig. 1). This body has previously been interpreted to be of mid-Cretaceous age, and if it does cross the TFZ, it would provide an important constraint on the timing of displacement along the fault. Two samples collected along the Stewart River near the northwestern edge of the Reid Lakes batholith (Fig. 1) previously yielded K-Ar biotite ages of 253.4 ± 5.8 Ma and 201.9 ± 3.7 Ma (Mortensen, in Hunt and Roddick, 1992), indicating that at least part of the batholith must be older than Cretaceous. In addition, intrusive rock units on the northeastern side of the TFZ (here termed the Moose Creek pluton) are compositionally distinct from those on the southwestern

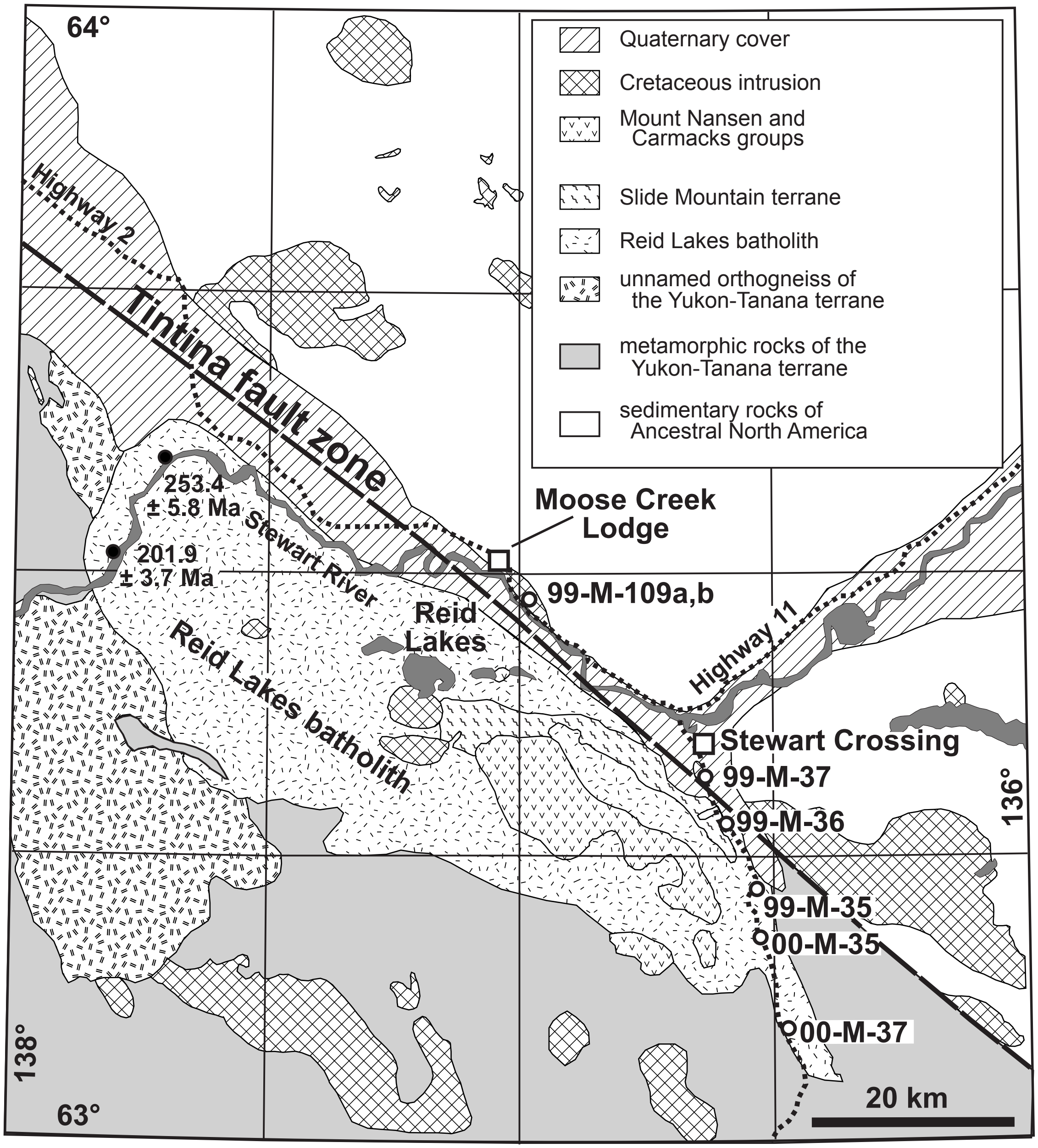


*Figure 1.* Simplified geology map of the McQuesten map area (modified from Colpron, 2006), illustrating the locations of K-Ar ages for the Reid Lakes batholith (filled circles) and locations for geochemical and dating samples (open circles).

side of the fault zone. In the most recent geological compilation map of central and southern Yukon (Colpron, 2006), the batholith is shown to consist of two parts, one part on the northeast side of the TFZ is believed to be Cretaceous, whereas the larger part southwest of the TFZ is inferred to be Paleozoic. In order to better constrain the age and tectonic significance of intrusive rocks in this area, samples of the Moose Creek pluton (northeastern side of the TFZ) and the southeastern portion of the Reid Lakes batholith (southwestern side of the TFZ) were collected from roadcuts along the Klondike Highway. U-Pb zircon dating and lithogeochemical studies have been carried out to determine the crystalline ages and geochemical character of these rock units.

## GEOLOGICAL SETTING AND LITHOLOGY OF INTRUSIVE UNITS

The Reid Lakes batholith underlies a large, poorly exposed area in the southwestern portion of the McQuesten map sheet (115P; Fig. 1). It is intruded by several undated bodies of granite interpreted to be of Cretaceous age, and is overlain by sequences of volcanic and sedimentary rocks that have been tentatively assigned to the Slide Mountain terrane and the Mount Nansen Group (Fig. 1). The batholith intrudes into metamorphic rocks of the Yukon-Tanana terrane. The nature of the contact between the batholith and several bodies of foliated intrusive rocks of the Yukon-Tanana terrane on the northwest and southwest sides is uncertain. Most exposures of the Reid Lakes batholith along the Klondike Highway consist of medium to coarse-grained, massive to locally weakly foliated, moderately altered hornblende-biotite granodiorite. One of the most southerly exposures of the Reid Lakes batholith is compositionally somewhat different from the rest of the body, and consists of massive hornblende-biotite granodiorite with abundant pinkish K-feldspar phenocrysts from 2-4 cm in diameter; this phase is also locally cut by narrow aplite and pegmatite veins. The Moose Creek pluton is exposed in scattered roadcuts along the Klondike Highway from just southeast of the Moose Creek Lodge to approximately 7 km southeast of Stewart Crossing (Fig. 1). Most of the rocks included within the Moose Creek pluton comprise massive, fine to medium-grained, biotite granite that are locally K-feldspar megacrystic. The granite is locally cut by abundant aplite and pegmatite dykes that contain minor garnet and tourmaline.

## ANALYTICAL METHODS

Sample location information and brief descriptions of the seven intrusive samples that were analyzed in this study are listed in Table 1. Geochemical analyses for four samples of the Reid Lakes batholith and three samples from the Moose Creek pluton were determined at the ALS Chemex laboratories in North Vancouver, using XRF methods for major elements, ICP-MS methods for trace and rare earth elements, and volumetric methods following mixed-acid digestion for measurement of ferrous iron content. Several aliquots of in-house geochemical monitors were analysed along with the unknown samples to ensure the analytical reliability. Analytical data are given in Table 2. Analytical techniques for U-Pb dating studies by ID-TIMS and LA-ICP-MS at the Pacific Centre for Isotopic and Geochemical Research are as described by Mortensen *et al*. (1995, 2007). Minor modifications to the LA-ICP-MS methods employed in this study include using the Plešovice zircon (Sláma *et al*., 2007) as the main external zircon standard, and a 197 Ma in-house zircon monitor for all analyses. In this study, a total of 16 line scans were collected for each sample. The time resolved

***Table 1.*** *Sample locations and rock descriptions.*

| Sample number | Unit name | UTM Zone | Northing | Easting | Rock type | Magnetic susceptibility |
|---|---|---|---|---|---|---|
| 99-M-35 | Reid Lakes batholith | 8 | 7010836 | 423599 | hbl-bt granodiorite | 0.4 |
| 99-M-36 | Reid Lakes batholith | 8 | 7016702 | 420450 | hbl-bt granodiorite | 0.41 |
| 00-M-35 | Reid Lakes batholith | 8 | 7008100 | 422750 | hbl-bt granodiorite | 0.35 |
| 00-M-37 | Reid Lakes batholith | 8 | 7006432 | 423449 | porphryitic hb-bt granodiorite | 0.31 |
| 99-M-37 | Moose Creek pluton | 8 | 7022396 | 418950 | bt-ms granite | 0.17 |
| 99-M-109a | Moose Creek pluton | 8 | 7039252 | 401691 | megacrystic granite | 0.13 |
| 99-M-109b | Moose Creek pluton | 8 | 7039252 | 401691 | aplite dyke | 0.06 |

Note: hbl = hornblende; bt = biotite; and ms = muscovite. Magnetic susceptibility measurements represent an average of 10 individual susceptibility measurements made on the outcrop using a hand-held magnetic susceptibility meter, and are given in x$10^{-3}$ SI units.

***Table 2.*** *Geochemical analyses of intrusive rock samples.*

| SAMPLE | 99-M-37 | 99-M-109a | 99-M-35 | 99-M-36 | 00-M-37 |
|---|---|---|---|---|---|
| $Al_2O_3$ | 14.75 | 14.15 | 16.03 | 17.21 | 14.41 |
| CaO | 2.39 | 1.77 | 6.88 | 8.5 | 4.7 |
| $Fe_2O_3$ | 3.32 | 2.35 | 6.99 | 7.93 | 6.25 |
| $K_2O$ | 5.04 | 4.47 | 1.77 | 1.1 | 4.55 |
| MgO | 0.8 | 0.58 | 3.34 | 3.72 | 2.73 |
| MnO | 0.07 | 0.07 | 0.13 | 0.15 | 0.11 |
| $Na_2O$ | 2.52 | 2.79 | 2.45 | 2.45 | 1.95 |
| $P_2O_5$ | 0.13 | 0.1 | 0.16 | 0.19 | 0.19 |
| $SiO_2$ | 68.86 | 70.57 | 58.78 | 54.17 | 61.02 |
| $TiO_2$ | 0.34 | 0.26 | 0.72 | 0.8 | 0.6 |
| LOI | 0.63 | 1.96 | 1.88 | 2.11 | 2.2 |
| TOTAL | 98.85 | 99.07 | 99.13 | 98.33 | 98.71 |
| | | | | | |
| FeO | 2.6 | 1.91 | 4.34 | 5.2 | 4.08 |
| $Fe_2O_3$/FeO | 0.16 | 0.12 | 0.5 | 0.41 | 0.52 |
| Ba | 968 | 775 | 563 | 379 | 998 |
| Ce | 90 | 53.5 | 37.5 | 31.5 | 138.5 |
| Cs | 5.3 | 6.7 | 0.7 | 0.6 | 3.1 |
| Co | 12.5 | 14.5 | 23.5 | 25 | 18.5 |
| Dy | 3.5 | 3.5 | 3.2 | 2.7 | 5.3 |
| Er | 1.6 | 2.1 | 1.9 | 1.7 | 3 |
| Eu | 1.3 | 0.9 | 1 | 1.2 | 1.4 |
| Gd | 6.5 | 4.3 | 3.6 | 3 | 6.8 |
| Ga | 18 | 19 | 17 | 19 | 19 |
| Hf | 5 | 5 | 4 | 2 | 5 |
| Ho | 0.6 | 0.7 | 0.6 | 0.5 | 1 |
| La | 47.5 | 28 | 18.5 | 16 | 77 |
| Pb | 30 | 35 | <5 | <5 | 15 |
| Lu | 0.1 | 0.4 | 0.3 | 0.3 | 0.4 |
| Nd | 38 | 21.5 | 16.5 | 14 | 48 |
| Ni | <5 | <5 | 5 | 5 | 15 |
| Nb | 15 | 15 | 8 | 7 | 18 |
| Pr | 10 | 5.8 | 4.4 | 3.6 | 14.6 |
| Rb | 203 | 198 | 49 | 30 | 170 |
| Sm | 7.4 | 4.1 | 3.4 | 2.6 | 8 |
| Sr | 389 | 386 | 388 | 527 | 392 |
| Ta | 6 | 6 | 2.5 | 2 | 3.5 |
| Tb | 0.9 | 0.7 | 0.5 | 0.5 | 1.1 |
| Th | 26 | 20 | 10 | 5 | 22 |
| Tm | 0.1 | 0.3 | 0.3 | 0.2 | 0.4 |
| W | 119 | 119 | 56 | 42 | 48 |
| U | 2.5 | 16.5 | 0.5 | 1 | 2 |
| V | 35 | 25 | 135 | 160 | 95 |
| Yb | 1 | 2 | 1.8 | 1.5 | 2.6 |
| Y | 14 | 21 | 16.5 | 14 | 27 |
| Zr | 130 | 120 | 120 | 74 | 160 |

signal from each analysis was carefully examined and portions of the signal that reflect the effects of post-crystallization Pb-loss and/or the presence of older inherited zircon cores were excluded from calculation of the final isotopic ratios. Analytical data for the ID-TIMS and LA-ICP-MS U-Pb dating study are reported in Tables 3 and 4, respectively. Interpreted crystallization ages are based on a weighted average of the calculated $^{206}Pb/^{238}U$ ages for a total of 14 to 15 individual analyses from each sample. Errors for the calculated ages are given at the 2 sigma level.

## GEOCHEMISTRY OF INTRUSIVE ROCK UNITS

Three samples of the Reid Lakes batholith (99-M-35, 99-M-36 and 00-M-37) and two samples of the Moose Creek pluton (99-M-37 and 99-M-109a) were analyzed (Table 2). The Reid Lakes batholith samples range from diorite to quartz diorite in composition and are metaluminous to weakly peraluminous, whereas the Moose Creek pluton samples yield granodiorite to granite compositions and are peraluminous in composition (Figs. 2a and 2b). All of the samples fall in the 'volcanic arc granite/syn-collisional granite' field on a Nb vs. Y plot (Fig. 2c). Calculated ferrous/ferric iron ratios indicate that the Reid Lakes batholith and Moose Creek samples are both relatively reduced, which corresponds to their low, but different, measured magnetic susceptibilities (Tables 1 and 2).

## U-PB DATING RESULTS

Two samples of the Reid Lakes batholith were dated using U-Pb zircon methods. Both samples yielded abundant coarse euhedral zircons, with no visible cores. Four fractions of strongly abraded zircon from sample 99-M-35 (Fig. 1) were analyzed using ID-TIMS methods (Table 3). This sample consists of medium to coarse-grained, equigranular, moderately altered but unfoliated hornblende-biotite granodiorite. Despite the strong abrasion, all four fractions were moderately discordant (Fig. 3a), indicating that a significant amount of post-crystallization lead loss had occurred. Sixteen line scans of zircons from this same sample were subsequently analysed using LA-ICP-MS methods (Table 4). All of these analyses were concordant (Fig. 3b), although two analyses yielded $^{206}Pb/^{238}U$ ages that are statistically anomalous. A weighted average of the $^{206}Pb/^{238}U$ ages for the remaining 14 analyses is 341.5 ± 0.7 Ma (mean square of weighted deviates, or MSWD, = 0.5; probability of fit, or POF, = 0.9). This is taken as the best estimate for the

***Table 3.*** *ID-TIMS U-Pb analytical data for sample 99-M-35.*

| Sample description[a] | Wt (mg) | U (ppm) | Pb (ppm)[b] | $^{206}Pb/^{204}Pb$ (meas.)[c] | Total common Pb (pg) | % $^{208}Pb$[c] | $^{206}Pb/^{238}U$[d] (± % 1σ) | $^{207}Pb/^{235}U$[d] (± % 1σ) | $^{207}Pb/^{206}Pb$[d] (± % 1σ) | $^{206}Pb/^{238}U$ age (Ma; ± % 2σ) | $^{207}Pb/^{206}Pb$ age (Ma; ± % 2σ) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A: N1,+149 | 0.064 | 201 | 11.7 | 11630 | 4 | 16.7 | 0.05359 (0.16) | 0.3945 (0.21) | 0.05338 (0.11) | 336.5 (1.0) | 345.0 (5.2) |
| B: N1,+149 | 0.080 | 191 | 10.6 | 7851 | 6 | 16.8 | 0.05080 (0.14) | 0.3761 (0.21) | 0.05371 (0.10) | 319.4 (0.9) | 358.7 (4.6) |
| C: N1,+149 | 0.101 | 172 | 9.9 | 8916 | 6 | 18.2 | 0.05178 (0.11) | 0.3811 (0.18) | 0.05338 (0.10) | 325.4 (0.7) | 344.8 (4.6) |
| D: N1,+149 | 0.067 | 180 | 10.6 | 11130 | 4 | 18.3 | 0.05343 (0.17) | 0.3928 (0.22) | 0.05332 (0.10) | 335.5 (1.1) | 342.6 (4.5) |

[a]N1 = non-magnetic at one degree side slope on Frantz magnetic separator; grain size given in microns
[b]radiogenic Pb, corrected for blank, initial common Pb, and spike
[c]corrected for spike and fractionation as determined from replicate analyses of NBS common Pb standards
[d]corrected for blank, fractionation and initial common Pb

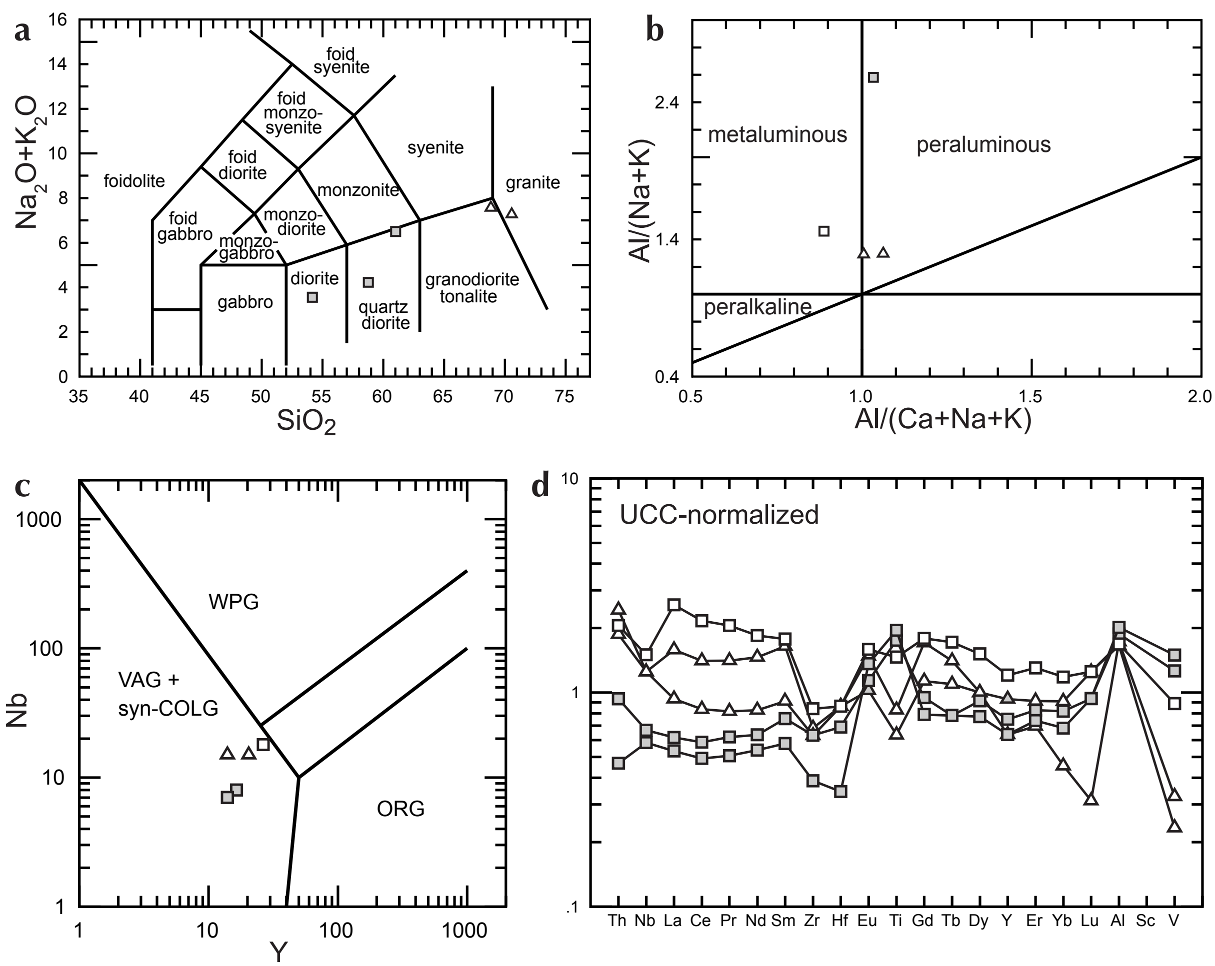


***Figure 2.*** *Discriminant plots of geochemical analyses of Reid Lakes batholith and Moose Creek pluton samples:* ***(a)*** *total alkalis versus silica (LeBas et al., 1986);* ***(b)*** *Shand alkalinity diagram;* ***(c)*** *Niobium versus Yttrium discriminant plot; WPG = within plate granite; VAG = volcanic arc granite; COLG = collisional granite; ORG = orogenic granite (Pearce et al., 1984);* ***(d)*** *Upper continental crust (UCC) normalized trace and rare earth element plot (normalized to values of McClennan, 2001); Moose Creek pluton samples are represented by open triangles, Reid Lakes batholith samples 99-M-35 and 99-M-36 are indicated by grey squares, and sample 00-M-35 is indicated by open squares.*

crystallization age of the sample. The anomalously old ages for the two analyses indicate the presence of a minor component of slightly older xenocrystic or inherited zircon component in the sample.

A second sample of the Reid Lakes batholith (sample 00-M-37; Fig. 1) was collected approximately 4 km to the southeast of sample 99-M-35. This sample was from the K-feldspar porphyritic phase of the batholith described above. Zircons from this sample were similar in appearance to those from sample 99-M-35. Sixteen analyses were carried out on zircons from within sample 00-M-37 (Table 4; Fig. 4a). Fifteen of the analyses yielded overlapping concordant analyses. A weighted average of the $^{206}Pb/^{238}U$ ages for the fifteen analyses is 355.9 ± 0.8 Ma (MSWSD = 0.3; POF= 1.0), which is taken as the best estimate for the crystallization age of the sample. A single analysis yields a somewhat younger age, reflecting significant post-crystallization Pb-loss.

A sample of massive, K-feldspar megacrystic biotite granite of the Moose Creek pluton was collected approximately 5 km southeast of the Moose Creek Lodge (sample 99-M-109a, Fig. 1). The sample yielded a moderate

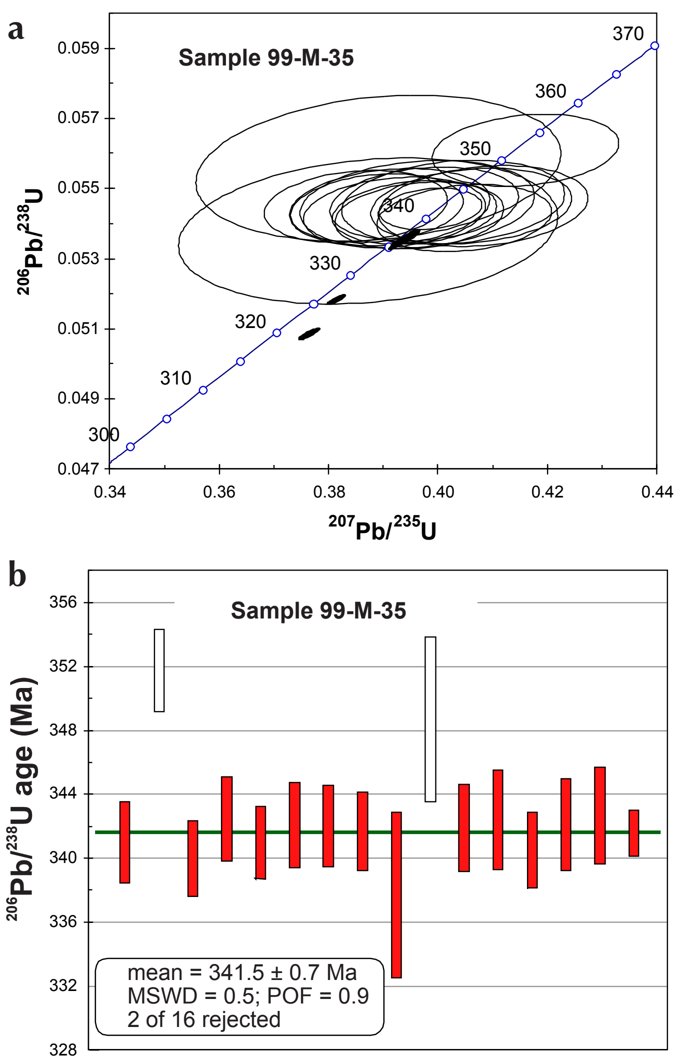


***Figure 3.*** *Concordia diagram illustrating:* **(a)** *U-Pb zircon analyses for sample 99-M-35 by ID-TIMS (solid ellipses) and LA-ICP-MS (open ellipses) methods; and* ***(b)*** *plot of* $^{206}Pb/^{238}U$ *ages for zircons from sample 99-M-35 completed using LA-ICP-MS methods. Errors are shown at the two sigma level (rejected analyses shown by open bars).*

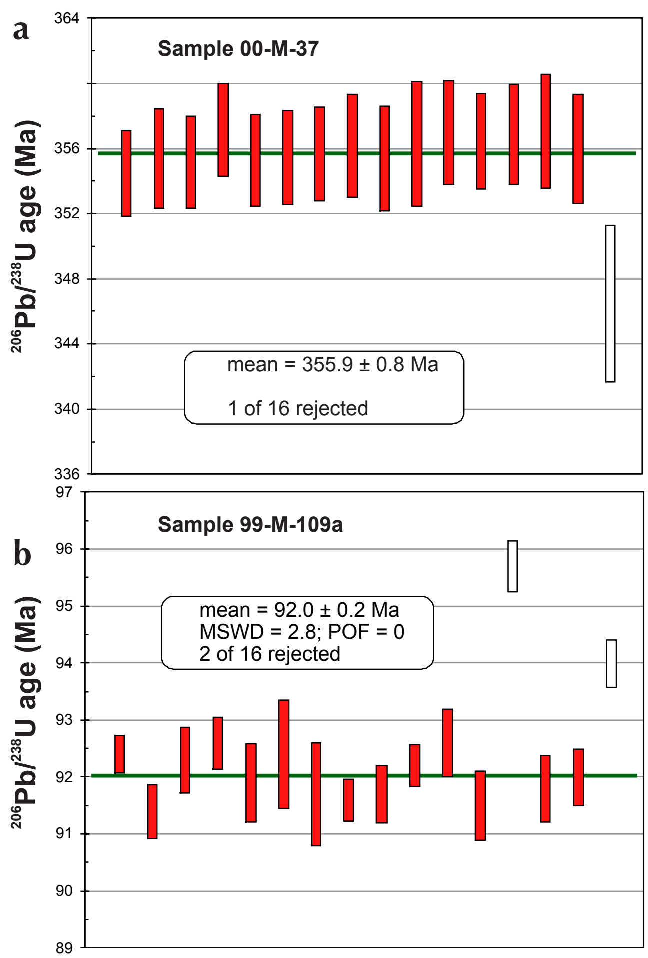


***Figure 4.*** *Plots of* $^{206}Pb/^{238}U$ *ages for zircons from samples 00-M-37* ***(a)*** *and 99-M-109a* ***(b)*** *completed using LA-ICP-MS methods. Errors are shown at the two sigma level (rejected analyses are represented by open bars).*

***Table 4.*** *LA-ICP-MS U-Pb analytical data for samples 99-M-35 and 00-M-37.*

| | Isotope ratios (1 sigma error) | | | | | | Calculated ages (1 sigma error) | | | | | | Ion count rate (cps) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analysis | $^{207}Pb/^{206}Pb$ | error | $^{207}Pb/^{235}U$ | error | $^{206}Pb/^{238}U$ | error | $^{207}Pb/^{206}Pb$ | error | $^{207}Pb/^{235}U$ | error | $^{206}Pb/^{238}U$ | error | 202 | 204 | 206 | 207 | 208 | 232 | 235 | 238 |
| **Sample 99-M-35** | | | | | | | | | | | | | | | | | | | | |
| a | 0.05248 | 0.00083 | 0.39204 | 0.00681 | 0.05432 | 0.00041 | 306.2 | 35.79 | 335.9 | 4.97 | 341 | 2.52 | 57 | 0 | 18022 | 946 | 4126 | 3978 | 2185 | 18817 |
| b | 0.05376 | 0.00082 | 0.41601 | 0.00697 | 0.05609 | 0.00042 | 360.8 | 33.97 | 353.2 | 5 | 351.8 | 2.58 | 0 | 0 | 23215 | 1249 | 5765 | 5466 | 2723 | 23519 |
| c | 0.05435 | 0.0008 | 0.40481 | 0.00653 | 0.05416 | 0.00039 | 385.4 | 32.63 | 345.1 | 4.72 | 340 | 2.39 | 6 | 37 | 21902 | 1191 | 5705 | 5566 | 2673 | 23018 |
| d | 0.05255 | 0.00085 | 0.39749 | 0.00705 | 0.05456 | 0.00043 | 309.3 | 36.24 | 339.8 | 5.13 | 342.5 | 2.64 | 49 | 26 | 22566 | 1187 | 5338 | 5386 | 2717 | 23585 |
| e | 0.05323 | 0.00075 | 0.39575 | 0.00614 | 0.05432 | 0.00037 | 338.7 | 31.69 | 338.6 | 4.47 | 341 | 2.28 | 48 | 0 | 19323 | 1029 | 4393 | 4145 | 2375 | 20359 |
| f | 0.05348 | 0.0009 | 0.40614 | 0.0075 | 0.0545 | 0.00044 | 349.1 | 37.68 | 346.1 | 5.41 | 342.1 | 2.69 | 0 | 9 | 15887 | 850 | 3149 | 2936 | 1915 | 16714 |
| g | 0.05238 | 0.00086 | 0.38497 | 0.00684 | 0.05449 | 0.00042 | 302 | 36.76 | 330.7 | 5.02 | 342 | 2.57 | 34 | 22 | 19501 | 1022 | 5000 | 5189 | 2433 | 20558 |
| h | 0.05283 | 0.0008 | 0.38885 | 0.00645 | 0.05444 | 0.0004 | 321.5 | 34.04 | 333.5 | 4.72 | 341.7 | 2.45 | 0 | 0 | 21076 | 1115 | 5297 | 5287 | 2631 | 22278 |
| i | 0.05362 | 0.00181 | 0.38723 | 0.01416 | 0.05379 | 0.00085 | 355.1 | 74.25 | 332.3 | 10.37 | 337.7 | 5.22 | 98 | 2 | 8461 | 454 | 1475 | 1178 | 1080 | 9085 |
| j | 0.05362 | 0.00174 | 0.38911 | 0.01363 | 0.05558 | 0.00085 | 355 | 71.33 | 333.7 | 9.96 | 348.7 | 5.17 | 86 | 31 | 7837 | 420 | 1096 | 919 | 997 | 8158 |
| k | 0.0532 | 0.00094 | 0.39118 | 0.00748 | 0.05447 | 0.00045 | 337.2 | 39.3 | 335.2 | 5.46 | 341.9 | 2.75 | 37 | 0 | 14546 | 775 | 3858 | 3887 | 1830 | 15479 |
| l | 0.0539 | 0.0011 | 0.3962 | 0.00877 | 0.05455 | 0.00051 | 366.8 | 45.6 | 338.9 | 6.38 | 342.4 | 3.13 | 0 | 31 | 11544 | 623 | 2745 | 2564 | 1456 | 12289 |
| m | 0.05418 | 0.00078 | 0.39659 | 0.00631 | 0.05423 | 0.00039 | 378.4 | 32.36 | 339.2 | 4.59 | 340.5 | 2.4 | 46 | 42 | 29687 | 1611 | 8443 | 9253 | 3773 | 31904 |
| n | 0.05324 | 0.00092 | 0.4083 | 0.00782 | 0.0545 | 0.00047 | 338.9 | 38.74 | 347.6 | 5.64 | 342.1 | 2.86 | 0 | 19 | 25861 | 1379 | 5526 | 5412 | 3142 | 27711 |
| o | 0.05325 | 0.00101 | 0.40279 | 0.00834 | 0.05461 | 0.00049 | 339.2 | 42.26 | 343.7 | 6.03 | 342.7 | 3.01 | 39 | 0 | 14146 | 754 | 3295 | 3381 | 1746 | 15154 |
| p | 0.05351 | 0.00046 | 0.39866 | 0.00382 | 0.05442 | 0.00024 | 350.3 | 19.39 | 340.7 | 2.78 | 341.6 | 1.44 | 74 | 19 | 87053 | 4668 | 15048 | 16298 | 10929 | 93752 |
| **Sample 00-M-37** | | | | | | | | | | | | | | | | | | | | |
| a | 0.05349 | 0.00082 | 0.41966 | 0.00708 | 0.05652 | 0.00043 | 349.7 | 34.34 | 355.8 | 5.06 | 354.5 | 2.62 | 0 | 0 | 46288 | 2476 | 7699 | 7626 | 5570 | 48311 |
| b | 0.05361 | 0.00096 | 0.42061 | 0.00825 | 0.05668 | 0.0005 | 354.4 | 39.93 | 356.5 | 5.89 | 355.4 | 3.04 | 25 | 3 | 28758 | 1542 | 4232 | 4083 | 3460 | 29935 |
| c | 0.05425 | 0.0009 | 0.42208 | 0.00771 | 0.05665 | 0.00047 | 381.3 | 36.99 | 357.5 | 5.5 | 355.2 | 2.84 | 58 | 0 | 34793 | 1889 | 5024 | 4965 | 4223 | 36246 |
| d | 0.05406 | 0.0009 | 0.42431 | 0.00779 | 0.05697 | 0.00047 | 373.3 | 37.29 | 359.1 | 5.55 | 357.2 | 2.88 | 91 | 34 | 49263 | 2666 | 7309 | 7055 | 5927 | 51030 |
| e | 0.05367 | 0.00089 | 0.41421 | 0.00754 | 0.05666 | 0.00047 | 357 | 37.09 | 351.9 | 5.41 | 355.3 | 2.84 | 61 | 0 | 51428 | 2766 | 7247 | 7129 | 6294 | 53582 |
| f | 0.05564 | 0.00093 | 0.43112 | 0.00791 | 0.05669 | 0.00047 | 437.5 | 36.35 | 364 | 5.61 | 355.5 | 2.87 | 12 | 0 | 38914 | 2170 | 8245 | 7969 | 4744 | 40528 |
| g | 0.05361 | 0.0009 | 0.42157 | 0.00781 | 0.05673 | 0.00048 | 354.5 | 37.67 | 357.2 | 5.58 | 355.7 | 2.9 | 31 | 26 | 55342 | 2975 | 11848 | 11317 | 6649 | 57603 |
| h | 0.05512 | 0.00101 | 0.42855 | 0.00862 | 0.05682 | 0.00052 | 416.9 | 40.11 | 362.1 | 6.12 | 356.2 | 3.16 | 64 | 0 | 33519 | 1853 | 5470 | 5547 | 4074 | 34843 |
| i | 0.05343 | 0.00102 | 0.42227 | 0.00882 | 0.05669 | 0.00053 | 347.2 | 42.45 | 357.7 | 6.3 | 355.4 | 3.24 | 35 | 0 | 32309 | 1733 | 4477 | 3922 | 3864 | 33672 |
| j | 0.0542 | 0.00123 | 0.42552 | 0.01058 | 0.05683 | 0.00063 | 379.1 | 50.06 | 360 | 7.54 | 356.3 | 3.85 | 17 | 34 | 18779 | 1022 | 2565 | 2252 | 2261 | 19523 |
| k | 0.05349 | 0.001 | 0.42247 | 0.00867 | 0.05693 | 0.00052 | 349.6 | 41.81 | 357.8 | 6.19 | 357 | 3.18 | 14 | 10 | 24706 | 1328 | 3819 | 3570 | 2957 | 25642 |
| l | 0.05309 | 0.00092 | 0.41361 | 0.00782 | 0.05686 | 0.00049 | 332.5 | 38.51 | 351.5 | 5.62 | 356.5 | 2.96 | 17 | 0 | 45317 | 2418 | 9517 | 9692 | 5500 | 47102 |
| m | 0.05328 | 0.00096 | 0.42431 | 0.00841 | 0.05692 | 0.00051 | 340.7 | 40.19 | 359.1 | 5.99 | 356.9 | 3.11 | 43 | 0 | 39820 | 2134 | 7637 | 7328 | 4729 | 41355 |
| n | 0.05195 | 0.00107 | 0.40534 | 0.00918 | 0.05695 | 0.00058 | 283.2 | 46.53 | 345.5 | 6.64 | 357.1 | 3.53 | 40 | 0 | 29329 | 1533 | 5405 | 5273 | 3555 | 30448 |
| o | 0.05433 | 0.00105 | 0.41913 | 0.00893 | 0.05678 | 0.00055 | 384.7 | 42.77 | 355.4 | 6.39 | 356 | 3.36 | 0 | 0 | 44850 | 2453 | 6940 | 6694 | 5500 | 46712 |
| p | 0.05577 | 0.00157 | 0.42051 | 0.01306 | 0.05523 | 0.00079 | 442.8 | 61.29 | 356.4 | 9.34 | 346.5 | 4.83 | 24 | 21 | 26154 | 1469 | 5344 | 5218 | 3281 | 28008 |
| **Sample 99-M-109a** | | | | | | | | | | | | | | | | | | | | |
| a | 0.04915 | 0.00045 | 0.09759 | 0.0009 | 0.01444 | 0.00005 | 155.1 | 21.34 | 94.5 | 0.83 | 92.4 | 0.33 | 17 | 7 | 46301 | 2278 | 1762 | 6036 | 22024 | 189472 |
| b | 0.05057 | 0.00066 | 0.09927 | 0.00128 | 0.01428 | 0.00007 | 221.1 | 29.83 | 96.1 | 1.18 | 91.4 | 0.47 | 80 | 0 | 38943 | 1973 | 5125 | 19300 | 18731 | 161196 |
| c | 0.04717 | 0.00078 | 0.09437 | 0.00154 | 0.01442 | 0.00009 | 57.4 | 38.18 | 91.6 | 1.43 | 92.3 | 0.57 | 93 | 0 | 22549 | 1066 | 451 | 1761 | 10641 | 92459 |
| d | 0.04899 | 0.00062 | 0.09671 | 0.00122 | 0.01447 | 0.00007 | 147.2 | 29.65 | 93.7 | 1.13 | 92.6 | 0.46 | 0 | 1 | 38121 | 1874 | 1048 | 3807 | 18229 | 155782 |
| e | 0.05033 | 0.00097 | 0.09818 | 0.00186 | 0.01436 | 0.00011 | 210.5 | 43.86 | 95.1 | 1.72 | 91.9 | 0.68 | 0 | 13 | 22590 | 1143 | 994 | 3808 | 10930 | 92994 |
| f | 0.05038 | 0.0014 | 0.09975 | 0.00273 | 0.01443 | 0.00015 | 212.5 | 63.17 | 96.5 | 2.52 | 92.4 | 0.95 | 0 | 11 | 11204 | 568 | 592 | 1496 | 5340 | 45914 |
| g | 0.05272 | 0.00134 | 0.10313 | 0.00258 | 0.01433 | 0.00014 | 316.5 | 56.71 | 99.7 | 2.38 | 91.7 | 0.9 | 108 | 0 | 13601 | 722 | 833 | 2828 | 6560 | 56153 |
| h | 0.04862 | 0.00049 | 0.09637 | 0.00097 | 0.01431 | 0.00006 | 129.4 | 23.44 | 93.4 | 0.9 | 91.6 | 0.37 | 66 | 38 | 51291 | 2514 | 1182 | 4506 | 24414 | 211979 |
| i | 0.04774 | 0.0007 | 0.09435 | 0.00138 | 0.01432 | 0.00008 | 85.4 | 35.36 | 91.5 | 1.28 | 91.7 | 0.51 | 0 | 0 | 25688 | 1238 | 654 | 2246 | 12261 | 106143 |
| j | 0.04796 | 0.00049 | 0.0944 | 0.00097 | 0.0144 | 0.00006 | 96.1 | 25.03 | 91.6 | 0.9 | 92.2 | 0.37 | 0 | 6 | 41446 | 2009 | 938 | 3352 | 19860 | 170281 |
| k | 0.04926 | 0.0008 | 0.09797 | 0.00158 | 0.01447 | 0.00009 | 160.3 | 37.67 | 94.9 | 1.46 | 92.6 | 0.59 | 38 | 0 | 25751 | 1283 | 748 | 2563 | 12212 | 105349 |
| l | 0.0472 | 0.00089 | 0.09326 | 0.00174 | 0.01429 | 0.0001 | 58.8 | 44.74 | 90.5 | 1.62 | 91.5 | 0.61 | 31 | 0 | 15568 | 743 | 694 | 2372 | 7429 | 64475 |
| m | 0.05537 | 0.0006 | 0.11406 | 0.00124 | 0.01496 | 0.00007 | 426.9 | 23.78 | 109.7 | 1.13 | 95.7 | 0.45 | 0 | 55 | 95919 | 5386 | 3991 | 6235 | 43897 | 379515 |
| n | 0.05178 | 0.00082 | 0.10096 | 0.00159 | 0.01435 | 0.00009 | 275.7 | 35.79 | 97.7 | 1.46 | 91.8 | 0.58 | 55 | 35 | 21828 | 1147 | 1090 | 3088 | 10553 | 90075 |
| o | 0.04756 | 0.00066 | 0.09321 | 0.0013 | 0.01437 | 0.00008 | 76.6 | 33.47 | 90.5 | 1.21 | 92 | 0.5 | 21 | 15 | 25832 | 1248 | 1483 | 5310 | 12423 | 106484 |
| p | 0.0477 | 0.00051 | 0.09605 | 0.00104 | 0.01469 | 0.00007 | 83.7 | 26.07 | 93.1 | 0.97 | 94 | 0.42 | 0 | 0 | 104507 | 5068 | 2005 | 6670 | 48914 | 421306 |

number of pale yellow zircons, some of which contained visible cloudy inherited cores. Fourteen LA-ICP-MS U-Pb analyses (Table 4; Fig. 4b), excluding two outliers, yielded a weighted mean $^{206}Pb/^{238}U$ age of 92.0 ± 0.2 Ma (MSWD = 2.8; POF = 0), which is taken as the best estimate for the crystallization age of this sample.

## DISCUSSION

Results of the study confirm that the Reid Lakes batholith on the southwest side of the TFZ is entirely distinct from the Moose Creek pluton that is immediately adjacent to it on the northeast side of the TFZ, in terms of lithology, geochemistry and crystallization age. Therefore, the juxtaposition of these unrelated intrusive bodies does not constrain the timing of displacement on the fault zone. The two phases of the Reid Lakes batholith described here yield U-Pb zircon ages that suggest correlation with Early Mississippian intrusive rock units in the Glenlyon map area to the southeast (Tatlmain and Ragged plutonic suites of Colpron *et al*., 2006). Normalized trace and rare earth element patterns for the Reid Lakes batholith samples (Fig. 2d) also support this correlation. The composition and U-Pb zircon age of the Moose Creek pluton indicates that it is part of the South Lansing plutonic suite of Mortensen *et al*. (2000).

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