U-PB ZIRCON GEOCHRONOLOGY OF BEDROCK SAMPLES COLLECTED IN THE EAGLE AND TANACROSS QUADRANGLES, EASTERN ALASKA

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U-PB ZIRCON GEOCHRONOLOGY OF BEDROCK SAMPLES COLLECTED IN THE EAGLE AND TANACROSS QUADRANGLES, EASTERN ALASKA

Michelle M. Gavel[1], Sean P. Regan[2], Mark Holland[3], Alec D. Wildland[1], Alicja Wypych[1], Travis J. Naibert[1], and Evan Twelker[1]

INTRODUCTION

This preliminary interpretive report presents uranium-lead (U-Pb) zircon ages from 50 igneous, sedimentary, and metamorphic samples collected during 2020 and 2021 in support of the Western Tanacross and Taylor Mountain bedrock-geologic mapping projects. These two projects encompass an area of ~2,600 square miles (~6,700 sq km) of eastern Interior Alaska including the Mosquito Fork, Dennison Fork, and Middle Fork of Fortymile River drainages (fig. 1). The majority of the Western Tanacross project area is located approximately 20 miles north of Tok, and a small portion is located to the southwest; the Taylor Mountain area is within a 50-mile radius of Chicken. Both project areas are of historical and current interest for the potential development of precious metals, base metals, and critical mineral resources. With this U-Pb geochronology dataset, our goals are to delineate the timing and character of igneous and tectonic events that may be linked to regional and local controls on mineralization and to characterize the regional source material of the area's metamorphic terranes.

The Taylor Mountain and Western Tanacross areas are comprised of widespread greenschist- to amphibolite-facies metamorphic rocks of the composite allochthonous Yukon Tanana Terrane (YTT) and the parautochthonous North American margin (pNA). Both terranes share Mississippian–Late Devonian metamorphic ages, and the suture between them is difficult to delineate due to multiple episodes of high-strain deformation (Ryan and others, 2021). Parautochthonous rocks in the field area include the Lake George assemblage, which is characterized by amphibolite-facies metasedimentary and metavolcanic rocks, as well as large bodies of augen gneiss and biotite orthogneiss (Dusel-Bacon and others, 2017). The Western Tanacross area also includes a small area of parautochthonous rocks within the Eastern Alaska Range. This includes quartzite and quartz schists of the Jarvis belt, which were metamorphosed to amphibolite grade, retrograded to greenschist, and are intruded by Triassic metamafic sills. Mafic to felsic metaigneous rocks, paragneiss, quartzite, and marble of the Fortymile River assemblage comprise YTT rocks of the field area and are interpreted to be part of a continental arc and back-arc system.

Both the Lake George and Fortymile River assemblages are intruded by Mesozoic mafic to felsic plutonic rocks. Syn- to post-tectonic Triassic and Jurassic granitoids are confined to the YTT. Voluminous post-tectonic Cretaceous to Paleogene intrusive and volcanic rocks that vary significantly in composition are widespread throughout both the Lake George and Fortymile River metamorphic assemblages (Dusel-Bacon and Williams, 2009; Dusel-Bacon and others, 2015).

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Non-marine sedimentary rocks are also found in both field areas, and fossil pollen from these units have mid-Cretaceous–Neogene depositional ages (Foster and Igarashi, 1990). These rocks are found in unconformable contact with metamorphic basement rocks or large intrusive bodies. Additionally, they have been observed on top of mid-Cretaceous (ca. 100–115 Ma) intrusive rocks or overlain by volcanic rocks (ca. 70 Ma) throughout eastern Alaska and Yukon (Twelker and others, 2021). In other areas, sedimentary rocks are overlain by 57 Ma rhyolite or cut by 57 Ma diabase dikes (Werdon and others, 2001).

The following products are included with this data release: geochronology summary tables, laboratory data, data dictionaries, cathodoluminescence images, scanning electron microscope backscatter images, and associated metadata. This data collection is released as a Preliminary Interpretive Report with an open end-user license. All files can be downloaded free of charge from the DGGS website: doi.org/10.14509/31013.

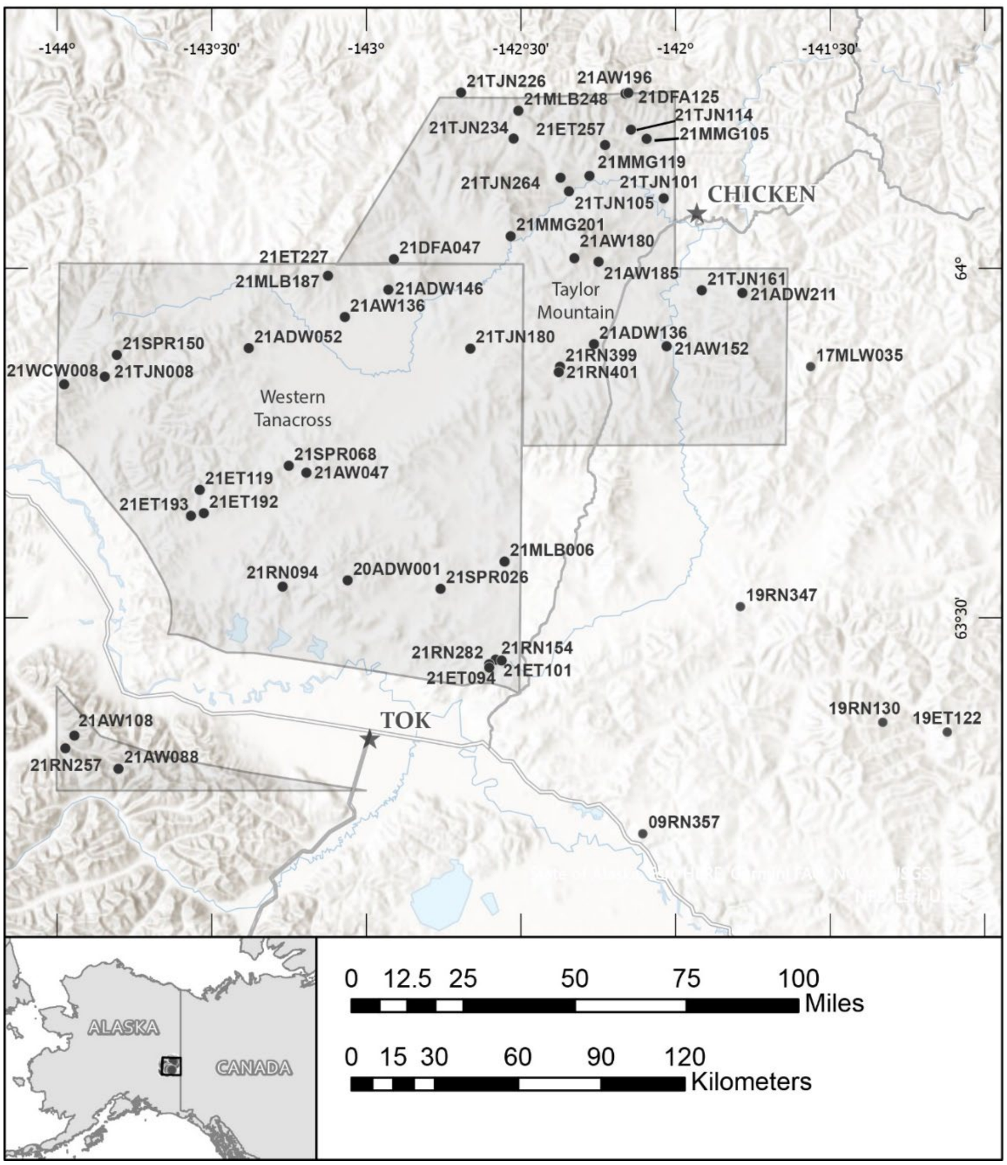


Figure 1. Map showing 2020 and 2021 project areas with locations of samples used for U-Pb analyses.

ANALYTICAL METHODS

Zircon extractions and analyses were carried out at the University of Arizona Laserchron Center (ALC). Detailed information about their mineral-separation techniques can be found on the ALC website (research.arizona.edu/arizona-laserchron-center). A summary of the primary steps are as follows: 1) cleaning and processing in a jaw crusher and roller mill; 2) removal of ferromagnetic minerals with a hand magnet, and removal of paramagnetic minerals with a Frantz magnetic separator; 3) density-based separation using heavy liquids (diiodomethane); 4) removal of "soft" minerals using a Wig-L-Bug; and 5) acid washing to remove pyrite and apatite.

Zircon crystals are then mounted, along with primary and secondary standards (table 1), on a 1-inch-round epoxy puck. For igneous- or metamorphic-crystallization (CZ) analyses, 40–50 grains are selected from the mineral separate for the mount. For detrital zircon (DZ) analyses (from sedimentary or metasedimentary rocks), the complete contents of the final mineral separate are poured onto the mount. All mounts are polished and then imaged by back-scattered electron (BSE) and cathodoluminescence (CL) techniques. The resulting BSE and CL images aid in zircon identification and targeting for geochronologic analysis.

All analyses were done via laser ablation inductively coupled plasma mass spectrometer (LA-ICP-MS) using the techniques documented by Gehrels and others (2008). Thirty-five grains were targeted for each CZ sample. Some grains were analyzed in multiple areas to investigate complex internal textural variations (e.g., convoluted zoning or inherited cores revealed by CL imaging). For DZ samples, as many as 300 grains were targeted but the number varied with abundance of zircon. Analysis locations across all samples were cleaned using a 30-µm spot size, which was set to three cycles. A 20-µm spot size set to 110 cycles was used for the main U-Pb analysis. Standards (table 1) were run at the beginning and end of each sample's analyses, as well as in between every three to five sample unknowns.

Table 1. Zircon standards used during the analysis. FC-1 serves as a primary standard; R33 and SL2 are secondary standards.

Standard	Standard	$^{206}Pb/^{238}U$ age (Ma, ± 2σ)	$^{206}Pb/^{207}Pb$ age (Ma, ± 2σ)	Reference
R33	Braintree Complex	419.3 ± 0.40	422.37 ± 0.36	Black and others, 2004; Mattinson, 1987
FC-1	Duluth Complex	1099.5 ± 0.3	1099.0 ± 0.2	Paces and Miller, 1993
SL2	Sri Lanka F	563.2 ± 4.8 Ma	568 ± 16.0 Ma	Gehrels and others, 2008

For CZ samples, ages were determined using a weighted mean of individual zircon dates, and a mean square weighted deviation (MSWD) was calculated for each weighted-mean age to assess the proportionality of dispersion to measurement uncertainty in each sample population. The analytical uncertainty of CZ ages is presented at two standard deviations (also written as 2-sigma or 2σ) with final uncertainty including random and systematic uncertainty added in quadrature (Spencer and others, 2016). A systematic uncertainty factor of two percent was used, following the approach of Coutts and others (2019) and Spencer and others (2016).

Individual zircon dates were qualified for inclusion in MSWD interpretation based on the following criteria: 1) only dates collected from zircon domains interpreted to record the youngest crystallization event were used (e.g., use CL imagery to target well-defined oscillatory zoning, magmatic overgrowths); 2) anomalously old dates from grains with no textural evidence for inheritance were determined to be xenocrystic or inherited, and thus excluded; and 3) if textural qualification yielded dates that did not define a cogenetic population (MSWD >> 1), we followed the approach of Spencer and others (2016) and excluded dates that did not overlap within 2-sigma of the covaried uncertainty of the Terra-Wasserburg concordia diagram.

To identify Phanerozoic Pb-loss, we compared U-Pb dates to total U concentration. If uranium concentration was observed to increase with decreasing U-Pb date, we interpreted that to indicate crystal lattice damage and excluded young dates from age calculations. If no correlation was observed, a kernel density estimation (KDE) plot was used to identify populations with potential Pb-loss (indicated by a trail of younger dates, or a negatively skewed tail). Some samples still yielded dates that did not conform to a single population after this treatment. In those cases, the weighted mean age is a best approximation of the crystallization age. The true age may be younger or older than the weighted mean age, and unresolvable due to Phanerozoic Pb-loss or inheritance.

For detrital samples, the above procedure was followed with some additional steps. During spot selection, grains were chosen randomly to avoid bias in size or texture (Gehrels, 2014). Metamict fragments were intentionally avoided. Only grains with less than 20 percent discordance were included in maximum depositional age (MDA) interpretations. We then used the youngest statistical population (YSP) approach of Coutts and others (2019) to establish an MDA. The YSP approach calculates the MDA as the weighted average of the youngest sub-population of two or more grains that yield an MSWD of ~1. Uncertainties for the YSP MDAs reported in table 3 were calculated using the same method as for CZ samples.

SAMPLE DESCRIPTIONS

Sample descriptions are based on field observations, thin section petrography, and CL-image photography of zircon grains used for analysis.

Late Cretaceous–Paleogene Intrusive and Volcanic Rocks

21ET257

21ET257 is a greenish gray, altered, granite porphyry dike with a grain size of 0.1 to 30 mm and the following mineralogy: 35 percent groundmass (very fine-grained quartz, feldspar, and sericite); 35 percent feldspar (tabular, phenocrystic); 15 percent quartz (subhedral, phenocrystic); 8 percent muscovite; 7 percent chlorite (replacing former biotite); and trace epidote (rare as inclusions in micas). The hand sample is partially weathered and was collected from an outcrop.

Sample 21ET257 yielded a population of subhedral to euhedral and elongated zircon grains 200–300 µm long (fig. 2). Most grains exhibit undisturbed oscillatory zonation with lesser irregular zoning within the cores, are inclusion-rich, and have minor areas of metamictization.

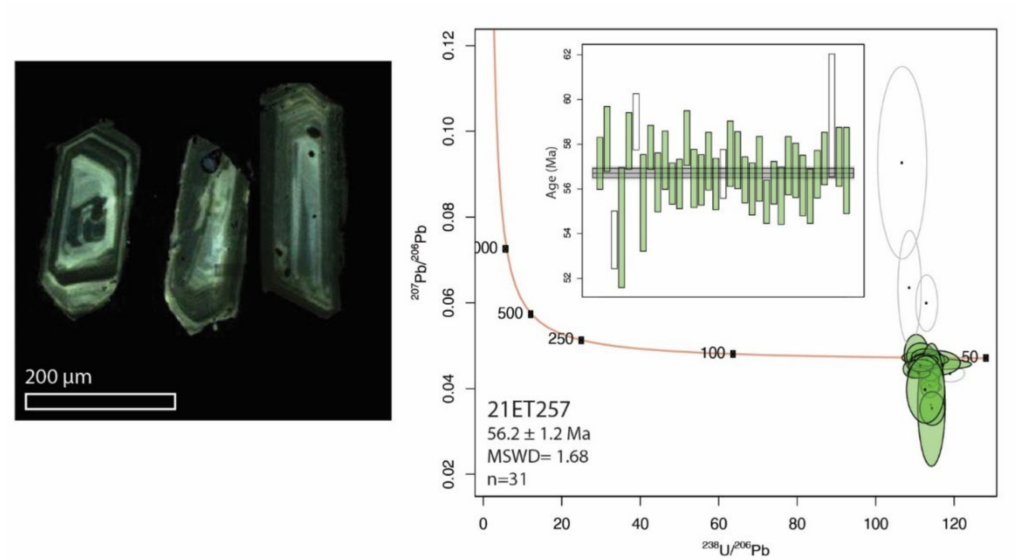


Figure 2. U-Pb data for sample 21ET257. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21DFA047

21DFA047 is a rusty purple, porphyritic, pyroxene-plagioclase dacite tuff with a phenocryst grain size typically about 2 mm and the following mineralogy: 12 percent plagioclase (phenocrysts with polysynthetic twinning, some grains appear broken); 10 percent clinopyroxene (90-degree cleavage and inclined extinction); 3 percent potassium feldspar (phenocrysts with Carlsbad twinning); 3 percent biotite (as flakes); 2 percent hornblende; 70 percent groundmass (amorphous to very fine-grained feldspar, opaques, and possible quartz); and trace hematite (as staining and replacing opaques). The rock is partially weathered, and the hand sample was collected from an outcrop.

Sample 21DFA047 yielded a population of subhedral to subrounded, elongated, and somewhat fractured zircon grains typically 75–100 μm (up to 250 μm) long (fig. 3). Internal textures are igneous and primarily display sector—and lesser lengthwise—zonation. Fractured and broken grains with jagged and resorbed edges are common. A few grains are CL-dark with a narrow CL-bright rim and were avoided during the analysis.

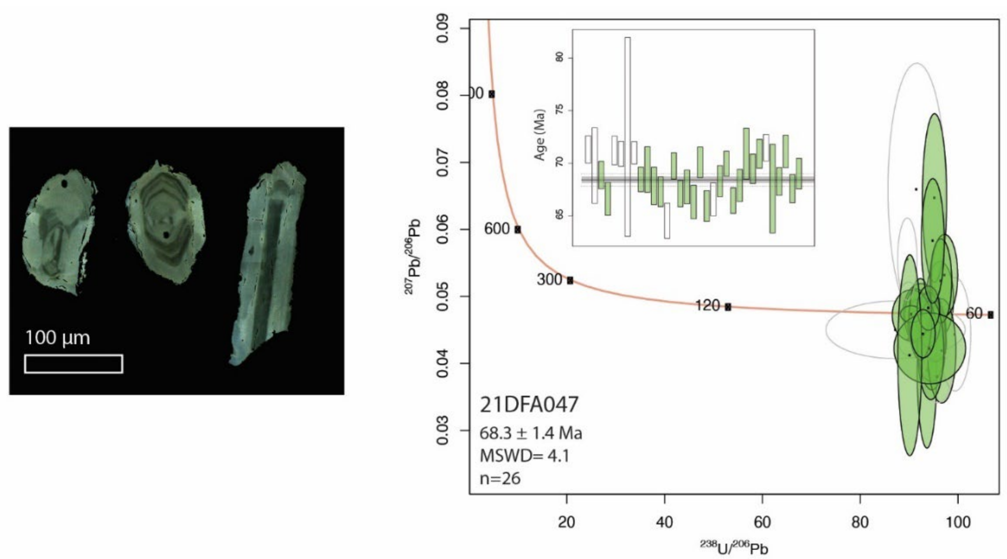


Figure 3. U-Pb data for sample 21DFA047. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21MLB248

21MLB248 is a tan to light brown granite porphyry dike with a grain size of <0.05 to 16 mm and the following mineralogy: 42 percent alkali feldspar (0.5 to 5 mm phenocrysts, subhedral to euhedral, and 0.05 mm groundmass grains with quartz); 38 percent quartz (subhedral to euhedral phenocrysts, 1 to 5 mm, and 0.05 mm groundmass); 14 percent plagioclase (0.5 to 1 mm phenocrysts, somewhat sericite altered, and 0.05 mm groundmass grains); 6 percent muscovite (0.05 to 0.5 mm grains, replacement of original biotite and of groundmass). Mineralization: trace pyrite. Alteration: strong sericitic alteration. Weathering: pervasive. The sample is about 30 percent 1 to 5 mm phenocrysts and 70 percent altered, very fine-grained, granular groundmass. The groundmass is aphanitic, but no broken crystals are observed, so it is not extrusive. Feldspar phenocrysts are up to 16 mm and quartz are up to 7 mm, with possible minor relict pyrite. The hand sample was collected from a subcrop.

Sample 21MLB248 yielded a population of subhedral and elongated to equant zircon grains 200–400 μm long (fig. 4). Internal textures preserved in these zircon grains are complex and convoluted, some displaying lengthwise and oscillatory zonation, with a mixture of CL-dark and CL-bright grains. Many of the grains have CL-dark rims with evidence of local resorption. Xenocrystic cores are abundant.

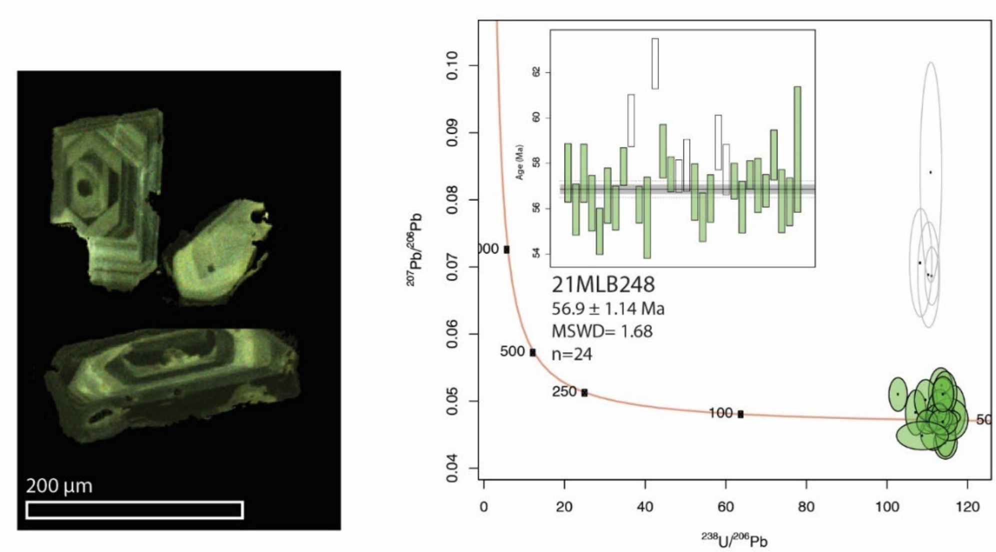


Figure 4. U-Pb data for sample 21MLB248. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

09RN357B

09RN357B is a granite porphyry dike sampled from float in the vicinity of the Area 6 mineral-exploration target (Tectonic Minerals Inc.'s Northway project; Schulze, 2019). The dated sample contains phenocrysts of biotite and feldspar in a very fine-grained, light-gray groundmass. A variety of felsic hypabyssal intrusions are exposed in float in the area; this sample is macroscopically like Werdon and others (2014) 09RN355A, which has a granite composition. DGGS also reports two felsic samples anomalous in molybdenum (09RN358A and 09RN360B in Werdon and others, 2014). Tectonic Metals reported anomalous copper and molybdenum from soil sampling and anomalous molybdenum in rotary air blast drilling (Schulze, 2019).

Sample **09RN357B** yielded a population of euhedral to subhedral zircon grains that are approximately 100–125 long (fig. 5). The grains display mostly weak- to fine-magmatic zonation with CL-bright rims. A few grains have cores that display irregular textures and are CL-dark—possibly inherited or metamorphic.

21TJN264

21TJN264 is gray rhyolite welded tuff with white and black crystals with grains up to 10 mm long and the following mineralogy: 10 percent quartz (0.1– 3 mm, anhedral, many broken, shard-like, some strongly embayed, some both broken and embayed, sub-mm shards are particularly common); 7 percent plagioclase (0.2–2 mm, subhedral, commonly twinned, many broken, even shards); 4 percent biotite (0.2–2 mm, subhedral, some broken and/or rounded, very fresh-looking); 2 percent lithic clasts, (0.3–1.5 mm, mostly lenticular pieces of fine-grained quartz-feldspar intergrowths); 2 percent alkali feldspar (0.2–1 mm, subhedral, untwinned); and 75 percent groundmass (0.01–0.1 mm, some glassy, might be mostly tiny shards). The tuff is about 23 percent (broken) crystals and two percent lithic clasts. Welded tuff samples are only seen and collected as float around an old prospecting pit and are not in place, but they are angular and likely not far traveled. The hole with these rocks was likely dug by a prospector in the 1970s to 1980s.

Sample 21TJN264 yielded a population of euhedral and elongated zircon grains 150–200 µm long, and up to 350 µm long (fig. 6). Most of the grains exhibit oscillatory zoning and sector zoning and are commonly fractured into pieces with jagged edges. Some cores have convoluted zonation. Inclusions, holes, and CL-dark zones were interpreted to be metamict and avoided during analysis.

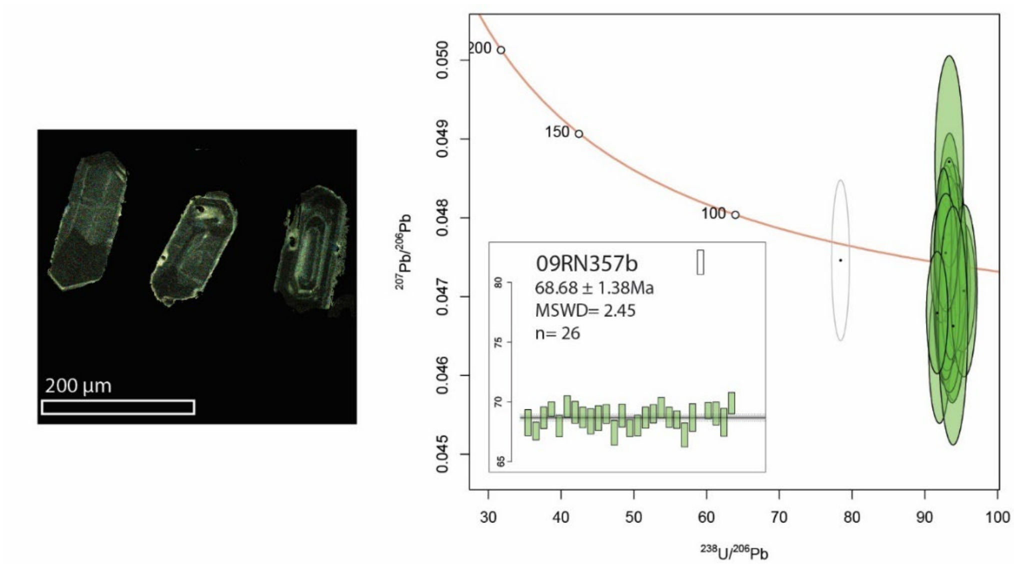


Figure 5. U-Pb data for sample **09RN357B**. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

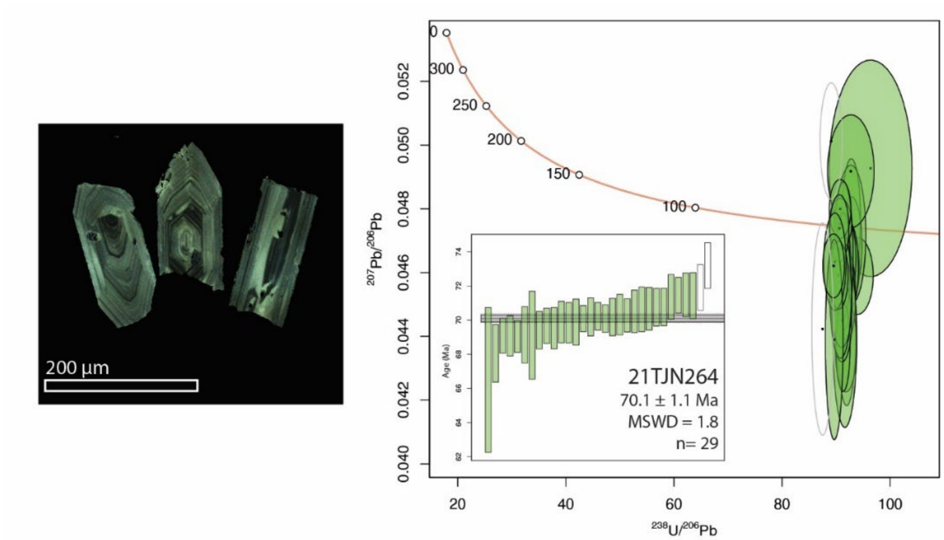
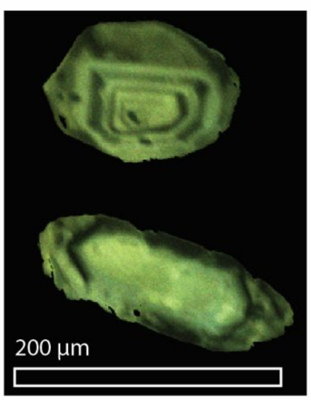


Figure 6. U-Pb data for sample 21TJN264. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21WCW008

21WCW008 is a grey quartz monzodiorite with the following mineralogy: 40 percent plagioclase (euhedral phenocrysts, 0.5–2 mm, cores partly altered to sericite and granular groundmass around 0.03–0.05 mm); 15 percent quartz (0.05–0.1 mm, anhedral, interstitial); 13 percent alkali feldspar (0.1–0.5 mm, interstitial); 13 percent biotite (0.2–1 mm, anhedral to subhedral grains with abundant inclusions (sponge-textured), very slightly chloritized); 6 percent augite (0.5 mm, very pale green); 5 percent orthopyroxene (0.2–1.5 mm, euhedral but surrounded by secondary amphibole); 5 percent actinolite (secondary amphibole replaces pyroxene); and 3 percent opaques (0.01–0.2 mm, subhedral, mostly magnetite). The sample is an actinolite-altered, porphyritic (coarse plagioclase) augite-biotite quartz monzodiorite with trace weathering and was collected from a frost boil.

Sample 21WCW008 yielded a population of anhedral to subhedral and equant zircon grains 100–200 µm long (fig. 7). Internal textures are overall convoluted with some grains preserving areas of oscillatory zonation. Pieces of broken zircon grains and irregular edges are common. A few grains appear to be completely altered or disturbed. Isotopic data suggests multiple age populations and the presence of xenocrystic zircon incorporated into this sample during emplacement. The 71.1 Ma age is interpreted as the emplacement age based on ages from samples with similar lithology in the study area.



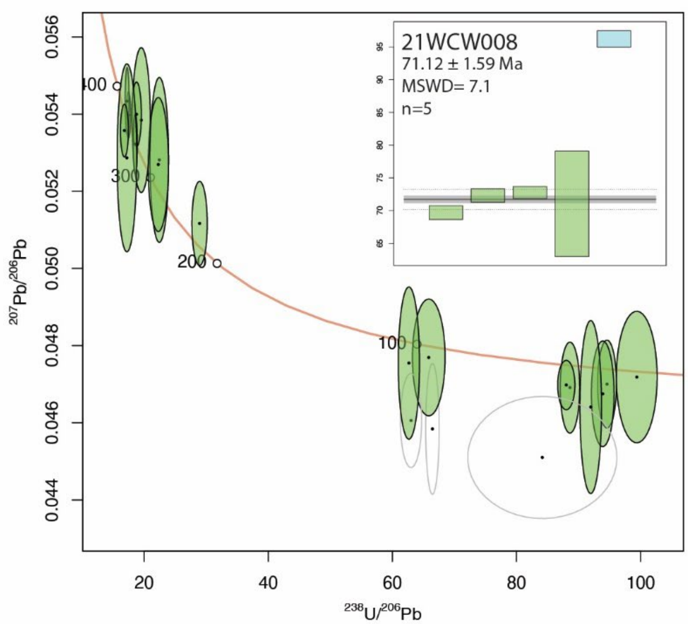


Figure 7. U-Pb data for sample 21WCW008. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

19ADW032

Sample 19ADW032 is severely altered volcaniclastic dacite breccia. The sample is light gray and brown, porphyritic, and vesicular with a phenocryst grain size of two to eight mm in a fine-grained, altered, devitrified groundmass and has the following mineralogy: 50 percent sericite altered fine devitrified groundmass; 20 percent lithics (subrounded volcanic clasts); 20 percent pumice (subrounded); and 10 percent quartz (as phenocrysts). The sample is generally vesicular, however, some of the voids could be weathered pumice. The sample was collected from subcrop and is heavily weathered and strongly altered.

Sample 19ADW032 yielded a population of euhedral, equant to elongated zircon grains with long axes ranging in length from approximately 75 to 225 μm (fig. 8). Internal textures are primarily oscillatory while several grains display convoluted zonation or xenocrystic cores. Several grains are fractured or recrystallized along their edges.

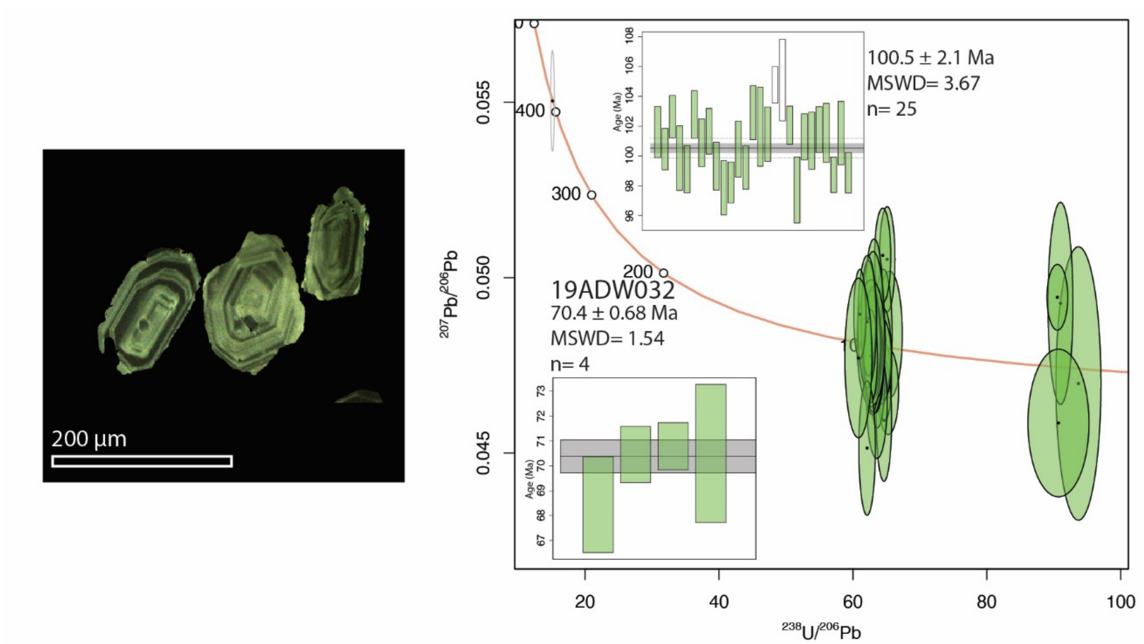


Figure 8. U-Pb data for sample 19ADW032. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

Mid-Cretaceous Volcanic and Intrusive Rocks

20ADW001

20ADW011 is a gray porphyritic rhyolite tuff from Sixtymile Butte with a phenocryst grain size of 1 to 3 mm and has the following mineralogy: 20 percent quartz (phenocrystic); 30 percent quartz (groundmass); and 50 percent feldspar (phenocrystic). The sample is partially weathered, blocky, has infrequent clasts, and was collected from an outcrop.

Sample 20ADW001 yielded a population of euhedral and dominantly elongated zircon grains 100–200 µm long (fig. 9). CL imaging of the grains reveals ubiquitous igneous internal textures (oscillatory and straight zonation). A lesser population of grains are fractured or recrystallized around their edges; a few have minor disrupted igneous core-rim zonation which suggests a possible intermediate stage of crystal growth or partial reset followed by continued oscillatory zonation. Some cores display irregular textures and convolute zonation.

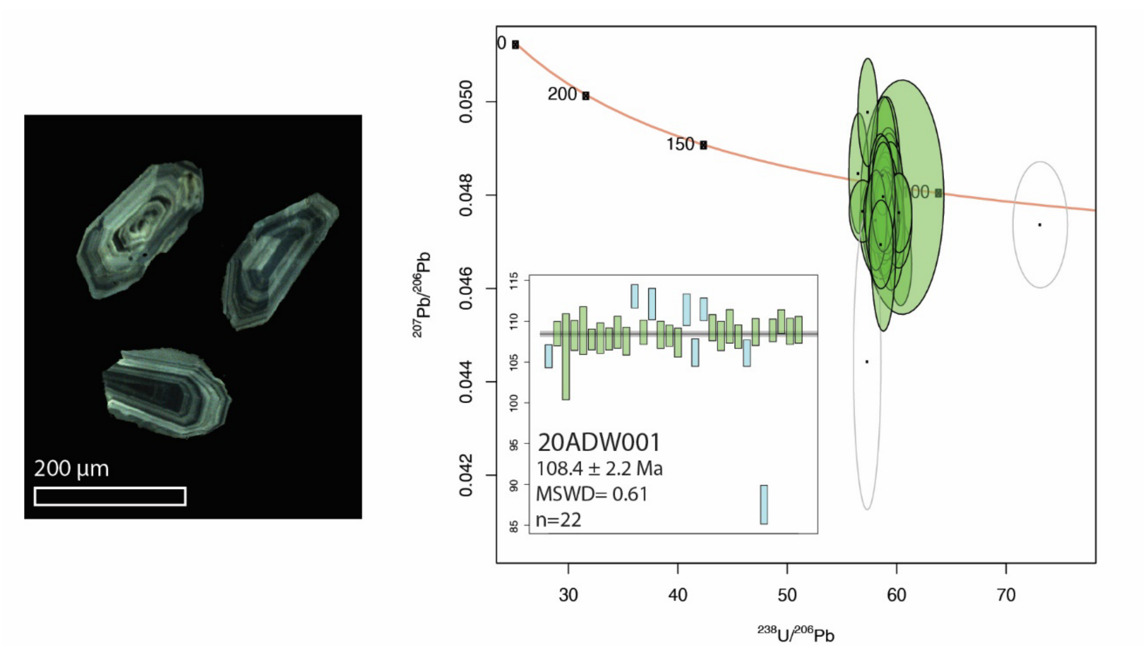


Figure 9. U-Pb data for sample 20ADW001. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21ET193

21ET193 is a light gray, strongly chloritized, hornblende-biotite granodiorite porphyry with a grain size of 0.05 to 3 mm and has the following mineralogy: 40 percent plagioclase (0.5–3.5 mm subhedral phenocrysts, and 0.05–0.1 mm, mostly granular groundmass grains intergrown with quartz, partly altered to sericite); 30 percent quartz (0.4–1.5 mm subhedral phenocrysts and 0.05 mm granular groundmass grains); 18 percent alkali feldspar (0.5–3 mm subhedral phenocrysts and 0.05–0.1 mm mostly granular groundmass grains intergrown with quartz); 7 percent chlorite (0.03–0.1 mm, aggregates that replace original hornblende and biotite); 2.8 percent epidote (0.1–0.5 mm, subhedral to anhedral, completely replacing biotite and hornblende with chlorite ± titanite); 1 percent muscovite (0.05–0.1 mm, subhedral, partial replacement of biotite and groundmass; dusting of plagioclase); 0.2 percent opaque (0.1–0.2 mm subhedral grains); 0.85 percent titanite (0.05–0.3 mm, subhedral to anhedral, especially common with altered mafic minerals); 0.12 percent biotite (rare residual grains, 0.3 mm long, chloritized); and 0.03 percent zircon (0.05–0.2, euhedral). The hand sample consists of about 20 percent phenocrysts (0.5–5 mm) and 80 percent granular groundmass (0.5 mm). The former hornblende and biotite grains were identified from their shapes and have been completely altered to chlorite + epidote ± titanite. The sample was collected from a subcrop.

Sample 21ET193 yielded a population of euhedral and elongated zircon grains 150–300 µm long (fig. 10). Internal textures dominantly display sector and oscillatory zoning with several grains having xenocrystic cores. Inclusions are common with some grains showing fractures throughout the higher uranium concentration cores. Subtle changes in the oscillatory zonation near the rims of the grains suggest a period of late-stage crystallization.

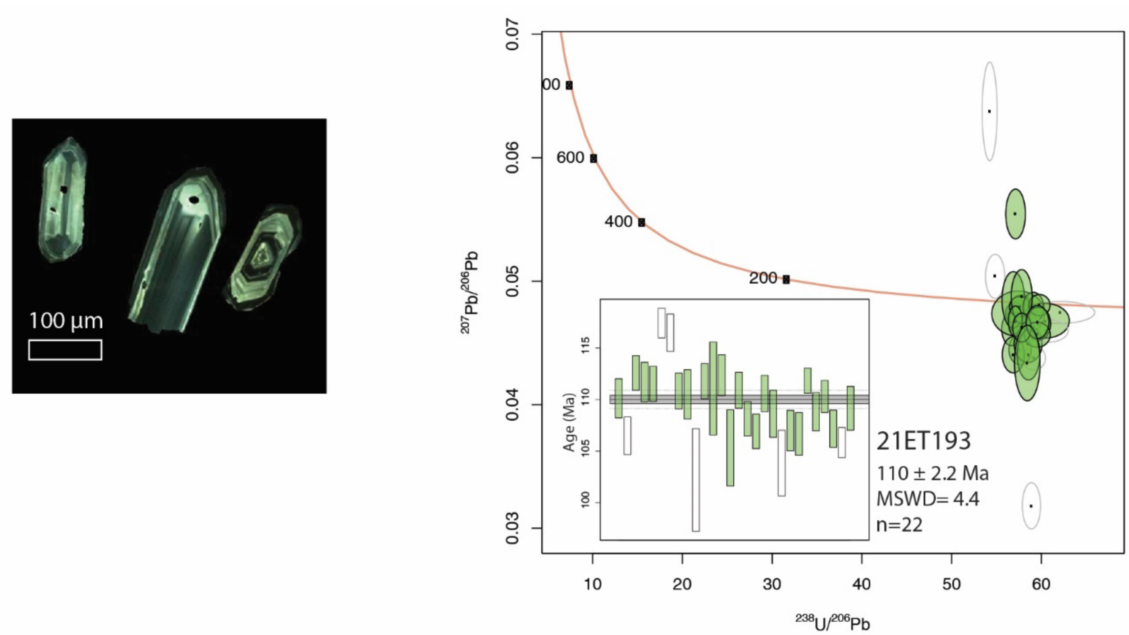


Figure 10. U-Pb data for sample 21ET193. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21ET119

21ET119 is a medium-gray, granite porphyry dike with a grain size of 0.1 to 3 mm and has the following mineralogy: 35 percent quartz (found as 0.2–2 mm subhedral, commonly embayed phenocrysts and 0.03–0.05 mm granular groundmass); 31 percent plagioclase (found as 0.6–2 mm phenocrysts partially replaced by calcite and 0.03–0.5 mm granular groundmass partially replaced by muscovite); 25 percent alkali feldspar (found as 0.5–1.5 mm phenocrysts and 0.03–0.05 mm granular groundmass); 5 percent chlorite (0.1–0.4 mm, completely replaced biotite); 2 percent muscovite (0.05–0.2 mm, subhedral replacement of biotite [with chlorite], of plagioclase, and of groundmass); 1 percent calcite (0.05–0.4 mm, replaced plagioclase cores and groundmass); and 1 percent opaque (0.1–0.3 mm, subhedral, especially common with chloritized biotite). Strongly chloritized biotite granite porphyry with 25 percent 0.5–2 mm phenocrysts and 75 percent very fine-grained granular quartz-feldspar groundmass. Rock displays trace weathering and the hand sample was collected from an outcrop.

Sample 21ET119 yielded a population of subhedral and equant to elongated zircon grains 75–200 µm long (fig. 11). Internal textures include lengthwise and oscillatory zonation. Cores display irregular zonation with areas of metamictization. The rims of the grains display uninterrupted igneous growth with occasional inclusions. Fractured and broken zircon grains are common.

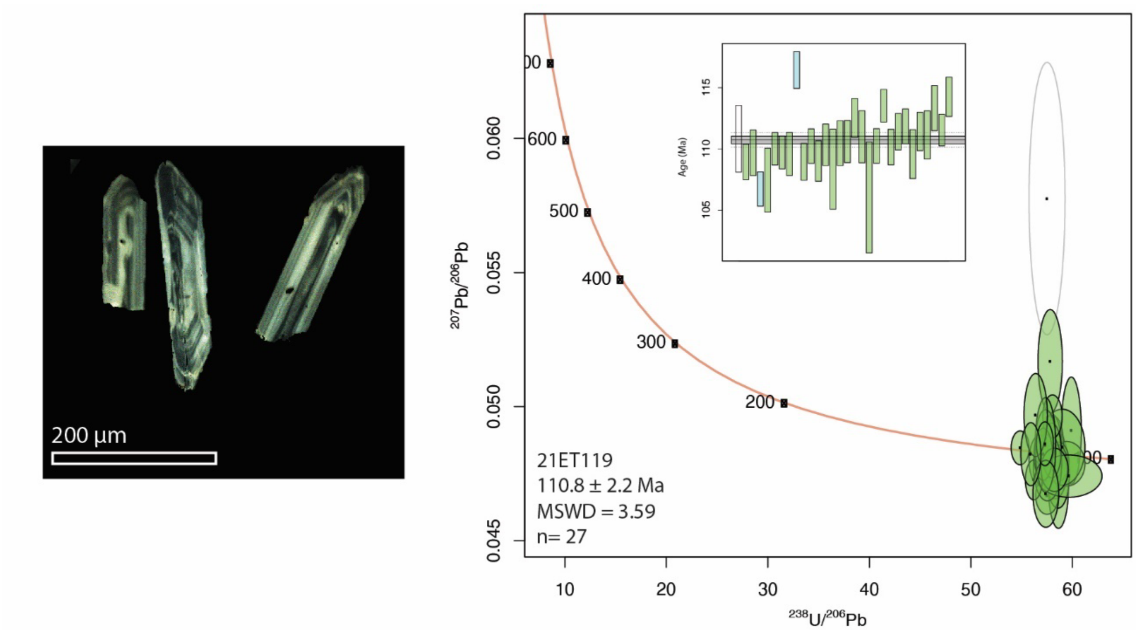


Figure 11. U-Pb data for sample 21ET119. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

19KS383

19KS383 is a tan to pink volcaniclastic rhyolite or dacite with a grain size of 0.2 to 12.0 mm with fragmented subangular clasts and euhedral crystals. The sample is fractured and veined and was found as float. Sample 19KS383 yielded a population of stubby, equant grains (fig. 12). Some appear fragmented.

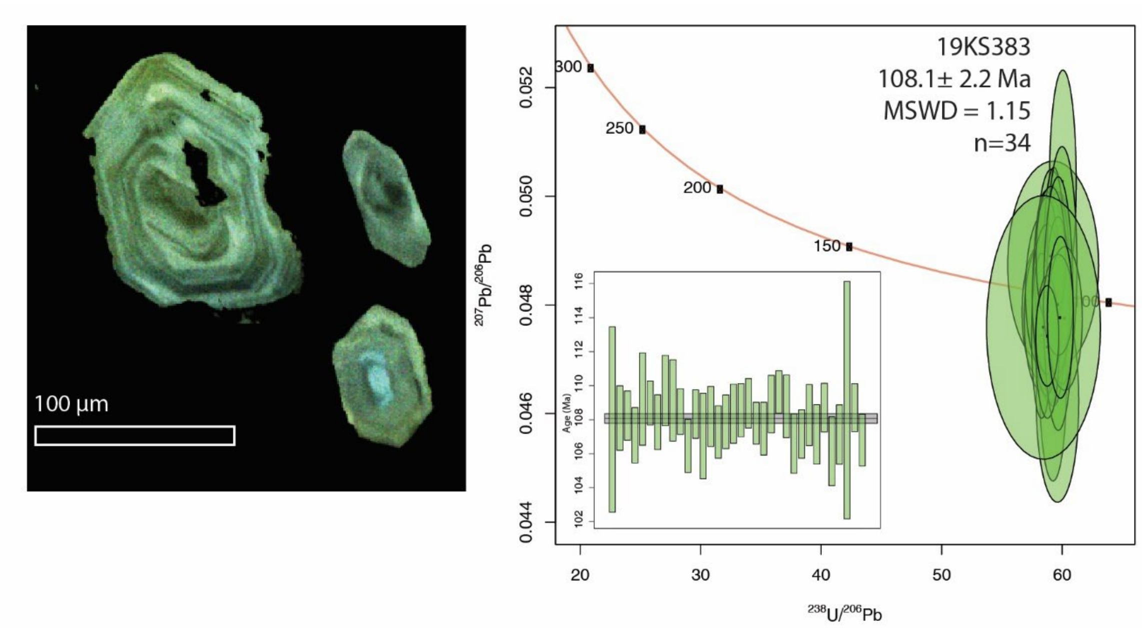


Figure 12. U-Pb data for sample 19KS383. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21MLB006

21MLB006 is a tan to light brown granite porphyry with a grain size of 0.01 to 5 mm and has the following mineralogy: 5 percent plagioclase (0.3–0.8 mm, phenocrysts, commonly dusted with sericite); 8 percent alkali feldspar (0.5–4.5 mm, phenocrysts, untwinned + microcline twinning); 5 percent quartz (0.3–0.8 mm, subhedral to anhedral, typically embayed and commonly surrounded by spherulites); 2 percent muscovite (0.05–0.3 mm, secondary after biotite + disseminated in groundmass); 80 percent groundmass (0.01–0.04 mm, 70 percent granular to 30 percent spherulitic). There is no obvious mineralization in hand sample, and it has trace weathering. It is difficult to determine whether the sample is intrusive or extrusive and is assumed to be granite porphyry (intrusion) for this report.

Sample 21MLB006 yielded a population of subhedral and elongated to equant zircon grains and most are 100–300 µm long (fig. 13). Internal textures are igneous and include sector, oscillatory, and lengthwise zonation. Many grains contain 20–30 µm-sized holes and/or inclusions, are fractured, in pieces, or have jagged edges.

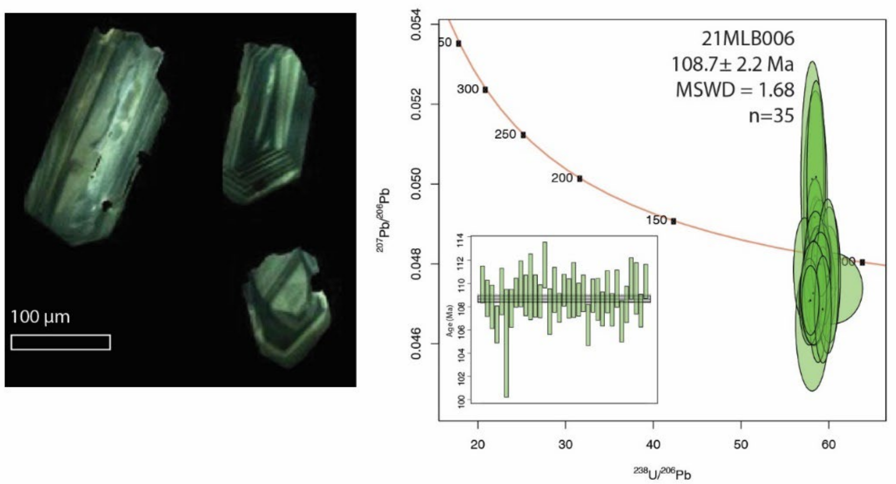


Figure 13. U-Pb data for sample 21MLB006. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

19RN347

19RN347 is a dark green rhyolite tuff with a grain size of 0.05 to 4 mm and has the following mineralogy: 10 percent quartz (broken); 5 percent feldspar (broken); 75 percent groundmass; 5 percent angular lithic clasts. Alteration in the sample is weak and weathering is trace. The sample was collected from a subcrop.

Sample 19RN347 yielded a population of euhedral to subhedral and elongated zircon grains 75–200 µm long (fig. 14). Internal textures are igneous, displaying well-defined zonation; only a few grains show local recrystallization. Many grains exhibit varying degrees of rim resorption and fractures at their edges. CL-dark areas are typically cores and are interpreted to be metamict.

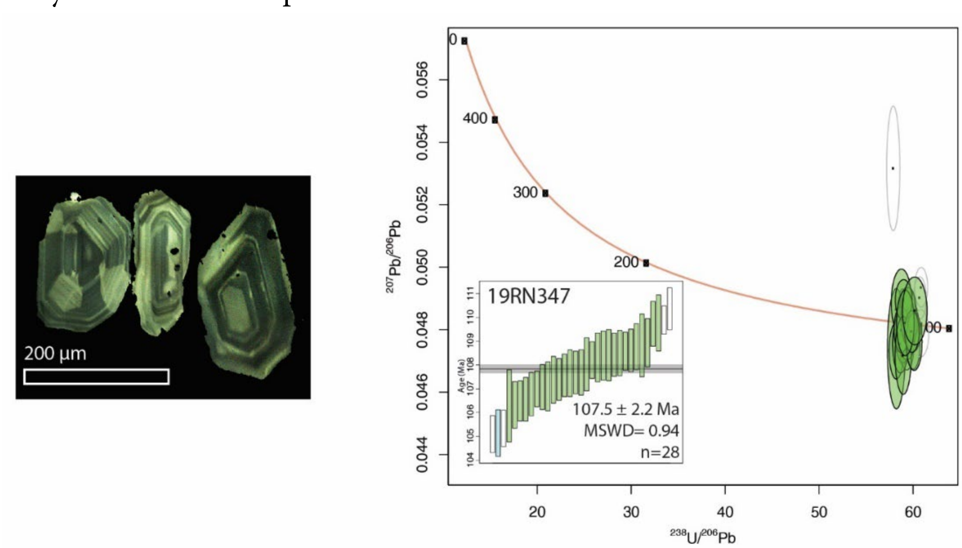


Figure 14. U-Pb data for sample 19RN347. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21RN094

21RN094 is a jointed, gray granite porphyry dike with a grain size up to 2 mm and has the following mineralogy: 15 percent plagioclase (0.1–1 mm phenocrysts with little or no alteration); 15 percent alkali feldspar (0.1–0.5 mm phenocrysts); 12 percent quartz (0.1–4 mm subhedral phenocrysts); 10 percent biotite (.05–0.1 mm, aggregates of secondary biotite, green to brown, replace magmatic biotite "books"); 3 percent clinozoisite (0.03–0.1 mm, subhedral grains replace plagioclase and groundmass); 1 percent chlorite (partial replacement of biotite); 0.5 percent ilmenite (0.05–0.1 mm elongate grains, common in biotite); 0.5 percent magnetite (0.05–0.1 mm subhedral disseminated grains); and 43 percent groundmass (0.005–0.05 mm, mostly granular quartz-feldspar, but also some granophyric texture).

Sample 21RN094 yielded a population of mostly subhedral and somewhat equant zircon grains 175–275 µm long (fig. 15). Internal textures are mostly igneous with oscillatory and convoluted zonation. Several grains are broken and fragmented, and few grains are elongated.

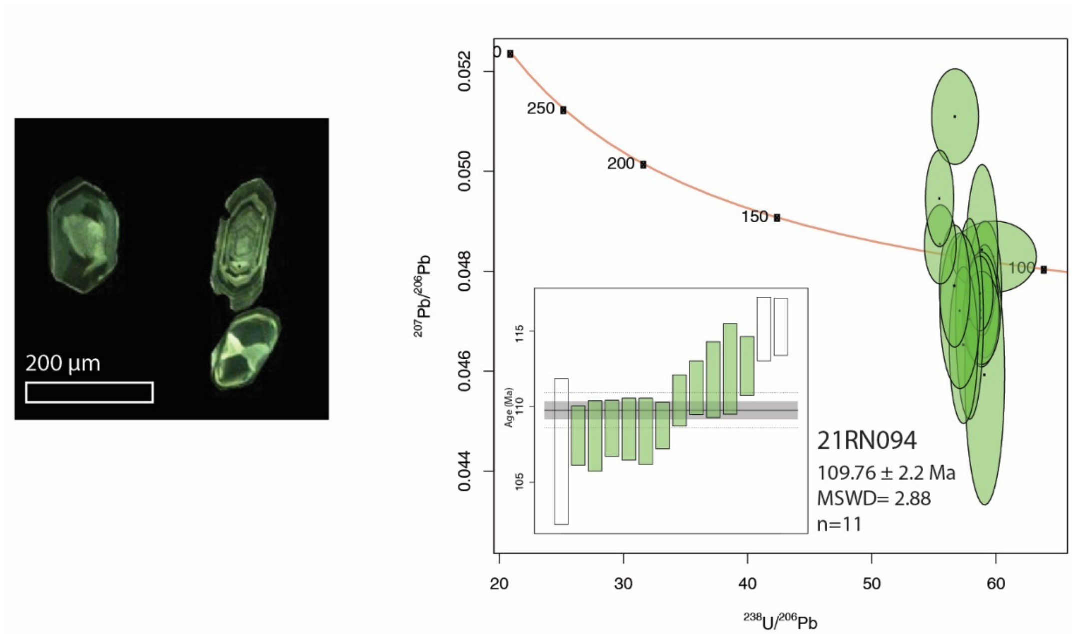


Figure 15. U-Pb data for sample 21RN094. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21RN282

21RN282 is a pinkish, jointed granite porphyry with a phenocryst grain size of 1 to 3 mm and has the following mineralogy: 35 percent quartz (0.005–0.5 mm, spherulitic-granular groundmass); 33 percent albite (0.1–1 mm euhedral phenocrysts, strongly sericitized, and also found in spherulitic groundmass); 27.5 percent alkali feldspar (0.005–0.5 mm, spherulitic-granular groundmass); 2 percent chlorite (0.1 mm needles, perhaps replacing biotite); 2 percent sericite (0.01–0.05 mm grains disseminated in plagioclase); 0.5 percent biotite (0.05–0.2 mm, mostly replaced by chlorite ± muscovite). Sample alteration is chloritized biotite and sericitized albite. Hand sample displays rare (~5 percent) 1–2 mm phenocrysts in a spherulitic-granular groundmass.

Major element analyses indicate high silica (low calcium and titanium) granite composition (Wypych and others, 2022). The hand sample is partially weathered and was collected from a subcrop.

Sample 21RN282 yielded a population of euhedral to subhedral and elongated (lesser equant) zircon grains 100–200 µm long (fig. 16). Internal textures display mostly oscillatory zonation with a few grains displaying sector zonation. Several grains are broken and fragmented, show fractures, are inclusion-rich, and have holes.

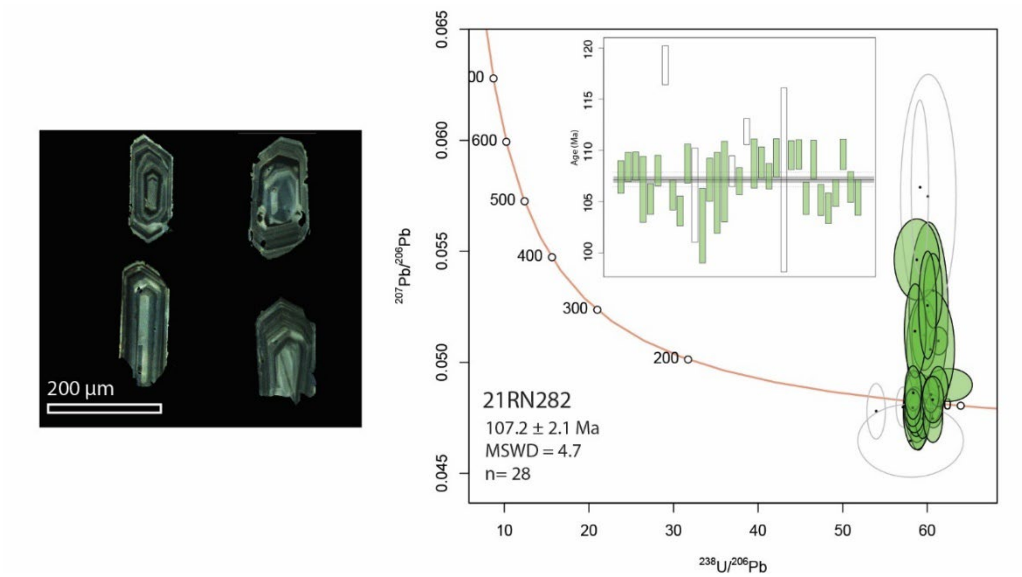


Figure 16. U-Pb data for sample 21RN282. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21RN399

21RN399 is a strongly altered, tan-green quartz monzonite with a grain size of 0.02 of 3 mm and has the following mineralogy: 40 percent alkali feldspar (0.1–1 mm, single Carlsbad twinning common); 25 percent plagioclase (0.3–1.5 mm, cores commonly replaced by calcite); 14 percent biotite (0.05–1.5 mm subhedral grains, many are tiny); 6 percent calcite (0.05–0.2 mm, replaces plagioclase cores and augite-hornblende, with chlorite); 5 percent quartz (0.1–0.2 mm, anhedral, interstitial); 4 percent chlorite (0.05–0.1 mm, replacement, with calcite, of hornblende and possibly augite); 4 percent opaque (0.05–0.4 mm, subhedral, probably magnetite in greater abundance than ilmenite); 1.5 percent apatite (0.05- to 0.25-mm-long grains, moderate relief); and 0.5 percent hornblende (0.4–1.5 mm, residual grains partly altered to calcite and chlorite, green-brown pleochroism). Rock is a strongly calcite and chlorite-altered hornblende-biotite quartz monzonite with a holocrystalline seriate to sub-equigranular texture. The hand sample was collected from a dug hole.

Sample 21RN399 yielded a small population of subhedral, elongate zircons that are 75–125 µm long and up to 200 µm long (fig. 17). Internal textures are mostly convoluted and patchy, with possible relict igneous oscillatory and sector zonation. Some grains have metamict and CL dark cores, while others have more typical oscillatory growth zoning or sector zoning. Inclusions are common and the edges can be jagged and/or fractured.

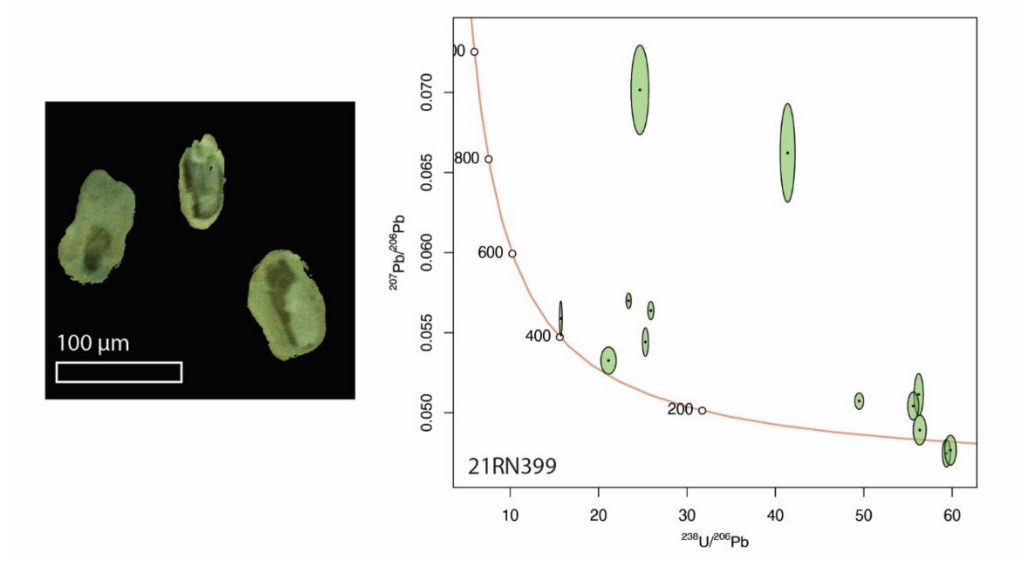


Figure 17. U-Pb data for sample 21RN399, cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram.

21SPR026

21SPR026 is a tan to pink, rhyolite crystal tuff with the following mineralogy: 15 percent alkali feldspar (0.2–2 mm, subhedral, untwinned or microcline twinned, many broken or fractured, minor sericite alteration); 10 percent quartz (0.1–4 mm, subhedral to anhedral, many broken or fractured, smaller grains especially display a shard-like shape); 10 percent lithic clasts (subangular, 0.3–3 mm, consisting of very fine-grained quartz-feldspar, difficult to distinguish from very altered plagioclase, some are laminated); 5 percent plagioclase (0.2–4 mm subhedral to anhedral crystals, many broken, most twinned, partly altered to sericite); 1 percent opaque (0.03–0.4 mm, subhedral, probably oxidized, may have originally been magnetite); 59 percent groundmass (0.004–0.1 mm, intergrown granular quartz + feldspar + muscovite). Sample alteration along discrete fractures. The hand sample is about 30 percent feldspar-rich broken crystals, 10 percent rhyolitic clasts, and 60 percent fine-grained groundmass. Chemical analysis of the sample is consistent with high-silica rhyolite (Wypych and others, 2022). Hand sample was collected from an outcrop.

Sample 21SPR026 yielded a population of subhedral, elongate to equant, and fractured zircon grains 75–250 µm long (fig. 18). Internal zonation is mostly convoluted with several of the equant grains displaying sector zoning. CL-dark areas, metamict cores, and holes are fairly common; they were avoided during analysis.

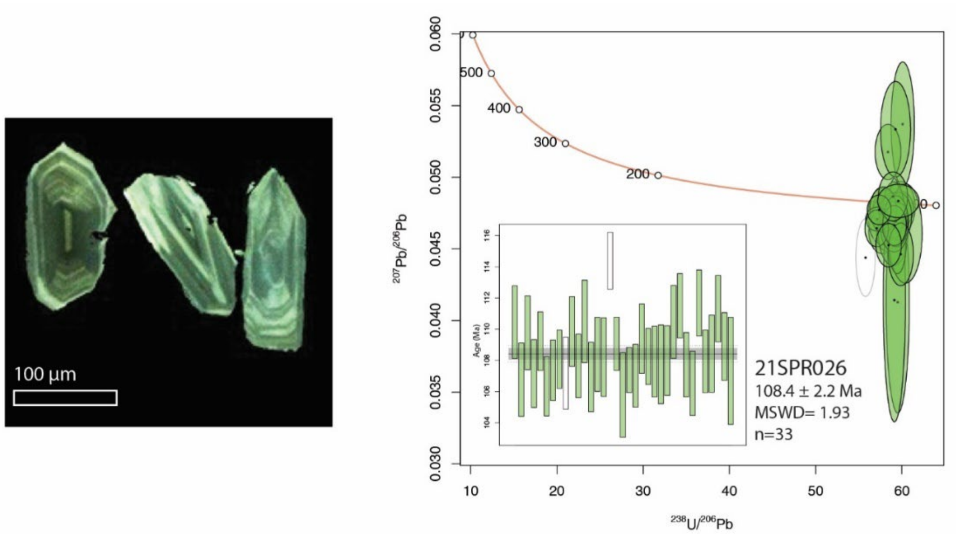


Figure 18. U-Pb data for sample 21SPR026. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21TJN008

21TJN008 is a slightly altered, seriate, hornblende biotite granodiorite with a grain size of 0.02 to 3 mm and has the following mineralogy: 45 percent plagioclase (0.2–2 mm subhedral to euhedral grains with common sericite cores); 7 percent hornblende with common biotite inclusions (0.3–2 mm); 13 percent alkali feldspar (0.3–1 mm, mostly interstitial); 12 percent biotite (subhedral isolated grains and inclusions in hornblende, partly altered to chlorite ± epidote); 18 percent quartz; one percent opaque minerals; and two percent sericite. The sample was collected from an outcrop which included mafic enclaves and aplite dikes.

Sample 21TJN008 yielded mostly euhedral zircon grains 200–500 µm long (fig. 19). Elongated grains with diffuse zonation are common. Some grains have convoluted zoning and possible xenocrystic cores, which were avoided during analysis.

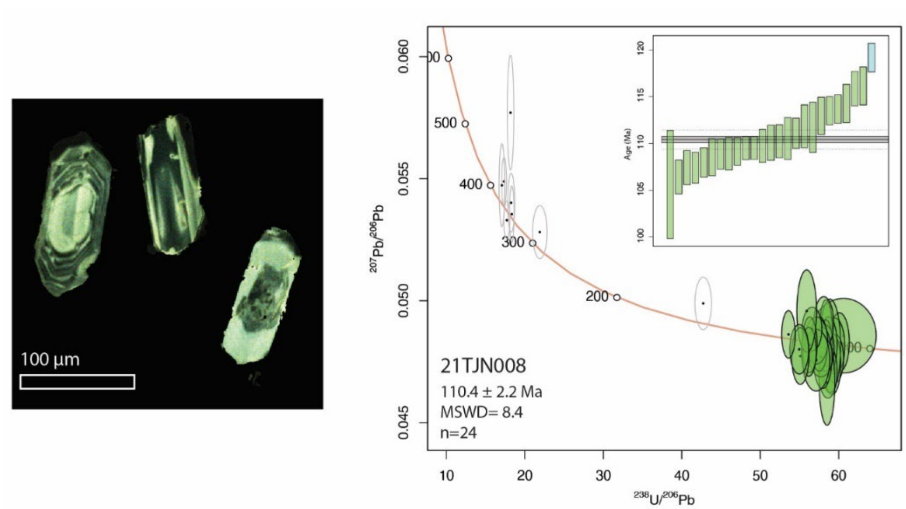


Figure 19. U-Pb data for sample 21TJN008. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21TJN114

21TJN114 is an altered granite with the following mineralogy: 35 percent plagioclase (0.1–0.7 mm, subhedral, commonly twinned, extensively altered by muscovite and/or clinozoisite); 30 percent quartz (0.1–1 mm, anhedral, interstitial, undulatory extinction common); 23 percent alkali feldspar (0.1–0.6 mm, untwinned, less altered than plagioclase); 5 percent chlorite (0.05–0.2 mm, subhedral aggregates, partly to completely replaces biotite, disseminated and in veinlets with clinozoisite); 3 percent clinozoisite (0.1–0.5 mm, disseminated in plagioclase and in veinlets with chlorite); 1.5 percent muscovite (0.2–0.4 mm, subhedral); 1 percent biotite (0.1–0.3 mm, subhedral, partly to completely replaced by chlorite); 1 percent pyrite (0.1–0.3 mm, partially oxidized cubes); and 0.5 percent titanite (0.1–0.5 mm, subhedral to anhedral, commonly associated with clinozoisite, probably secondary). The sample contains patchy pyrite on fracture surfaces. The sample is sericite-altered, sub-equigranular, biotite granite. It appears to be almost aplitic with chlorite-clinozoisite veinlets. The hand sample was found as float.

Sample 21TJN114 yielded a population of subhedral and equant (a few elongated) zircon grains 50–100 µm long (fig. 20). Internal textures of several grains are igneous and display oscillatory and sector zonation, however many of the more equant grains preserve a convoluted and mosaic zonation. Cores are present and assumed to be inherited. The rims of some of the zircon grains are jagged and CL-bright, but too narrow to analyze.

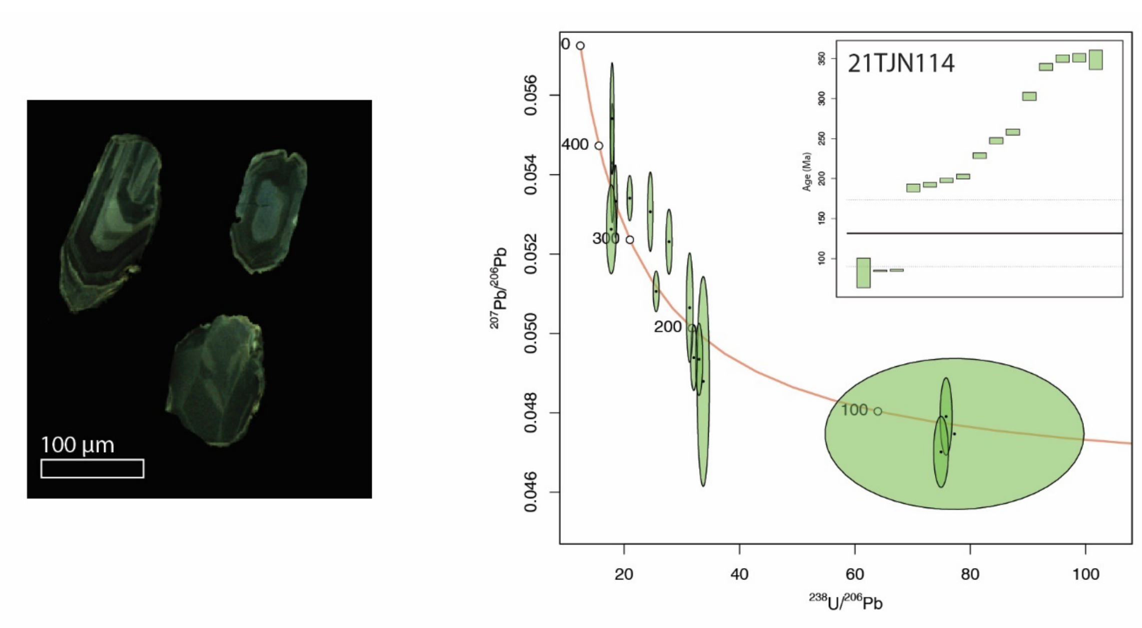


Figure 20. U-Pb data for sample 21TJN114. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of ^{206}Pb/^{238}U weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21TJN180

21TJN180 is a pinkish-weathering rhyolite tuff with the following mineralogy: 35 percent clasts (glassy, strongly iron oxide stained, and laminated shards, 0.3–3 mm); 33 percent glass (isotropic or nearly isotropic matrix); 15 percent devitrified glass (zones and lenses of 0.003 to 0.005 mm intergrown quartz and feldspar, possible alkali); 5 percent plagioclase (0.5–2 mm, broken crystals more abundant than euhedral crystals, strong concentric zoning); 5 percent quartz (0.1–3 mm, broken, euhedral, and strongly embayed grains); 5 percent alkali feldspar (0.3–1 mm broken crystals, untwinned or Carlsbad twinned, possible sanidine); and 2 percent biotite (0.5–2 mm, euhedral grains). The rock is a potassically altered, partially weathered rhyolite crystal-lithic tuff and is about 15 percent crystals (many broken), 35 percent rhyolitic clasts, and 50 percent glassy or formerly glassy matrix. The hand sample was found as float.

Sample 21TJN180 yielded a population of subhedral to euhedral and elongated with lesser equant zircon grains with an average length of 200–350 µm (fig. 21). Most of the grains exhibit oscillatory zoning—several with sector zoning—and are commonly fractured with jagged edges. Inclusions are also common throughout the population; CL-dark zones were interpreted to be metamict and avoided.

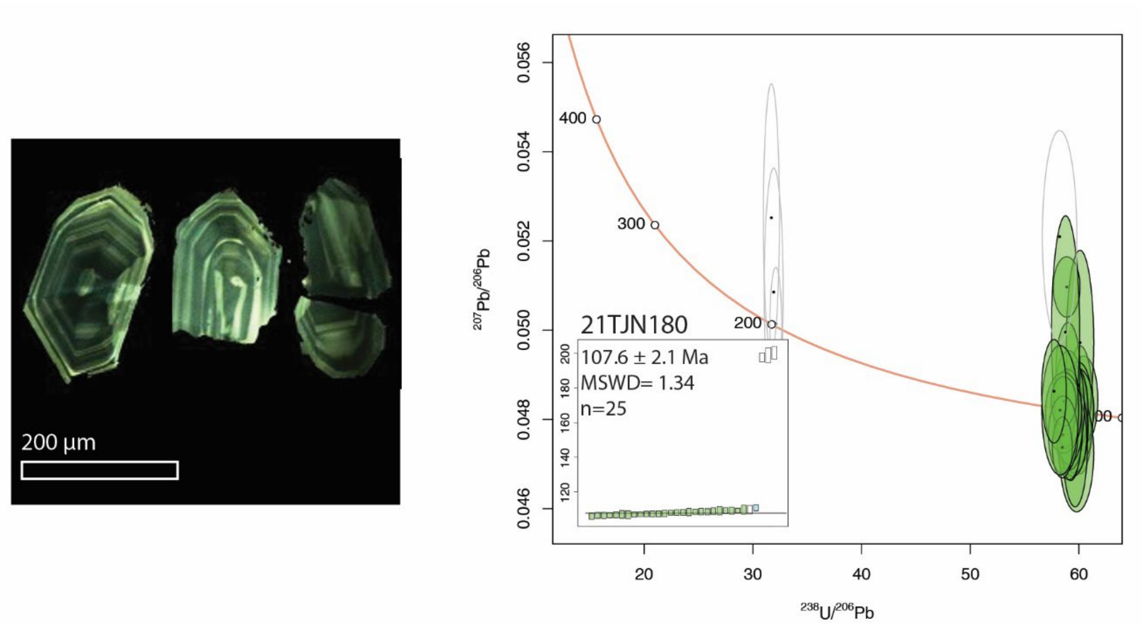


Figure 21. U-Pb data for sample 21TJN180. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

Jurassic Intrusive and Metamorphic Rocks

21ADW052

21ADW052 is a slightly mylonitic, green and dark gray amphibolite with the following mineralogy: 43 percent plagioclase (0.1–1 mm, anhedral, some twinned, major to minor replacement by sericite and/or epidote); 40 percent hornblende (0.2–2.5 mm, subhedral, green-blue green-brown pleochroic grains); 4 percent epidote (0.05–0.8 mm subhedral to anhedral grains, replacement of hornblende [with chlorite], as irregular replacements of plagioclase, and as veinlets cross-cutting schistosity); 3 percent alkali feldspar (0.2–1 mm, anhedral, microcline, twinned); 3 percent chlorite (0.05–0.2 mm, major replacement of biotite and minor replacement of hornblende); 2 percent biotite (0.1–0.4 mm, subhedral grains, partly to completely replaced by chlorite); 2 percent sericite (0.02–0.07 mm, subhedral replacements of plagioclase); and trace amounts of apatite, titanite, and opaques. The hornblende and biotite (now mostly chlorite) grains are relatively well-aligned. The plagioclase is weakly to strongly sericitized. The sample is cross-cut by epidote-rich veinlets, partially weathered, found near quartzite and gneiss, and was collected from an outcrop.

Sample 21ADW052 yielded a population of subhedral to subrounded zircon grains 50–200 µm long (fig 22). Internal textures display a relict oscillatory zonation with a metamorphic and convoluted overprint, and inherited cores are common (typically CL-dark). The grains often display fractures and are broken/recrystallized at their edges.

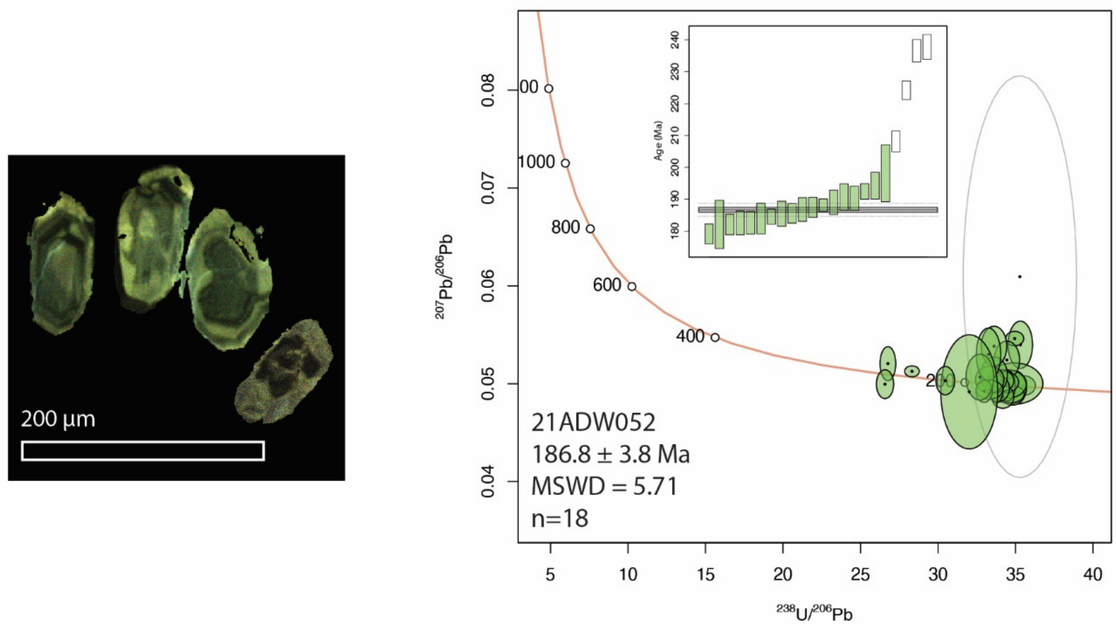


Figure 22. U-Pb data for sample 21ADW052. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21AW136

21AW136 is a pale gray, porphyritic granodiorite with a grain size 0.03 of 15 mm—up to 15-mm-long feldspar phenocrysts in a finer, up to 5-mm-long feldspar, quartz, biotite, and hornblende matrix— and has the following mineralogy: 45 percent plagioclase (0.5–5 mm, subhedral, commonly twinned, concentrically zoned, partly replaced by epidote); 20 percent alkali feldspar (1–8 mm, subhedral to anhedral, untwinned or microcline twinned, albite exsolution is common; larger grains are oikocrystic); 19 percent quartz (0.03–1.5 mm, anhedral, commonly interstitial, commonly with undulatory extinction); 10 percent hornblende (0.3–3 mm, subhedral to euhedral, green-blue to green-brown pleochroism, some grains have biotite inclusions, slightly altered to epidote and chlorite); 2 percent biotite (0.2–1 mm, subhedral, found as isolated grains and inclusions in hornblende); and minor amounts of epidote, titanite, apatite, allanite, and opaques. The sample was collected from a subcrop and is a slightly altered, porphyritic biotite-hornblende granodiorite with randomly oriented grains. The large potassium feldspar grains contain many inclusions.

Sample 21AW136 yielded a population of euhedral and equant to elongated zircon grains averaging 75–125 µm in length (fig. 23). Internal textures are igneous with oscillatory zoning from core to rim and lesser convoluted zonation in the cores. Large fractures are very common and there is some evidence of metamictization, both of which were avoided during analysis.

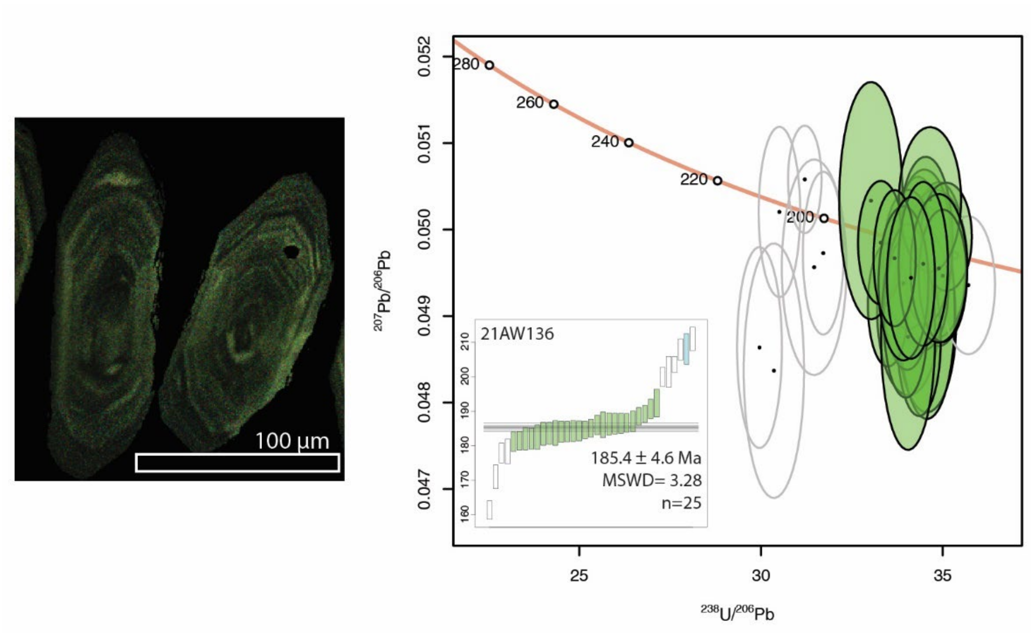


Figure 23. U-Pb data for sample 21AW136. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21AW180

21AW180 is a black and white, subequigranular syenite with a grain size of 3 to 5 mm and has the following mineralogy: 70 percent feldspar (subhedral, grain size up to 3 mm and largely sericitized); 15 percent clinopyroxene (colorless to gray, medium relief); 10 percent biotite (large biotite flakes that are partially altered to chlorite and have frequent opaque inclusions); 5 percent opaque mineral (likely magnetite as suggested by high magnetic susceptibility measurements at sample location); and trace garnet (two small and nearly round grains in thin section are isotopic and likely garnet, possibly as xenocrysts). This sample was collected from the Taylor Mountain Batholith and is the first thin-section observed to have pyroxene instead of hornblende. The sample displays trace weathering and was collected from an outcrop.

Sample 21AW180 yielded a few zircon grains that are anhedral to subhedral, elongated and fractured, and around 75–150 µm in length (fig. 24). Zonation is very convoluted with some lengthwise zoning preserved. CL-bright rims are common and too narrow for analysis.

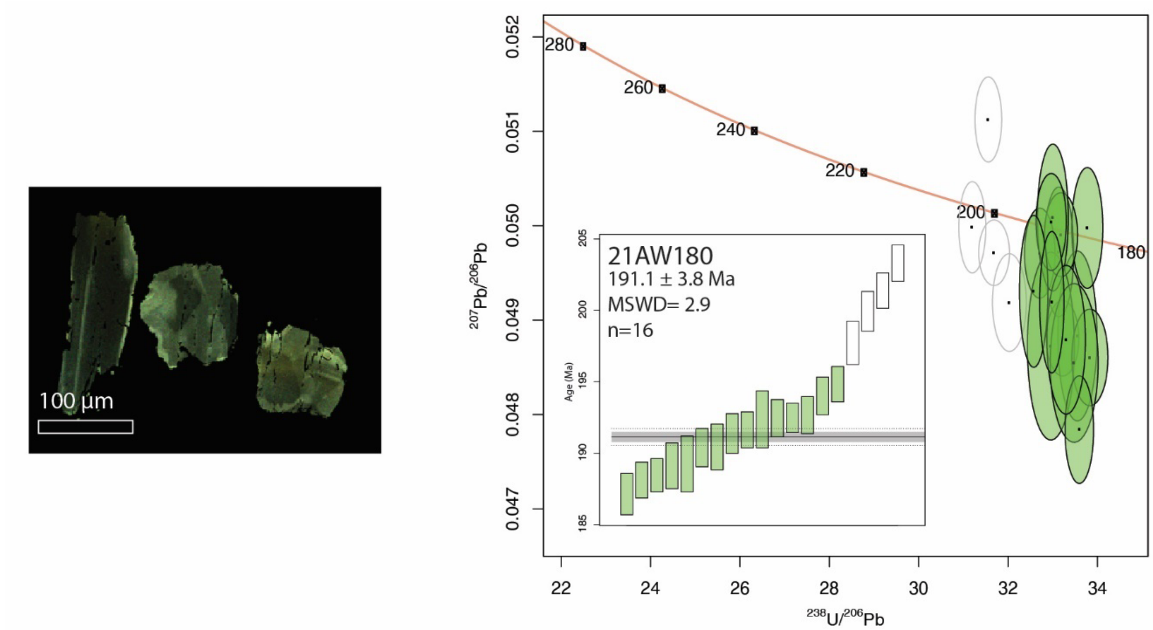


Figure 24. U-Pb data for sample 21AW180. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21ET227

21ET227 is a light gray, subequigranular to porphyritic, granite dike with a grain size of 0.1 to 1 mm and has the following mineralogy: 39 percent alkali feldspar (1–4 mm, subhedral, albite exsolution common); 32 percent quartz (0.1–1 mm, anhedral); 20 percent plagioclase (0.5–1.5 mm, subhedral); 3.5 percent biotite (0.1–0.5 mm subhedral grains, partly altered to chlorite); 2.5 percent chlorite (partial alteration of biotite); 1.5 percent epidote (0.1–0.3 mm, subhedral, associated with chloritized biotite, also found as inclusions in plagioclase); 0.5 percent opaque (0.1–0.2 mm, subhedral, probably magnetite); and 0.5 percent titanite (subhedral). The sample's mineralization is local clots of pyrite and chalcopyrite, now iron oxide. The rock is interpreted to be a propylitically altered, porphyritic hornblende-biotite granite with local inclusions of syenite and possible gneiss. Porphyritic grains are randomly oriented. The hand sample is partially weathered and was collected from an outcrop.

Sample 21ET227 yielded a zircon population with a variety of textures (fig. 25). Grains are mostly subhedral to euhedral and elongated, or equant and subrounded, and 100–250 µm long. Internal textures are magmatic and display oscillatory or sector zonation with occasional evidence of intermediate resorption preceding the final stage of crystal growth. Several zircon grains are CL-dark, and some grains display a more convoluted chemical zonation or fractures. These are interpreted to be metamict and were avoided during analysis.

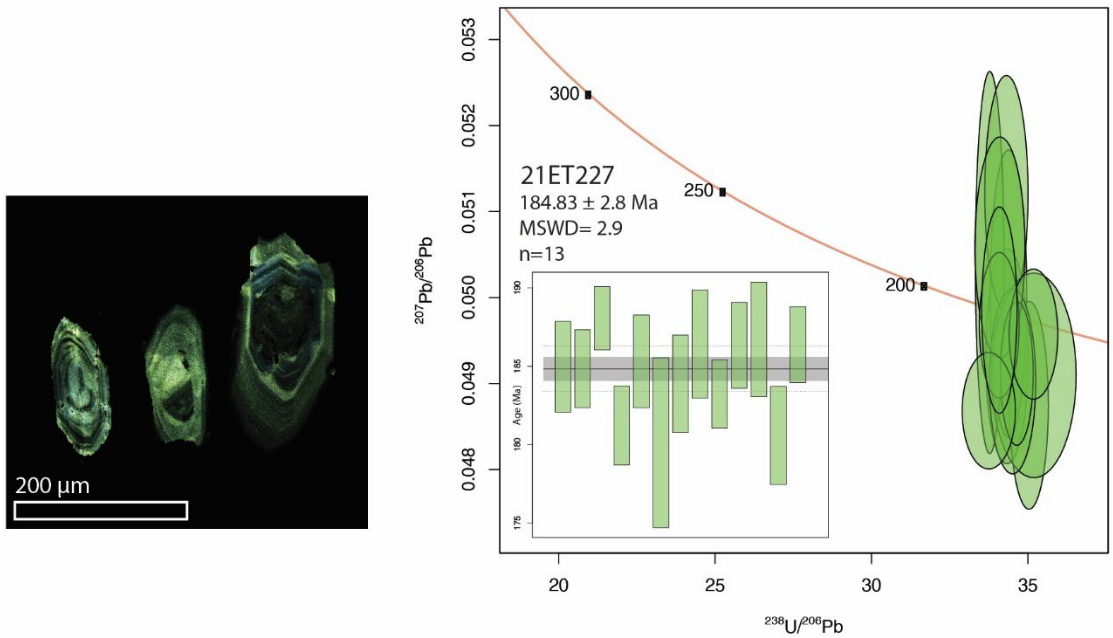


Figure 25. U-Pb data for sample 21ET227. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21MLB187

21MLB187 is an altered, porphyritic hornblende-quartz syenite with a grain size of 0.2 to 30 mm and has the following mineralogy: 45 percent alkali feldspar (0.5–10 mm, albite exsolution); 20 percent plagioclase (0.5–3 mm, subhedral, sericite, calcite and epidote alterations are common); 14 percent hornblende (0.3–3 mm, mostly euhedral but with chlorite alteration along cleavage surfaces); 14 percent quartz (0.2–1.5 mm, anhedral, interstitial); 2 percent chlorite (partial replacement of hornblende and complete replacement of biotite); 1 percent sericite (0.01–0.05 mm grains replacing plagioclase); 1 percent epidote (0.05–0.2 mm, subhedral, surrounds and replaces hornblende); 1 percent titanite (0.1–1 mm, subhedral to anhedral, possibly secondary); 0.5 percent apatite (0.05–0.2 mm, subhedral to euhedral); and 0.5 percent opaque (0.03–0.1 mm, subhedral, mostly assumed to be magnetite). The hornblende is slightly chloritized. The hand sample has trace weathering and was collected from an outcrop.

Sample 21MLB187 yielded a population of euhedral and elongate zircon grains approximately 200–250 µm long (fig. 26). Internal textures are igneous and display oscillatory zonation and core-rim textures (commonly xenocrystic cores followed by continued crystal growth). Fractures through the grains are infrequent and there is some evidence of local resorption at their edges. Most grains are CL-bright with few areas of radiation damage that are CL-dark.

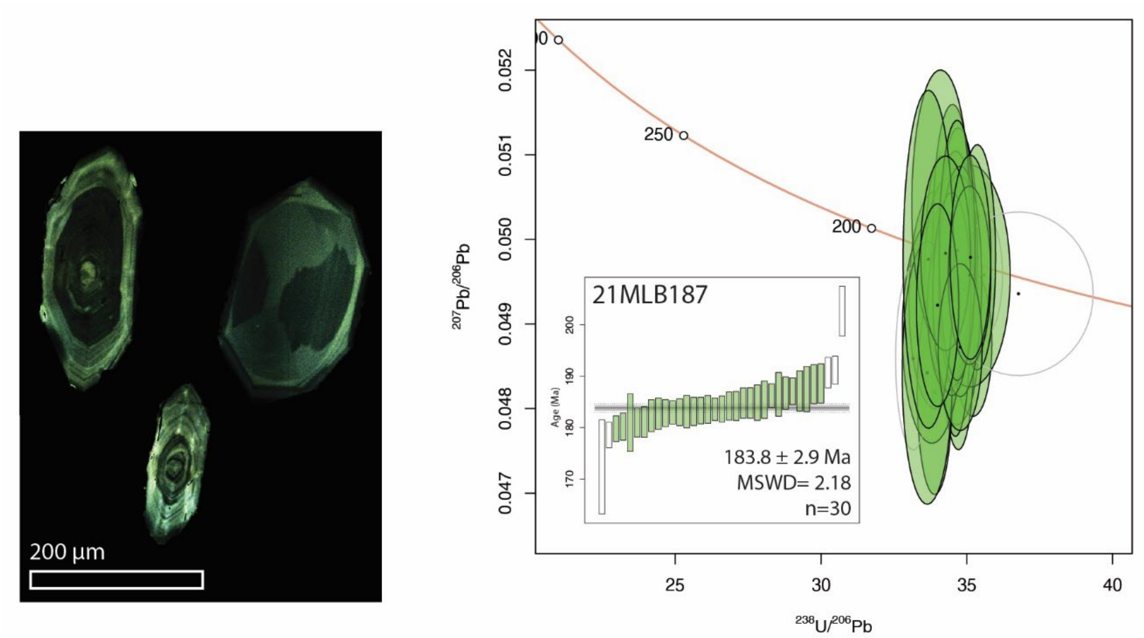


Figure 26. U-Pb data for sample 21MLB187. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

Triassic Intrusive Rocks

21ADW136

21ADW136 is a dark gray and black, quartz diorite with a grain size of <1 to 3 mm and has the following mineralogy: 30 percent plagioclase (phenocrystic, subhedral, with occasional myrmekite around rims); 20 percent microcline (phenocrystic, tartan twinning, occurs alternating with plagioclase albite twins and as the core of some zoned plagioclase); 20 percent hornblende (elongate with some interstitial quartz); 15 percent biotite (elongate, forms weak foliation, minor chlorite alteration); 15 percent quartz (granoblastic, very fine-grained, interstitial, undulose extinction observed). The sample is interpreted to be a weakly foliated marginal portion of the Taylor Mountain batholith with fabric defined by hornblende and biotite. Sample is partially weathered and found as float.

Sample 21ADW136 yielded a population of euhedral and elongate zircon grains approximately 150–250 µm long (fig. 27). Internal texture displays dominantly oscillatory zonation with lesser irregularities with core and rims.

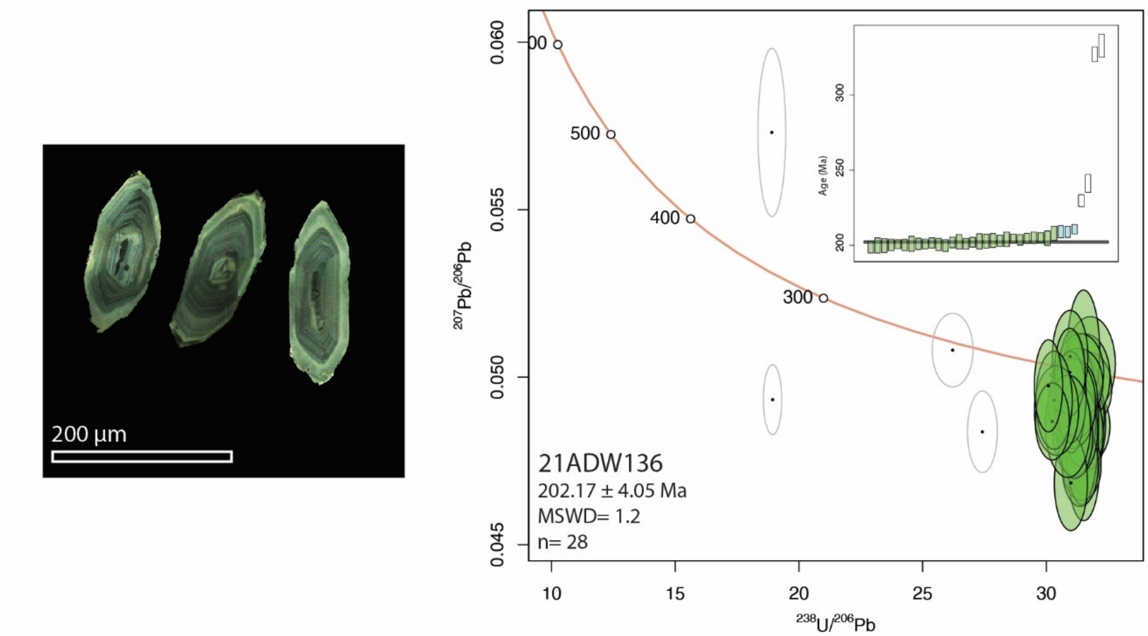


Figure 27. U-Pb data for sample 21ADW136. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21ADW146

21ADW146 is a dark gray and black, altered gabbro with a grain size of 0.05 to 3 mm and has the following mineralogy: 35 percent clinozoisite (0.1–0.3 mm, subhedral masses replace original plagioclase, anomalous blue interference colors); 20 percent actinolite (0.3–1 mm, nearly colorless, replaces hornblende); 15 percent albite (0.1–0.2 interstitial grains with clinozoisite and chlorite, replaces former plagioclase); 14 percent hornblende (0.5–3 mm phenocrysts, partly replaced by actinolite); 5 percent muscovite (0.05–0.25 mm, randomly oriented grains completely replace [with epidote] original plagioclase, cross-cutting veinlets); 5 percent chlorite (scaley masses replace hornblende and plagioclase); 3 percent opaque (0.1–0.4 mm, subhedral to anhedral, partly replaced by titanite); 2 percent epidote (0.1 mm, subhedral, distinctly yellow-green pleochroic, higher relief than the clinozoisite); and 1 percent titanite (0.05–0.1 mm, subhedral, disseminated, some surrounds opaque). The sample is a coarse-grained gabbro with bleached and weathered plagioclase that are replaced by clinozoisite, muscovite, and albite. Hornblende crystals have been replaced by actinolite and chlorite. Sample is weakly magnetic compared to other parts of the ridge it was collected from, is partially weathered, and was collected from an outcrop.

Sample 21ADW146 yielded a population of [fill in rest of sentence regarding zircon yield]. CL imaging of the zircon grains extracted from this sample were not provided from the lab, but backscatter electron (BSE) imaging (fig. 28) shows that zircons are 100–300 um long and mostly anhedral or fragments. U/Th ratios of individual grains are ambiguous (Corfu and others, 2003) and thus are not useful for discerning igneous versus metamorphic origin in this case.

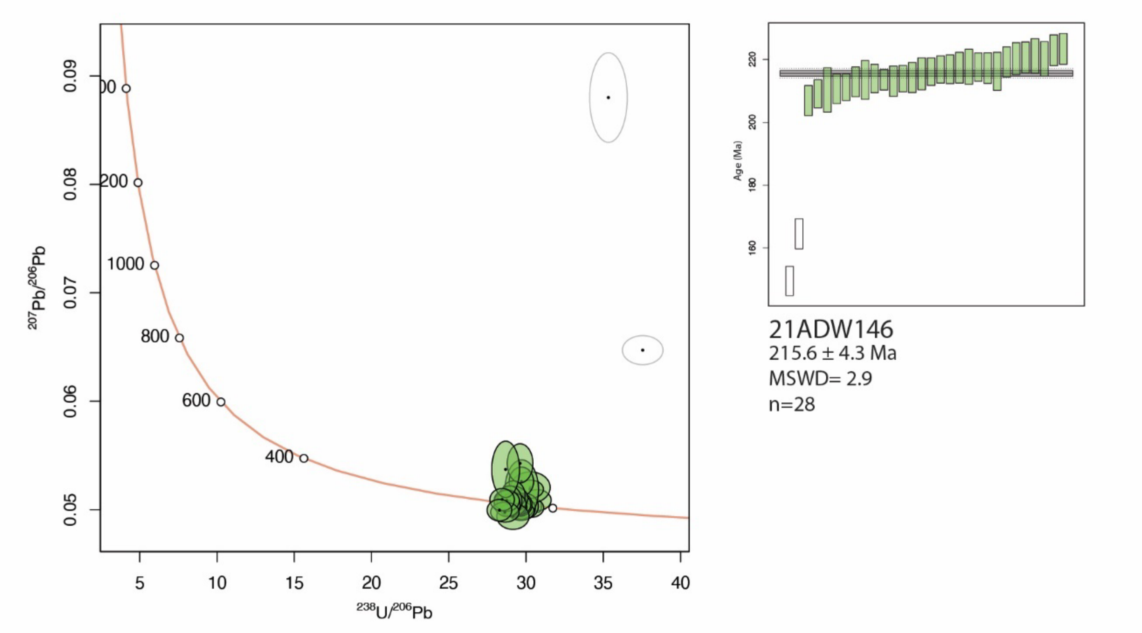


Figure 28. U-Pb data for sample 21ADW146. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21AW152

21AW152 is a weakly strained and foliated, dark gray to dark green, hornblende gabbro with a grain size of 0.3 to 13 mm and has the following mineralogy: 60 percent plagioclase (0.3–1.5 mm, commonly twinned, with minor sericite alteration); 29 percent hornblende (0.3–1.3 mm long, green-brown-blue pleochroic, and semi-aligned); 3 percent chlorite (alteration of former biotite); 2 percent calcite (associated with chlorite in former hornblende grains); 2 percent titanite (surrounding ilmenite); 1 percent ilmenite (isolated grains, often surrounded by titanite); 1 percent epidote (with calcite and chlorite in former hornblende grain); 1 percent sericite (minorly replacing plagioclase); 1 percent apatite (typically 0.05 mm, subrounded, with inclusions); and trace pyrite (0.03–0.05 mm, subhedral, disseminated grains). Large, up to 13-mm long, aligned feldspar phenocrysts are in a matrix of mostly hornblende grains with some feldspar. Pyrite is disseminated throughout the rock. Gabbro is not sufficiently foliated to be a gneiss but there is too much alignment of the crystals to be completely undeformed. Sample is observed to have trace weathering and was collected from an outcrop.

Sample 21AW152 yielded a population of euhedral and equant to elongated zircon grains typically 100–200 µm long (fig. 29). All grains are CL-bright with occasional xenocrystic cores that appear to be metamict, but the majority display regular oscillatory zonation.

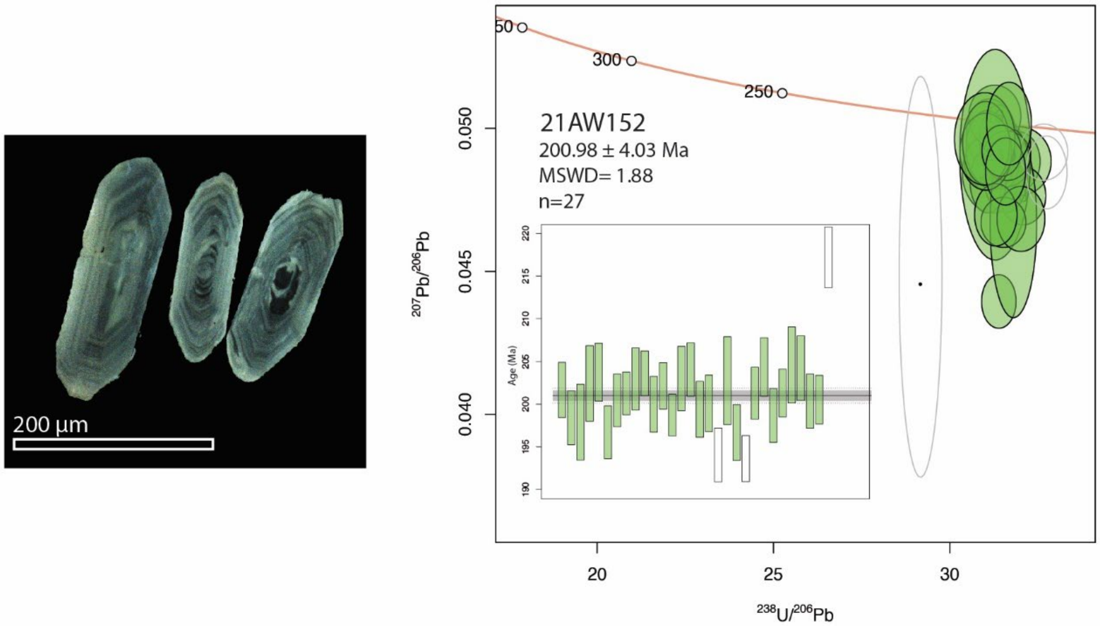


Figure 29. U-Pb data for sample 21AW152. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21AW185

21AW185 is a gray and tan, tonalite porphyry dike with a grain size of 0. 01 to 10 mm and has the following mineralogy: 25 percent feldspar (phenocrystic, typically 2 mm, but up to 10 mm long in hand sample, and are highly altered to sericite); 15 percent chlorite (blobs of chlorite are roughly tabular shaped, resembling phenocrysts of clinopyroxene[?], some residual skeletal grains in their centers); 5 percent clinopyroxene (2–5 mm long, medium-high relief, pale gray to colorless, high birefringence, skeletal grains within phenocryst-shaped blobs of chlorite); 5 percent opaque mineral (likely to be magnetite [± pyrite] based on high magnetic susceptibility and shape, up to 0.5 mm); and 50 percent groundmass. The sample was collected from a subcrop and is severely calcite-chlorite-sericite altered.

Sample 21AW185 yielded a population of euhedral, fractured, and equant to elongated zircon grains 100–300 µm long (fig. 30). Internal textures are primarily igneous with alternating CL-bright and Cl-dark oscillatory zonation. Some grains have very convoluted zonation, evidence of metamictization, and holes or inclusions in their cores. The rims of the zircon grains are commonly jagged and/or fractured. The 203 Ma age was interpreted as the dike emplacement age, with older grains being attributed to country rock xenocrysts.

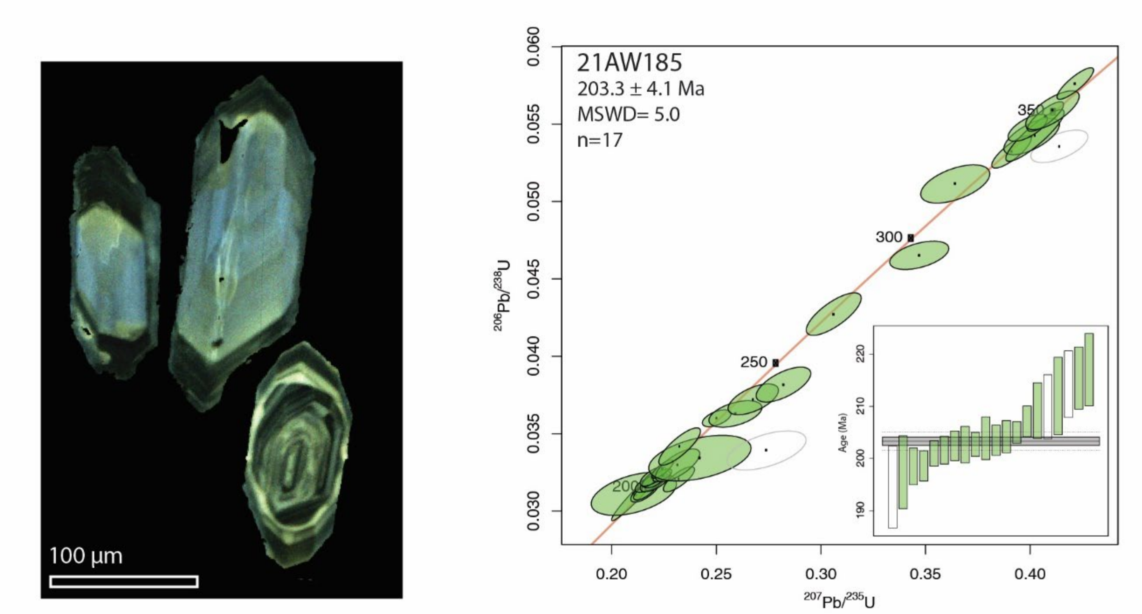


Figure 30. U-Pb data for sample 21AW185. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21RN257

21RN257 is a green, gneissic metagabbro with a grain size of 0.2 to 2 mm and the following mineralogy: 70 percent hornblende (0.3–1 mm, blue-green-brown pleochroic); 20 percent epidote (aggregates of 0.05 mm grains, high relief and birefringence); 7 percent titanite (aggregates of 0.05 mm crystals); 1.5 percent biotite (interstitial to hornblende); 1 percent quartz (interstitial); and 0.5 percent magnetite (as inclusions in cores of titanite). The sample is a biotite-epidote-hornblende amphibolite which lacks plagioclase, shows signs of trace weathering, and was collected from a subcrop. The chemical composition indicates a mafic protolith (Wypych and others, 2022).

Sample 21RN257 yielded a small population of subhedral and elongated zircon grains approximately 200 µm long (fig. 31). The zircon grains display relict sector zonation with a metamorphic overprint of convoluted and thickened bands. There is some evidence of resorption and/or recrystallization at the grain edges which can be CL-bright.

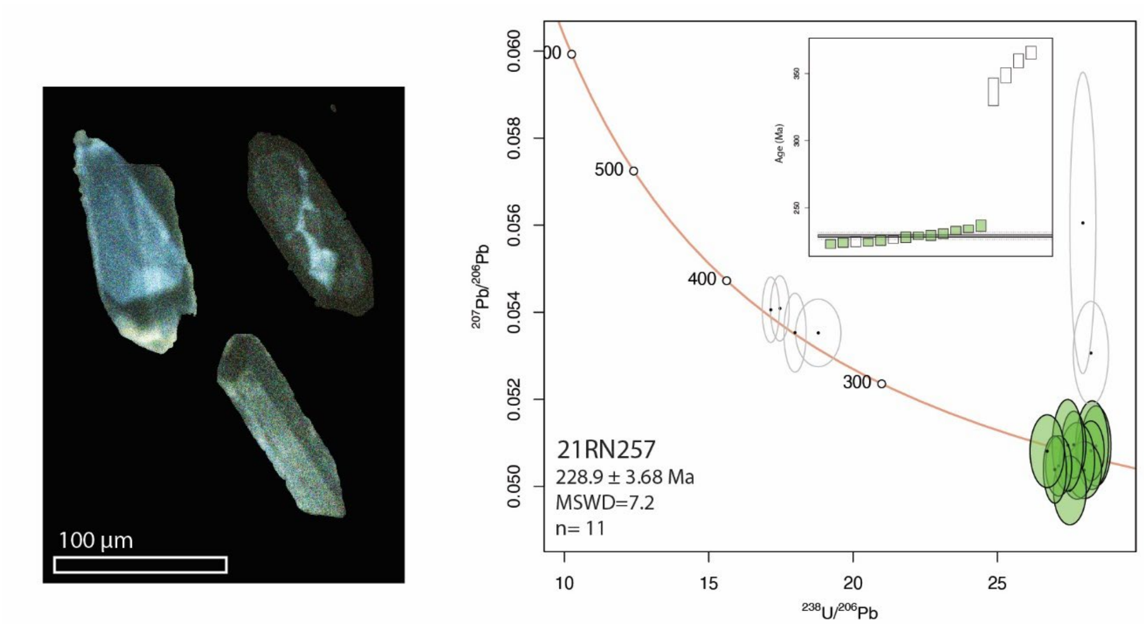


Figure 31. U-Pb data for sample 21RN257. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21TJN101

21TJN101 is an altered, porphyritic granodiorite with bimodal grain size of 0.5 to 5 mm and has the following mineralogy: 45 percent plagioclase (0.5–5 mm, subhedral, commonly twinned, moderately altered to muscovite, calcite and/or clinozoisite); 20 percent quartz (0.1–1 mm, anhedral, interstitial, commonly with undulatory extinction); 11 percent alkali feldspar (0.5–4 mm, subhedral); 8 percent biotite (0.1–0.5 mm, subhedral, green [secondary?] + brown [primary] grains, partly replaced by chlorite + epidote); 5 percent epidote (0.1–1 mm subhedral yellow-green pleochroic grains); 4 percent chlorite (0.1–0.3 mm, partial replacement of hornblende and biotite); 2 percent muscovite (0.05–0.2 mm, subhedral grains, replacing plagioclase); 2 percent clinozoisite (0.02–0.05 mm grains as aggregates replace plagioclase); 1 percent calcite (0.1–0.3 mm, anhedral, replaces plagioclase); 1 percent apatite (0.05–0.3 mm subhedral-euhedral grains); and 1 percent titanite (0.05–0.3 mm subhedral to euhedral grains, commonly with opaque inclusions, so likely secondary), mineralization: quartz and calcite veinlets with pyrite. The vein selvages are chloritized, and pyrite is on vein surfaces. Minor pyrite is disseminated in the granodiorite where veins are closely spaced. Rock is a propylitically altered, porphyritic biotite granodiorite. A hand sample was collected from a subcrop.

Sample 21TJN101 yielded a population of euhedral to subhedral and elongated zircon grains 50–200 µm long (fig. 32). All the grains are CL-dark to medium bright and dominantly preserve igneous textures. Several grains display a more complex and mosaic zonation, possible xenocrystic cores, and are either fractured and/or resorbed at their edges.

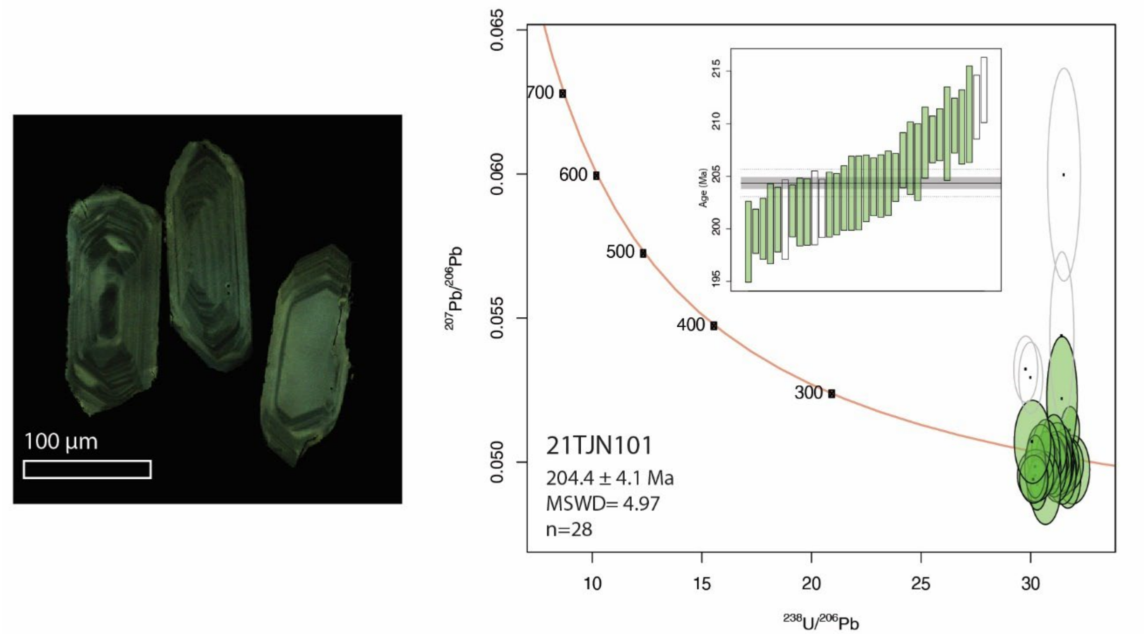


Figure 32. U-Pb data for sample 21TJN101. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21TJN161

21TJN161 is a white to light gray, seriate trondhjemite with a grain size of 0.1 to 3 mm and has the following mineralogy: 58 percent plagioclase (0.5–3 mm, subhedral, sericite dusted, oligoclase); 18 percent quartz (0.1–1.5 mm, anhedral, interstitial); 10 percent chlorite (0.1–0.3 mm, nearly complete replacement of hornblende with calcite, also nearly complete replacement of biotite); 4 percent alkali feldspar (0.5–1 mm, subhedral, microcline twinned); and minor amounts of sericite, titanite, biotite, and opaques. The sample is strongly altered, with the mafic minerals completely altered to a chlorite-calcite-epidote assemblage. However, the sample is fresher looking than other plutonic rocks along the ridge and was collected from a dug hole.

Sample 21TJN161 yielded a population of subhedral and equant zircon grains 100–150 µm long (fig. 33). Zonation is dominantly fine and oscillatory, with few xenocrystic cores. Many of the grains have fractures but remain unbroken. Inclusions and small areas of metamictization are present and were avoided during analysis.

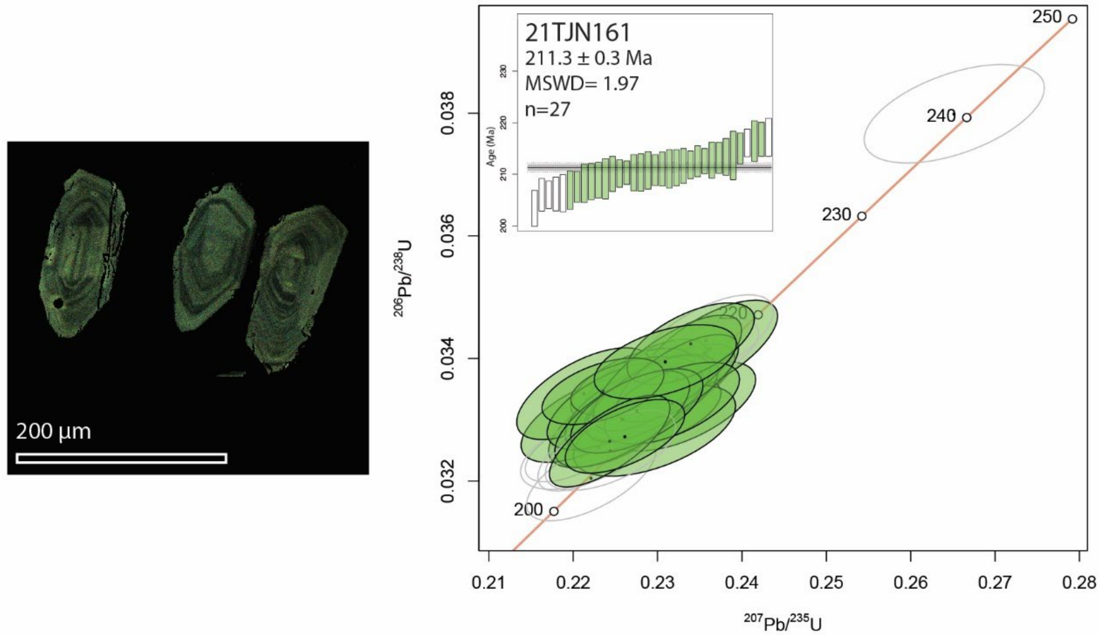


Figure 33. U-Pb data for sample 21TJN161. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21TJN234

21TJN234 is an amphibole-bearing tonalite with a grain size of 0.1 to 6 mm and has the following mineralogy: 55 percent plagioclase (0.2–5 mm, subhedral to euhedral, commonly twinned, strong concentric zoning is very common, partly replaced by sericite, calcite, and/or epidote); 20 percent quartz (0.1–2 mm, anhedral, undulatory extinction is common); 5 percent alkali feldspar (0.3–1.5mm, subhedral, untwinned, minor sericite, reflective index less than quartz; 7 percent hornblende (0.5–2 mm, euhedral to subhedral, green-blue-green-brown pleochroic, slightly replaced by chlorite + epidote); 5 percent chlorite (0.1–0.3 mm, subhedral, almost completely replaces biotite with epidote); 2 percent opaque (0.1–0.5 mm, euhedral to anhedral, partly replaces and partly replaced by titanite); 1 percent titanite (0.05–0.3 mm, anhedral to euhedral, commonly associated with chlorite and commonly contains opaque inclusions; some is probably late magmatic and some is secondary); 0.5 percent calcite (0.1–04 mm, anhedral, replacement of plagioclase, especially cores); 0.5 percent sericite (0.03–0.06 mm, subhedral, partly replaces biotite and plagioclase); and 0.5 percent biotite (0.1–0.3 mm, anhedral residual grains, mostly replaced by chlorite + epidote + sericite). The rock is propylitically altered, porphyritic, biotite-hornblende granodiorite with randomly oriented grains; some very coarse, mostly medium- to fine-grained; the plagioclase is very strongly zoned. The hand sample was collected from an outcrop.

Sample 21TJN234 yielded a population of euhedral and equant (lesser elongated) zircon grains175–350 µm long (fig. 34). The zircon grains are overall CL-bright, preserve oscillatory zoning, with some convoluted or complex zoning. A few grains have CL-dark cores and are interpreted to be metamict while others are fractured and/or altered: shown by jagged or convoluted zoning at their edges.

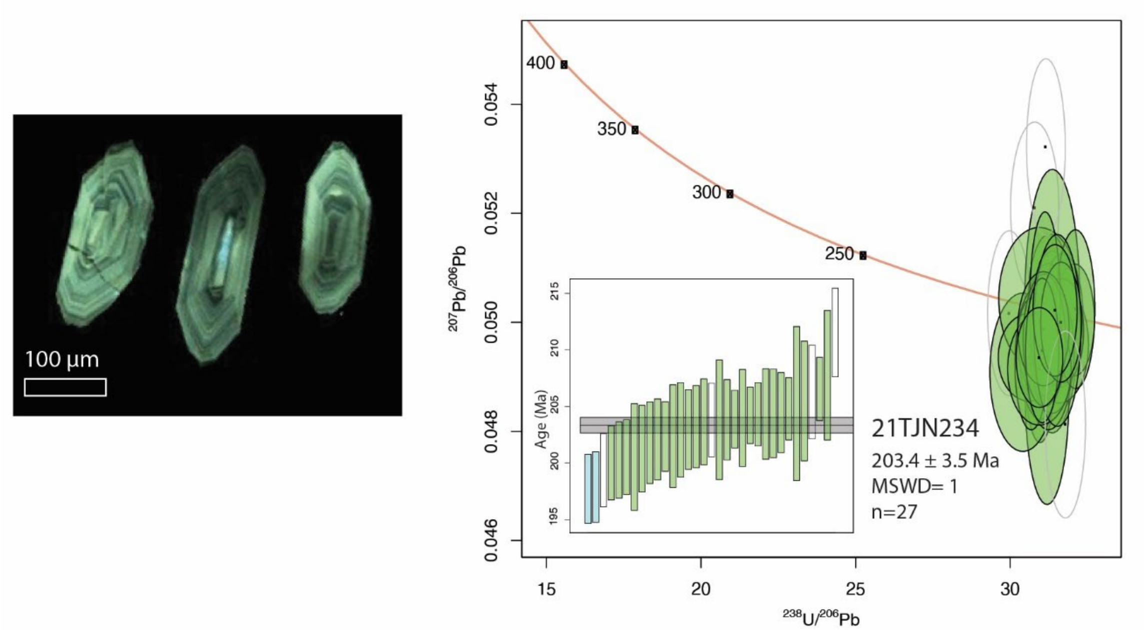


Figure 34. U-Pb data for sample 21TJN234. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

Permian Metamorphic and Igneous Rocks

21AW196

21AW196 is a leucocratic porphyritic granite with grain size of 0.1 to 6 mm and has the following mineralogy: 30 percent alkali feldspar (0.3–6 mm, subhedral grains, commonly twinned or with exsolution textures); 35 percent quartz (0.5–3 mm, anhedral grains, commonly with undulatory extinction); 26 percent plagioclase (0.2–2 mm subhedral grains, commonly twinned); 6 percent biotite (0.3–1.5 mm subhedral grains and grain clusters, slightly chloritized); 2 percent muscovite (0.1–0.3 mm, subhedral disseminated grains, common as replacements of feldspars); and 1 percent garnet (0.1–0.2 mm, irregular, anhedral grains). The sample is partially weathered and was collected from an outcrop of the Mount Warbelow pluton.

Sample 21AW196 yielded a population of euhedral to subhedral and elongate zircons 75–150 µm long (fig. 35). Internal textures are convoluted or display minor oscillatory zonation. All the grains are CL-dark which suggests metamictization or other odd uranium signal (isotopic data is discordant). A few of the zircon grains have CL-bright cores, and many are left as fractured or pieces of grains. No age was calculated for this sample due to strong alteration and unresolvable discordance.

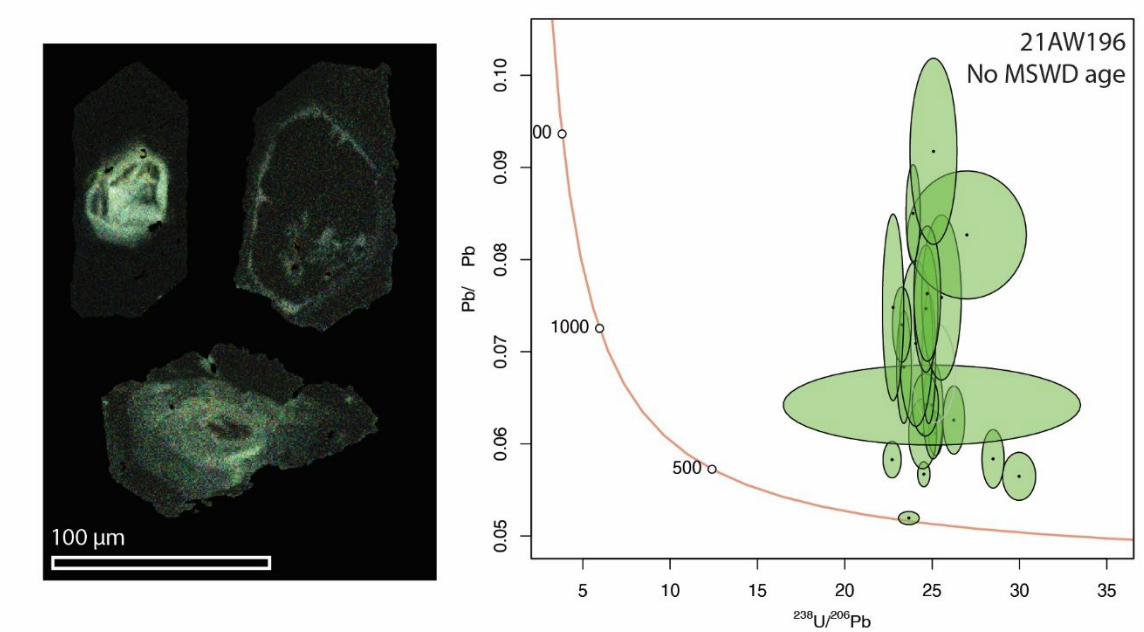


Figure 35. U-Pb data for sample 21AW196. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram.

21AW108

21AW108 is a dark gray to dark green, gabbroic greenstone with very-fine-grained phenocrysts in an aphanitic groundmass with a grain size of 0.1 to 0.5 mm and has the following mineralogy: 40 percent hornblende (0.1–0.6 mm, subhedral, green-brown pleochroic grains, surrounded and partly replaced by actinolite); 25 percent plagioclase (0.3–0.5 mm, anhedral, mostly untwinned, partly replaced by calcite, clinozoisite, chlorite and probably albite); 16 percent actinolite (0.1–0.5 mm, subhedral, colorless-pale green amphibole, surrounds and partly replaces hornblende); 12 percent chlorite (aggregates of 0.02–0.05 mm subhedral grains, colorless with low first-order interference colors, replaces plagioclase); 4 percent calcite (0.04–1 mm, subhedral, replaces plagioclase); 1 percent opaque (0.02–0.2 mm, subhedral to euhedral, mostly magnetite); 1 percent titanite (0.03–0.1 mm, subhedral to anhedral, associated with actinolite and chlorite replacement of hornblende); and trace amounts of apatite, muscovite, and clinozoisite. The randomly oriented hornblende grains are surrounded and partly replaced by randomly oriented actinolite; plagioclase is partly replaced by randomly oriented chlorite and calcite; could be called an extremely altered hornblende gabbro or otherwise greenstone. The sample is partially weathered and was collected from an outcrop.

Sample 21AW108 yielded a population of 100–200 µm-long zircon grains that are very fractured and mostly fragments (fig. 36). Primary textures include sector and straight zonation that is largely obscured by the fractures and irregular zonation. Zircon grains are overall CL-dim to -dark colored.

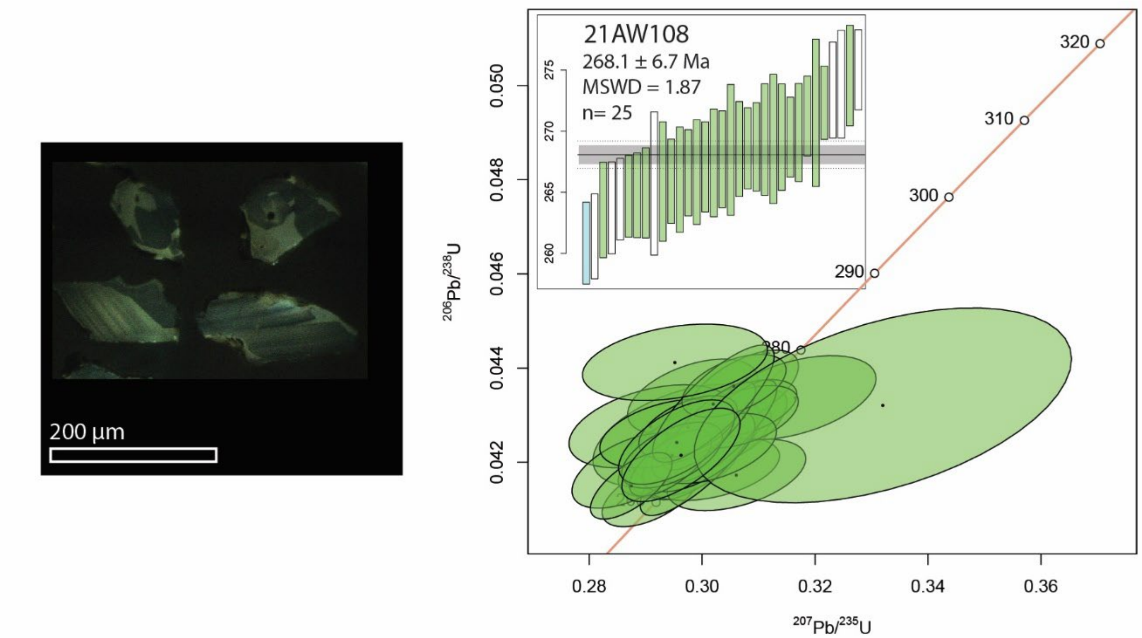


Figure 36. U-Pb data for sample 21AW108. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21ET101

21ET101 is a dark green, gneissic amphibolite with a grain size of 0.01 to 3 mm and has the following mineralogy: 48 percent hornblende (0.03–0.7 mm, green-brown-blue pleochroic amphibole); 47 percent plagioclase (0.1–2 mm, some twinned, dusted with sericite, An_{15-45}); 2 percent ilmenite (0.05–0.15 mm, subhedral isolated grains and rare inclusions in titanite); 1 percent epidote (rare); 1 percent titanite (0.1–1 mm, isolated subhedral grains, many with ilmenite inclusions); and minor calcite and biotite as disseminated grains. Foliation is defined by hornblende, weathering is trace, and the sample was collected as float.

Sample 21ET101 was originally separated and mounted for detrital zircon analyses and yielded a population of subhedral to subrounded, equant, and approximately 50–100 µm long zircon grains (fig. 37). Internal zonation is convoluted, probably preserves a metamorphic overprint, and grains are CL-bright. Resorbed edges and fractures are common throughout the grains.

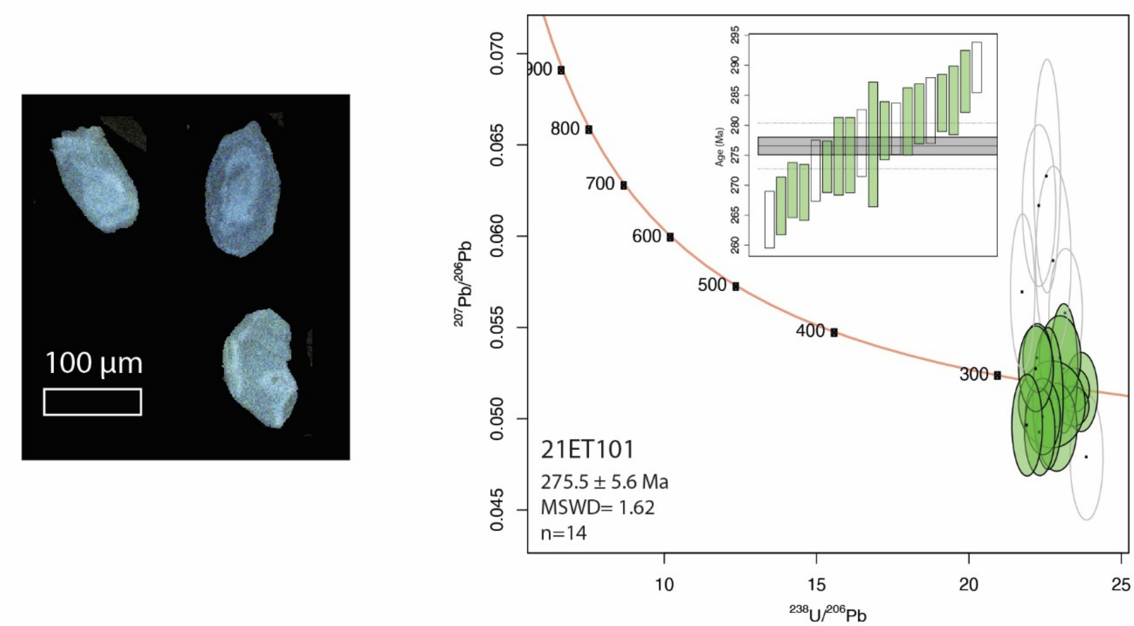


Figure 37. U-Pb data for sample 21ET101. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

19ET122

Sample 19ET122 is a foliated, pale green to tan greenschist with an average grain size of < 0.1 mm and has the following mineralogy: 45 percent quartz (0.05–0.1 mm, granular, subgrains, irregular boundaries, undulatory extinction); 25 percent albite (0.05–2mm); 10 percent chlorite (chlorite and clinozoisite are interstitial to granular quartz, form bands defining foliation); five percent clinozoisite (0.05 mm, disseminated, interstitial to quartz); 2 percent titanite; and 1 percent white mica.

The resulting isotopic data (n=10) suggests that this sample is metasedimentary, and there were not enough grains to determine an MDA. However, single concordant grains between 270 Ma–1.7 Ga were observed.

21MMG201

21MMG201 is a black and white, altered, biotite hornblende quartz diorite with a grain size of 0.5 to 2 mm and has the following mineralogy: 50 percent plagioclase (1–4 mm, randomly oriented, interlocking and appear to maintain their primary igneous texture, twinned, slightly to completely altered to epidote and sericite, some optically zoned); 16 percent hornblende (1–5 mm, as isolated grains and 1 cm clumps of grains; green-blue-brown pleochroic, partly altered to actinolite-epidote-chlorite); 10 percent quartz (0.1–0.5 mm, interstitial); 6 percent biotite (0.5–2 mm, partly to completely chloritized); 5 percent chlorite (0.05–0.2 mm, anomalously purple interference color, replaces biotite and hornblende); 4 percent epidote (0.02–0.1 mm, yellow-green pleochroic, as alteration of hornblende, biotite, and plagioclase); 3 percent sericite (0.005–0.01 mm flakes in plagioclase); 3 percent magnetite (0.02–0.4 mm, subhedral to euhedral, disseminated and in altered biotite); 2 percent actinolite (alteration of hornblende); and 1 percent microcline (rare 0.1–0.7 mm grains). The sample is epidote-sericite-chlorite altered, shows trace weathering, and was collected as float.

Sample 21MMG201 yielded a population of subhedral and elongated zircon grains with long axes typically 200-400µmlong (fig. 38). Internal textures are primarily igneous with lengthwise and sector zoning. Many of the zircon grains are broken.

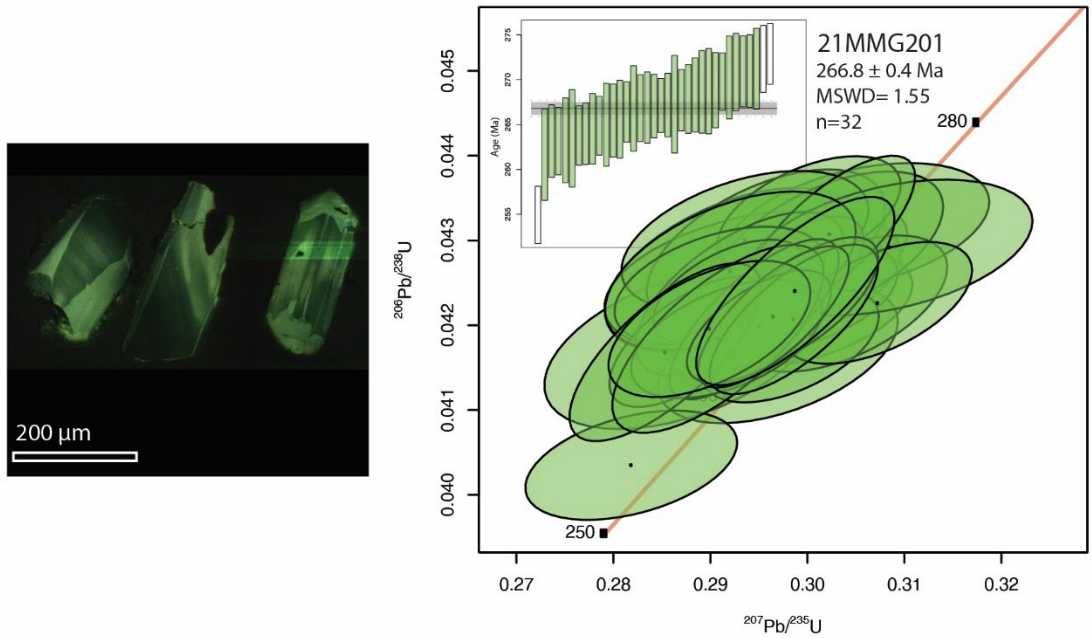


Figure 38. U-Pb data for sample 21MMG201. Cathodoluminescence images of representative zircon population, and Tera-Wasserburg concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

Devonian-Mississippian Metamorphic Rocks

21AW088

21AW088 is a porphyroclastic and schistose, kaolinite-altered paragneiss; slightly greenish and gray in color, weathering silver to maroon with a grain size of 0.1 to 7 mm and has the following mineralogy: 63 percent quartz (0.1–1 mm long anhedral grains with strong undulatory extinction); 15 percent kaolinite (0.002 mm grains that replace, as aggregates, 0.2–1.5 mm round to lenticular grains of former feldspar); 10 percent muscovite (0.03–1 mm subhedral grains; larger ones define schistosity, smaller ones are intergrown with disseminated calcite and veinlets with calcite); 5 percent calcite (0.1–0.3 mm long anhedral grains, disseminated with muscovite [after feldspar] and in cross-cutting veinlets with muscovite); 4 percent albite (difficult to observe in thin section because of the altered nature of the rock, however geochemical analysis suggests albite is present); and 3 percent opaque mineral (0.05–0.3 mm, subhedral to anhedral, partly or mostly oxidized, possibly former ilmenite + magnetite). The sample is a thinly layered schistose rock with large, up to 7-mm long, rotated feldspar porphyrocrysts. The texture resembles a paragneiss, but if so, all the feldspar has been replaced by sericite + calcite or by kaolinite. Sample collected from an outcrop.

This sample was originally interpreted to be metaigneous and was analyzed via LA-ICP-MS as such. The resulting isotopic data suggest this sample is metasedimentary and does not aid the regional interpretation.

21MMG105

21MMG105 is a deep black to gray, retrograded amphibolite with a grain size of 0.05 to 10 mm and has the following mineralogy: 45 percent hornblende (green pleochroism, grains are oriented along foliation planes and contain many inclusions, elongate and radial); 37 percent clinozoisite (0.1–0.5 mm aggregates of subhedral grains, replacement of plagioclase); 4 percent muscovite (0.05 –1 mm, intergrown with clinozoisite as replacement of plagioclase); 4 percent opaque mineral; 4 percent quartz (very fine-grained, intergrown with clinozoisite and muscovite); 5 percent biotite (only seen on one side of the thin section in a group along foliation); 3 percent chlorite (replacing hornblende and biotite); 5 percent epidote; and trace titanite. The amphibolite layer is approximately 3 meters thick at the sample location and the hand sample was collected from an outcrop.

Sample 21MMG105 yielded a population of subhedral to anhedral and mostly equant zircon grains 100–150 µm long (fig. 39). Internal textures display relict oscillatory and sector zonation with a metamorphic and convoluted overprint. Several grains are CL-dark and are interpreted to be metamict. Resorption and jagged edges are common throughout the zircon population.

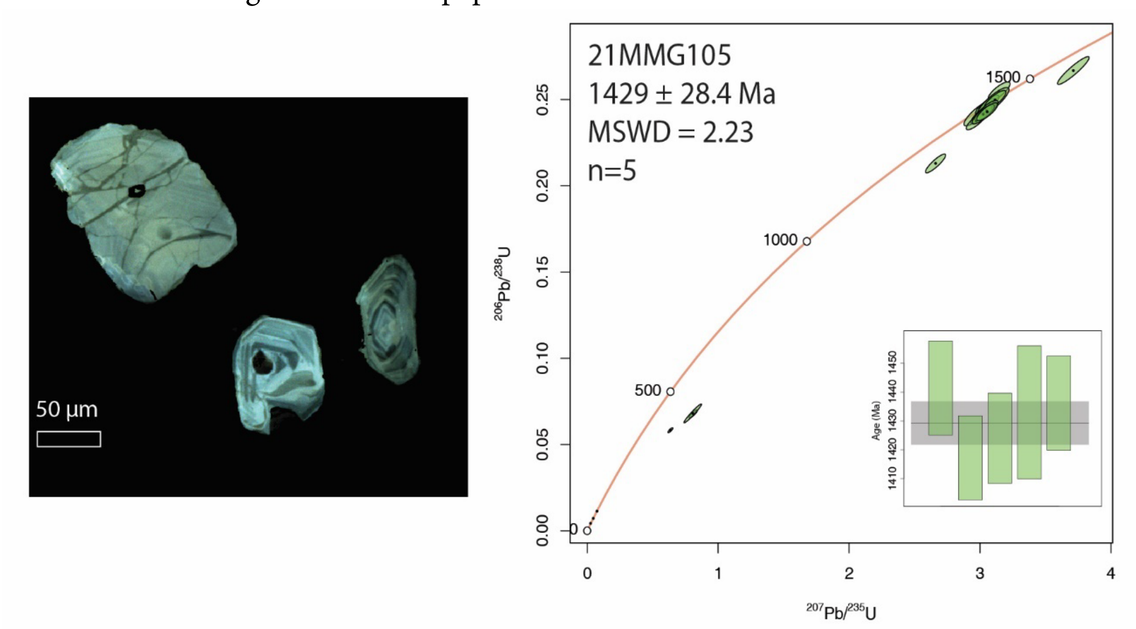


Figure 39. U-Pb data for sample 21MMG105. Cathodoluminescence images of representative zircon population, and concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21MMG119

21MMG119 is a massive greenstone with a grain size of 0.5 to 3 mm and has the following mineralogy: 35 percent clinozoisite (very fine-grained replacement of plagioclase); 15 percent actinolite (0.5–3 mm, possibly a pseudomorph after clinopyroxene); 15 percent quartz (fine-grained replacement of plagioclase); 10 percent albite (very fine-grained replacement of plagioclase); 10 percent prehnite (replaces former plagioclase); 5 percent epidote (disseminated in former mafic sites); 5 percent chlorite (disseminated, partial replacement of plagioclase); 3 percent calcite (disseminated in former plagioclase); 1 percent titanite (0.05 mm, pseudomorphs after ilmenite); and 1 percent muscovite (0.05 mm). The sample appeared to be entirely plagioclase and hornblende in hand sample; however, petrographic examination indicates the sample was gabbroic and entirely replaced by randomly oriented secondary minerals.

Sample 21MMG119 yielded a population of anhedral, elongated and equant, and strongly fractured zircon grains 50–200 µm long (fig. 40). Relict igneous lengthwise and oscillatory zonation is overprinted by metamorphic convoluted, thickened bands, and mosaic textures. Zircon grains are commonly fractured, broken, and jagged around their edges.

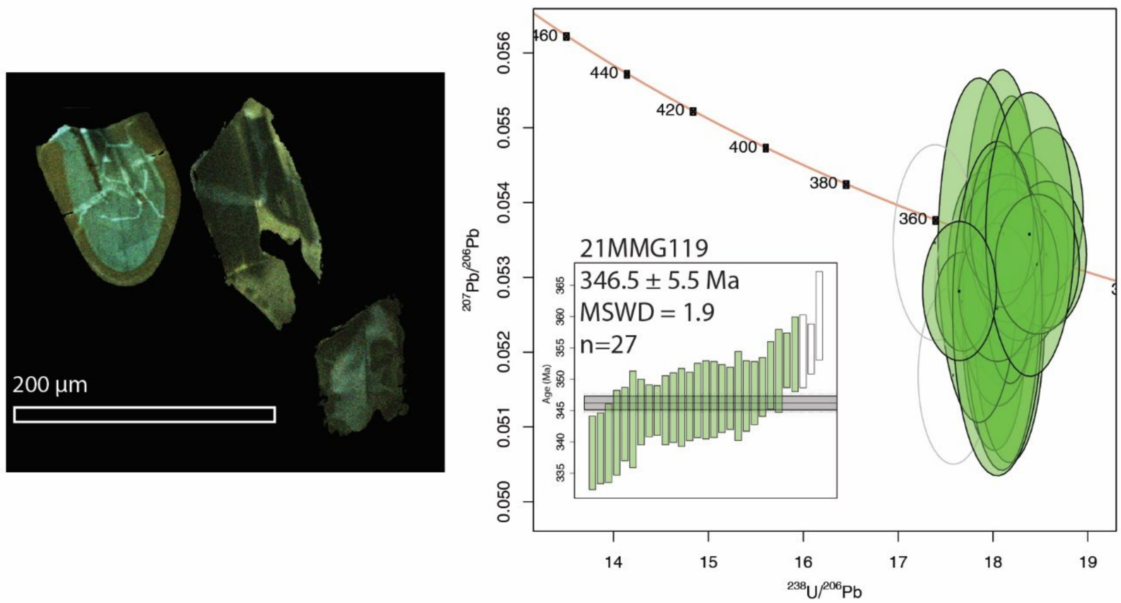


Figure 40. U-Pb data for sample 21MMG119. Cathodoluminescence images of representative zircon population, and concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

17MLW035

17MLW035 is a quartzite; dark gray in color with blue/purple cast, weathers tan, recrystallized, and sucrosic with a grain size of < 0.1 mm and has the following mineralogy: 95 percent quartz; 3 percent white mica; and 2 percent biotite. The sample is noted to have dark bands and weak foliation and was found as float. This sample yielded very few fragmented, CL-bright grains that exhibited broad and fine oscillatory zoning. No age was calculated for this sample due to low zircon yield and discordance.

21TJN226

21TJN226 is a strongly chloritized, leucocratic, hornblende-biotite granodiorite orthogneiss with recrystallized and altered mafics. Most of the quartz phenocrysts appear to be granulated into smaller grains, but not obviously sheared. The sample has a grain size of 0.1 to 3 mm and the following mineralogy: 40 percent plagioclase (0.1–3 mm, subhedral, commonly twinned, dusted with sericite); 36 percent quartz (0.05–0.5 mm, anhedral, former larger phenocrysts broken into jigsaw puzzle pieces, undulatory extinction is ubiquitous; some might be secondary); 15 percent alkali feldspar (0.1–2 mm, untwinned, less sericite dusted than plagioclase, refractive index is less than quartz); 5 percent chlorite (0.05–0.3 mm, replaces hornblende and biotite); 1 percent calcite (0.05–0.1 mm, anhedral, disseminated in groundmass); 0.5 percent hornblende (0.1 mm, remnants of grains, subhedral, mostly altered to chlorite); 0.5 percent sericite (0.03–0.05 mm, dusting of plagioclase); 0.5 percent biotite (0.1 mm, subhedral, remnants, mostly altered to chlorite + sericite); 0.5 percent apatite (0.05 mm, euhedral needles); and 0.5 percent opaque (0.05–0.1 mm, subhedral, probably magnetite + ilmenite). The hand sample was collected from a subcrop.

Sample 21TJN226 yielded a population of subhedral and equant zircon crystals 100–125 μm long (fig. 41). CL imaging reveals many inherited cores with occasional metamict zones. Subsequent zircon crystal growth around cores shows oscillatory and straight zonation. Fractures (and possibly holes) are commonly found throughout the population. CL-bright rims are shown on several grains and are too narrow for analysis.

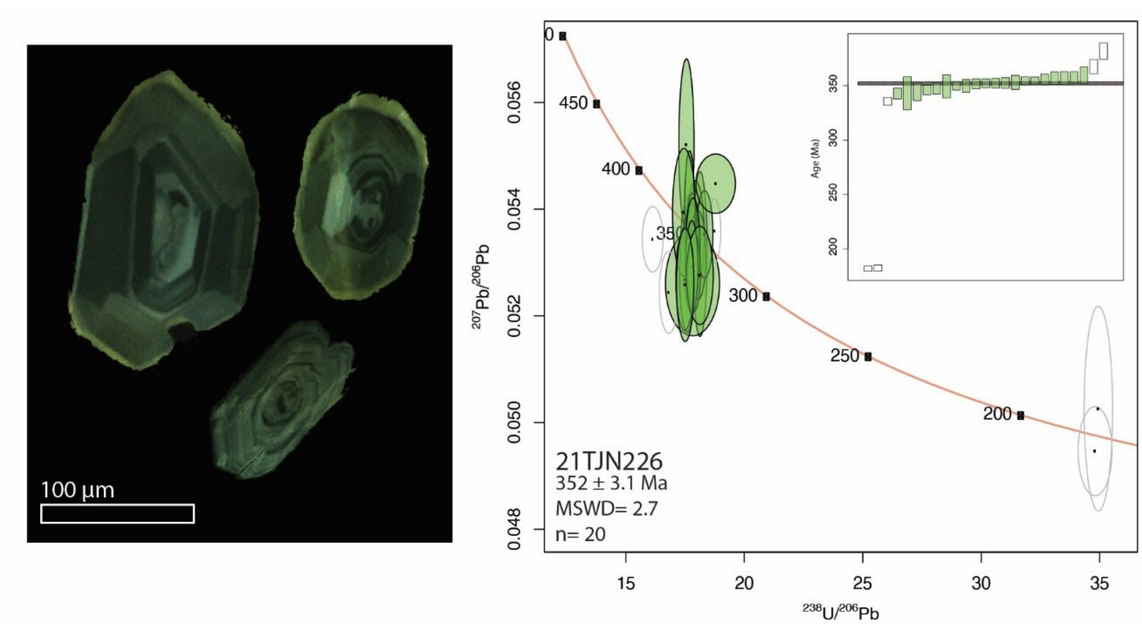


Figure 41. U-Pb data for sample 21TJN226. Cathodoluminescence images of representative zircon population, and concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21SPR068

21SPR068 is a garnet-plagioclase-quartz paragneiss, and the major element composition suggests a sedimentary protolith (Wypych and others, 2022) with a grain size range of 0.1 to 5 mm and the following mineralogy: 40 percent quartz; 30 percent plagioclase (untwinned, biaxial positive, 0.05–0.15 mm, partly replaced by clinozoisite); 20 percent garnet (porphyroblasts 0.5–3 mm, with only traces of retrograde alteration); 4 percent muscovite (0.2–0.5 mm); 3.9 percent clinozoisite (high relief, anomalously blue interference colors, irregular shape, 0.05–0.1 mm), 1 percent chlorite (0.1–0.3 mm); one percent titanite (rare subhedral 0.03–0.05 mm grains); and 0.1 percent zircon (0.02 mm, elongate, moderate birefringence, grains parallel schistosity). A hand sample was collected from an outcrop.

Approximately 50 zircon grains were extracted from sample 21SPR068 for isotopic analysis. This population of zircon is primarily subhedral, equant, and 100–225 μm long (fig. 42). Most zircon grains preserve oscillatory zoning; however, some are also convoluted, fractured, metamict, and display a complex core and rim texture. This sample was originally assumed to be an orthogneiss in the field, but further petrographic examination and compositional analysis suggest a sedimentary or altered tonalitic protolith.

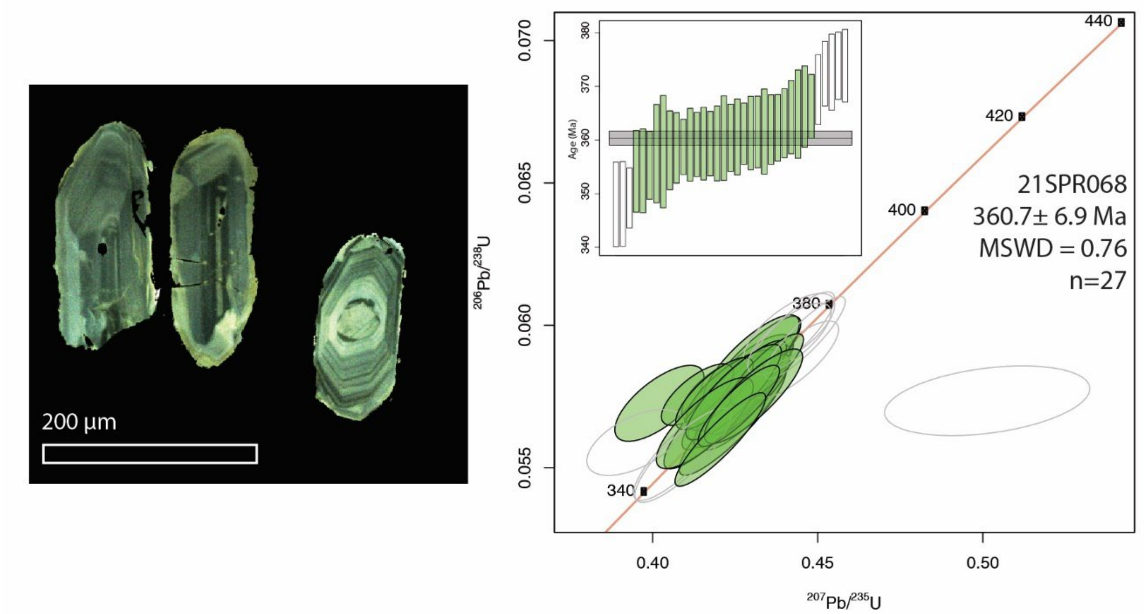


Figure 42. U-Pb data for sample 21SPR068. Cathodoluminescence images of representative zircon population, and concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

21SPR150

21SPR150 is a well-annealed, pink to gray orthogneiss, with significant retrograde alteration, a grain size of <1 to 6 mm, and the following mineralogy: 30 percent quartz; 40 percent potassium feldspar; 20 percent plagioclase; and 10 percent chlorite, trace epidote. The sample's alteration includes rare epidote veinlets and chlorite, which is presumably secondary after biotite. The major-element composition is consistent with a granite protolith (Wypych and others, 2022), but no augen are evident. A hand sample was collected from an outcrop.

Sample 21SPR150 yielded a population of subhedral and elongated with lesser equant zircon grains 50–250 μm long (fig. 43). Internal textures are primarily igneous and preserve a mix of oscillatory, sector, and lengthwise zonation. Metamorphic rims are very common. CL-dark zones are interpreted to be areas of metamictization and were avoided during analysis. Many of the zircon grains display areas that are fractured or recrystallized and were also avoided. This sample was initially described as a paragneiss, but further petrographic and major element composition analysis suggests the sample is an orthogneiss.

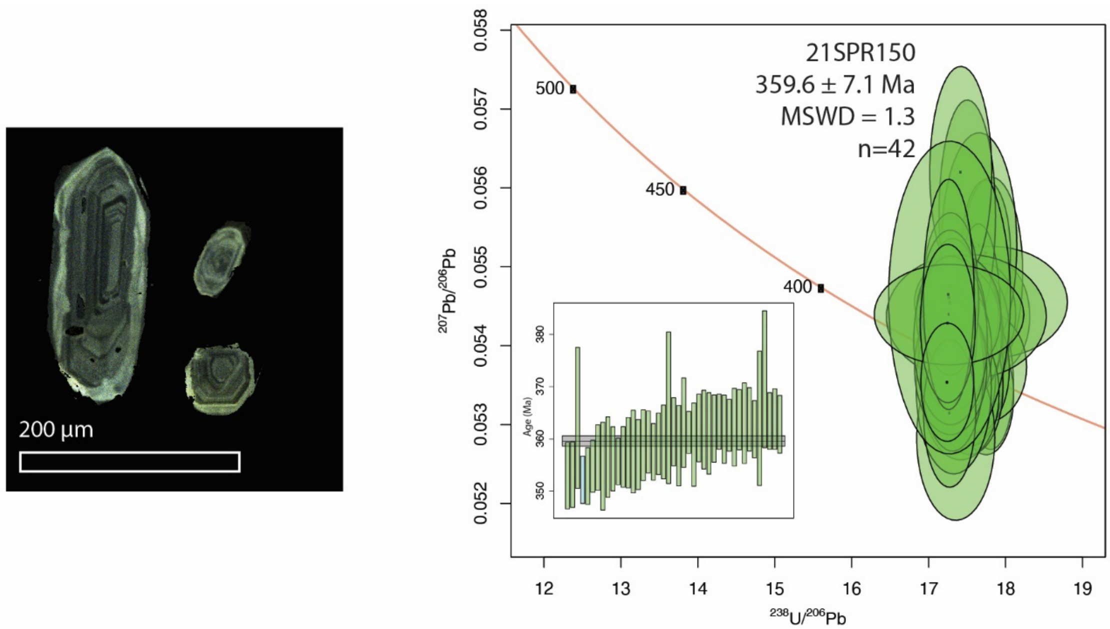


Figure 43. U-Pb data for sample 21SPR150. Cathodoluminescence images of representative zircon population, and concordia diagram with inset plot of $^{206}Pb/^{238}U$ weighted average of preferred ages. Ovals and bars indicate uncertainty at the 2-sigma level and those shown in green were included in age calculations. MSWD, mean square of weighted deviates.

Metasedimentary Detrital Sample Descriptions

21ADW211

21ADW211 is quartz schist collected for DZ; grayish brown in color; fine- to medium-grained, crenulated, foliated; schistose; with a grain size ranging from 0.5 to 1. 5 mm and has the following mineralogy: 60 percent quartz (granoblastic); 20 percent white mica (elongate, forms weak foliation fabric, minor chloritization); 10 percent biotite (elongate, oxidation along foliation planes common and makes a brownish color); 9 percent feldspar (abundant small inclusions, minor sericite alteration); and 1 percent suspect garnet (high relief, colorless, isotropic, mostly rounded and not hex- or octagonal). The sample is partially weathered and was found as float. The sample location has mixed quartzite found as float.

21AW047

21AW047 is a metaconglomerate collected for DZ; gray to green in color, foliated and parted, and weathering pale brown with a grain size of 1 mm to 50 cm. One trondhjemitic clast has the following mineralogy: 54 percent albite (0.2 –2 mm, subhedral, commonly twinned); 35 percent quartz (0.1–1.5 mm, anhedral, undulatory extinction common, present in all parts of the thin section slide); 7 percent chlorite (0.2–2 mm, subhedral to euhedral, grains do not appear to be secondary, mostly restricted to the schistose part of the sample); 2 percent muscovite (0.1–1 mm, subhedral, present with chlorite in the more schistose portion of the sample); 1 percent biotite (0.1–0.4 mm, subhedral, unaltered); 0.6 percent titanite (0.1–0.6 mm, euhedral to subhedral, restricted to schistose portion of sample); 0.2 percent rutile (typically about 0.01 mm, subhedral, mostly found in the schistose portion of sample); and 0.2 percent apatite (0.1–0.2 mm long, subhedral). The sample in outcrop contained large, up to 50 cm long, but averaging 2 cm, stretched clasts of meta-plutonic, quartzite, and pure quartz in a chlorite, muscovite, and biotite-rich matrix. The detrital zircon sample is mostly of metaplutonic (trondhjemitic) clasts plus matrix. The sample was collected from an outcrop and is partially weathered.

21DFA125

21DFA125 is a strongly foliated, very fine-grained, micaceous quartz schist with a grain size of 0.01 to 1 mm and has the following mineralogy: 85 percent quartz (granoblastic and very fine-grained, also found as aggregates of quartz grains up to 1.5 mm); 13 percent muscovite (very fine-grained, mostly found as elongated clusters within the foliation); and 2 percent hematite (staining around mica). The sample is confirmed to be a quartzite by chemical analysis, (Wypych and others, 2022) is partially weathered, and was collected from a subcrop.

19RN130

19RN130 is a pale green, chloritic muscovite quartz schist with a grain size of 0.5 to 2.0 mm and has the following mineralogy: 40 percent quartz; 30 percent muscovite; 20 percent chlorite; and 10 percent feldspar with trace weathering. Some muscovite is perpendicular to the schistose surface. This schist was collected for DZ analysis, but the resulting mineral separates were 95 percent rutile, and the returned DZ dataset contained too few grains for a robust YSP MDA.

21TJN105

21TJN105 is a clinozoisite-chlorite-muscovite-quartz schist with a grain size of 0.1 to 1 mm and has the following mineralogy: 75 percent quartz (granoblastic and fine-grained, undulose extinction); 15 percent muscovite (0.1–0.3 mm flakes defining the foliation); 2 percent clinozoisite (discontinuous bands of subhedral equant grains); 7 percent chlorite (typically intergrown with chlorite); and 1 percent opaques (including pyrite); mineralization: sparse pyrite-chlorite-quartz veinlets, also disseminated pyrite. The hand sample was collected from an outcrop.

Cretaceous Sedimentary Rocks

21ET094

21ET094 is predominantly fine- to medium-grained, angular to subrounded clasts of rhyolite and kaolinite-altered rhyolite with thin beds, locally graded with a grain size of 0.01 to 1 mm and has the following mineralogy: 94 percent lithic clasts (0.1–0.3 mm, angular to sub-rounded, granular very fine-grained quartz-feldspar intergrowths, partly altered to kaolinite); 5 percent quartz (0.1–0.2 mm, sub-angular to sub-rounded); and 1 percent opaques (0.05–0.1 mm, mostly weathered to limonite, might have been pyrite). There are a few possible coal clasts and plant fossils. The hand sample was collected from a subcrop.

21ET192

21ET192 is a poorly sorted, volcaniclastic pebbly sandstone to conglomerate consisting of almost entirely kaolinite-altered rhyolitic clasts and quartz cement. The coarse fraction of the rock is dominated by subangular felsic volcanic clasts with few quartz grains observed in outcrop. The sample grain size is 0.5 to 30 mm and has the following mineralogy: 96 percent lithic clasts (0.2–4 mm, sub-rounded to sub-angular, rhyolitic clasts; mostly very fine-grained and granular, but some grains are granophyric or thinly laminated; partly altered to kaolinite, confirmed by x-ray diffraction); 3.5 percent quartz (cement, thin 0.02 mm bands that partly to completely surround individual clasts and rare rounded clast ranging from 0.2 to 0.4 mm); 0.3 percent alkali feldspar (0.2–0.6 mm rounded grains, partly converted to kaolinite); and 0.2 percent biotite (0.2 –0.4 mm, partly chloritized). Some float blocks suggest crude bedding with subordinate coarse sandstone. The sample was collected from a subcrop.

21RN401

21RN401 is a sandy, rhyolitic volcaniclastic conglomerate; gray to white, interbedded, clast supported, with a grain size of 0.2 to 20 mm and the following mineralogy: 100 percent clasts (rounded rhyolitic clasts, 0.4 mm to 1 cm, many with spherulites, most with feldspar ± quartz phenocrysts, some fiamme present, less than half of the fiamme are less than 2-mm long) and partial weathering. The hand-held x-ray fluorescence composition is that of a typical rhyolite, so the rock must be mostly felsic volcanic clasts. Hand sample found as float.

RESULTS AND DISCUSSION

A summary of all interpreted CZ and DZ ages are included in table 2 and table 3, respectively. Detailed data including isotope ratios, U, Th, and Pb measured quantities, and raw date data are included for each sample in Appendix A. Grains that were filtered out during data reduction are not included in interpreted ages reported below or in table 3.

Table 2. U-Pb crystallization best-weighted-mean age results. Lithologies are from Wypych and others (2022) and Gavel and others (2022) and do not necessarily reflect the lithology or geologic significance of the sample analyzed. If no age is reported, justification for no age is given.

Sample	Lithology	Longitude	Latitude	Weighted-Mean Age (Ma)	2σ (Ma)	n	MSWD
21ET257	granite porphyry	64.17436	-142.228	56.2	1.1	30	1.68
21MLB248	granite porphyry	64.22267	-142.509	56.9	1.1	24	2.82
21DFA047	dacite tuff	64.01293	-142.911	68.3	1.4	26	3.53
09RN357B	granite porphyry	63.18697	-142.104	68.7	1.4	26	2.45
21TJN264	rhyolite welded tuff	64.13086	-142.278	70.1	1.4	29	1.8
21WCW008	quartz monzodiorite	63.83508	-143.977	71.1	1.4	5	7.1

Sample	Lithology	Longitude	Latitude	Weighted-Mean Age (Ma)	2σ (Ma)	n	MSWD
19ADW032	volcaniclastic dacite	62.91064	-141.043	100.5	2.0	25	3.67
21RN282	granite porphyry	63.43289	-142.603	107.2	2.1	28	4.65
19RN347	rhyolite tuff	63.51616	-141.791	107.5	2.2	28	0.94
21TJN180	rhyolite welded tuff	63.88602	-142.664	107.6	2.2	25	1.34
19KS383	volcaniclastic rhyolite	63.52554	-141.893	108.1	2.2	34	1.15
21SPR026	rhyolite tuff	63.54178	-142.76	108.4	2.2	34	1.9
20ADW001	rhyolite tuff	63.55411	-143.061	108.4	2.2	22	0.61
21MLB006	granite porphyry	63.58102	-142.553	108.7	2.2	35	1.68
21RN094	granite porphyry	63.54504	-143.271	109.8	2.2	11	2.88
21ET193	granodiorite porphyry	63.6469	-143.567	110.0	2.2	22	4.4
21ET119	granite porphyry	63.68407	-142.539	110.8	2.2	26	3.59
21TJN008	granodiorite	63.84605	-143.846	110.4	2.2	24	8.4
21MLB187	quartz syenite	63.98927	-143.125	183.8	3.7	30	2.18
21ET227	granite	63.98946	-143.124	184.8	3.7	13	
21AW136	granodiorite	63.93099	-143.07	185.4	3.7	25	3.28
21ADW052	amphibolite	63.88661	-143.381	186.8	3.8	18	5.71
21AW180	syenite	64.1033	-142.328	191.1	3.8	15	2.8
21AW152	foliated hornblende gabbro	63.88931	-142.029	201.0	4.0	27	1.88
21ADW136	quartz diorite	63.89239	-142.264	202.2	4.1	28	1.2

Sample	Lithology	Longitude	Latitude	Weighted-Mean Age (Ma)	2σ (Ma)	n	MSWD
21AW185	tonalite porphyry	64.00944	-142.249	203.3	4.1	17	5
21TJN234	tonalite	64.18341	-142.524	203.4	1.4	27	1
21TJN101	altered granodiorite	64.09916	-142.039	204.4	4.1	28	4.97
21TJN161	trondhjemite	63.96888	-141.916	211.3	4.2	27	4.97
21ADW146	greenstone	63.96977	-142.929	215.6	4.4	28	2.85
21RN257	metagabbro	63.31104	-143.974	228.9	4.7	11	7.2
21MMG201	quartz diorite	64.04552	-142.533	266.8	5.3	32	1.55
21AW108	gabbroic greenstone	63.32946	-143.944	268.1	5.4	25	1.87
21ET101	amphibolite	63.42813	-142.603	275.5	5.6	14	1.62
21MMG119	greenstone	64.12826	-142.372	346.5	7.0	27	1.9
21TJN226	granodiorite	64.24819	-142.694	352.0	4.1	30	2.7
21SPR150	orthogneiss	63.87706	-143.807	359.6	1.3	42	1.3
21SPR068	paragneiss	63.71869	-143.251	360.7	1.7	27	1.68
21MMG105	amphibolite	64.18312	-142.094	1429	28.4	5	2.23
17MLW035	quartzite	63.86034	-141.563	No age due to low zircon yield and discordance.			
19ET122	quartz schist	63.3347	-141.121	No age due to insufficient sampling.			
21AW088	altered meta-sedimentary	63.28126	-143.802	No age due to strong alteration and Pb loss. Some concordant Proterozoic grains.			

Sample	Lithology	Longitude	Latitude	Weighted-Mean Age (Ma)	2σ (Ma)	n	MSWD
21AW196	granite	64.24668	-142.163	No age due to strong alteration and Pb loss. Some concordant Proterozoic grains. ~258 Ma?			
21RN399	quartz monzonite	63.86016	-142.374	No age due to strong alteration, poor zircon yield, and Pb loss. Two concordant Cretaceous grains.			
21TJN114	granite	64.19606	-142.144	No age due to strong alteration, poor zircon yield, and Pb loss.			

Table 3. Detrital zircon analysis Youngest Statistical Population Maximum Depositional Age (YSP MDA) result summary.

Sample	Map Unit	Lithology	n Total	Age Range (Ma)	YSP MDA (Ma)	2s (MA)	n YSP	MSWD
21ADW211	MDfms	quartz schist	97	109-2632	250.6	5.2	9	1.56
21AW047	MDfms	metaconglomerate	104	360-2808	375.0	7.8	5	2.18
21DFA125	MDfms	quartzite	267	72-2830	417.8	9.1	3	2.58
21ET094	TKs	volcaniclastic sandstone	222	59-1837	70.0	1.4	63	0.36
21ET192	TKs	volcaniclastic conglomerate	291	63-363	67.4	1.4	35	0.58
21RN401	TKs	volcaniclastic conglomerate	196	65-1986	68.8	1.4	97	1.24
21TJN105	Mcm	quartzite	268	343-3277	355.2	7.2	6	2.01

Late Cretaceous-Paleogene Intrusive and Volcanic Rocks

Two granite porphyry samples, 21ET257 and 21MLB248, returned weighted-mean ages of 56.1 ± 1.1 Ma and 56.8 ± 1.1 Ma, respectively. Both samples have grain morphology indicative of magmatic crystallization conditions, with sample 21MLB248 appearing darker in CL imagery than 21ET257. Temporally equivalent rocks are reported from Yukon, Canada (Yukon Geological Survey, 2020) and eastern Alaska (Wildland and others, 2021). Samples 21DFA047 and 21TJN264 are dacite and rhyolite welded tuff which returned ages of 68.2 ± 1.4 Ma and 70.1 ± 1.4 Ma, respectively. Sample 21WCW008 returned an age of 71.1 ± 1.4 Ma. These ages all fall within a well-documented range of crystallization ages for this region (Allen and others, 2013; Flanigan and others, 2000; Kreiner and others, 2019; Twelker and others, 2021; Wildland and others, 2021).

Cretaceous-Paleogene Sedimentary Rocks

Three Cretaceous sedimentary samples, 21ET094, 21ET192, and 21RN401 all yielded excellent grain populations for detrital zircon analyses and returned Late Cretaceous MDAs (fig. 44; table 3). 21ET192 and 21RN401 are volcaniclastic conglomerates that returned YSP MDAs of 67.4 ± 1.4 Ma and 68.8 ± 1.4 Ma, respectively. Both samples included mid-Cretaceous (101–110 Ma) and Mississippian-Devonian age populations (325–363 Ma); 21RN401 also included a population (n=5) of Proterozoic grains. Sample 21ET094 was collected from volcaniclastic sandstone near a modern exposure of a mid-Cretaceous granite body and returned a YSP MDA of 70 Ma ± 1.4 Ma. Sample 19AW206 (YSP weighted mean 103.2 ± 2.2 Ma;

Twelker and others, 2021) was collected east of 21ET094 in a similar isolated exposure of Cretaceous sedimentary rocks, and its older age may be due to surrounding rock lithics entrained during an eruption. Each of these MDAs is likely the result of volcaniclastic material from alkaline (70–66 Ma) magmatism that was widespread in the Yukon-Tanana Uplands (YTU; Allen and others, 2013; Bacon and others, 2014). Exposures of similar age and lithology in the YTU region have been interpreted to be fault or volcanism related (Foster and others, 1994).

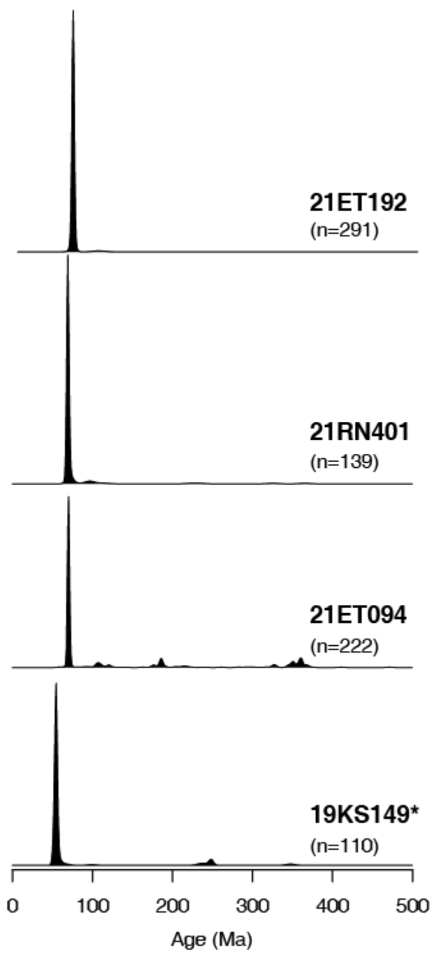


Figure 44. Kernel density estimate (KDE) plots for Cretaceous-Paleogene sedimentary rock samples.

Mid-Cretaceous Intrusive and Volcanic Rocks

Mid-Cretaceous intrusive and volcanic rocks returned ages of 100–110 Ma and are related to the regionally observed ca. 115–98 Ma arc and back-arc magmatism interpreted to represent renewed northeast-dipping subduction outboard of the YTT and collision of the Wrangellia composite terrane (Hart and others, 2004; Allan and others, 2013; Dusel-Bacon and others, 2015). Samples 21SPR026, 21MLB006, and 21TJN180 (figs. 18, 13, and 21) represent map unit Kwff (rhyolite tuffs to dacite tuff, Twelker and others, 2021), returned ages of 107–108 Ma, and are contemporaneous with Kwff ages observed in the eastern part of the Tanacross Quadrangle (Twelker and others, 2021; Wildland and others, 2021). Similarly, 20ADW001 is from the Sixtymile Butte volcanic center (map unit Ksfv) and returned an age of 108.4 ± 2.1 Ma. Samples 21RN282, 21ET193 (Kg), and 21ET119 (figs. 16, 10, and 11) are all granite or granodiorite porphyry that returned ages between 107 and 110 Ma. These are also consistent with granite porphyry ages observed to the east (Twelker and others, 2021; Wildland and others, 2021).

Jurassic and Triassic Intrusive Rocks

Samples 21MLB187 and 21AW136, a quartz syenite and a porphyritic granodiorite from a body near the Kechumstuk pluton, returned ages of 183.8 ± 3.7 Ma and 185.4 ± 3.7 Ma, respectively (figs. 26 and 23). 21AW180, of similar lithology but from a syenite body within the Taylor Mountain batholith, returned an age of 191.1 ± 3.8 Ma. These correlate well with Jurassic plutons to the north of the field area (ca. 181–191 Ma; Day and others, 2014). The 191 Ma syenite within the Taylor Mountain batholith is interpreted to be an intrusion related to Jurassic plutonism.

Triassic intrusive rocks in the Taylor Mountain and Western Tanacross map areas are mostly related to the Taylor Mountain batholith (TMB) and are among the earliest Mesozoic intrusive rocks found in the YTT. Ages from this study's Triassic samples range from 201–215 Ma. Sample 21AW185 (fig. 30) from near the top of Taylor Mountain returned an age of 203.3 ± 4.1 Ma. Near the Taylor Highway, a SHRIMP U-Pb age of 218 Ma ± 3.9 Ma was recorded (Jones and O'Sullivan, 2020). One tonalite from Diamond Mountain (21TJN234) and one altered granodiorite from the northern margin of the TMB (21TJN101) returned ages of 203.4 ± 1.4 Ma and 204.4 ± 4.1 Ma, respectively. 21AW152, a gabbroic phase within the TMB with an age of 201.0 ± 4.0 Ma, and 21ADW136, a 202.2 ± 4.1 Ma quartz diorite, are both strained and weakly foliated. These two samples may be related to Jurassic intrusions observed in the YTT, but higher-precision dating methods would be required to investigate further.

Permian Metamorphic and Igneous Rocks

Three samples returned Permian ages between 266 and 275 Ma. Sample 21MMG201 (fig. 38), an altered quartz diorite mapped within the Chicken assemblage returned an age of 266.8 ± 5.3 Ma. This age is more closely correlated with the Permian Klondike assemblage, but the nearest similar observed ages are to the north on Mount Warbelow in the Eagle Quadrangle (this report) and in the northeastern Tanacross Quadrangle (Jones and O'Sullivan, 2020). It could represent a Klondike-associated intrusion into the Chicken assemblage—a sample from Mount Warbelow, 21AW196, returned an age of about 258 Ma, however, the sample is interpreted to have experienced significant Pb loss and/or alteration evidenced by CL-dark zircon grains and should not be relied on for interpretation. Sample 21AW108 (268.1 ± 5.4 Ma; fig. 36) was collected in the Alaska Range and is an altered metamafic rock that is interpreted as a sill in the Jarvis quartzite. Sample 21ET101 (fig. 37), an amphibolite within the Lake George metamorphic assemblage returned an age of 275.5 Ma ± 5.6 Ma. Permian ages have not been historically associated with Lake George assemblage, but the correlation of Alaska Range amphibolite facies rocks with Lake George is not entirely certain.

Mississippian and Devonian Metamorphic Rocks

Parautochthonous North America (Lake George Assemblage)

One sample in the Lake George assemblage (pNA), an orthogneiss, returned an age of 359.6 ± 1.3 Ma (21SPR150, fig. 43). Other orthogneisses and augen orthogneisses from within the Lake George assemblage in eastern Alaska are similar in age (Wildland and others, 2021).

Allochthonous Yukon Tanana Terrane (Fortymile Assemblage)

Sample 21TJN226, an orthogneiss within the Fortymile River assemblage of the YTT, yielded an age of 352.0 ± 4.1 Ma. Other Fortymile River orthogneiss samples have returned similar ages (approximately 355–341 Ma; Dusel-Bacon and others, 2006). A Fortymile River assemblage paragneiss (sample 21SPR068 [fig. 42]) returned an age of 360.7 ± 1.7 Ma, but its lithology is suspect due to its lack of other Paleozoic to Proterozoic age populations and is probably a metamorphosed-altered tonalite. Three samples of Fortymile River metasedimentary rocks yielded detrital zircon populations suitable for interpretation. Sample 21ADW211 (fig. 45), a quartz schist, yielded a YSP MDA of 250.6 ± 5.2 Ma. A nearby quartz schist has a SHRIMP U-Pb crystallization age of 258 Ma (Jones and O'Sullivan, 2020), but it is described as experiencing Cretaceous Pb loss. Samples 21AW047 (fig. 45), a metaconglomerate, and 21DFA125 (fig. 45), a quartzite, returned YSP MDAs of 357 ± 7.8 Ma and 417.8 ± 9.1 Ma, respectively.

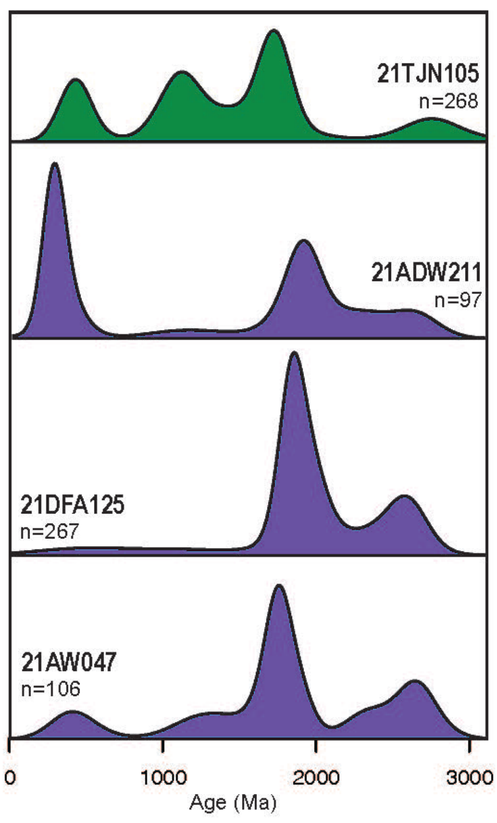


Figure 44. Kernel density estimate (KDE) plots for Paleozoic metamorphic rock samples.

Chicken Metamorphic Complex

Sample 21MMG119 (fig. 40), a Chicken assemblage metamafic greenstone returned an age of 346.5 ± 7.0 Ma. A nearby metagabbroic sample from Jones and O'Sullivan (2020) with an age of 339 Ma suggests that some mafic protoliths of the Chicken assemblage are Mississippian in age. Sample 21TJN105 (fig. 45), a Chicken assemblage quartzite, has a YSP MDA of 355.2 ± 7.2 Ma, suggesting Early Mississippian deposition contemporaneous with some greenstones (e.g., 21MMG119).

Other Paleozoic Metamorphic Rocks

Sample 21RN257 (228.9 ± 4.7 Ma; fig. 30) is a metagabbro within the Jarvis quartzite in the Alaska Range. This sample correlates with other Triassic gabbros reported in the eastern Alaska Range and southeastern YTU (Sicard and others, 2017; Solie and others, 2019; Dashevsky and others, 2003).

Sample 21ADW052 is a mylonitic amphibolite from the Fortymile assemblage that returned an age of 186.7 ± 3.8 Ma. Most zircons in this sample have Th/U ratios >0.1, which can indicate metamorphic zircon origin, and CL-bright rims that we interpret as metamorphic growth rims. This age may be related to Jurassic metamorphism during thrusting of the Fortymile assemblage over the Lake George assemblage.

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