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Geology of the Clairmont Springs 7.5-Minute Quadrangle and Geochronology of the Alabama Blue Ridge

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GEOLOGY OF THE CLAIRMONT SPRINGS 7.5-MINUTE QUADRANGLE AND GEOCHRONOLOGY OF THE ALABAMA BLUE RIDGE

A Master's Thesis

Presented to

The Graduate College of

Missouri State University

In Partial Fulfillment

Of the Requirements for the Degree

Master of Science, Geography and Geology

By

Adelie Ionescu

July 2021

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GEOLOGY OF THE CLAIRMONT SPRINGS 7.5-MINUTE QUADRANGLE

AND GEOCHRONOLOGY OF THE ALABAMA BLUE RIDGE

Geography, Geology, and Planning

Missouri State University, July 2021

Master of Science

Adelie Ionescu

ABSTRACT

The Alabama Blue Ridge (USA) of the southern Appalachians contains metamorphic rocks and structures associated with island arc accretion and continent-continent collision that record the Acadian and Alleghenian orogenies. The western Blue Ridge is underlain by Cambrian to Mississippian, clastic and carbonate, low-grade, greenschist facies metamorphic Talladega belt that formed outboard from the Alabama promontory or along the Laurentian margin. The eastern Blue Ridge contains the Neoproterozoic to Paleozoic, lithologically diverse, high grade, middle to upper amphibolite facies Ashland Supergroup. Geologic mapping of the Clairmont Springs 7.5- minute quadrangle unveils tectonic relationships between the eastern and western Blue Ridge and U-Pb zircon geochronology constrains the timing of metamorphism of strata and Neoacadian-Alleghenian thrust fault development; and unveils new information on the relationship between the Appalachian foreland and hinterland. A complex partitioning of deformation model is proposed to account for out-of-sequence fault movement and Taconic to Alleghenian metamorphic ages.

KEYWORDS: Alabama Blue Ridge, Neoacadian orogeny, geologic mapping, zircon geochronology, metamorphism, southern Appalachians

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In the interest of academic freedom and the principle of free speech, approval of this thesis indicates the format is acceptable and meets the academic criteria for the discipline as determined by the faculty that constitute the thesis committee. The content and views expressed in this thesis are those of the student-scholar and are not endorsed by Missouri State University, its Graduate College, or its employees.

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This thesis is dedicated to the aliens that will one day try to conquer this Earth. I am ready for your challenges; this is just practice.

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OVERVIEW

The Appalachian Mountains were assembled over millions of years through the periodic accretion and collision of crustal material. Three main orogenic events--the Taconic, Acadian, and Alleghenian, are recorded in the metamorphic rocks and structures of the present-day Appalachians. Evidence of these events, however, is not preserved along the entire length of the mountain chain, particularly in the southern Appalachians of Georgia and Alabama where a scarcity of northwest-directed thrusts is in sharp contrast with classic Appalachian structures found in Tennessee and beyond. The Blue Ridge province of Alabama is underlain by metasedimentary to metavolcanic rocks, amphibolites, and plutons. It is divided into the eastern and western Blue Ridge by the Hollins Line fault, which marks a significant change in metamorphic grade between the greenschist facies Talladega belt to the northwest and the mid-to-upper amphibolite facies Ashland Supergroup to the southeast. To investigate this, 1:24,000 scale geologic mapping of the Clairmont Springs quadrangle, which includes units of both the western and eastern Blue Ridge, was combined with U-Pb geochronology to unravel the geologic history of the area. U-Pb ages unveil diachronous metamorphism in the Alabama Blue Ridge occurring from the Taconic to Alleghenian orogenies. Metamorphic ages from the Ashland Supergroup are found to be older than those from the adjacent Talladega belt and Wedowee-Emuckfaw belt. The order and timing of two regional thrust faults, the Hollins Line and the Goodwater-Enitachapco faults, was also investigated. Age data concludes that the Hollins Line fault must have been post-340 Ma and the Goodwater-Enitachapco fault occurred post-320 Ma. A final model reflects non-sequential thrusting and suggests complex partitioning of deformation for the area.

PART 1: GEOLOGY OF THE CLAIRMONT SPRINGS 7.5-MINUTE QUADRANGLE,

TALLADEGA AND CLAY COUNTIES, ALABAMA

Abstract

The Clairmont Springs 7.5-quadrangle in southeastern Talladega and northern Clay County, Alabama is within the Alabama Blue Ridge province of the southern Appalachians (Figure 1). The Blue Ridge, also referred to as the northern Piedmont, is faulted upon the Appalachian fold and thrust belt and is divided into the western and eastern Blue Ridge (Raymond et al., 1988). The quadrangle contains the Lay Dam Formation of the Talladega Group, the Hillabee Greenstone, and the Poe Bridge Mountain and Mad Indian groups of the Ashland Supergroup (Figure 2). The Lay Dam Formation is Silurian to Lower Mississippian in age (Tull and Barineau, 2012) and occupies the northwestern portion of the quadrangle. The Ordovician Hillabee Greenstone is faulted against rocks of the Talladega Group (Tull and Barineau, 2012) and is exposed in the valley adjacent to the southern slope of Talladega Mountain, along Talladega Creek. The central and southeastern portions of the quadrangle are underlain by the Neoproterozoic to lower Paleozoic Ashland Supergroup, which includes the Poe Bridge Mountain Group and intercalated Ketchepedrakee Amphibolite, and the Mad Indian Group and associated plutons, including igneous plutons that may correlate with the Bluff Springs Granite (Barineau et al., 2015; Szabo et al., 1988). The units strike generally northeast-southwest, and dip 5-85° southeast. The northwestern portion of the quadrangle contains the Hillabee thrust fault system, a thin-skinned thrust which places the Ordovician Hillabee Greenstone upon the Lower Mississippian Erin Slate of the Talladega Group (Tull and Barineau, 2012) and Hollins Line fault is above the Hillabee and represents the boundary between rocks of the Talladega belt and rocks of the Ashland-Wedowee-Emuckfaw belt as well as a change in metamorphic grade (Tull and Barineau, 2012; Stowell et al., 2019).

Introduction

The Clairmont Springs quadrangle (plate) is within southeastern Talladega and northern Clay counties, Alabama (Figure 1). The quadrangle is made up of mostly rural land, along with a portion of the Talladega National Forest. Portions of the area are leased by logging companies and were previously mined for graphite (Prouty, 1923). The Pinhoti National Recreation Trail crosses through the northwestern part of the quadrangle. Alabama Highway 77 runs east-west across the southern half of the area, while an active railroad operated by CSX Transportation Co. runs through the northern half of the area, parallel to Talladega Creek. The city of Talladega is located 22 km to the northwest on the Talladega quadrangle, and the city of Ashland lies 4 km to the east of the quadrangle on the adjacent Lineville West quadrangle. Alabama Highway 9 lies just south of the quadrangle. The Cheaha Mountain quadrangle, containing the highest point in Alabama, is located directly to the northeast of the Clairmont Springs quadrangle. The presence of a major highway, trail, and railroad makes this a high-use area for transportation and recreation. The Pinhoti Trail and nearby Cheaha Mountain are a source of tourism, and the various timberland operations scattered across the quadrangle signify that this area is of economic importance. Geologic mapping of the Clairmont Springs quadrangle was completed as part of the U.S. Geological Survey’s National Cooperative Geologic Mapping Program (EDMAP component; Award No. G20AC00298) to provide basic geologic information for further planning and development. The following report outlines the investigation and explores the geologic implications of the results.

Location

The Clairmont Springs 7.5-minute quadrangle (lat. 33°22′30″ and 33°15′00″; long.

85°52′30″ and 86°00′00″) is in southeastern Talladega and northern Clay counties, Alabama (Figure 1). The city of Talladega lies to the northwest of the area, and the city of Ashland is just 2 miles off-quad to the east. The quadrangle is within the Alabama Blue Ridge province (Raymond et al., 1988) and ranges in elevation from 860 to 1840 feet. The northwestern part of the quadrangle contains Talladega Mountain, which is underlain by phyllite, sandstone, and quartzite and is the highest point on the quadrangle at 1840 feet. Poe Bridge Mountain lies in the southern part of the quadrangle, which is characterized mainly by schists of various compositions and irregular lenses of amphibolite. A change in topography and lithology occurs on the south side of the mountain, where the Poe Bridge Mountain Group grades into the Mad Indian Group and plutons associated with the Bluff Springs Granite. The area is made up of farmland, National Forest land, and leased timberland. Talladega Creek runs across the northern half of the map alongside a Class I railroad operated by CSX Transportation Co. The Talladega Creek valley is occupied by slate and low-grade phyllite.

Geologic Setting

The Clairmont Springs quadrangle is within the Blue Ridge province, which is faulted against the Appalachian fold and thrust belt by the Talladega-Cartersville fault (Neathery, 1975; Tull and Barineau, 2012). The units in the Blue Ridge region have undergone various pulses of metamorphism and plutonism associated with the Acadian and Alleghenian orogenies (Tull, 2002). The northwestern-most portion of this region is made up of low-grade metasedimentary units of the Talladega Group with the metavolcanic Hillabee Greenstone at the stratigraphic top (Tull and Stow, 1980). The eastern Blue Ridge contains high-grade units of the Ashland Supergroup, which is made up of the Poe Bridge Mountain and Mad Indian groups (Raymond et

al., 1988). The southeasternmost portion of the Blue Ridge is made up of the Wedowee and Emuckfaw groups but lies southeast of the quadrangle (Tull, 1978).

Previous Investigations

The term "Talladega Group" was coined by Smith (1888) and stratigraphy for Talladega County was detailed in an 1897 report by McCalley. Prouty (1923) complied a geologic and mineral resources report for Clay County, and also proposed that the Hillabee Greenstone was an intrusive unit along a fault between the Talladega Group and Ashland Supergroup. A 1:500,000 scale Geologic Map of Alabama by Adams et al. (1926) compiled previous mapping and investigations; and interpreted the Hillabee Greenstone as a sill along a fault plane. Butts (1926) reported on all Paleozoic rocks in Alabama and divided the Talladega belt into upper and lower units. Geologic mapping of the Lineville East, Ofelia, Wadley North and Mellow Valley quadrangles that are located starting at two quadrangles to the east was completed by Neathery and Reynolds (1975). Neathery and Reynolds (1975) mapped the contact between the Hillabee Greenstone and the Ashland Supergroup as gradational, and also proposed that the Hillabee Greenstone was interbedded with the upper Talladega Group. The geology of the area was also described in field trip guidebooks by the Alabama Geological Survey (Neathery and Tull, 1975; Tull and Stow, 1979). Early work on the Hillabee Greenstone was completed by Tull et al. (1978) and Tull and Stow (1980). Tull et al. (1978) also divided the Alabama Piedmont northwest of the Brevard fault zone into the Talladega, Coosa, and Tallapoosa structural blocks, and also designated the Ashland units as a supergroup. A geologic map for portions of the Lineville West, Ironaton, and Cheaha Mountain quadrangles was published by Robinson et al. (1984). These quadrangles lie directly east and north of the Clairmont Springs quadrangle.

Significant findings on the age of the Erin Slate member of the Talladega Group were described by Gastaldo et al. (1993). A 1:250,000 scale state map of Alabama was compiled in 1988 (Szabo et al., 1988). Geologic maps at the 1:24,000 scale include the Sleeping Giants and Talladega quadrangles (Irvin and Bearce, 2003, 2005) directly to the northwest and the Milltown (Whitmore and Steltenpohl, 2017) and Alexander City quadrangles (Weinmann and Steltenpohl, 2018) to the southeast and three quadrangles to the south, respectively.

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The Clairmont Springs quadrangle was mapped as part of the USGS National Cooperative Geologic Mapping program (Award No. G20AC00298) and funding through Missouri State University. The author thanks Dr. Matthew P. McKay for his mentorship, knowledge, and support. Additional thanks to Robert Milstead of Hancock Natural Resources Group for granting access to private lands.

Stratigraphy

The northwestern portion of the quadrangle contains low grade metasedimentary and metavolcanic rocks of the Talladega Group and western Blue Ridge province, which range from Silurian to Lower Mississippian (Butts, 1926; Tull et al., 1988; Gastaldo et al., 1993). Above the Talladega Group lies the Hillabee Greenstone, an Ordovician bimodal metavolcanic unit of lower greenschist facies (Tull and Barineau, 2012). The rest of the quadrangle is underlain by medium- to high-grade metasedimentary rocks of the Ashland Supergroup contained within the eastern Blue Ridge that are Neoproterozoic to lower Paleozoic in age (Barineau et al., 2015).

Ashland Supergroup. Rocks of the Ashland Supergroup make up the hanging wall of the Hollins Line fault. Prouty (1923) was the first to describe the "Ashland Series" in Clay County as the units that lie between the Hollins Line fault and the Goodwater-Enitachapco fault, now known as the eastern Blue Ridge. Neathery (1975) was the first to refer to the lowermost unit as the Poe Bridge Formation. The Higgins Ferry Group to the southwest is interpreted to be the stratigraphic equivalent of the Poe Bridge Mountain Group (Tull, 1978). Overlying this unit is the Mad Indian Group and its southwestern equivalent, the Hatchet Creek Group. Tull (1978) designated the Poe Bridge Mountain and Higgins Ferry Groups into the Ashland Supergroup after correlating across the Millerville antiform. In the Clairmont Springs quadrangle, the Ashland Supergroup is represented by the Poe Bridge Mountain Group and the Mad Indian Group. In general, the sequence strikes northeast-southwest and dips 5-85° to the southeast. This sequence has a high degree of metamorphic overprint, so protolith interpretations are difficult to make. The unit is dominantly metapelitic, with smaller amounts of metasandstone and amphibolite (Drummond et al., 1988; Barineau et al., 2015). The area has no carbonate rocks, though sequences of metapelite and metagraywacke could suggest that the Ashland Supergroup originated as turbidites in a slope-rise environment along a rifted continental margin (Tull, 1978; Drummond et al., 1988; Allison, 1992). High amounts of graphite in the unit suggests deposition of sands and muds (Allison, 1992). Zircon U-Pb ages of 1150 and 964 Ma (Das, 2006) suggest that the Ashland Supergroup contains Grenville-source sediment, but the age of this unit is not well constrained. The sequence is likely Neoproterozoic to early Paleozoic age and is underlain by the Paleozoic Laurentian shelf units of the Talladega Group and overlain by the Wedowee Group that is intruded by the Cambro-Ordovician Elkahatchee Quartz Diorite (Drummond et al., 1988; Allison, 1992; Tull et al., 2007; Barineau et al., 2015). The amphibolites in the area were

intruded as basaltic flows with geochemical signatures that suggest an ocean-floor origin (Stow et al., 1984).

Poe Bridge Mountain Group. The Poe Bridge Mountain Group is the lowermost unit of the eastern Blue Ridge. On the Clairmont Springs quadrangle, the Poe Bridge Mountain Group occupies most of the central portion of the map, bounded by Talladega Creek to the northwest and Mines Road to the southeast; and forms a sequence of rolling hills and narrow valleys. The best exposures of this unit lie on Poe Bridge Mountain, in the southernmost part of the quadrangle. This area is public National Forest land as well as private land owned by Hancock Natural Resources that has been leased to logging companies. The Poe Bridge Mountain Group is composed of feldspathic graphite schist, graphitic quartzite, garnet-muscovite-biotite schist, garnet quartzite, and irregular lenses of amphibolite, mapped separately as the Ketchepedrakee Amphibolite (Figure 3 and 4). Pockets of garnetiferous altered mafic rock and calc-silicate gneiss with a garnet + clinopyroxene + hornblende + plagioclase assemblage are present but uncommon (Allison, 1992). Mineral assemblages suggest that the Poe Bridge Mountain Group experienced peak metamorphic conditions of middle to upper amphibolite facies, with kyanite and staurolite present as index minerals (Barineau et al., 2015). The unit approaches ~4km thickness on the Clairmont Springs quadrangle, since the base of it is cut out by the Hollins Line fault. U-Pb ages of 1.1 Ga to 964 Ma (Das, 2006) indicate Grenville-source sediment for this unit. Based on ages of the surrounding stratigraphy, the age of the Poe Bridge Mountain group is Neoproterozoic to early Paleozoic (Drummond et al., 1988; Allison, 1992; Tull et al., 2007; Barineau et al., 2015). Mean metamorphic U-Pb zircon ages, indicated by U/Th ratios greater than 10 for the Appalachians, from this study range from ~274 to ~448 Ma, suggesting Taconic to Alleghenian activity (Appendix A).

Ketchepedrakee Amphibolite. The Ketchepedrakee Amphibolite appears as irregular lenses within the Poe Bridge Mountain Group and is found mostly in the vicinity of London Mountain, Lizard Scrape Mountain, and along Idaho Road in the center of the quadrangle. The Ketchepedrakee Amphibolite is a dark gray to black, fine- to coarse-grained unit of hornblende and plagioclase with accessory quartz, garnet, biotite, clinopyroxene and epidote (Stow et al., 1984) (Figure 5). Amphibolite beds range in thickness from a few centimeters to a few hundred meters. Based on geologic setting, geochemical and mineralogical analysis, Stow et al. (1984) noted that this unit is compositionally like low-potassium tholeiitic basalt and could signify deposition as sills or flows in a back-arc basin after deposition of sedimentary units. Thomas et al. (1980) similarly interpreted the amphibolite as ocean-floor basalt sequences interbedded with deep water metasediments.

Mad Indian Group. The Mad Indian Group appears in the southeastern corner of the Clairmont Springs quadrangle and is marked by a distinct topography change, where the steep terrain and higher elevation of Poe Bridge Mountain transitions to gently rolling hills and farmland southeast of Mines Road. In this area, the rocks are poorly exposed and heavily weathered. The Mad Indian Group is more homogeneous than the Poe Bridge Mountain Group and consists mainly of feldspathic biotite-muscovite-garnet schist and occasional lenses of micaceous quartzite (Figure 6 and 7). Metamorphic rocks within the Mad Indian Group locally contain kyanite and sillimanite. Deformed tonalite inliers and pegmatite lenses are present throughout the Mad Indian Group. On the Clairmont Springs quadrangle, the Mad Indian group dips 30-50° southeast. The contact of this unit with the Poe Bridge Mountain Group is gradational and interpreted as stratigraphic (Tull, 1978; Drummond, 1986). The Mad Indian Group experienced higher grade metamorphism than the surrounding units (Stowell et al., 2019)

and lacks primary structures that may indicate the protolith, however, given the pelitic composition, Mad Indian Group rock protoliths were likely sedimentary (Barineau et al., 2015). Like the Poe Bridge Mountain group, the Mad Indian Group has Grenville-age source sediment (Das, 2006) and is interpreted to be Neoproterozoic to early Paleozoic age from stratigraphic relationships (Drummond et al., 1988; Allison, 1992; Tull et al., 2007; Barineau et al., 2015). A ~357 Ma Sm-Nd garnet age brackets peak metamorphism in the Mad Indian Group (Dickson et al., 2019). Mean metamorphic ages from this study range from ~347 Ma to ~370 Ma (Appendix A).

Igneous Rocks within the Mad Indian Group. Occasional lenses of deformed tonalite were observed within the Mad Indian Group. These lenses may correlate to the Rockford or Bluff Springs Granite (Drummond, 1986; Allison, 1992). Russell et al. (1987) reported a 366 Ma Rb-Sr whole rock age estimate for the Bluff Springs Granite and Stowell et al. (2019) reported a nearly identical 366 Ma U-Pb zircon analysis for the Bluff Springs. The Rockford Granite contained two distinct zircon populations at 377 and 390 Ma (Stowell et al., 2019) and a population of Grenville age (1.0-1.2 Ga) recycled grains (Drummond et al., 1988). The 1988 Geologic Map of Alabama (Szabo et al., 1988) classifies igneous rocks in the Clairmont Springs area with the Bluff Springs Granite and are interpreted as intruding the Mad Indian Group. Barineau et al. (2015) puts the Rockford Granite as the only intrusion in the Mad Indian Group.

Hillabee Greenstone. The Hillabee Greenstone occupies the structural top of the Talladega belt. On the Clairmont Springs quadrangle, it lies along Talladega Creek in the valley along the southern flanks of Talladega Mountain. The unit is ~2.5 km thick but is cut out by both the underlying Hillabee thrust system and overlying Hollins Line fault (Barineau et al., 2015). Lithologies found in the area where mainly mafic phyllite with rare instances of fine-grained

greenstone. The Hillabee Greenstone is bimodal and includes basalt and dacite modes (Tull and Stow, 1980). All rocks are sub-alkaline with mafic units being tholeiitic, and the felsic units being calc-alkaline (Tull and Stow, 1980). The mafic greenstone and phyllite have the same chemical and mineralogical assemblage of actinolite, epidote, albite and chlorite (Tull et al., 1978). Overall, the unit was poorly exposed and sometimes difficult to distinguish from the Erin Slate. The true thickness of the Hillabee Greenstone is hard to discern, since the unit is bounded by the Hollins Line fault, which cuts out strata (Tull and Barineau, 2012). Element analyses suggest that the Hillabee Greenstone formed by volcanism caused by westward under-thrusting of a continental margin by oceanic lithosphere, which resulted in closure of a backarc (Tull and Stow, 1980; Tull et al., 1998). Zircon analyses (Russell, 1978; Russell et al., 1984; McClellan et al., 2007; Tull et al., 2007) have confirmed that the Hillabee Greenstone is Ordovician in age and therefore must be in fault contact with Mississippian strata within the underlying Talladega belt. This contact illustrates that the Hillabee Greenstone was juxtaposed along a fault that was concordant to the underlying metasedimentary stratigraphy, therefore creating flat-on-flat geometry (Tull et al., 2007; Tull and Barineau, 2012).

Talladega Group. The Talladega Group is the most extensive unit of the western Blue Ridge. Rocks of the Talladega Group are exposed in the northwestern corner of the Clairmont Springs quadrangle and on the ridge, northern slope, and southern slope of Talladega Mountain. The Talladega Group includes the Lay Dam Formation, Butting Ram Sandstone/Cheaha Quartzite, the Jemison Chert-Chulafinnee Schist undifferentiated, and the Erin Slate (Tull, 2002). The lithologies found include graphitic phyllite, chlorite-sericite phyllite, slate, quartz metasandstone, quartzite, and metaconglomerate. The Talladega Group, dominated by turbidites, shallow water sandstones, and shales, is thought to be a Paleozoic successor basin sequence that

developed above a regional unconformity along Laurentian continental margin (Tull and Telle, 1989; Tull, 2002). This extensional environment likely resulted from back-arc rifting, which allowed the bimodal volcanic arc complex Hillabee Greenstone to form (Tull and Telle, 1989).

Lay Dam Formation. The Lay Dam Formation of the Talladega Group is exposed in the northwestern corner of the Clairmont Springs quadrangle. This area is made up of a valley and the northern slope of Talladega Mountain. The best exposures of this unit lie on NFS Road 66, which runs along the ridge of Talladega Mountain. It is composed of predominantly foliated green chlorite-sericite phyllite that weathers tan/orange with minor interlayers of dark green metagraywacke, found on the western edge of the quadrangle (Figure 8 and 9). Occasional lenses of graphitic slate were also found on the quadrangle. The sequence dips 15-70° southeast. Unit compositions indicate that this sequence was deposited rapidly in deep water, followed by shallow water sequences towards the stratigraphic top of the unit (Tull and Telle, 1989; Tull, 1998). Silurian to Pennsylvanian conodonts in its upper portion, Early Ordovician conodonts in the underlying Sylacauga Marble Group, and Early to Middle Devonian fauna in the overlying Butting Ram Sandstone and Jemison Chert units (Tull and Barineau, 2012) constrains the age of this unit to Silurian-Devonian. Over its thickness of ~40 m, the Lay Dam Formation grades into the metasandstone/metaconglomerate of the Butting Ram Sandstone/Cheaha Quartzite (Tull and Barineau, 2012).

Butting Ram Sandstone/Cheaha Quartzite. The Butting Ram Sandstone and its northeastern equivalent, the Cheaha Quartzite, lie on the northwestern portion of the Clairmont Springs quadrangle along the ridge of Talladega Mountain. These two units consist of white to gray, medium to coarse grained quartz sandstone, quartzite, and metaconglomerate (Figure 10 and 11). Beds can be thin to massively bedded and have occasional chlorite-sericite phyllite

interbeds. The Butting Ram/Cheaha Quartzite sequence can range from 200-400 m thickness on the Clairmont Springs quadrangle, and generally dips 10-80° southeast, with occasional northwest-dipping measurements. A metaconglomerate within the Butting Ram Sandstone/Cheaha Quartzite interval contains quartzite clasts that range from ~2 cm to 20 cm length. This sequence indicates a return to a stable basin margin and a shallow coastal environment, as evidenced by the mature quartz arenites (Tull, 2002). Early Devonian shallow marine fauna were found near the base of this sequence by Carrington (1973).

Jemison Chert/Chulafinnee Schist undifferentiated. The Jemison Chert-Erin Slate undifferentiated lies on the southern slope of Talladega Mountain on the Clairmont Springs quadrangle. This unit contains gray-white to orange-red medium grained fissile quartz sandstone and chlorite-sericite ± graphite phyllite (Figure 12). The lithologies found in this unit suggest a decrease in sediment supply considering the underlying sandstones and represents a period of tectonic stability (Tull, 2002). Beds of quartz sandstone range from 20 to 50 m thickness. Occasional metasandstone occurs near the gradational contact between this unit and the underlying Butting Ram Sandstone/Cheaha Quartzite (Tull, 2002). Towards the top of the unit, there is a noticeable increase in graphitic phyllite interlayers. The unit is poorly exposed on the quadrangle and beds are massive, but generally dip southeast. The lower portion of this unit contains lower Devonian marine invertebrate fauna (Butts, 1926). King and Keller (1992) used “metachert” to describe the Jemison Chert and noted that its texture is more like a foliated quartzite but it likely had a chert protolith. This notion was evident on the quadrangle as no true chert was identified. Erin Slate. The Erin Slate is a facies equivalent of the Jemison Chert-Chulafinnee Schist and is sometimes grouped together (Barineau et al., 2015), since it can contain interlayers of metasandstone and quartzite. On the Clairmont Springs quadrangle,

graphitic phyllite and greenish-grey sericite phyllite along with rare instances of black slate are found at the foot of Talladega Mountain. Beds dip 15-50º southeast. This more carbonaceous, clay-rich sequence indicates deposition under more anaerobic conditions, likely a deep-water basin (Tull, 2002). Periastron reticulatum fauna within the uppermost portion of the Erin Slate constrain its age to the lowest Mississippian (Gastaldo et al., 1993).

Structural Geology

Structural features mapped with the Clairmont Springs quadrangle are shown on the geologic map and in cross section A-A′ (Appendix B). The quadrangle contains units from the Blue Ridge province, previously referred to as the northern Piedmont, which is separated from the Appalachian fold and thrust belt by the Talladega-Cartersville fault in the northwest and from the Inner Piedmont by the Brevard fault zone to the southeast. The western Blue Ridge Talladega belt is separated from the eastern Blue Ridge Ashland-Wedowee-Emuckfaw belt by the Hollins Line fault (Barineau et al., 2015). The Hillabee thrust fault is also found on the quadrangle and places the Ordovician Hillabee Greenstone upon Mississippian units of the Talladega Group (Tull and Barineau, 2012).

Hillabee Thrust Fault. As a result of the Hillabee Greenstone's concordancy with the underlying Talladega Group and the lack of a metamorphic break between it and the Erin Slate, the Hillabee Greenstone was previously thought to be Devonian (Tull et al., 2007; Barineau, 2009). This hypothesis was later refuted by a number of workers who concluded Ordovician ages from isotopic data for the Hillabee Greenstone, meaning it must be in fault contact with the Talladega Group (Russell, 1978; Russell et al., 1984; Tull et al., 2007; McClellan et al., 2007). Since the underlying rocks of the Talladega Group have very similar metamorphic and

deformational traits as the Hillabee, the Hillabee thrust fault is either pre or synmetamorphic (Tull et al., 2007; McClellan et al., 2007; Barineau, 2009). The Hillabee Greenstone, which can be traced for over 200 km, is in contact with both horses of the Hollins Line footwall duplex over its entire length and maintains a flat-on-flat geometry with the underlying units, which suggest that deformation was minimal prior to and during emplacement (Barineau, 2009; Barineau et al., 2015). The stratigraphy of the Hillabee Greenstone itself is internally concordant and parallel to the internal stratigraphy of the Erin Slate (Tull et al., 2007; Barineau et al., 2009). Final emplacement of the Hillabee Greenstone must have occurred before metamorphism (334-320 Ma McClellan et al., 2007) but after deposition of the Mississippian Erin Slate, the youngest unit in the Talladega Group (Barineau et al., 2015). Movement along the Hillabee thrust and emplacement of the Hillabee Greenstone is thought to fall between 375-359 Ma, since the youngest rocks of the Talladega Group are upper Devonian to lower Mississippian (Butts, 1926; Gastaldo et al., 1993; Tull et al., 2007). On the Clairmont Springs quadrangle, the Hillabee thrust fault manifests as a topographic break, where the steep southern slope of Talladega Mountain, underlain by the Jemsion Chert-Chulafinnee Schist undifferentiated and the Erin Slate, transitions to a flat valley and gentle gradient of Talladega Creek, underlain by the Hillabee Greenstone.

Hollins Line Fault. The Hollins Line fault marks the boundary between the western and eastern Blue Ridge, where rocks of the Talladega belt lie in the footwall and units of the Ashland-Wedowee-Emuckfaw belt lie in the hanging wall (Barineau, 2009; Tull and Barineau, 2012). This fault has been studied by a number of workers since Prouty (1923). It marks a distinctive change in metamorphic grade, from the lower greenschist facies of the Hillabee Greenstone to the middle to upper amphibolite facies of the Ashland Supergroup. Rocks of the

Talladega belt are interpreted to be the most internal segments of the Appalachians that still have a Laurentian affinity post-Rodinia breakup (Barineau, 2009), and rocks of the eastern Blue Ridge have been viewed as remnants of exotic terranes, though recent detrital zircon data has challenged this idea (Barineau, 2009). On the Clairmont Springs quadrangle, the Hollins Line fault is marked by a topographic break, where the low-lying valley overlain by the Hillabee Greenstone switches to sequences of rolling hills overlain by the Ashland Supergroup. The Hollins Line fault is made up of roof, floor, and splay thrusts (Barineau, 2009) which create fault bounded horses stacked in en-echelon right sense (Tull et al., 2007). This characterizes the Hollins Line fault as a footwall duplex thrust system (Barineau, 2009). Talladega belt units are often truncated by the 18 floor and splay thrusts, where the Butting Ram/Cheaha Quartzite marks the base of the horses and the splay thrusts most commonly cut through the Hillabee Greenstone (Barineau, 2009). On the Clairmont Springs quadrangle, no such structures were found, however. Structural constraints described by various workers suggest that the Hollins Line fault is a postmetamorphic dextral, transpressional fault likely Permian in age that formed in response to crustal shortening during the Alleghenian orogeny (Tull et al., 2007, 2012; Barineau, 2009; Tull and Barineau, 2012).

Deformation and Metamorphism

The earliest instance of deformation in the Alabama Blue Ridge occurred simultaneously with metamorphism. Metamorphic grade within the Clairmont Springs quadrangle varies from lower greenschist facies in the Talladega belt north of the Hollins Line fault system, to middle and upper amphibolite facies in the Ashland Supergroup south of the fault (Tull, 1978; Barineau et al., 2015), meaning that Hollins Line fault represents a deviation from the typical west-to-east

increase in metamorphic grade (Tull, 1978). The Talladega belt contains a range of metasedimentary to metavolcanic units, but only the uppermost units of the belt are found on the Clairmont Springs quadrangle. Kish (1990) reported K-Ar whole rock ages from the Talladega belt to average 390 Ma. Russell (1987) reported a 382 ± 14 Ma K-Ar hornblende age from the Talladega belt. 360- 320 Ma (McClellan et al., 2007) metamorphic ages from Talladega belt record initial metamorphism, but peak metamorphism occurred at 334–320 Ma from 40Ar/39Ar muscovite ages (McClellan et al., 2007). Pressure and temperature estimates for the Talladega belt from various workers concluded ~350C at ~3.5 kbar (Tull and Stow, 1980; Lim, 1998; Tull et al., 1998; McDonald, 2000), indicating lower greenschist conditions. These ages suggest that following the emplacement of the Ordovician Hillabee Greenstone, units of the Talladega belt were subjected to Acadian-Alleghenian greenschist facies metamorphism that peaked during the earliest Alleghenian (McClellan et al., 2007; Barineau, 2009). For the eastern Blue Ridge, Wampler et al. (1970) concluded 348 Ma metamorphic age from K-Ar hornblende. Other researchers confirmed 395 ± 20 Ma. (Durham, 1993) and 366 ± 25 Ma (Russell, 1978) Rb/Sr whole rock ages for the eastern Blue Ridge. Drummond (1986) and Allison (1992) made pressure, temperature, and fluid composition estimates for the Ashland Supergroup. Poe Bridge Mountain estimates were 665°C and 4.54 kb. Mad Indian Group estimates were 660°C and 6.84 kb (Drummond, 1986; Allison, 1992). Dickson et al. (2019) reported conditions at 6.5 to 9 kilobar and 550–650 °C with peak conditions at ca. 357 Ma from a single garnet within the Mad Indian Group. These data suggest metamorphism occurring as early as the Acadian, but likely peaking during the Neoacadian.

Summary

Geologic mapping of the Clairmont Springs 7.5-minute quadrangle (lat. 33°22′30″ and 33°15′00″; long. 85°52′30″ and 86°00′00″) reveals detailed information on the distribution of bedrock geologic units and geologic structures of the area (Appendix B). Units within the quadrangle constitute portions of the Alabama Blue Ridge province (Raymond et al., 1988). Formal stratigraphic sequences include Silurian to Early Mississippian Talladega Group and its members: the Lay Dam Formation, Butting Ram Sandstone/Cheaha Quartzite, Jemison Chert/Chulafinnee Schist undifferentiated, and the Erin Slate. These rocks are low grade metasedimentary units. The Hillabee thrust fault places the Ordovician Hillabee Greenstone upon the Talladega Group. The Hollins Line fault is the boundary between rocks of the eastern and western Blue Ridge, and is marked by a change in topography and metamorphic grade (Raymond et al., 1988; Tull and Barineau, 2012). This thrust fault puts rocks of the Ashland Supergroup upon the Hillabee Greenstone. The Ashland Supergroup contains the Poe Bridge Mountain Group and associated Ketchepedrakee Amphibolite, and the Mad Indian Group and associated plutons. These units are middle to upper amphibolite facies, and Neoproterozoic in age (Barineau et al., 2015).

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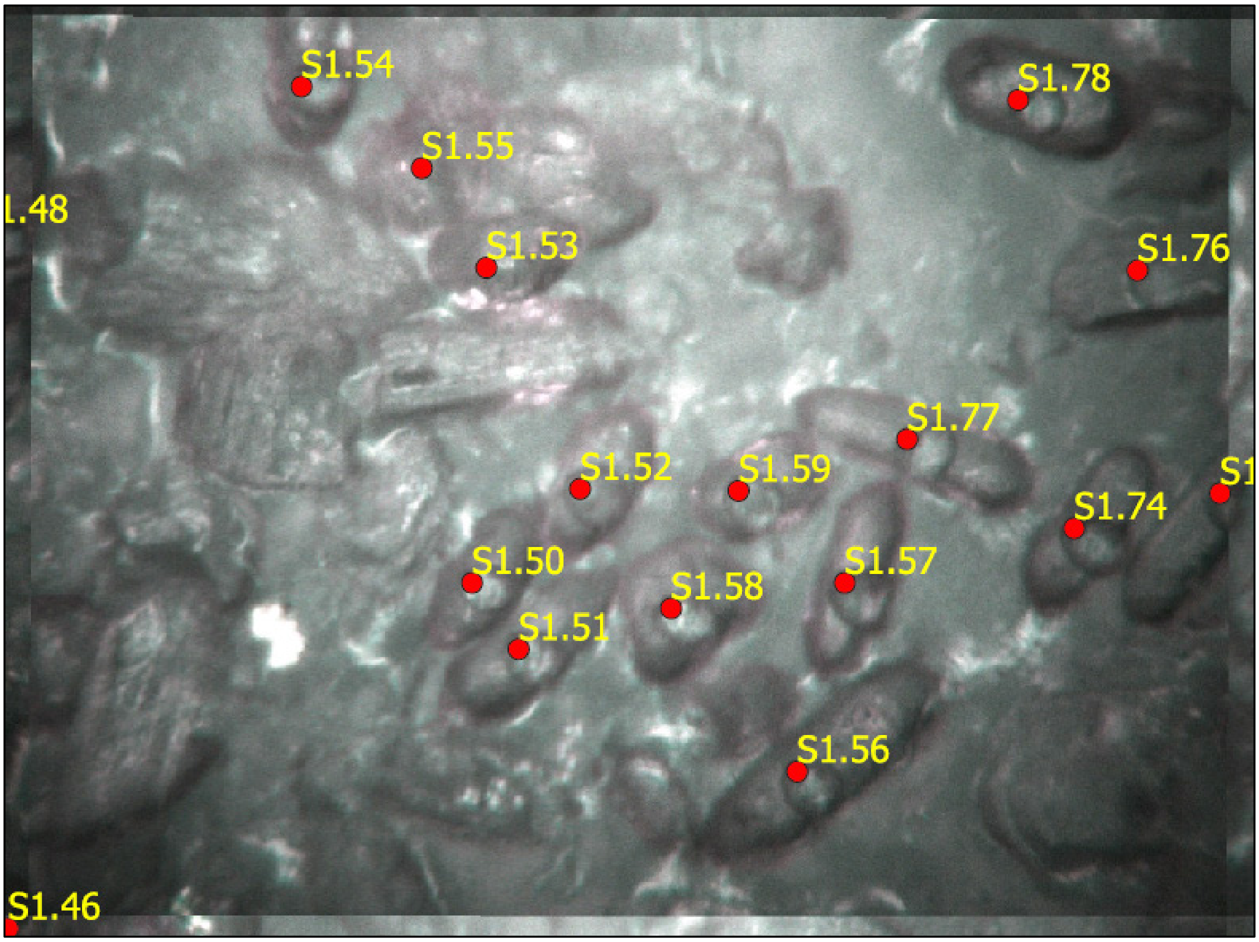
PART 2: U-Pb ZIRCON AGE ESTIMATES FOR METAMORPHISM OF THE EASTERN BLUE RIDGE OF ALABAMA



Abstract

U-Pb zircon analysis of metamorphic rims in fourteen samples reveal new information on the timing of metamorphism and the nature of structural relationships in the western and eastern Blue Ridge of Alabama. High-grade rocks of the Ashland Supergroup yielded ages of ~345-370 Ma, constraining metamorphism to the Neoacadian orogeny. Distinct populations in selected samples yielded ages of 274-293 Ma, coinciding with the Alleghenian orogeny, while two anomalous samples yielded mean ages of 390 and 448 Ma, reflecting pre-Neoacadian activity. The collective data suggest that metamorphism was diachronous, and that the Ashland Supergroup underwent metamorphism before the adjacent, lower-grade sequences of the Talladega Group to the northwest and Wedowee-Emuckfaw belt to the southeast. This information has ramifications for structures bounding the Ashland Supergroup, where the northern-boundary Hollins Line fault must be post-340 Ma, and the southern-boundary Goodwater-Enitachapco fault must be post-320 Ma. This suggests that thrust faults in the eastern Blue Ridge did not develop in sequence, and that the two bounding faults mentioned separate rocks that underwent individual thermal evolutions during various protracted orogenic episodes.

Introduction

Collisional orogens are the result of the closing of oceanic basins, terrane accretion, and collision of continents. Alpine-style orogens (Appalachians, Himalayas) are dominated by deformation associated with continent-continent collision; with early deformation related to arc accretion. The Appalachian Mountains in North America were assembled over orogenic events that reflect 1) the creation of Laurentian and Gondwanan passive margins during the Cambrian to Early Ordovician (Taconic orogeny) 2) the collision of various peri-Gondwanan terranes with

Laurentia that culminated in the closure of the Iapetus Ocean during the Devonian (Acadian orogeny) 3) and the collision of Laurentia and Gondwana, creating Pangaea (Alleghenian orogeny) (van Staal et al., 2009) (Figure 13). A Neoacadian orogeny (360-340) has been proposed for the southernmost Appalachians (Hatcher, 2010) that overlaps in time, but not in space with the end of Acadian deformation and magmatism (van Staal et al., 2009). Previous geochronology studies in the eastern Blue Ridge and Inner Piedmont provinces of the southern Appalachians have reported distinct ∼350-Ma (Neoacadian) and ∼330-Ma (early Alleghenian) metamorphic events (Dennis and Wright, 1997; Carrigan et al., 2001; Kohn, 2001; Hames et al., 2007), which is significantly different than that of the surrounding provinces. Alleghenian activity is prominent in the southern Appalachian foreland (Guthrie et al., 1995).

The western Blue Ridge-greenschist facies Talladega belt contains some of the youngest units (Mississippian) in the metamorphosed Appalachians, while also representing the most outboard portion of Laurentian cover rocks in the entire mountain belt (Tull and Barineau, 2012). The structural and stratigraphic position of this unit means it can provide valuable information on the tectonic and metamorphic history of the southernmost Appalachians (Tull and Barineau, 2012). The Neoacadian Hollins Line fault juxtaposes middle to upper amphibolite facies rocks of 28 the Ashland Supergroup upon the lower grade Talladega belt. The Ashland Supergroup of the eastern Blue Ridge and its southwestern neighbor, the Wedowee-Emuckfaw belt, are separated by the late Alleghenian Goodwater-Enitachapco fault (Tull, 1987; Steltenpohl et al., 2013), and record mid-crustal conditions that are an essential part in understanding the thermal and tectonic evolution of the region. Previous research has constrained peak metamorphism to 334-320 Ma (McClellan et al., 2007) in the Talladega belt, ~357 Ma (Dickson et al., 2019) in the Ashland Supergroup, and 331-320 Ma (Stowell et al., 2019) in the Wedowee-Emuckfaw belt. Therefore,

no temporal trends in metamorphism are clear from the available data. To provide additional age constraints, for metamorphism in the medial Ashland Supergroup of the eastern Blue Ridge, U-Pb zircon geochronology ages were obtained from fourteen samples. The ages in this study support recent data that suggests the Ashland Supergroup was metamorphosed before the adjacent units, which result in complex structural implications for the region and its geologic history.

Geologic and Tectonic Background

The Appalachians are an accretionary orogen that formed on the eastern Laurentian margin by a complete Wilson cycle (Hatcher, 2010). They contain evidence for four Paleozoic orogenic events: the Taconic (440– 480 Ma), Acadian (410–380 Ma), Neoacadian (360?-340) and Alleghenian (325–265 Ma) (Hatcher, 2010) (Figure 13). These orogenies are not ubiquitous along the entire length of the mountain chain, and numerous geo- and thermochronology studies have shown that this is especially true for the southernmost Appalachians of western Georgia and Alabama (Steltenpohl and Kunk, 1993; Steltenpohl et al., 2005; McClellan et al., 2007; Merschat et al., 2012; Stowell et al., 2019). The Ordovician Taconic orogeny is well defined in the Blue Ridge of the Carolinas, Tennessee, and Georgia, but lacking in Alabama; and was characterized 29 by the collision of Laurentia with a volcanic arc (Hatcher, 2010; Tull and Barineau, 2012). The Devonian Acadian orogeny was a Cordilleran-style orogen that produced a huge mountain belt that can be traced across the modern Atlantic Ocean and is equivalent to the Caledonian Orogeny in Europe (Hatcher, 2010). Evidence for this event in the southern Appalachians is sparse, since extensive deformation is believed to have occurred later during the Neoacadian orogeny (Hatcher, 2010). In the Southern Appalachians, the Neoacadian orogeny began around

370 Ma and continued until the beginning of the Alleghenian orogeny ca. 325 Ma. The Neoacadian event was marked by dextral strike-slip kinematics associated with a few hundred kilometers of terrane transport, but it is unclear whether this was a single protracted event, or episodic (Hatcher, 2010; Merschat et al., 2012). Finally, the Alleghenian Orogeny was the last major event that affected eastern North America during the Paleozoic. The Alleghenian orogeny was marked by the collision of Laurentia with Gondwana, which transported the Blue Ridge Piedmont megathrust at least 350 kilometers towards the North American craton (Hatcher, 2005). The Alleghenian orogeny was complete at 265 Ma and is marked by the construction of Pangea (Hatcher, 2005). Evidence for the Alleghenian orogeny is prominent in the foreland fold and thrust belt of the southernmost Appalachians (Hatcher, 2005).

Characterization of Appalachian Structures

The Appalachians, as well as many other mountain chains, are composed of a series of large thrust faults. Thrust faults manifest when a section of earth converges with and compresses another section (Shaw et al., 1999). Thrust fault deformation occurs in two varieties, and this study focuses on imbricated splays. Imbricate structures formed by the stacking of two or more thrust sheets are found in fold-andthrust belts worldwide (Suppe, 1983; Shaw et al., 1999). Fault splays develop along a subhorizontal fault, known as the decollement. Commonly, deformation is such that thrusts become 30 progressively younger towards the foreland, or in the direction of transport and beginning closest to the source of stress (Shaw et al., 1999) (Figure 14). This is known as in-sequence thrusting, where younger thrust faults will form in the footwalls of older thrusts and verge in the same direction as older thrusts (Shaw et al., 1999). On the other hand, in breaking-backward sequences, shear is transmitted toward the hinterland and, in contrast,

younger thrusts will form in the hanging walls of older thrusts, but still verge in the same direction as the older thrusts (Shaw et al., 1999). In this system, thrusts become progressively younger toward the hinterland, and the progressive splays develop behind the frontal splay (Shaw et al., 1999). In a breaking-backward sequence, slip can displace and refold portions of the shallow thrust, resulting in fold limbs that display a variety of dip domains (Shaw et al., 1999).

Differences in southern Appalachian structures are most visible between Tennessee, western North and South Carolina, and northern Georgia and Alabama (Steltenpohl et al., 2013). Eastern Tennessee contains a thin-skinned foreland fold-and-thrust belt with many coplanar, NW-striking thrust faults (Steltenpohl et al., 2013). In contrast, the Valley and Ridge of Alabama and Georgia has NE-striking Alleghenian thrust faults, where Cambrian to Pennsylvanian strata is bounded by metamorphic thrusts of the Talladega slate belt to the southeast, and undeformed basement strata to the northwest (Thomas and Bayona, 2001). The Talladega-Cartersville fault is the frontal Blue Ridge fault in Alabama and is the southern Appalachian master décollement (Steltenpohl et al., 2013). This fault is a complex structure with decapitated folds that do not follow classic foreland fold-and-thrust-belt geometry found in Tennessee (Tull, 1984; Steltenpohl et al., 2013). The Hollins Line fault is equivalent to the Hayesville thrust and is the basal eastern Blue Ridge fault in Alabama (Tull, 1984; McClellan et al., 2007; Tull et al., 2007); but unlike the Hayesville fault, the Hollins Line is an oblique, right-slip transpressional fault (Mies, 1991). This means that right-slip motion in the Blue Ridge of Alabama occurs considerably further toward the foreland (Steltenpohl et al., 2013).

Regional Geology

The southern Appalachians are divided into provinces that represent Laurentian basement, passive margin, and accreted terranes of Laurentian and exotic affinity (Hatcher, 2005). The southern Appalachians of Alabama and Georgia are part of a structural recess with Paleozoic and older units (McClellan et al., 2007). The Blue Ridge of Alabama is separated from the Appalachian fold and thrust belt by the Talladega-Cartersville fault in the northwest and from the Inner Piedmont by the Brevard fault zone to the southeast (Raymond et al., 1988) (Figure 15). Both the Blue Ridge and the Inner Piedmont are allochthonous and lie above the southern Appalachian master decollement, a subhorizontal fault which surfaces as the Talladega-Cartersville fault and separates the Blue Ridge rocks from the Alleghenian foreland basin sedimentary units of the Mississippian to Pennsylvanian Parkwood Formation, Bangor Limestone, and Pottsville Formation (Tull, 1984). Regional deformation in the eastern Blue Ridge and Inner Piedmont is marked by shallow NE-SW foliations and lineations (Merschat et al., 2005; Huebner et al., 2017).

The Alabama Blue Ridge province is further divided into the western Blue Ridge, characterized by Grenville basement and low-grade, metasedimentary rocks of the Talladega belt (Raymond et al., 1988) and the eastern Blue Ridge, which contains the deeper water metasedimentary units of the Ashland Supergroup (Barineau et al., 2015) (Figure 15). The Proterozoic to lower Paleozoic rifted-margin Talladega belt was thrust upon Paleozoic sequences of the Valley and Ridge province and represents the outermost preserved part of the Laurentian margin, meaning it should record the earliest events that affected the area in a breaking-backward sequence (Raymond et al., 1988; Tull and Barineau, 2012). The Hillabee Greenstone metavolcanic sequence marks the structural top of the western Blue Ridge (Raymond et al., 1988). The Hollins Line fault system separates the western Blue Ridge (footwall) from the

eastern Blue Ridge (hanging wall) (Tull and Barineau, 2012; Barineau et al., 2015). Structurally above the Ashland Supergroup lies Goodwater-Enitachapco fault, with the Wedowee-Emuckfaw belt as the hanging wall (Raymond et al., 1988)

Talladega belt. Rocks of the Talladega belt are metamorphosed up to greenschist faces, and fossil evidence has indicated that the units range in age from Cambrian to early Mississippian (Tull et al., 1988; Gastaldo et al., 1993; Tull and Barineau, 2012). Some of the older sequences can be correlated with unmetamorphosed units in the northwest foreland fold and thrust belt (Tull et al., 1988; Johnson and Tull, 2002). The Talladega belt contains the following units: the Kahatchee Mountain Group, the Sylacauga Marble Group, the Talladega Group, and the overlying Hillabee Greenstone (Tull and Barineau, 2012). Sequences of the Talladega belt are interpreted to have experienced on Paleozoic, prograde metamorphic event (Tull and Barineau, 2012).

Talladega Group. The upper clastic sequence Talladega Group contains the Silurian to early Devonian Lay Dam Formation, the early Devonian Butting Ram/Cheaha Quartzite, the early to middle Devonian Jemison Chert, and the early Mississippian Erin Slate (Tull et al., 1988; Gastaldo et al., 1993; Tull, 2002; Tull and Barineau, 2012). The Lay Dam Formation is characterized by chlorite-sericite phyllite interbedded with occasional lenses of metaturbidites, metaconglomerates, and olistostromal units (Tull and Barineau, 2012). Overlying this sequence are the shallow, near-shore marine environment metasandstones of the Butting Ram-Cheaha Quartzite, with occasional layers of chlorite-sericite phyllite (Tull and Barineau, 2012). Graphite chlorite-sercite phyllite, slate, and metachert dominate the Jemison Chert-Erin Slate facies equivalents (Tull, 2002; Tull and Barineau, 2012). Structurally above this sequence is the bimodal Hillabee Greenstone, characterized by mafic phyllites and greenstones with occasional

quartz metadacite (Tull and Barineau, 2012). Ordovician U-Pb ages from the Hillabee Greenstone suggest that it is faulted upon the Talladega Group (Russell, 1978; McClellan et al., 2007). Emplacement of the Hillabee Greenstone must have occurred before metamorphism of the Talladega belt (334-320 Ma McClellan et al., 2007) but after deposition of the Mississippian Erin Slate, the youngest unit in the Talladega Group (Barineau et al., 2015). Movement along the Hillabee thrust and emplacement of the Hillabee Greenstone is thought to fall between 375- 359 Ma, since the youngest rocks of the Talladega Group are upper Devonian to lower Mississippian (Butts, 1926; Gastaldo et al., 1993; Tull et al., 2007). On the Clairmont Springs quadrangle, the Hillabee thrust fault manifests as a topographic break, where the steep southern slope of Talladega Mountain, underlain by the Jemsion Chert-Chulafinnee Schist undifferentiated and the Erin Slate, transitions to a flat valley and gentle gradient of Talladega Creek, underlain by the Hillabee Greenstone. This contact, known as the Hillabee thrust, has flaton-flat thrust geometry and is in concordance with the underlying units (Tull et al., 2007; Tull and Barineau, 2012). Only a couple hundred meters of the Hillabee Greenstone is preserved throughout the majority of the length of the belt below the Hollins Line fault, and at some locations it is completely cut out (Tull, 1982; Tull and Barineau, 2012).

Ashland Supergroup. The Ashland Supergroup, part of the eastern Blue Ridge of Alabama, is characterized by diverse lithologies of high-grade (middle to upper amphibolite facies) mid-crustal sequences (Barineau et al., 2015). The lowest unit stratigraphically is the Poe Bridge Mountain Group, which is dominated by biotite-muscovite schists of varying graphite, garnet, quartz, and feldspar levels (Barineau et al., 2015) Rocks can locally include kyanite, sillimanite, or staurolite. Rarer lithologies include garnetiferous mafic rock, iron-bearing units, and pegmatites. Notably, the Poe Bridge Mountain Group is distinguished from the overlying

Mad Indian Group by the presence of garnet quartzite and lenses of orthoamphibolite (Ketchepedrakee Amphibolite) (Barineau et al., 2015). The Mad Indian Group is characterized by similar sequences of biotite-muscovite schist with fluctuating amounts of garnet, graphite, quartz, and feldspar (Barineau et al., 2015). The contact between the two units is gradational, and protoliths of these units are most likely pelite, metagraywacke, and ocean floor basalts, suggesting that the Ashland Supergroup was formed in a continental slope and rise along a rifted margin (Barineau et al., 2015)

Structural Background. The Hollins Line fault thrusts rocks of the Ashland Supergroup above the Talladega belt (Raymond et al., 1988). It is a NE-SW–striking fault that was active during the Neoacadian orogeny, coeval with the Brevard fault (Merschat et al., 2005). Thrust stacking of the eastern Blue Ridge along the Hollins Line fault occurred post-early Mississippian (Gastaldo et al., 1993). Structural indicators suggest it is a post-metamorphic dextral, transpressional fault that likely formed as a result of crustal shortening due to the Alleghenian orogeny during the Permian (Tull et al., 2007; Barineau, 2009; Tull and Barineau, 2012).

Southeast of the Hollins Line fault, the Goodwater-Enitachapco fault marks the boundary between rocks of the Ashland Supergroup and the Wedowee-Emuckfaw belt (Raymond et al., 1988). The timing of the last displacement along the Goodwater-Enitachopco fault is constrained by 327 Ma (Steltenpohl et al., 2005, 2013) muscovite ages and is likely to be early Alleghenian. A trondjhemite found locally revealed a 366 Ma age, which was interpreted to be the maximum age of movement along the Goodwater-Enitachapco fault (Steltenpohl et al., 2013). The Goodwater-Enitachopco fault cuts the underlying Hollins Line and Talladega-Cartersville faults, Ashland Supergroup, and foreland Pennsylvanian units, so its current trace must have developed after metamorphism occurred in the Talladega and Ashland-Wedowee-Emuckfaw belts, after

deposition of foreland Pennsylvanian strata, and after emplacement of the Ashland-Wedowee-Emuckfaw belt upon the Talladega belt (Tull, 2011; Barineau, 2009; Tull and Barineau, 2012; Barineau et al., 2015).

Timing of Metamorphism

The timing of metamorphism in the Blue Ridge of Alabama is constrained by 40Ar/39Ar and K-Ar cooling ages (Stowell et al., 1996; McClellan et al., 2007; Steltenpohl et al., 2013), Rb/Sr isochrons (Stowell et al., 1996), U-Pb zircon overgrowth ages (Russell et al., 1987; Stowell et al., 1996; Tull et al., 2009; McClellan et al., 2007; Stowell et al., 2019) and garnet Sm-Nd data (Stowell et al., 2019; Dickson et al., 2019). Rb-Sr and U-Pb pluton ages in the Blue Ridge are all 335 Ma or older (Russell et al., 1987; Tull et al., 2009; Stowell et al., 2019). Rocks of the Talladega belt in the western Blue Ridge are believed to have undergone one Paleozoic, prograde metamorphic event (Tull, 1982) at lower-greenschist facies conditions of ~350C at ~3.5 kbar (Tull and Stow, 1980; Lim, 1998; Tull et al., 1998), similar to rocks of the Dahlonega gold belt to the northeast. Previous 40Ar/39Ar data from the Talladega belt are consistent with mid-Carboniferous metamorphism and deformation (Guthrie et al., 1995; Steltenpohl et al., 2005). 40Ar/39Ar data from muscovite in the western Blue Ridge indicate peak metamorphism at 334– 320 Ma (McClellan et al., 2007), or during the early Alleghenian. Initial metamorphism in the Talladega belt occurred between 360-320 Ma (McClellan et al., 2007). Emplacement of the Hillabee Greenstone must have occurred before metamorphism of the Talladega belt but after deposition of the youngest unit in the Talladega Group, the Mississippian Erin Slate (Barineau et al., 2015). Movement along the Hillabee thrust is suspected to range from 375-359 Ma, since the youngest rocks of the Talladega Group are upper Devonian to lower Mississippian (Gastaldo et

al., 1993; Tull et al., 2007). In the eastern Blue Ridge, ages of 1.1 Ga to 964 Ma (Das, 2006) are typical of Laurentian Grenville basement and suggest that Ashland Supergroup sediments were supplied from Laurentian margin. Data from Dickson et al. (2019) indicate metamorphism in the Mad Indian Group occurred at 6.5 to 9 kilobar and 550–650 °C with peak conditions at ca. 357 Ma from a single garnet. Garnet Sm-Nd ages from the Wedowee-Emuckfaw Group suggest peak metamorphism between 331-320 Ma for the region (Stowell et al., 2019). U-Pb zircon ages of plutons in the eastern Blue Ridge ranged from 390-335 Ma (Stowell et al., 2019). Units of the eastern Blue ridge in northern Georgia have 40Ar/39Ar ages ranging from ∼330 to 322 Ma (Dallmeyer, 1988), which infer cooling through ∼500°C during the mid-Carboniferous (McClellan et al., 2007). Evidence for Taconic metamorphism in the Alabama Blue Ridge is mostly absent, which contrasts with confirmed Taconic activity in the western and eastern Blue Ridge further northeast (Liogys and Tracy, 2002; Moecher et al., 2004). Thermobarometic studies from garnet-muscovite-biotite-plagioclase equilibrium in the eastern Blue Ridge of Alabama indicate that regional metamorphism occurred around 580°C to 665°C at 4.7 to 8.5 kbar (Gibson and Speer, 1986; Drummond et al., 1988; Stowell et al., 1996). Further southeast, U-Pb zircon from the Elkahatchee Quartz Diorite has yielded ages between 388–355 Ma (Steltenpohl et al., 2013; Barineau et al., 2015). U-Pb zircon dates of ca. 450 Ma for the Kowaliga and Zana gneisses were reported by Hawkins et al. (2013) (Stowell et al., 2019). 40Ar/39Ar muscovite cooling ages for the Jackson's Gap Group are ~315 Ma, indicating uplift during this time (Whitmore, 2018).

Methodology

The mineral zircon is widely used in geochronology because it is highly resistant to

chemical attack and has a very high blocking temperature, meaning that the core of a grain can record timing of initial crystallization, while its surrounding “rims” can preserve subsequent geologic events (Gehrels, 2011, 2014). The crystal structure of zircon is such that it allows a slight amount of uranium to substitute for zirconium, but very much excludes lead, and this makes it an ideal mineral for the U-Pb geochronology method (Gehrels, 2011). When age-dating rocks using the mineral zircon, an important part of the analysis process is to distinguish whether ages represent the initial growth of igneous zircon, or a secondary crystallization resulting from metamorphic events (Gatewood and Stowell, 2012). The most indicative information in making this distinction is the ratio of uranium to thorium. Gatewood and Stowell (2012) illustrated that that discordant, young zircon with high U/Th ratios that are greater than 10 are likely metamorphic. Yakymchuk et al. (2018) illustrated that metamorphic fluids are enriched in U compared to Th and that high U/Th ratio zircon are overwhelmingly from metamorphic rocks. Mixing between Proterozoic and Cretaceous rims of low and high U/Th values suggest that crystallization occurred with metamorphic fluids. Zircons with low U/Th ratios (below 10) indicate igneous material.

Fourteen samples were collected from the Talladega Group and the Ashland Supergroup on the Porter Gap and Clairmont Springs 7.5-minute quadrangles in Alabama (Figure 16, Table 1). Samples were processed using standard mineral separation techniques. Zircon grains were handpicked and placed onto tape mounts, allowing for greater spatial resolution. Depth profiling using the LA-ICPMS (laser ablation inductively coupled mass spectrometry) laboratory at the University of Arkansas allowed for the acquisition of rim and core ages. Measured 206Pb/238U ratios were normalized using standard Plešovice (Plešovice Czech Republic). Data were reduced using IGOR Pro data analysis software and plotted in Excel 39 and Density Plotter. Metamorphic

rims were separated out by U/Th ratios greater than 10, which reflect metamorphic overgrowth in the Appalachians. Kernel density estimate (KDE) diagrams were created for the full population of grains per sample, normalized to 0.1 with a bandwidth of 25. Weighted mean age plots singled out the most representative populations by MSWD (mean square weighted distance) values ~1 to reveal mean ages for metamorphism and recrystallization. In most samples anomalously old ages were interpreted as inherited or detrital grains, while ages that were abnormally young, high-U or high-Pb outliers where likely affected by Pb loss or contamination.

Results

Lay Dam Formation. Samples CS311 and PGAL78 (Figure 17A and 17B) were collected from the Lay Dam Formation. CS311 is a medium grained, dark green metagraywacke. It yielded 115 zircon grains that range from 834 Ma to 1.89 Ga with a population peak occurring at ~1.3 Ga. 41 grains yielded a mean age of 1187.77 ± 6.23 Ma with MSWD of 1.88.

PGAL78 is a coarse-grained, foliated dark green metagraywacke. 54 total zircon grains range in age from 976 Ma to 1.97 Ga with a population peak occurring at ~1.2 Ga. 27 grains yielded a mean age of 1181.26 ± 7.31 Ma with an MSWD of 1.69.

Butting Ram/Cheaha Quartzite. Samples 19ALAI07, 19ALAI10, and PGAL20 (Figure 17C, 17D, 17E) were collected from the Butting Ram Sandstone/Cheaha Quartzite.

19ALAI07 is a metasandstone of >90 % siliceous grains from the ridge of Talladega Mountain. 121 total zircon grains range in age from 870 Ma to 3.03 Ga. A significant population peak, along with grains that have U/Th ratios greater than 10, indicating metamorphism, occurs at ~1-1.2 Ga. A population of 33 grains yielded a mean age of 1224 ± 7.07 Ma with an MSWD of 1.91.

19ALAI10 is a dark grey quartzite from the ridge of Talladega Mountain. 63 total grains range from 510 Ma to 3.14 Ga with a population peak at 1.2 Ga. 30 grains had mean of 1163.91 ± 6.86 Ma with an MSWD of 2.31.

PGAL20 is an >90% quartz metaconglomerate collected from the ridge of Horn Mountain. 73 grains range in age from 684 Ma to 3.07 Ga, with a population peak at ~1.2 Ga. 31 grains yielded a mean age of 1200.44 ± 7.23 with and MSWD of 1.57.

Poe Bridge Mountain Group. Samples 19ALAI57, 19ALAI58, 19ALAI02, 19ALAI08, CS198, and CS221 (Figure 17F, 17G, 17H, 17I, 17J, 17K) were collected from the Poe Bridge Mountain Group. Samples 19ALAI02 and 19ALAI57 are medium-grained feldspathic schists with garnet, muscovite, and minimal biotite.

19ALAI02 yielded 35 total zircon grains with ages ranging from 240 Ma to 2.4 Ga and a significant population peak at ~370 Ma. Out of 31 metamorphic rims with U/Th ratios ranging from 10.8 to 91.2, a population of 9 rims yielded a mean of 347.76 ± 3.24 with an MSWD of 3.71.

19ALAI57 yielded 18 zircon grains total, ranging from 318 Ma to 1.5 Ga with a population peak at ~380 Ma. 4 metamorphic rims with U/Th ratios ranging from 12.1 to 26.3 had a mean of 366.78 ± 7.69 Ma and an MSWD of 0.94.

Sample 19ALAI58 is a garnet quartzite that yielded 121 grains spanning from 273 Ma to 1.6 Ga with a major population peak at ~420 Ma and two lesser peaks at ~820 Ma and 1.05 Ga. 27 total metamorphic rims with U/Th ratios ranging from 10.72 to 84 yielded a mean of 347.77 ± 2.37 Ma with an MSWD of 10.9. A high MSWD is likely indicative of mixing material. From this population, the six youngest grains yielded a mean of 293.26 ± 4.6 Ma with an MSWD of 1.32. Only one grain out of this subpopulation had an abnormally high U concentration,

indicative of Pb loss. A third plot that omits the six youngest rims yielded a mean of 367.44 ± 2.76 with an MSWD of 4.31, and is interpreted as the truer age of Neoacadian metamorphism.

Sample 19ALAI08 is a poorly consolidated, highly weathered garnet schist/garnet quartzite that yielded 95 total zircon grains ranging from 210 Ma to 1.48 Ga. Population peaks occur at ~425, 560, and 840 Ma. The sample contained 29 possible metamorphic rims with a range of 210 Ma to 1.47 Ga and U/Th ratios ranging from 10.42 to 78.9. 20 rims yielded a mean age of 390.4 ± 11.8 with an MSWD of 1.81.

Sample CS198 is a garnet-graphite schist. 114 total grains ranged from 629 Ma to 2.19 Ga, with a population peak occurring at ~1.2-1.3 Ga. 61 grains yielded a mean age of 1143.09 ± 5.17 Ma with an MSWD of 1.96.

CS221 is a biotite-muscovite-graphite-feldspar schist. It yielded 98 total zircon grains ranging from 370 Ma to 1.53 Ga with several population peaks occurring at ~400 Ma, 550 Ma, 750 Ma, and 1 Ga. This sample also yielded 40 possible metamorphic rims with U/Th ratios ranging from 10.12 to 1170, where 10 rims had a mean age of 448.4 ± 12.5 with an MSWD of 1.07. These rims had high U concentrations, indicative of Pb loss.

Mad Indian Group. Samples 19ALAI 54 and 19ALAI01 (Figure 17L, 17M) are medium to coarse grained muscovite-biotite-garnet-kyanite schists from the Mad Indian Group. Sample 19ALAI54 had ages ranging from 361.7 Ma to 1.4 Ga from 22 grains with a population peak at ~380 Ma and 960 Ma. 3 zircon rims with U/Th ratios ranging from 41 to 150 yielded mean of 370.96 ± 5.4 Ma with an MSWD of 0.64.

Sample 19ALAI01 yielded 136 grains with ages spanning from 232 Ma to 2.6 Ga with a major peak at ~350 Ma. 29 zircon rims with U/Th ratios ranging from 10.84 to 184 had a mean of 336.43 ± 1.95 Ma with an MSWD of 14.3. A plot of the six youngest rims yielded a mean of

274.33 ± 3.57 Ma with an MSWD of 7.7. None of the grains in this subpopulation had abnormally high U concentrations, which would indicate Pb loss. A third plot omitting the six youngest rims yielded a mean age of 347.83 ± 2.41 Ma with an MSWD of 3.24.

Sample 19ALAI53 (Figure 17N) is a tonalite intruding the Mad Indian Group. It yielded 121 total zircon grains with ages spanning from 310 Ma to 1.5 Ga. A significant population peak occurs at ~350 Ma. 19 total rims with U/Th ratios ranging from 10 to 56.8 yielded a mean of 348.56 ± 1.39 Ma with an MSWD of 10.5. Of those 19 rims, a population of 14 rims yielded a mean age of 354.96 ± 2.09 with an MSWD of 1.93.

Discussion

Samples from the Talladega Group yielded mean ages between 1163 to 1224 Ma, which is indicative of Grenville orogeny deposition/source material/recycling. Grains with U/Th ratios greater than 10 were present in the samples and also coincided with Grenville orogenic activity, suggesting a Grenville metamorphic core source.

Samples from the Ashland Supergroup were significantly more complex, with definite populations of Grenville recycled grains, Pan-African (600-800 Ma) recycled grains, and possible recording of various pulses of metamorphism that align with the Taconic to Alleghenian orogenies. Only one sample, CS198, did not record evidence of post-Grenville metamorphism. Otherwise, mean ages for metamorphism, indicated by U/Th ratios greater than 10, ranged from 274 to 448 Ma including plots of the six youngest grains in two samples (Figure 17). Plots of the six youngest grains in samples 19ALAI01 and 19ALAI58 yielded mean ages of 274 and 293 Ma respectively, implying a second metamorphic event during the later Alleghenian. Without these six youngest grains, mean ages for the two samples skewed older, and samples 19ALAI02,

19ALAI57, 19ALAI58, 19ALAI01, 19ALAI54, and 19ALAI53 yielded mean ages between 345 to 370 Ma, illustrating strongly Neoacadian activity. Sample 19ALAI53, a pluton, records a metamorphic age of 354 Ma which could also be the timing of its emplacement considering that the vast majority of analyses, metamorphic or otherwise, are concentrated around this mean age. This unit could represent the Bluff Springs Granite, which has been mapped as intruding the Mad Indian Group (Szabo et al., 1988). Stowell et al. (2019) reported a 366 Ma U-Pb zircon age for the Bluff Springs Granite. Samples 19ALAI08 and CS221 were notably older outliers, with mean metamorphic ages of 390 and 448 Ma, respectively. While these ages could reflect the Taconic to Acadian thermal events, there is a lack of evidence for these events in the Blue Ridge of Alabama. The subpopulation of grains for sample CS221 had abnormally high-U concentrations, indicating Pb loss; so, the 448 Ma mean age is less likely due to an actual event.

Interpretations and Structural Implications

The range of metamorphic ages for all the samples collected from the Ashland Supergroup illustrate diachronous metamorphism in the region. Its relationship with the surrounding units is complex, however. The underlying Talladega Group records peak metamorphism at 334-320 Ma (McClellan et al., 2007), while the overlying Wedowee-Emuckfaw belt experienced peak conditions at 331-320 Ma (Stowell et al., 2019); both of which reflect earliest Alleghenian activity. 40Ar/39Ar muscovite cooling ages for the Mitchell Dam Amphibolite, the stratigraphic equivalent of the Ketchepedrakee Amphibolite, are 333.8 ± 1.7 and 329.6 ± 1.1 Ma (Steltenpohl et al., 2005).

The Ashland Supergroup, which occupies the hanging wall of the Hollins Line fault, was metamorphosed before the Talladega belt footwall rocks, meaning that the Hollins Line fault

must be post-340 Ma, since the Ashland Supergroup rocks would already have undergone metamorphism, while the underlying rocks would have not. The Ashland Supergroup also occupies the footwall of the Goodwater-Enitachapco fault, which is younger than the Hollins Line fault and the Talladega-Cartersville fault further northwest because it cuts both. Since peak metamorphism in the Wedowee Group occurred 331-320 Ma, the Goodwater-Enitachapco fault must be post-320 Ma. Movement along the Goodwater-Enitachapco from Steltenpohl (2013) is constrained to 327 Ma from muscovite cooling ages, but because the Hollins Line fault could still have been active into the Permian, the current trace of this fault could post-date this age by 30-50 My (Barineau et al., 2015). It has also been suggested that this 327 Ma age could represent cooling ages associated with uplift of the Ashland-Wedowee-Emuckfaw belt, but this would be unlikely considering peak metamorphism ages (Tull et al., 2007; Barineau, 2009; Barineau et al., 2015; Stowell et al., 2019). Movement along the Alexander City fault to the southeast post-dates 369 Ma (Steltenpohl et al., 2013), but is believed to be Carboniferous considering its resemblance to other Alleghenian shear zones (Steltenpohl et al., 2013). Further south, movement along the Brevard fault zone was episodic and occurred in the Neoacadian and Alleghenian (Bobyarchick, 1999; Vauchez, 1987).

The timing of fault movement and metamorphism, as well as metamorphic grade, indicate a complex tectonic history for the Alabama Blue Ridge. Given this complexity and the ages presented, it is unlikely that structures in this region are forward-breaking. It is likely that thrusts are out of sequence considering that the Goodwater-Enitachapco fault must be post-320 Ma, and no such stringent constraints exist for the Alexander City fault and Brevard fault zone, even though both are suspected to have been active sometime during the Alleghenian. The model proposed (Figure 18) for the Blue Ridge involves synchronous thrust stacking, where two

structural blocks are metamorphosed simultaneously and then exhumed; and this exhumation and overthrusting initiates metamorphism in the two alternate blocks. The proposed timeline is as follows:

1) Based on metamorphic ages and ages of exhumation, the Ashland Supergroup and Emuckfaw/Jackson's Gap group were deposited pre-370 Ma.

2) The Ashland Supergroup underwent metamorphism between 370-345 Ma (ages from this study), with the peak being at 357 Ma (Dickson et al., 2019), which all coincides with the deposition of top of the Talladega belt (Erin Slate), which is constrained to the Tournaisian (358-346 Ma) from fossil evidence (Gastaldo et al., 1993). The processes by how this occurred are still unknown and would require further investigation. In accordance with this model, the Emuckfaw/Jackson's Gap Group would be undergoing metamorphism at the same time as the Ashland Supergroup. This notion is supported by the ~315 40Ar/39Ar muscovite cooling age (Whitmore, 2018).

3) Post-345 Ma to post-320 Ma, the Ashland Supergroup is brought up along the Hollins line fault considering peak metamorphism for the Talladega group is constrained to 334-320 Ma (McClellan et al., 2007), and simultaneously the Emuckfaw/Jackson's Gap Groups are brought up along the Alexander City fault since peak metamorphism is constrained to 331-320 Ma in the Wedowee Group (Stowell et al., 2019). This is also supported by the ~315 Ma muscovite cooling ages in the Jackson's Gap Group (Whitmore, 2018), since the unit could not have been buried very deep if it is cooling through 325 degrees Celsius. In short, thrust loading of the Ashland Supergroup and Emuckfaw/Jackson's Gap Group initiated metamorphism in the Talladega belt and Wedowee Group, respectively.

4) Post-320 Ma, everything is stacked together along the Goodwater-Enitachapco fault, since

it cuts the underlying Hollins Line and Talladega-Cartersville faults and Ashland Supergroup (Barineau et al., 2015). This final stacking could also account for the Alleghenian subpopulations of the six youngest grains in samples 19ALAI58 and 19ALAI01.

Conclusion

Metamorphic rocks from the eastern Blue Ridge in Alabama including the Talladega Group and Ashland Supergroup yielded mean U-Pb zircon ages indicative of diachronous metamorphism that blurs the boundary between the Neoacadian and Alleghenian orogenies. Notably, the Ashland Supergroup yielded mean metamorphic ages of ~345-370, which are significantly older than the peak ages of metamorphism found in the adjacent Talladega belt and Wedowee Group that are restricted to 334-320 Ma (McClellan et al., 2007; Stowell et al., 2019). These analyses imply that thrust faults bounding the Ashland Supergroup, the Hollins Line and Goodwater-Enitachapco fault, are post-340 Ma and post-320 Ma, respectively. A model for the Alabama Blue Ridge suggests synchronous thrust stacking of the Emuckfaw/Jackson's Gap Group and the Ashland Supergroup, with later, simultaneous metamorphism occurring in the Talladega belt and Wedowee Group as a result of exhumation of the latter two units along the Hollins Line and Alexander City faults. This model accounts for metamorphism and exhumation of the Ashland Supergroup, burial and metamorphism of the Talladega belt and Wedowee Group (McClellan et al., 2007; Stowell et al., 2019), the muscovite cooling age from the Jackson's Gap Group (Whitmore, 2018) and explains the Permian metamorphic subpopulations from samples 19ALAI58 and 19ALAI01. Further investigations will involve acquiring He cooling ages for the Ashland Supergroup, and three samples have already been sent out. Based on the model (Figure 18), the hypothesis is that these ages will be around 315 Ma, similar to the cooling ages for the

Jackson's Gap Group (Whitmore, 2018). A more quantitative hypothesis is as follows:

1) Peak metamorphism in the Mad Indian Group occurred at 357 Ma at 650 degrees from a single garnet (Dickson et al., 2019). A hornblende cooling (closure temperature 525 degrees 49 Celsius) age from the Mitchell Dam Amphibolite, which is the southwestern equivalent of the Ketchepedrakee Amphibolite (lies within the Ashland Supergroup), is ~333 Ma (Steltenpohl et al., 2005).

2) If we assume that these are peak ages and cooling ages for the whole Ashland Supergroup, that means that over 24 million years, the rocks had to cool 125 degrees.

3) If we add in the data from this study, which concluded a 370-345 Ma range for metamorphism, the rocks had to cool 125 degrees over the course of 7 to 37 million years. If we divide the cooling range of 125 degrees Celsius by the range of years, this results in a cooling rate of 4 to 17 degrees per million years.

4) He closure temperature is 200 degree Celsius, so in order to find the rate of cooling to 200 degrees, we take the 525 degree hornblende closure temperature and subtract it by 200 degrees to get 325 degrees

5) If we take 325 degrees divided it by our cooling rates of 4-17 degrees per million years, we arrive at a range of 19-81 million years.

6) If we take this range and subtract it from the Mitchell Dam Amphibolite cooling age (333 Ma), we can predict that our He cooling ages will lie between 314 and 252 Ma. The 314 Ma in particular is significant, since the Jackson's Gap cooling age is ~315 Ma (Whitmore, 2018). This indicates fast cooling, and would support the synchronous thrust stacking model. If the resulting ages are closer to 252 Ma, this indicates slower cooling, and would be less supportive of metamorphism initiated by fault movement.

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SUMMARY

Geologic mapping of the Clairmont Springs 7.5-minute quadrangle and U-Pb zircon geochronology of the eastern Blue Ridge of Alabama was completed to provide more complete picture of the geologic history of the southern Appalachians. Geologic mapping allowed for detailed cataloguing of lithologies and structures in the area, while geochronology unveiled metamorphic ages and complex structural implications for the area. U-Pb zircon metamorphic rim ages of ~345-370 Ma for the Ashland Supergroup, along with previous metamorphic ages for the surrounding Talladega belt, Wedowee Group, and Jackson's Gap Group, imply synchronous thrust stacking of structural blocks, where metamorphism of alternate blocks was caused by regional overthrusting. Further studies will involve obtaining (U-Th)/He cooling ages which will aide in deciding the accuracy of the proposed model.

Table 1. UTM locations for each sample.

Sample Name	Location
19ALAI01	602990, 3681043
19ALAI02	602359, 3685218
19ALAI07	599352, 3691760
19ALAI08	598743, 3682204
19ALAI10	596535, 3690020
19ALAI53	599499, 3679965
19ALAI54	598510, 3679324
19ALAI57	602697, 3690257
19ALAI58	598498, 3681913
CS198	595626, 3683661
CS221	597639, 3679571
CS311	593035, 3690181
PGAL20	587580, 3686714
PGAL78	583126, 3679518

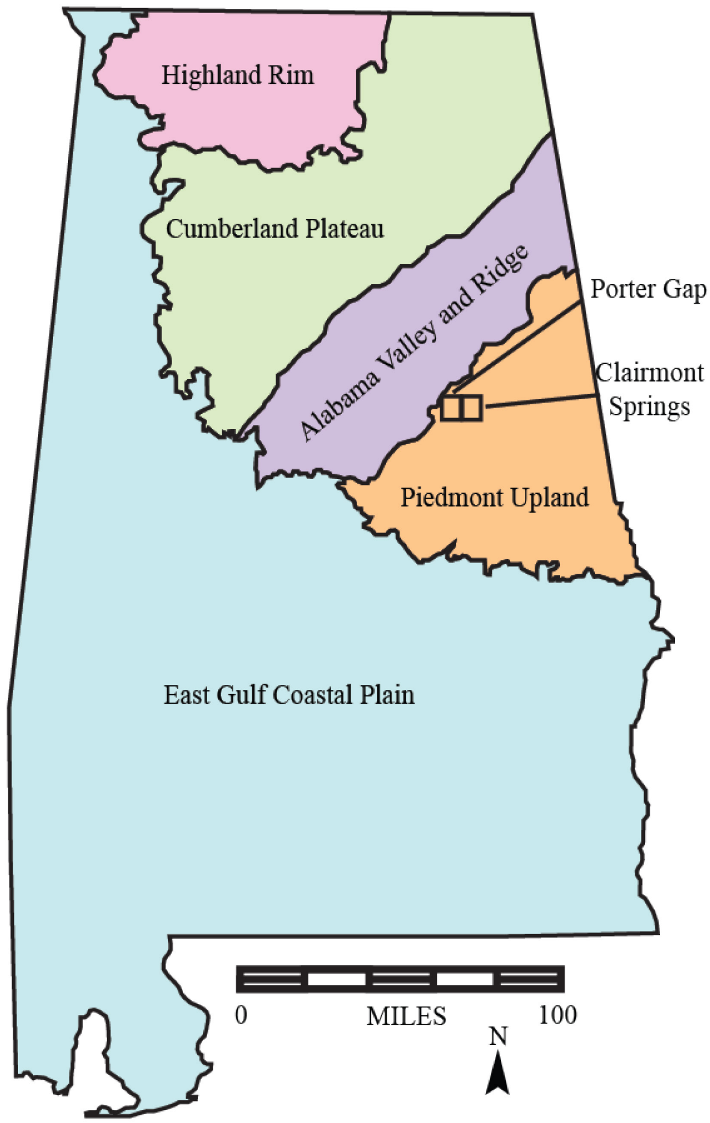


Figure 1. Province map of Alabama showing the location of the Clairmont Springs 7.5-minute quadrangle, Talladega and Clay counties (modified from Sapp and Emplaincourt, 1975; McKay 2015, 2016).

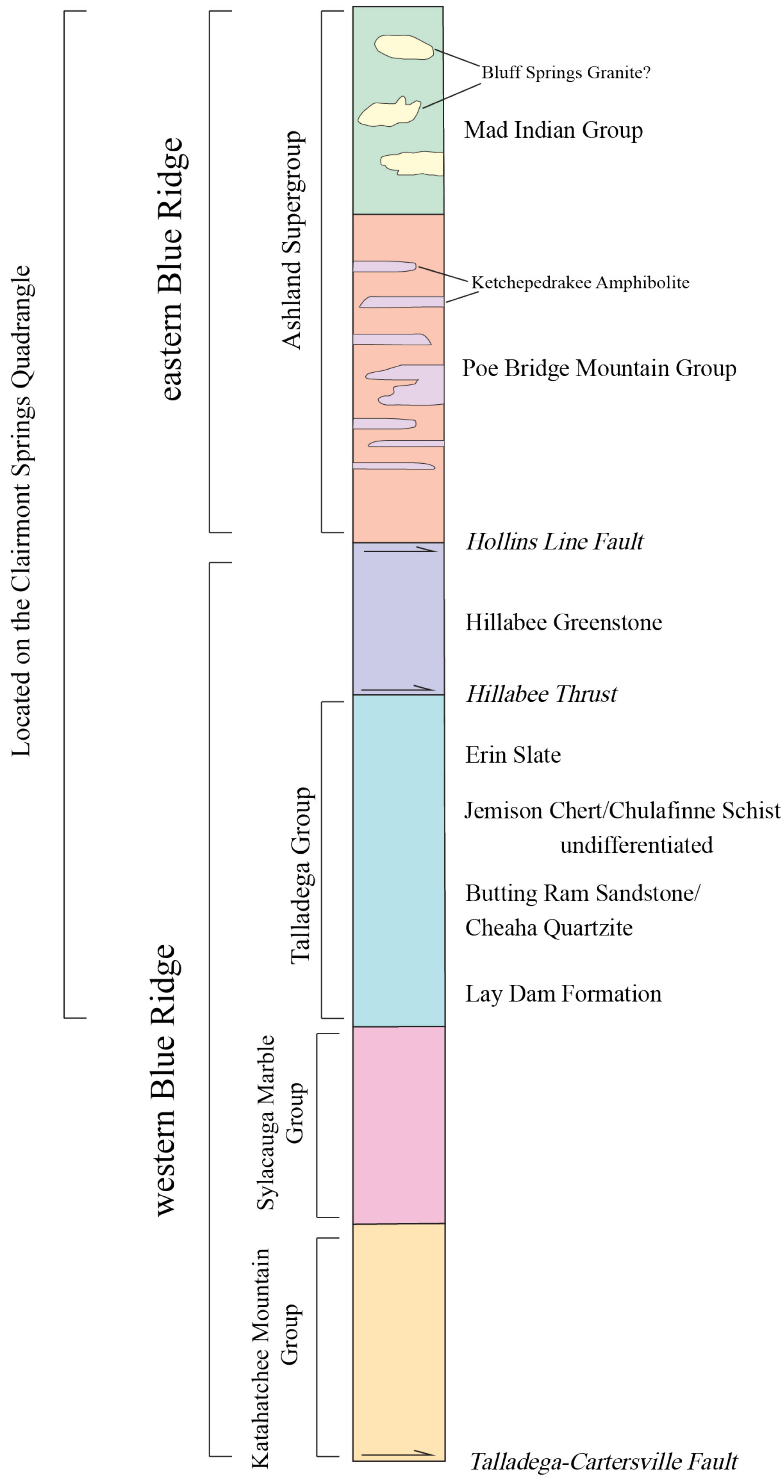


Figure 2. Stratigraphic column of the Alabama Blue Ridge showing the units found on the Clairmont Springs 7.5-minute quadrangle (modified from McClellan et al., 2007 and Barineau et al., 2015)

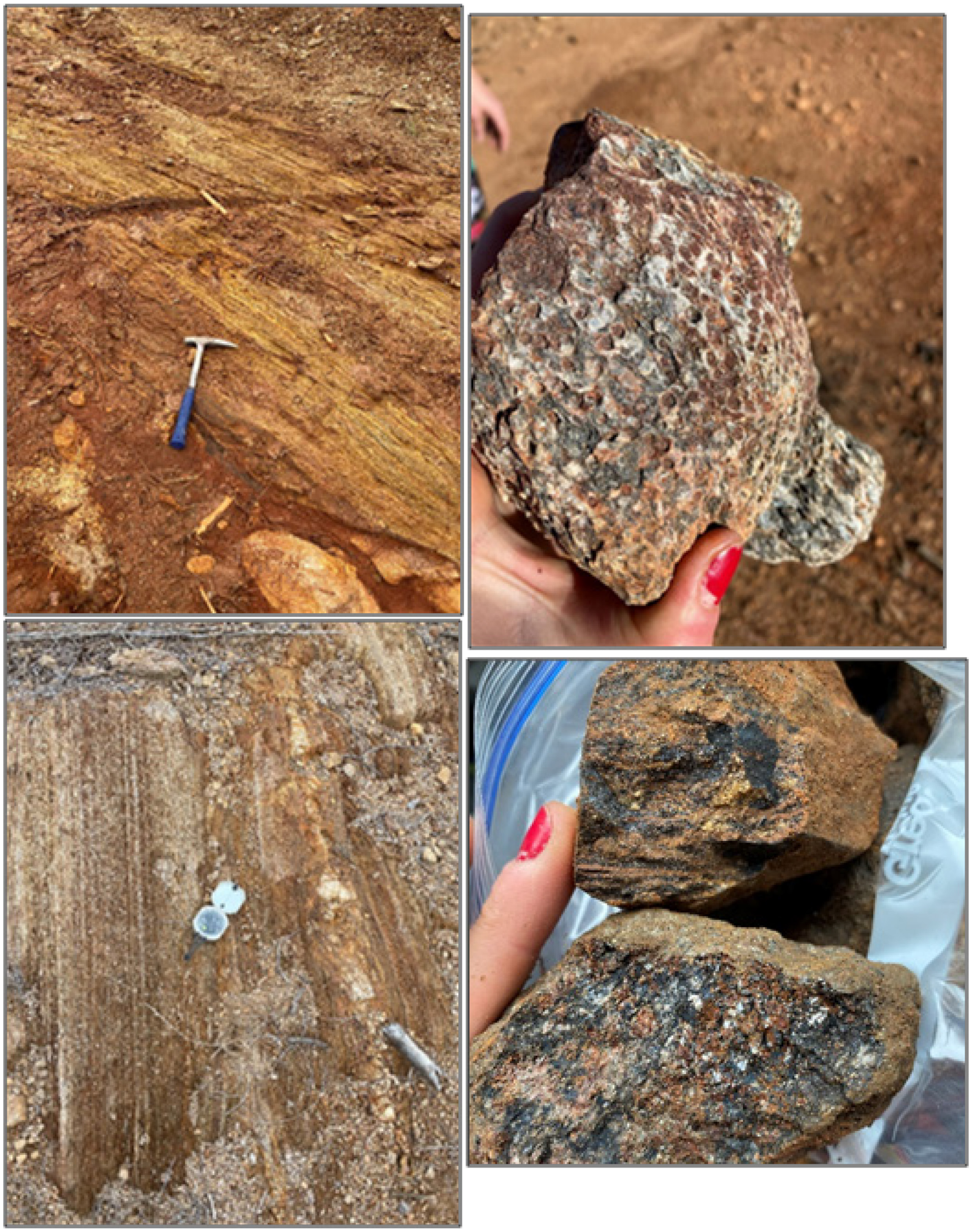


Figure 3. Outcrops and hand samples of garnet schist ± graphite, biotite, muscovite, quartz (left, top right), garnetiferous mafic rock (bottom right) of the Poe Bridge Mountain Group.

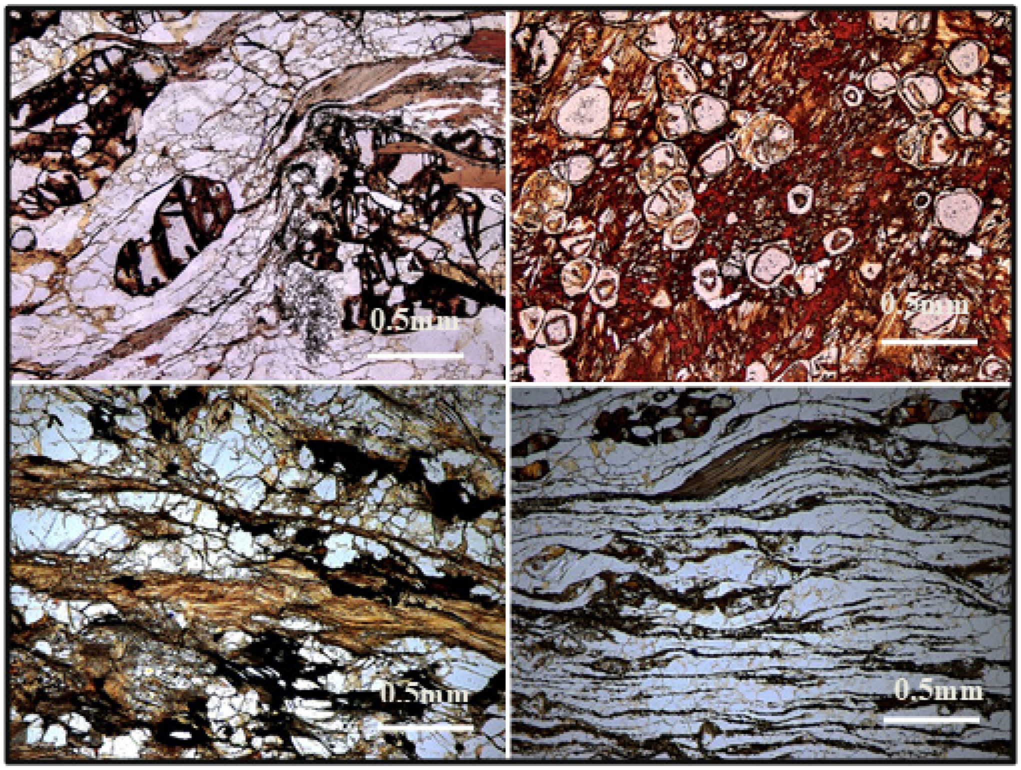


Figure 4. Poe Bridge Mountain Group thin sections with 2.97x2.23 mm field of view and 4x magnification.

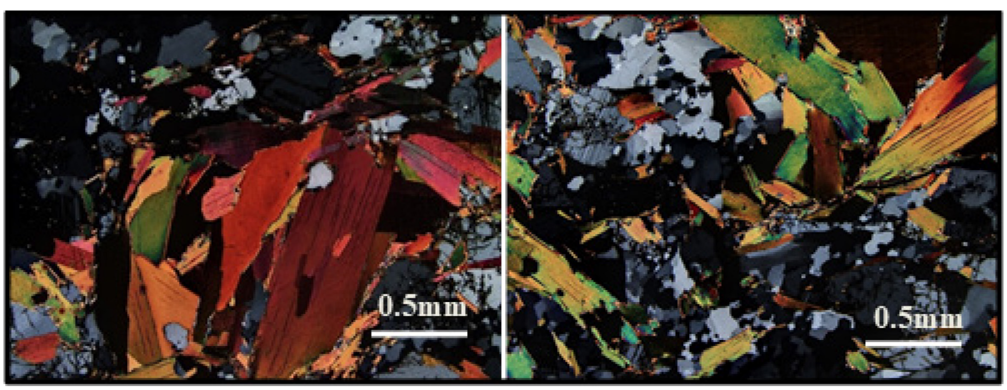


Figure 5. Ketchepedrakee Amphibolite thin sections with 2.97x2.23 mm field of view and 4x magnification.

Figure 6. Outcrops and hand samples of high weathered garnet-quartz-sericite schist (top, bottom left) of the Mad Indian Group, foliated tonalite from within the Mad Indian Group (bottom right).

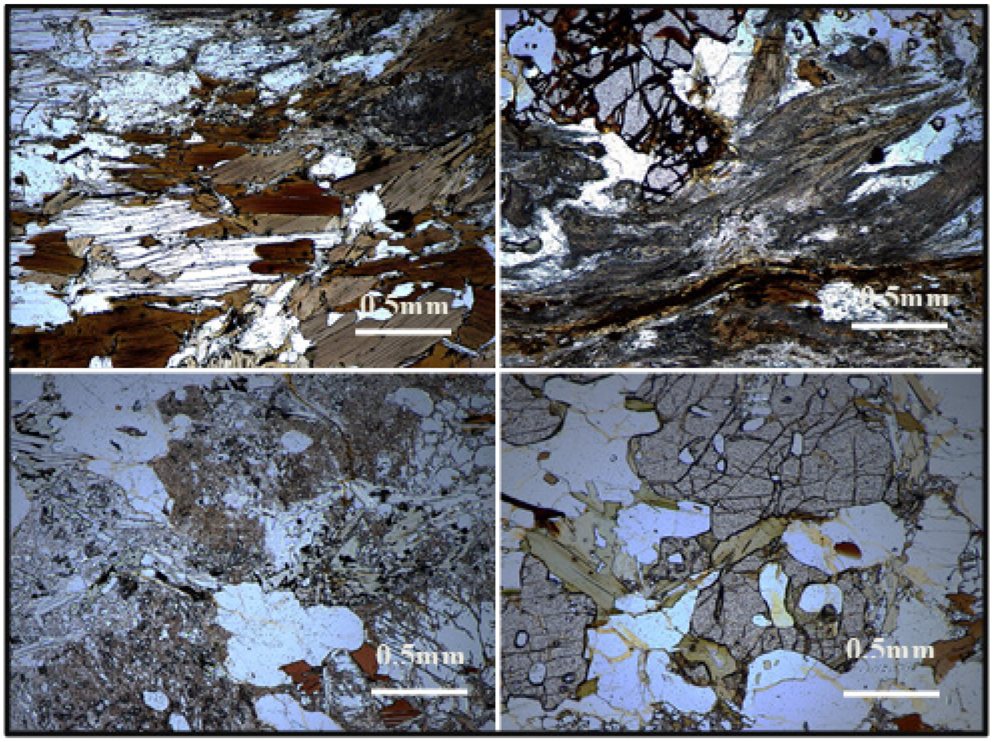


Figure 7. Mad Indian Group thin sections and tonalite (Bluff Springs Granite) thin sections with 2.97x2.23 mm field of view and 4x magnification.

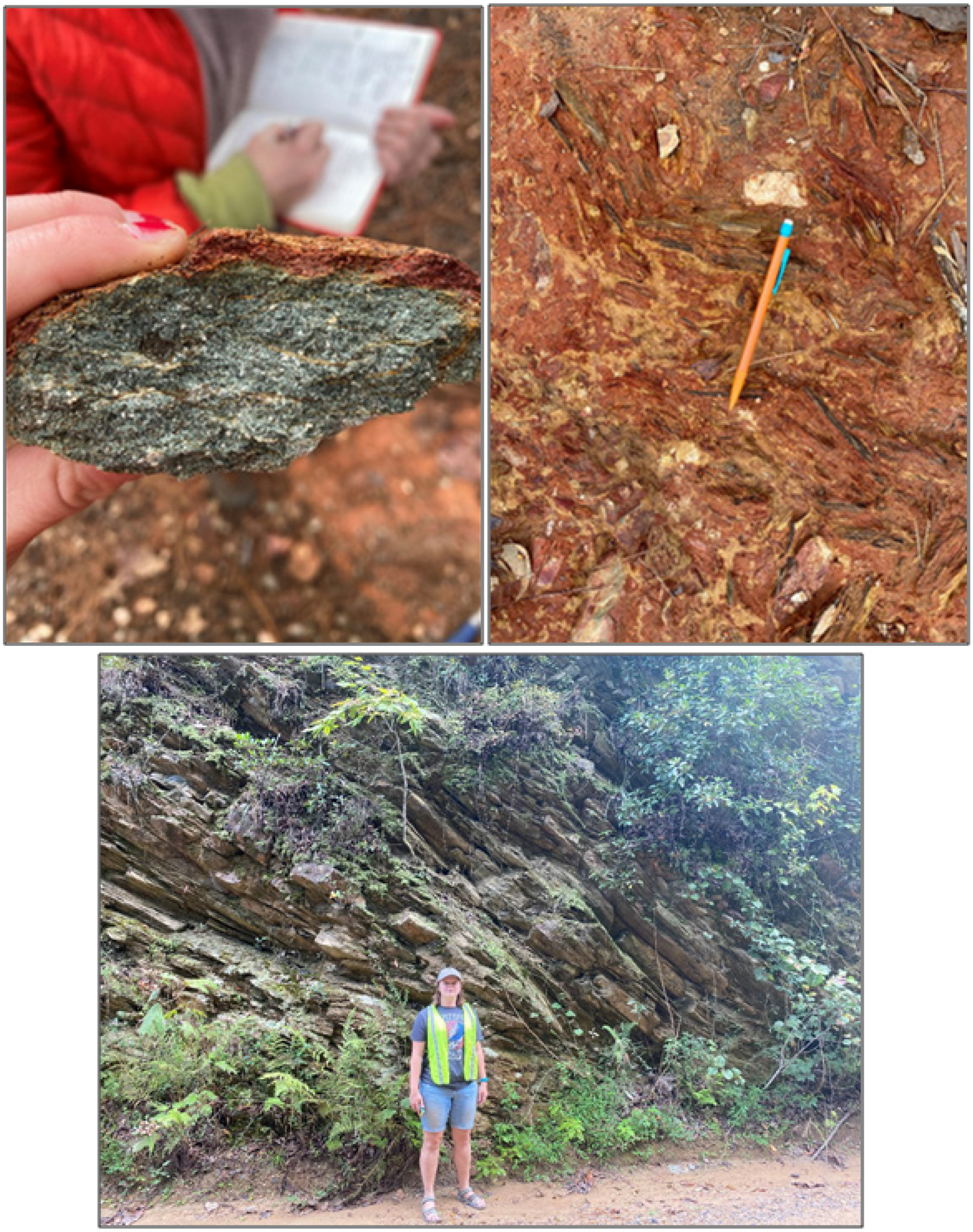


Figure 8. Highly deformed phyllite and metagraywacke (left), outcrop of interbedded quartzose phyllite and quartzite (right); both Lay Dam Formation.

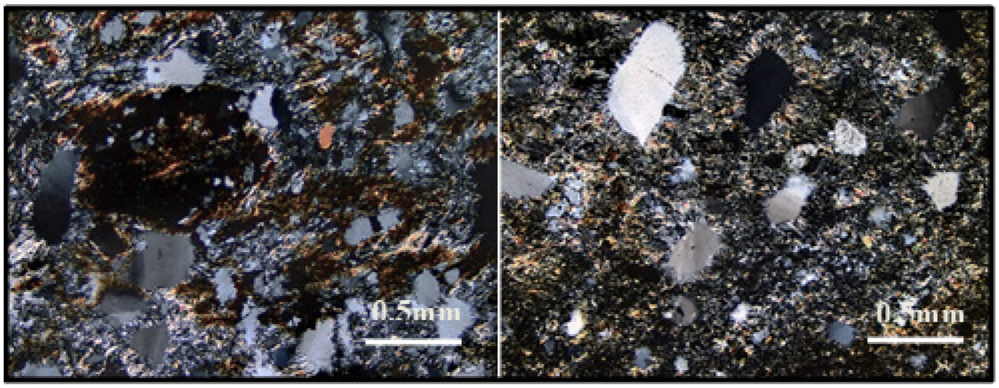


Figure 9. Lay Dam Formation thin sections with 2.97x2.23 mm field of view and 4x magnification.

Figure 10. Metasandstone, quartzite, and metaconglomerate of the Butting Ram/Cheaha Quartzite.

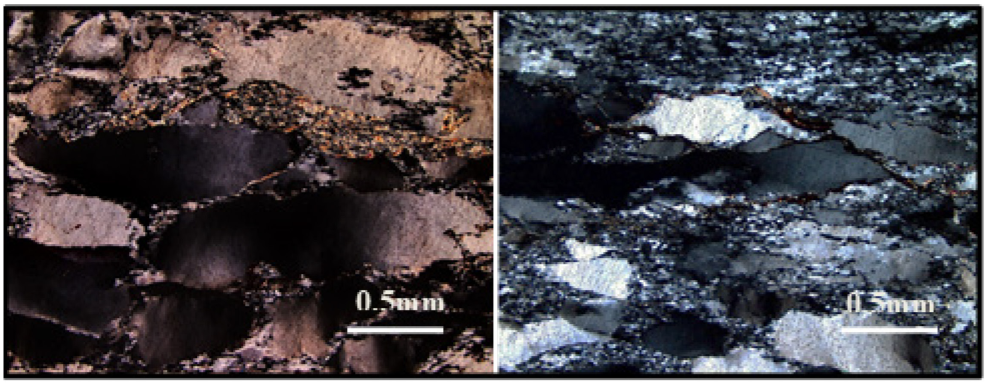


Figure 11. Butting Ram/Cheaha Quartzite thin sections with 2.97x2.23 mm field of view and 4x magnification.

Figure 12. Metasandstone (bottom) and quartzite (right) of the Jemison Chert-Chulafinnee Schist undifferentiated. Black slate of the Erin Slate (left).

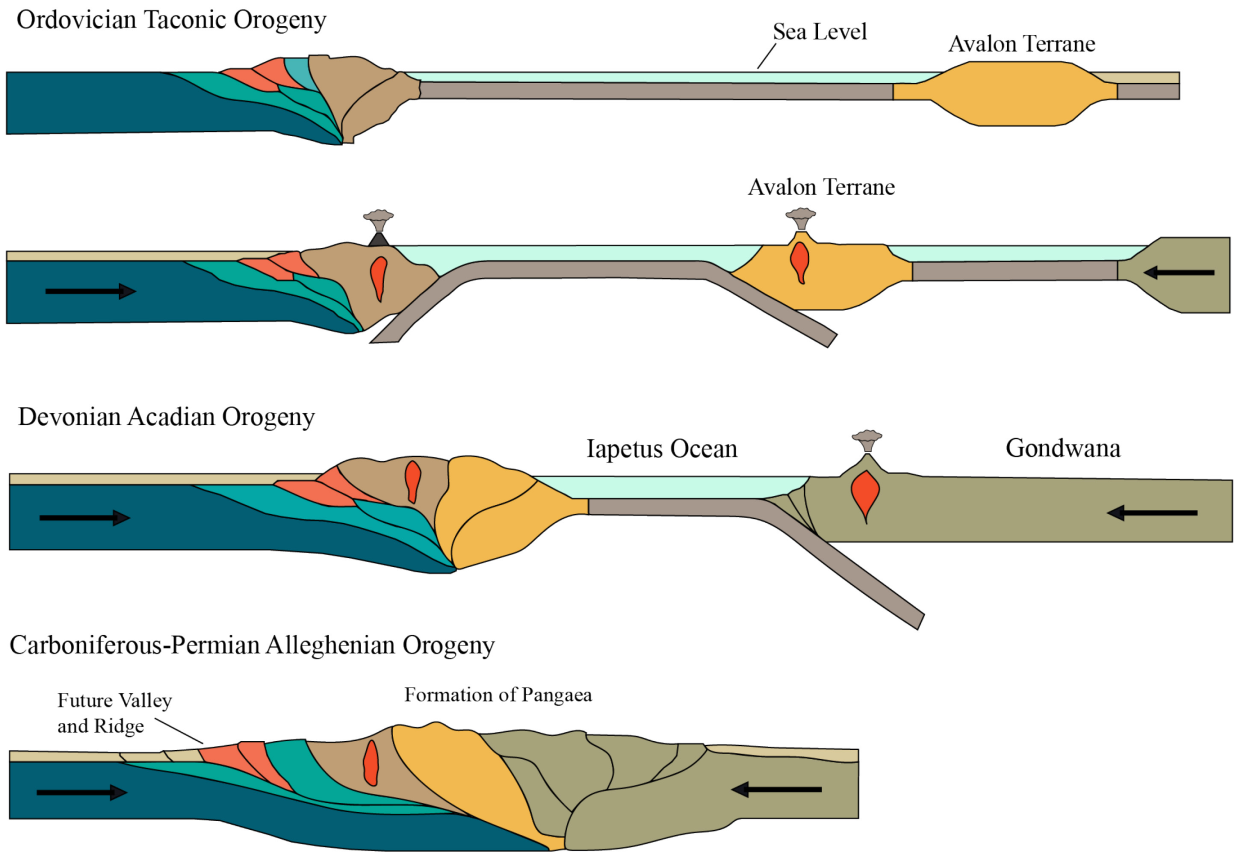


Figure 13. Schematic cross sections of the Appalachian orogenic events (modified from Marshak, 2008).

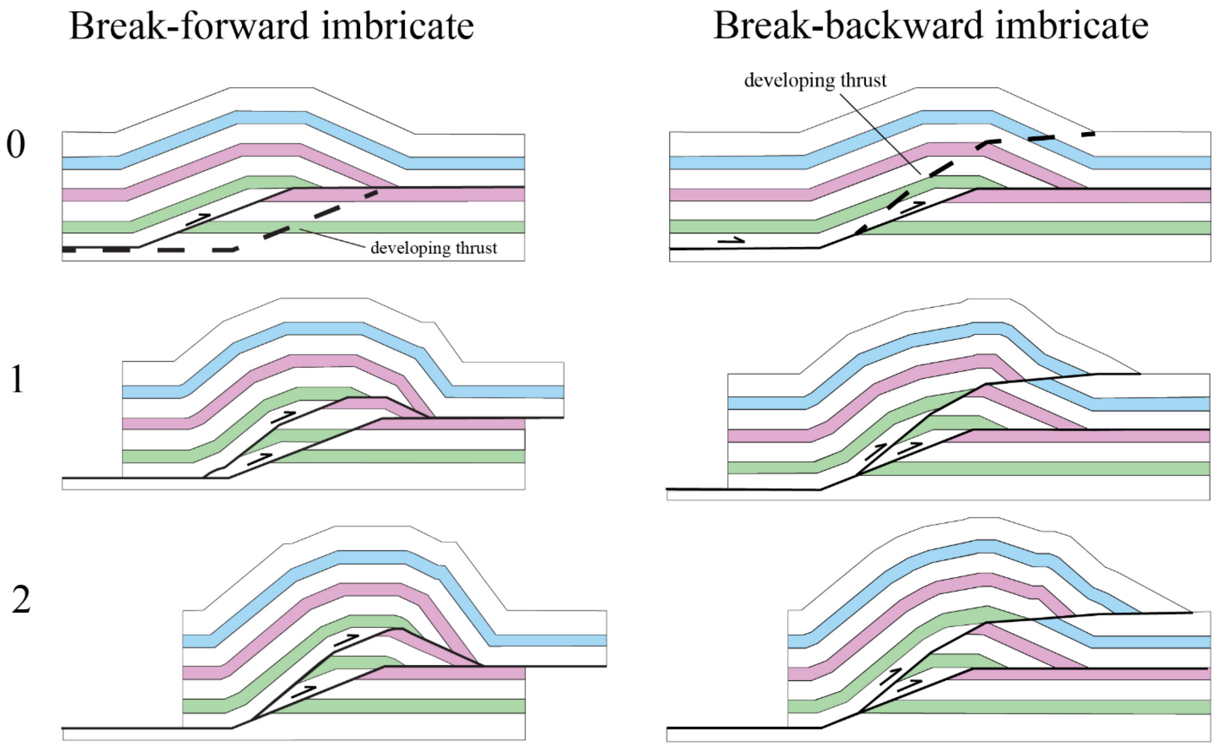


Figure 14. Schematic of imbricate shear fault bend folding, where forward-breaking structures are characterized by a changing of the ramp angle and more accommodation space for strata, while backward-breaking structures display a constant dip angle for the backramp and shear is transmitted toward the hinterland (modified from Shaw et al., 1999 and Schultz 2013).

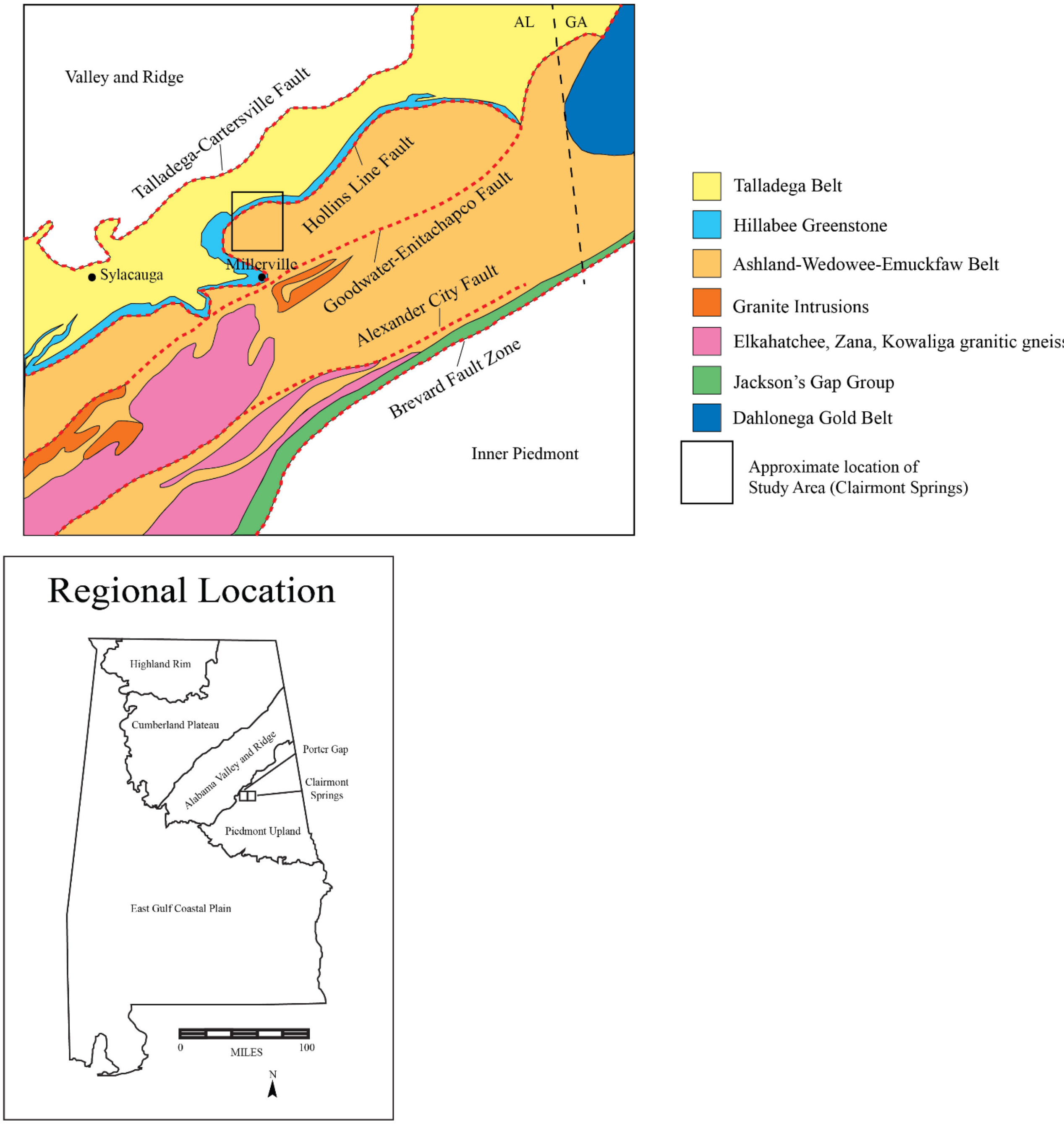


Figure 15. Tectonic map of the Blue Ridge in Alabama and part of Georgia. Approximate location of study area show, along with major units and structures (modified from McClellan et al., 2007; Steltenpohl et al., 2013; Stowell et al., 2019).

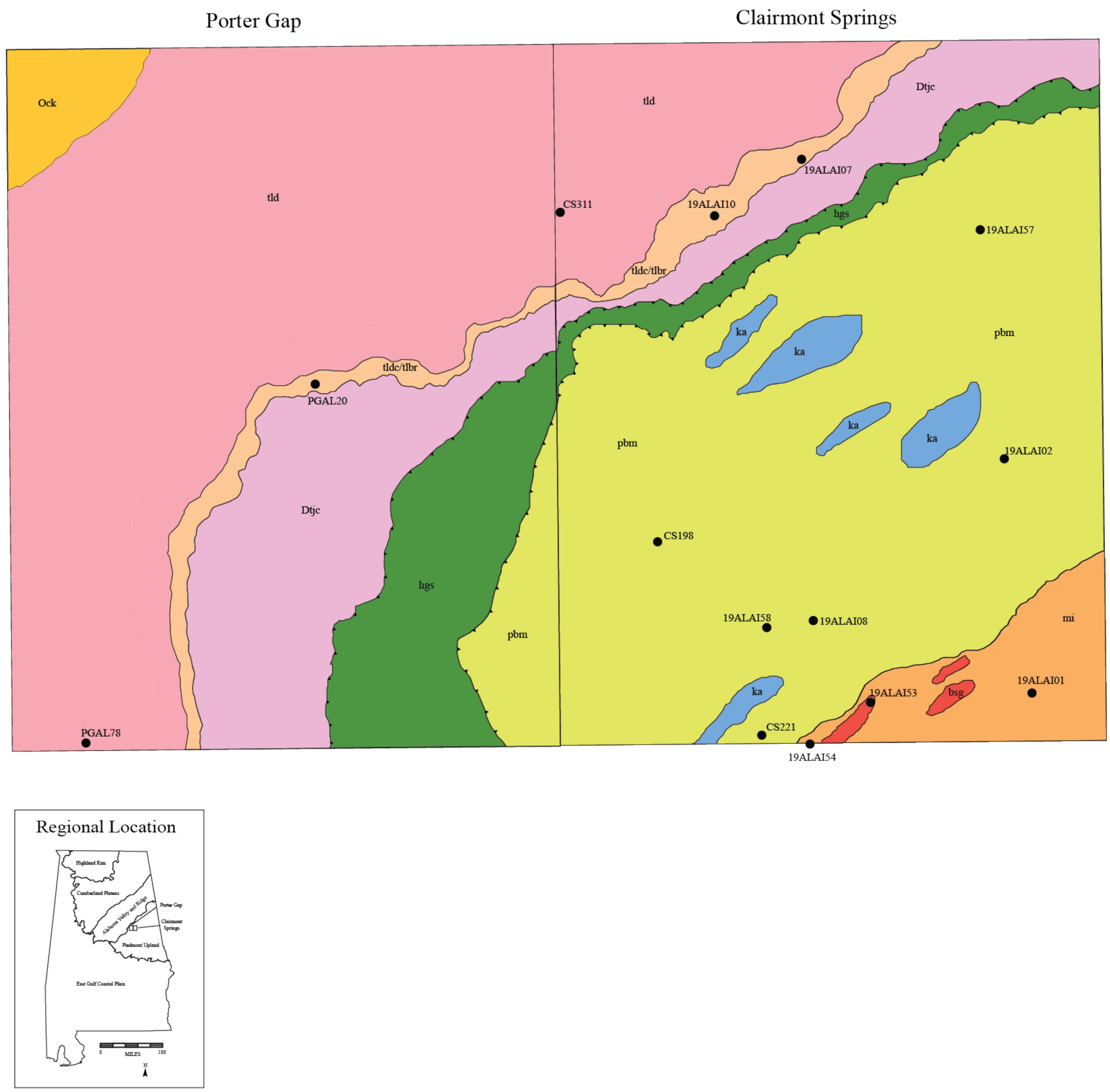
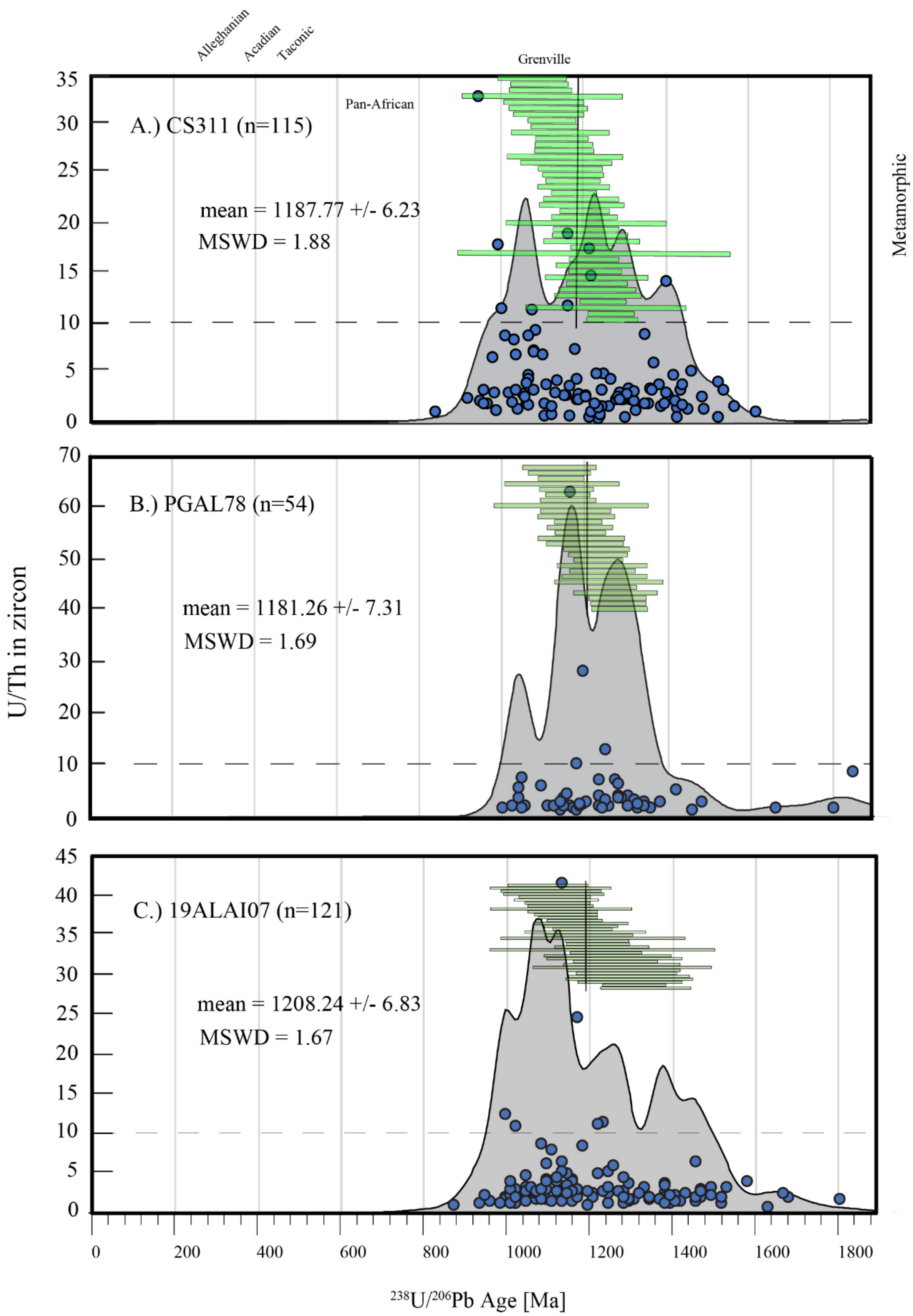
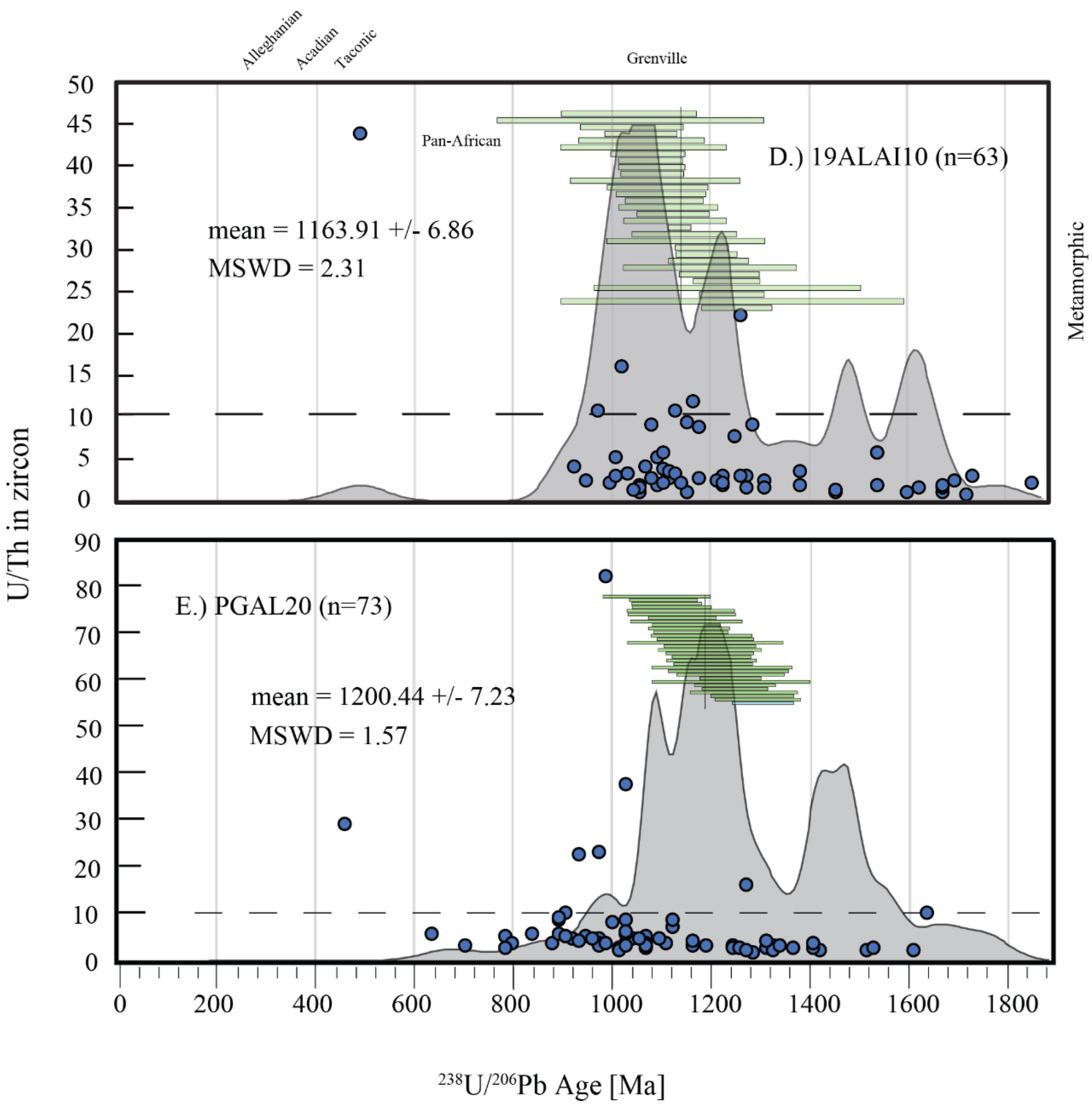
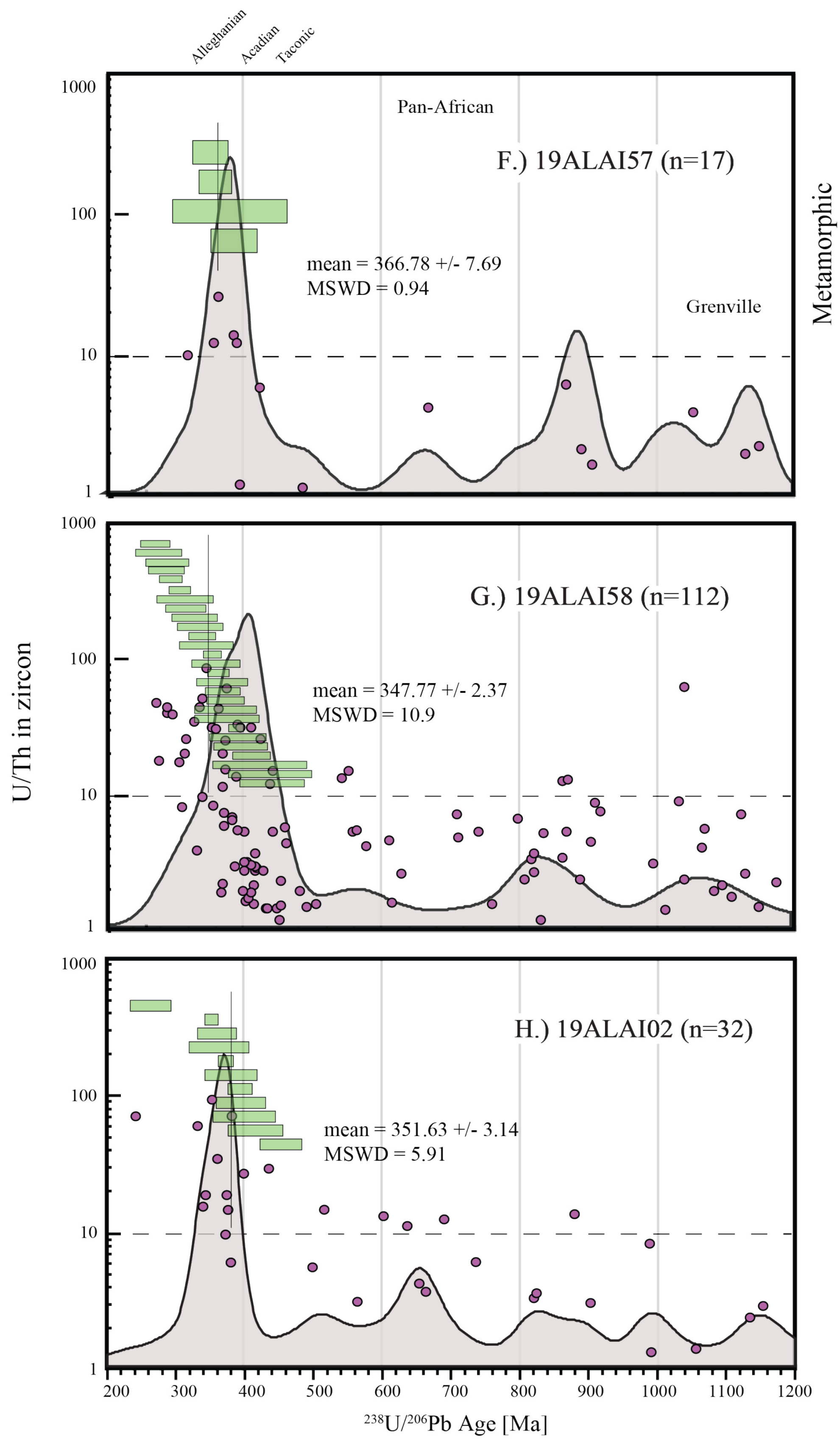


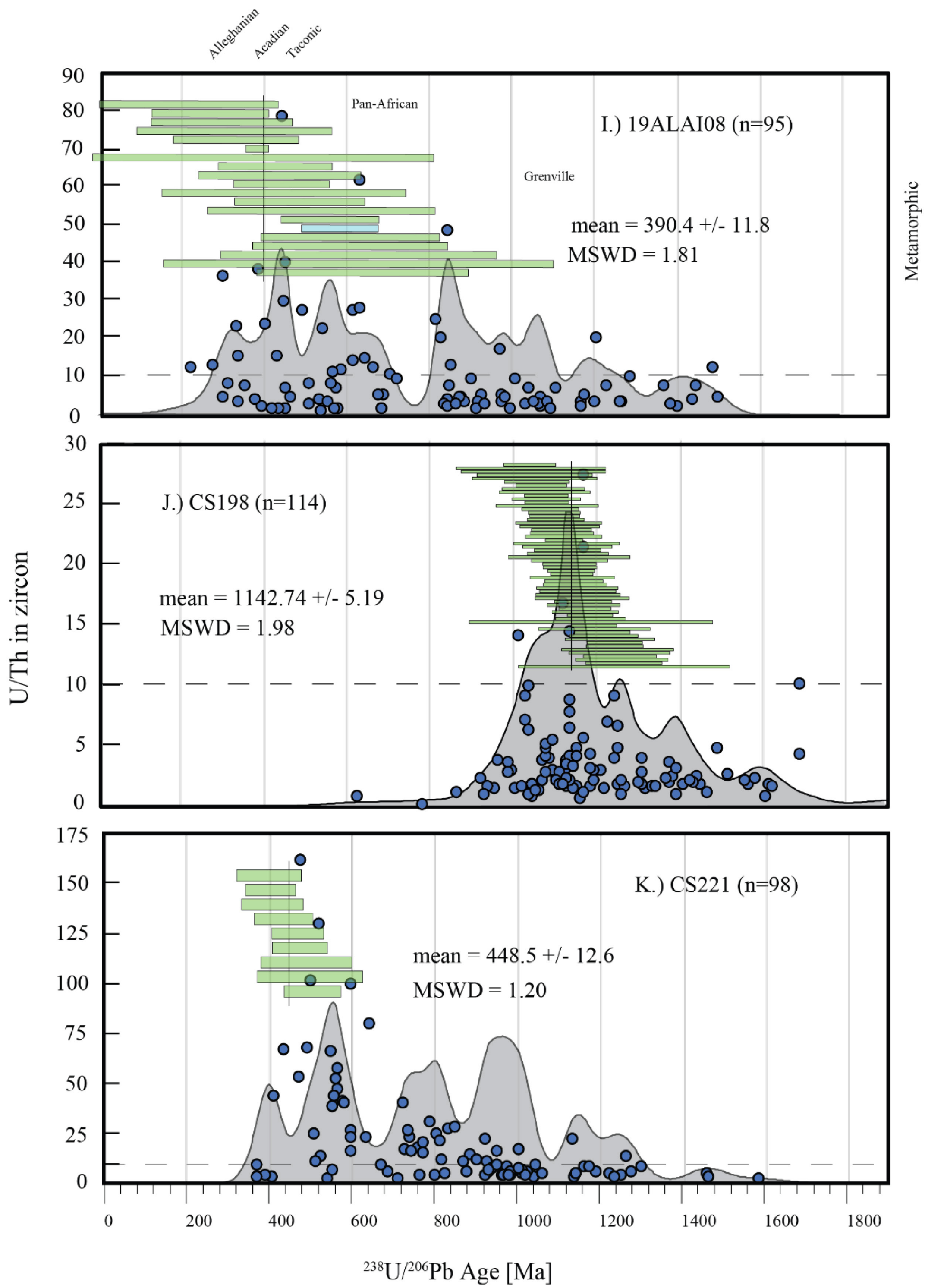
Figure 16. Preliminary geologic map of the Porter Gap and Clairmont Springs 7.5-minute quadrangles showing the location of all fourteen samples collected.


Alleghanian
Acadian
Taconic
Grenville
Pan-African
Metamorphic
A.) CS311 (n=115)
mean = 1187.77 +/- 6.23
MSWD = 1.88
B.) PGAL78 (n=54)
mean = 1181.26 +/- 7.31
MSWD = 1.69
C.) 19ALAI07 (n=121)
mean = 1208.24 +/- 6.83
MSWD = 1.67
U/Th in zircon
238U/206Pb Age [Ma]


Alleghanian
Acadian
Taconic
Grenville
Pan-African
D.) 19ALAI10 (n=63)
mean = 1163.91 +/- 6.86
MSWD = 2.31
Metamorphic
U/Th in zircon
E.) PGAL20 (n=73)
mean = 1200.44 +/- 7.23
MSWD = 1.57
$^{238}U/^{206}Pb$ Age [Ma]



Alleghanian
Acadian
Taconic
Pan-African
F.) 19ALAI57 (n=17)
mean = 366.78 +/- 7.69
MSWD = 0.94
Grenville
Metamorphic
G.) 19ALAI58 (n=112)
mean = 347.77 +/- 2.37
MSWD = 10.9
H.) 19ALAI02 (n=32)
mean = 351.63 +/- 3.14
MSWD = 5.91
U/Th in zircon
1000
100
10
1
200 300 400 500 600 700 800 900 1000 1100 1200
^{238}U/^{206}Pb Age [Ma]


Alleghanian
Acadian
Taconic
Pan-African
Grenville
I.) 19ALAI08 (n=95)
mean = 390.4 +/- 11.8
MSWD = 1.81
Metamorphic
J.) CS198 (n=114)
mean = 1142.74 +/- 5.19
MSWD = 1.98
K.) CS221 (n=98)
mean = 448.5 +/- 12.6
MSWD = 1.20
U/Th in zircon
$^{238}U/^{206}Pb$ Age [Ma]

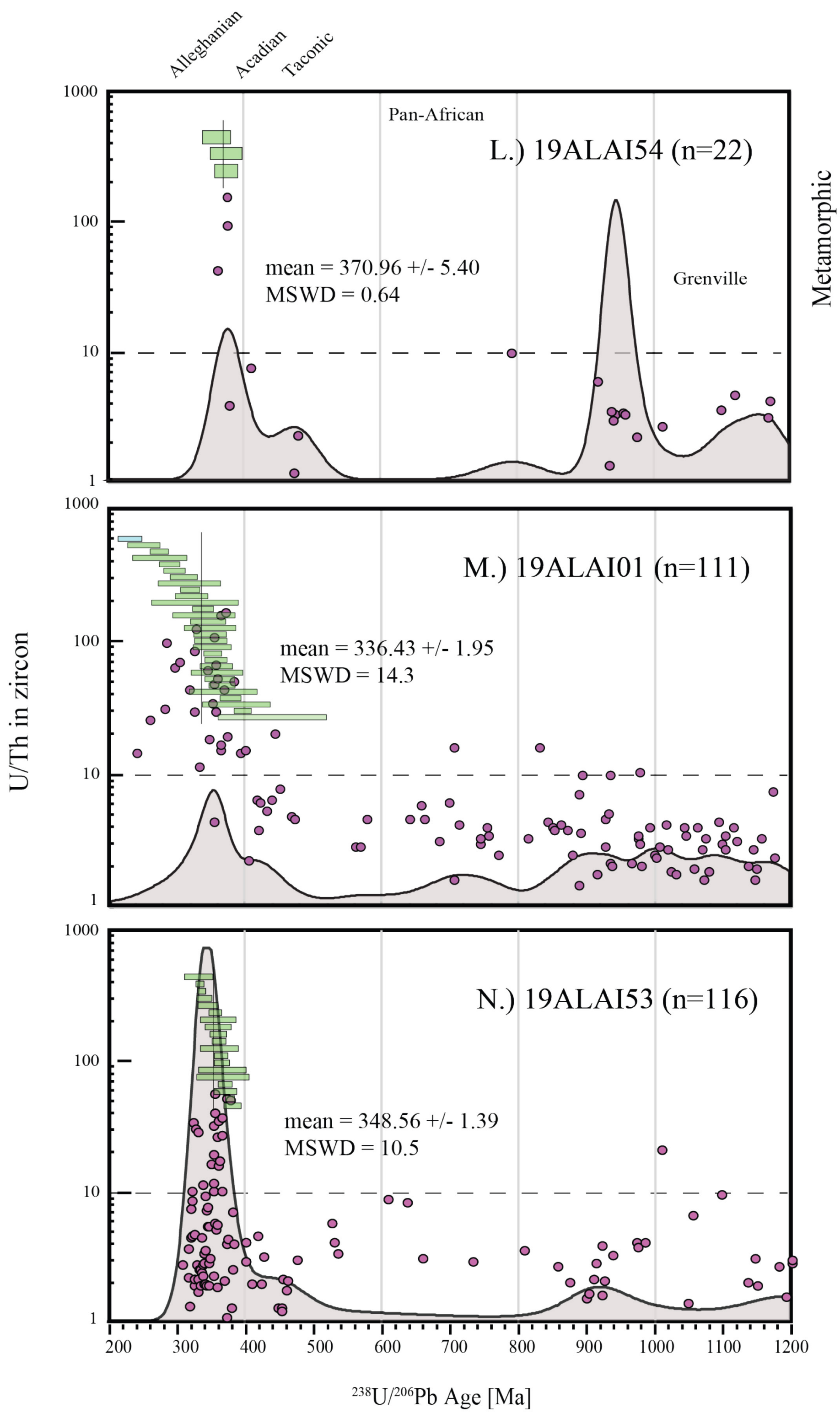


Figure 17. Weighted mean age plot and U/Th ratios for all samples superimposed onto kernel density estimates (KDEs), which plot 206Pb/238U ages (Ma) vs. U/Th ratios in zircon.

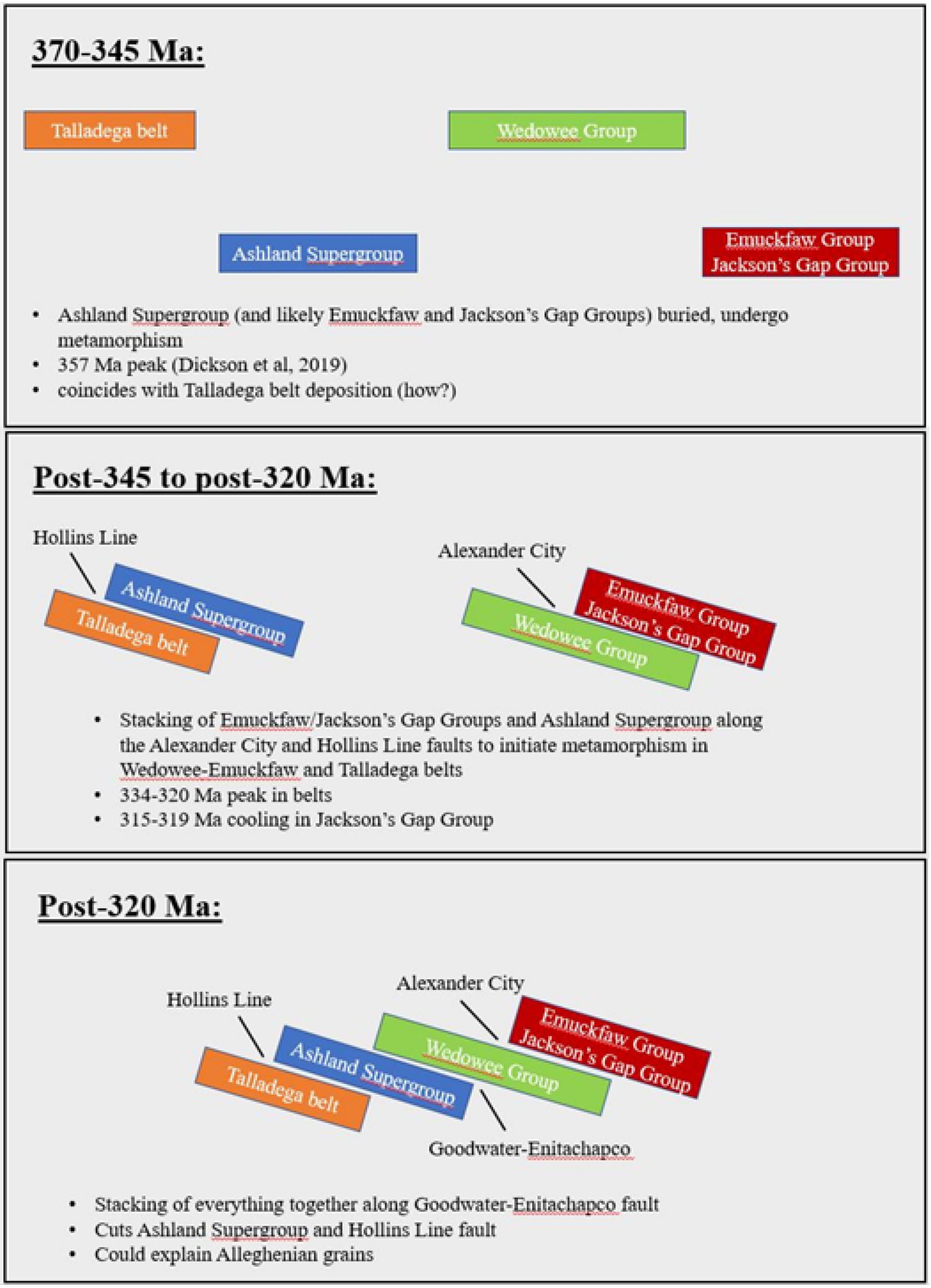


Figure 18. Model for synchronous thrust stacking of the Blue Ridge of Alabama.

APPENDICES

Appendix A: U-Pb Zircon Ages

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
CS311	CS311.01	1.463	0.026	0.1381	0.0024	0.0747	0.0011	834	14	1053	28	951	1.079	834	14
	CS311.02	1.45	0.18	0.115	0.0068	0.116	0.033	698	40	1380	170	354	1.73	1380	170
	CS311.03	3.26	0.11	0.2549	0.0079	0.0881	0.0018	1460	41	1374	42	337	3.82	1374	42
	CS311.04	28.7	3.3	0.33	0.033	0.616	0.025	1810	160	4528	62	11.5	0.874	4528	62
	CS311.05	2.252	0.061	0.1893	0.0039	0.0842	0.0023	1120	22	1288	54	159.8	2.304	1288	54
	CS311.06	2.278	0.042	0.2122	0.0034	0.0764	0.0014	1240	18	1096	39	302	0.7	1096	39
	CS311.09	1.722	0.045	0.1617	0.0037	0.0755	0.0016	965	21	1075	43	859	9.27	1075	43
	CS311.10	1.976	0.041	0.1819	0.0038	0.0765	0.0017	1076	21	1104	50	331.3	3.85	1104	50
	CS311.100	1.804	0.038	0.1767	0.0027	0.0748	0.0015	1049	15	1058	41	467	4.85	1058	41
	CS311.101	2.341	0.038	0.2034	0.003	0.0844	0.0014	1193	16	1302	29	833	3.394	1302	29
	CS311.102	3.248	0.078	0.2655	0.0041	0.0893	0.0017	1517	21	1396	37	335	2.775	1396	37
	CS311.104	2.462	0.061	0.2157	0.0037	0.0841	0.002	1258	20	1286	50	132.1	2.35	1286	50
	CS311.105	1.704	0.042	0.1694	0.0032	0.0738	0.0011	1008	17	1027	32	819	6.78	1027	32
	CS311.106	2.096	0.068	0.1866	0.005	0.0824	0.002	1101	27	1232	48	285	0.66	1232	48
	CS311.107	1.752	0.061	0.1704	0.0047	0.074	0.0018	1013	26	1026	47	453	8.36	1026	47
	CS311.108	1.666	0.045	0.1656	0.0028	0.0722	0.0016	987	16	978	47	339	2.98	978	47
	CS311.109	2.874	0.077	0.2343	0.0046	0.0885	0.0012	1355	24	1389	28	726	1.97	1389	28
	CS311.11	3.14	0.1	0.2536	0.005	0.089	0.0023	1455	26	1391	46	208.2	14.1	1391	46
	CS311.110	1.74	0.11	0.1664	0.0054	0.0775	0.0088	990	30	960	120	90	1.972	960	120
	CS311.111	1.784	0.048	0.1707	0.0028	0.0751	0.0021	1015	15	1058	52	226	4.42	1058	52

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	CS311.112	2.601	0.091	0.2178	0.0059	0.0859	0.0021	1268	31	1313	47	176	2.15	1313	47
	CS311.113	2.034	0.047	0.1849	0.0032	0.0788	0.0014	1093	17	1154	36	414	18.9	1154	36
	CS311.114	1.932	0.045	0.1761	0.0036	0.0787	0.0015	1045	20	1155	37	1063	11.7	1155	37
	CS311.115	2.182	0.057	0.1947	0.0032	0.0798	0.0024	1146	17	1160	57	318	3.65	1160	57
	CS311.116	2.476	0.072	0.2074	0.004	0.0842	0.0025	1214	21	1280	59	135	3.09	1280	59
	CS311.117	1.987	0.064	0.1734	0.0037	0.0815	0.0028	1030	20	1237	64	194.8	1.64	1237	64
	CS311.118	2.408	0.039	0.2053	0.0028	0.0835	0.0012	1203	15	1273	29	514	2.343	1273	29
	CS311.119	1.838	0.061	0.1744	0.0038	0.0762	0.003	1035	21	1053	77	440	1.958	1053	77
	CS311.12	1.543	0.056	0.1428	0.0048	0.0777	0.0019	859	27	1115	49	398	0.88	1115	49
	CS311.13	1.986	0.097	0.1769	0.0042	0.08	0.0042	1049	23	1100	100	42.3	1.92	1100	100
	CS311.15	2.285	0.049	0.2044	0.0036	0.0796	0.0015	1198	19	1177	38	323	2.34	1177	38
	CS311.16	1.761	0.055	0.1579	0.0036	0.0793	0.0027	944	20	1157	72	167	0.77	1157	72
	CS311.17	1.758	0.042	0.1666	0.0025	0.0749	0.0016	993	14	1046	44	360.1	2.907	1046	44
	CS311.18	2.09	0.032	0.191	0.0028	0.0774	0.0011	1126	15	1130	29	941	4.29	1130	29
	CS311.19	1.424	0.096	0.1329	0.0072	0.0792	0.0052	801	42	1070	120	52.7	7.25	1070	120
	CS311.20	1.817	0.05	0.1563	0.0047	0.0796	0.0011	934	26	1180	28	884	2.846	1180	28
	CS311.21	3.13	0.1	0.2456	0.007	0.0906	0.0024	1413	36	1421	49	147.3	1.512	1421	49
	CS311.22	1.708	0.039	0.1654	0.0024	0.0724	0.0012	986	13	995	31	802	11.4	995	31
	CS311.23	2.954	0.053	0.2343	0.0035	0.0898	0.0011	1356	18	1416	24	519	2.205	1416	24
	CS311.24	0.833	0.06	0.0666	0.0032	0.0822	0.0065	415	19	1230	170	226	0.4	1230	170
	CS311.24	1.186	0.035	0.1204	0.0029	0.0711	0.0026	732	17	950	67	676	3.35	950	67
	CS311.25	1.521	0.051	0.1517	0.0035	0.0719	0.0024	910	20	939	69	152.9	32.6	939	69
	CS311.26	2.568	0.086	0.2126	0.0052	0.0859	0.0027	1248	25	1316	56	143	3.15	1316	56
	CS311.	2.266	0.067	0.203	0.0041	0.0805	0.0021	1190	22	1199	53	302	2.73	1199	53

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	27														
	CS311.28	1.477	0.04	0.1455	0.0039	0.0729	0.0012	875	22	1004	34	1616	8.68	1004	34
	CS311.29	1.731	0.05	0.1645	0.0031	0.0753	0.0018	981	18	1054	48	316	3.98	1054	48
	CS311.30	2.023	0.041	0.1837	0.0036	0.0797	0.0014	1086	19	1177	34	1016	4.43	1177	34
	CS311.31	3.082	0.064	0.2451	0.0045	0.091	0.0014	1412	23	1443	28	384	1.464	1443	28
	CS311.32	2.825	0.07	0.2355	0.0055	0.0874	0.0017	1362	29	1356	37	324	3.47	1356	37
	CS311.33	1.483	0.056	0.1357	0.0048	0.0808	0.0013	819	27	1206	31	1085	0.587	1206	31
	CS311.34	2.21	0.1	0.1973	0.0069	0.083	0.0022	1157	38	1241	54	306	4.97	1241	54
	CS311.35	2.501	0.062	0.2237	0.0063	0.0835	0.0023	1299	32	1296	40	235	2.88	1296	40
	CS311.36	2.972	0.098	0.2433	0.0044	0.0917	0.0029	1403	23	1429	56	200	3.231	1429	56
	CS311.37	1.874	0.049	0.1726	0.0036	0.0818	0.0014	1025	20	1233	33	1012	0.922	1233	33
	CS311.38	1.62	0.046	0.1664	0.0033	0.0736	0.0019	992	18	1012	54	259.3	2.962	1012	54
	CS311.39	2.3	0.12	0.208	0.0062	0.0891	0.0066	1215	33	1260	100	49.1	4.35	1260	100
	CS311.40	2.705	0.085	0.2291	0.0052	0.0902	0.002	1328	28	1411	43	463	4.79	1411	43
	CS311.41	1.717	0.041	0.1754	0.0035	0.0754	0.0018	1041	19	1071	41	640	7.1	1071	41
	CS311.42	1.698	0.042	0.1741	0.004	0.0751	0.0019	1034	22	1071	39	455	3.24	1071	39
	CS311.43	1.55	0.04	0.1651	0.0029	0.0725	0.0016	985	16	981	46	508	1.202	981	46
	CS311.44	1.495	0.042	0.1648	0.0035	0.0714	0.0017	983	19	944	51	279	2.16	944	51
	CS311.45	2.226	0.087	0.1999	0.008	0.0893	0.0023	1170	44	1393	48	287	3.01	1393	48
	CS311.46	2.739	0.095	0.2242	0.0051	0.0954	0.0025	1302	27	1517	55	559	4.15	1517	55
	CS311.47	1.979	0.042	0.1905	0.0025	0.0814	0.0011	1124	14	1224	26	756	4.95	1224	26
	CS311.48	1.431	0.052	0.1577	0.0035	0.0719	0.002	943	19	949	60	150.8	1.962	949	60
	CS311.49	2.875	0.063	0.2498	0.004	0.091	0.0018	1437	21	1434	36	437	3.79	1434	36
	CS311.50	2.064	0.057	0.2077	0.0036	0.0786	0.0024	1216	19	1145	61	132.5	2.723	1145	61

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge 206_238	FinalAge206 _238_Int2SE	FinalAge 207_206	FinalAge207 _206_Int2SE	Approx_ U_PPM	Final_U_ Th_Ratio	Best Age (Ma)	BA err
	CS311.51	1.319	0.045	0.1386	0.0044	0.0747	0.0023	835	25	1035	60	168	1.425	1035	60
	CS311.52	2.238	0.067	0.21	0.0056	0.0838	0.0014	1227	30	1276	32	707	2.67	1276	32
	CS311.53	1.613	0.035	0.1676	0.0035	0.0756	0.0016	998	19	1068	41	815	11.25	1068	41
	CS311.54	1.885	0.042	0.1952	0.0035	0.0764	0.0014	1149	19	1093	36	487	6.8	1093	36
	CS311.55	1.759	0.065	0.1823	0.0043	0.0752	0.0024	1078	23	1030	50	274	3.24	1030	50
	CS311.56	1.32	0.14	0.134	0.015	0.0839	0.0043	797	82	1210	100	97.2	1.08	1210	100
	CS311.57	2.151	0.065	0.1943	0.0055	0.0873	0.0022	1143	30	1343	48	157.3	1.962	1343	48
	CS311.58	1.776	0.038	0.1739	0.0031	0.0795	0.0016	1033	17	1170	40	544	7.37	1170	40
	CS311.59	1.825	0.051	0.1712	0.0031	0.0824	0.002	1018	17	1239	48	393	3.29	1239	48
	CS311.60	1.319	0.069	0.1288	0.0061	0.0775	0.0012	783	35	1124	30	1405	3.04	1124	30
	CS311.61	1.817	0.048	0.1749	0.0043	0.0797	0.0017	1038	24	1179	45	397	2.36	1179	45
	CS311.62	2.386	0.07	0.2061	0.0053	0.0867	0.0019	1206	28	1342	41	776	8.8	1342	41
	CS311.63	1.582	0.049	0.14	0.0033	0.0853	0.0025	844	19	1293	55	266	0.624	1293	55
	CS311.64	2.819	0.078	0.231	0.0062	0.0918	0.0015	1337	33	1452	31	434	5.15	1452	31
	CS311.65	1.136	0.044	0.1179	0.0034	0.072	0.0011	718	20	974	32	1897	6.59	974	32
	CS311.66	2.247	0.057	0.2004	0.0043	0.0839	0.0016	1180	22	1281	38	528.7	2.322	1281	38
	CS311.67	2	0.058	0.1797	0.0054	0.0818	0.0013	1064	29	1230	31	824	1.54	1230	31
	CS311.68	1.784	0.038	0.1762	0.0033	0.0749	0.001	1048	18	1057	28	829	8.77	1057	28
	CS311.69	2.437	0.06	0.2004	0.0042	0.09	0.0017	1176	22	1417	36	318	0.555	1417	36
	CS311.70	1.701	0.042	0.1665	0.0025	0.0752	0.0017	995	14	1059	49	371	1.79	1059	49
	CS311.71	2.595	0.067	0.2189	0.0046	0.0877	0.0018	1275	24	1359	41	334	3.34	1359	41
	CS311.72	2.65	0.1	0.2076	0.007	0.0934	0.0023	1213	38	1482	47	425	1.333	1482	47
	CS311.73	1.988	0.05	0.1774	0.0046	0.0819	0.002	1051	25	1220	47	607	1.927	1220	47
	CS311.	2.246	0.07	0.2032	0.0051	0.0809	0.002	1191	27	1197	47	195.1	2.56	1197	47

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	74														
	CS311.75	1.558	0.033	0.1544	0.0027	0.0736	0.0014	925	15	1021	40	462	2.034	1021	40
	CS311.76	1.834	0.052	0.1727	0.0045	0.0772	0.0016	1025	25	1116	44	431	1.64	1116	44
	CS311.77	3.205	0.086	0.2419	0.0051	0.096	0.0022	1395	26	1530	43	178	3.3	1530	43
	CS311.78	2.483	0.064	0.2211	0.0051	0.0812	0.0017	1286	27	1210	41	489	14.7	1210	41
	CS311.79	3.03	0.12	0.2467	0.007	0.0879	0.0023	1419	36	1363	50	398	6	1363	50
	CS311.80	1.654	0.049	0.1572	0.0025	0.0753	0.002	941	14	1049	52	173.1	2.555	1049	52
	CS311.81	2.75	0.12	0.2173	0.006	0.0911	0.0031	1265	32	1432	61	80.3	1.829	1432	61
	CS311.82	2.34	0.13	0.1796	0.005	0.0948	0.0046	1063	27	1517	85	145.4	0.533	1517	85
	CS311.83	1.779	0.04	0.1509	0.0037	0.0854	0.0025	905	21	1321	61	321.7	1.539	1321	61
	CS311.84	3.04	0.12	0.2466	0.0073	0.0856	0.002	1417	38	1308	47	362	2.41	1308	47
	CS311.85	2.993	0.091	0.2333	0.0056	0.093	0.0022	1350	29	1480	45	188	2.57	1480	45
	CS311.86	2.236	0.074	0.1872	0.0058	0.087	0.0019	1104	31	1349	40	569	1.954	1349	40
	CS311.87	2.327	0.07	0.1982	0.0049	0.0861	0.0021	1164	26	1319	47	173.6	1.273	1319	47
	CS311.88	1.61	0.062	0.167	0.0032	0.0699	0.0023	995	17	910	68	147	2.544	910	68
	CS311.89	5.55	0.17	0.3472	0.0084	0.1162	0.0029	1917	40	1890	45	198	1.73	1890	45
	CS311.90	2.367	0.039	0.208	0.0023	0.0827	0.0012	1218	12	1253	29	488.3	1.634	1253	29
	CS311.91	1.672	0.096	0.1468	0.0067	0.0819	0.0024	880	38	1224	60	226	1.48	1224	60
	CS311.92	3.665	0.077	0.2766	0.0052	0.097	0.0016	1573	26	1556	32	253	1.712	1556	32
	CS311.93	2.635	0.086	0.2246	0.0049	0.0855	0.0018	1304	26	1309	42	484	5.2	1309	42
	CS311.94	2.199	0.067	0.1947	0.0046	0.081	0.0016	1145	25	1206	41	720	17.4	1206	41
	CS311.95	2.172	0.057	0.1935	0.0044	0.0818	0.0014	1139	24	1238	38	593	3.36	1238	38
	CS311.96	1.712	0.037	0.174	0.0031	0.0724	0.0014	1036	17	984	38	518	17.77	984	38
	CS311.97	1.455	0.033	0.1355	0.0028	0.0785	0.0013	818	16	1149	33	1130	2.77	1149	33

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	CS311.98	4.019	0.072	0.2965	0.0039	0.0994	0.0014	1673	19	1610	26	478	1.104	1610	26
	CS311.99	2.311	0.078	0.2016	0.0052	0.084	0.0018	1182	28	1280	42	595	2.59	1280	42
PGAL78	PGAL78.01	1.67	0.048	0.1636	0.0028	0.0728	0.0019	976	16	981	53	317	1.612	976	16
	PGAL78.02	1.699	0.05	0.1653	0.0029	0.0732	0.0016	985	16	1001	43	325.7	1.899	1001	43
	PGAL78.03	1.847	0.048	0.1639	0.0045	0.081	0.0015	977	25	1207	36	974	1.82	1207	36
	PGAL78.04	1.947	0.051	0.1812	0.0035	0.0768	0.0018	1076	19	1115	45	305	1.05	1115	45
	PGAL78.05	1.939	0.075	0.1661	0.0072	0.0846	0.0012	987	41	1299	28	1099	1.638	1299	28
	PGAL78.06	2.633	0.06	0.2216	0.0041	0.0855	0.0018	1289	22	1317	41	282	2.63	1317	41
	PGAL78.07	1.22	0.11	0.099	0.011	0.0914	0.0025	601	61	1427	53	1455	1.05	1427	53
	PGAL78.08	2.31	0.077	0.1992	0.006	0.0836	0.0015	1179	31	1276	34	665	1.95	1276	34
	PGAL78.09	2.485	0.081	0.2141	0.0054	0.0842	0.0021	1249	29	1274	49	211	3.65	1274	49
	PGAL78.10	1.704	0.042	0.1546	0.004	0.0771	0.0011	925	22	1119	28	798	3.26	1119	28
	PGAL78.11	2.347	0.073	0.2001	0.0041	0.0845	0.0017	1175	22	1293	40	558	3.07	1293	40
	PGAL78.12	1.856	0.034	0.1736	0.0035	0.0777	0.0011	1031	19	1135	27	916	1.767	1135	27
	PGAL78.13	1.728	0.064	0.1664	0.0038	0.0753	0.0027	991	21	1031	70	135.4	2.06	1031	70
	PGAL78.15	2.615	0.06	0.2218	0.0044	0.0871	0.0014	1290	23	1353	32	549	2.75	1353	32
	PGAL78.16	1.426	0.066	0.1227	0.0059	0.0822	0.0028	745	34	1233	66	427	1.71	1233	66
	PGAL78.16	2.132	0.084	0.2091	0.005	0.0797	0.0034	1223	26	1143	94	185	1.624	1143	94
	PGAL78.17	2.128	0.091	0.1739	0.0034	0.0902	0.0032	1033	19	1387	66	612	5.16	1387	66
	PGAL78.18	2.396	0.062	0.2143	0.004	0.0831	0.0015	1250	21	1259	34	315	3.26	1259	34
	PGAL78.19	2.658	0.061	0.2307	0.0035	0.086	0.0016	1338	18	1325	35	251.1	1.42	1325	35
	PGAL78.20	2.222	0.061	0.2008	0.0054	0.0822	0.0013	1178	29	1241	30	832	6.89	1241	30
	PGAL78.21	1.542	0.03	0.1507	0.0029	0.0759	0.001	904	16	1088	27	1357	1.976	1088	27
	PGAL7	2.056	0.055	0.1849	0.0038	0.0825	0.002	1093	20	1249	51	345	6.26	1249	51

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	8.22														
	PGAL78.23	1.988	0.091	0.1883	0.0065	0.0784	0.0034	1109	36	1121	70	131	1.968	1121	70
	PGAL78.24	2.184	0.075	0.141	0.01	0.1293	0.0099	844	60	1970	120	970	0.913	1970	120
	PGAL78.25	2.263	0.045	0.2024	0.0033	0.0829	0.0015	1187	18	1254	35	577	3.92	1254	35
	PGAL78.26	2.167	0.047	0.1938	0.0039	0.0828	0.0015	1141	21	1256	34	831	3.37	1256	34
	PGAL78.27	2.319	0.052	0.2117	0.0043	0.0809	0.0016	1237	23	1204	40	368	3.95	1204	40
	PGAL78.28	2.318	0.038	0.2104	0.0034	0.0809	0.0012	1230	18	1208	30	685	6.84	1208	30
	PGAL78.29	1.942	0.056	0.1784	0.0035	0.0795	0.0022	1058	19	1167	53	204	2.186	1167	53
	PGAL78.30	1.834	0.051	0.1709	0.0032	0.079	0.002	1016	18	1155	47	166.6	1.083	1155	47
	PGAL78.31	2.236	0.067	0.2027	0.0031	0.0821	0.0021	1189	16	1223	52	123.3	3.22	1223	52
	PGAL78.32	1.363	0.054	0.1243	0.0046	0.08	0.0019	759	24	1176	47	635	2.53	1176	47
	PGAL78.33	2.117	0.055	0.1963	0.0037	0.0791	0.0017	1154	20	1164	40	242	2.065	1164	40
	PGAL78.34	4.31	0.37	0.256	0.011	0.1178	0.0066	1463	59	1810	110	212	8.6	1810	110
	PGAL78.35	2.452	0.049	0.1965	0.0032	0.0921	0.0021	1156	17	1450	44	537	2.59	1450	44
	PGAL78.36	2.631	0.062	0.2299	0.0044	0.0838	0.0016	1333	23	1273	37	187	1.895	1273	37
	PGAL78.37	2.328	0.048	0.2107	0.0037	0.0791	0.0012	1232	20	1165	31	830	28.1	1165	31
	PGAL78.38	1.74	0.078	0.1541	0.0056	0.0816	0.0025	922	31	1217	55	460	1.629	1217	55
	PGAL78.39	2.183	0.085	0.1845	0.0043	0.0852	0.0025	1094	24	1313	58	482	2.01	1313	58
	PGAL78.40	2.146	0.057	0.1844	0.0036	0.0848	0.0017	1090	20	1297	39	398	2.158	1297	39
	PGAL78.41	1.956	0.047	0.183	0.0043	0.0787	0.0016	1082	23	1154	43	553	9.96	1154	43
	PGAL78.42	2.28	0.055	0.2055	0.0035	0.0815	0.0018	1204	19	1218	40	512	12.8	1218	40
	PGAL78.43	1.96	0.036	0.1862	0.003	0.0778	0.0014	1100	16	1136	34	680	62.9	1136	34
	PGAL78.44	1.39	0.047	0.1386	0.0043	0.073	0.00096	836	24	1014	29	1197	3.37	1014	29
	PGAL78.45	2.11	0.065	0.1984	0.0042	0.0774	0.0022	1166	22	1102	56	155.1	1.763	1102	56

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	PGAL78.46	1.617	0.038	0.1613	0.0031	0.0735	0.0015	964	17	1021	46	509	7.39	1021	46
	PGAL78.47	1.805	0.054	0.1693	0.0038	0.0778	0.0013	1007	21	1132	33	872	4.09	1132	33
	PGAL78.48	1.637	0.041	0.163	0.0034	0.0736	0.0013	972	19	1019	35	815	5.39	1019	35
	PGAL78.49	1.6	0.029	0.1565	0.0027	0.0755	0.0012	937	15	1071	31	1106	5.97	1071	31
	PGAL78.50	2.099	0.039	0.195	0.0029	0.0789	0.0012	1150	15	1160	29	760	2.22	1160	29
	PGAL78.51	1.885	0.063	0.1873	0.0033	0.0742	0.0019	1106	18	1020	53	199	1.358	1020	53
	PGAL78.52	3.85	0.15	0.2612	0.0074	0.1088	0.0022	1493	38	1764	38	587	1.61	1764	38
	PGAL78.53	1.678	0.05	0.1225	0.0045	0.1021	0.0032	743	26	1628	58	365	1.42	1628	58
	PGAL78.54	2.001	0.055	0.1889	0.0044	0.0773	0.0014	1114	24	1115	38	531	2.46	1115	38
19ALAI07	19ALAI07.01	2.103	0.088	0.1917	0.004	0.0801	0.0024	1130	22	1177	62	427	6.38	1130	22
	19ALAI07.01	3.068	0.087	0.2404	0.0063	0.0936	0.0016	1388	33	1493	32	652	3.21	1493	32
	19ALAI07.02	2.909	0.07	0.2274	0.0036	0.093	0.0021	1320	19	1468	43	265	3.02	1468	43
	19ALAI07.03	3.16	0.13	0.2488	0.007	0.0907	0.0023	1429	37	1433	53	155	2.55	1433	53
	19ALAI07.04	2.658	0.068	0.227	0.0046	0.0848	0.0013	1317	24	1301	31	405	1.6	1301	31
	19ALAI07.05	1.738	0.066	0.1708	0.0028	0.0741	0.0028	1016	16	997	79	130.6	1.52	997	79
	19ALAI07.06	1.6	0.088	0.1602	0.0045	0.0742	0.004	956	25	930	120	57.3	1.267	930	120
	19ALAI07.07	1.78	0.058	0.1683	0.0036	0.0769	0.0027	1002	20	1089	74	131.7	1.646	1089	74
	19ALAI07.08	1.743	0.056	0.1681	0.0028	0.0754	0.0025	1001	15	1067	66	132.8	1.617	1067	66
	19ALAI07.09	1.902	0.043	0.1764	0.0021	0.0782	0.0019	1047	12	1135	50	304	1.479	1135	50
	19ALAI07.10	1.767	0.061	0.1718	0.0032	0.0755	0.0025	1021	18	1049	66	180.5	3.13	1049	66
	19ALAI07.100	2.384	0.076	0.207	0.0041	0.0823	0.0019	1212	22	1239	46	228	5.16	1239	46
	19ALAI07.101	1.847	0.098	0.1798	0.0048	0.0744	0.0042	1064	26	940	120	59.4	2.327	940	120
	19ALAI07.102	2.142	0.039	0.1964	0.0023	0.0785	0.0012	1156	13	1154	32	604	4.11	1154	32
	19ALA	2.173	0.045	0.1995	0.0026	0.0784	0.0017	1172	14	1152	41	380.2	3.843	1152	41

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	I07.103														
	19ALA I07.104	2.212	0.069	0.2026	0.0051	0.0782	0.0015	1188	28	1136	39	501	2.6	1136	39
	19ALA I07.105	2.66	0.12	0.2136	0.0094	0.0894	0.0013	1242	51	1409	29	894	2.088	1409	29
	19ALA I07.106	1.844	0.057	0.1493	0.0033	0.0878	0.0012	896	19	1377	29	1760	2.44	1377	29
	19ALA I07.107	2.169	0.039	0.201	0.0024	0.0776	0.0011	1180	13	1129	27	1305	41.8	1129	27
	19ALA I07.108	2.166	0.068	0.2046	0.0037	0.0759	0.002	1199	20	1078	55	284	2.84	1078	55
	19ALA I07.109	2.979	0.092	0.2373	0.0051	0.0905	0.0019	1376	26	1425	39	325	1.54	1425	39
	19ALA I07.11	2.327	0.04	0.2112	0.0022	0.0804	0.0012	1235	12	1202	29	1100	2.52	1202	29
	19ALA I07.110	2.248	0.061	0.1825	0.004	0.0886	0.001	1079	22	1394	22	1320	1.271	1394	22
	19ALA I07.111	1.433	0.092	0.1452	0.0066	0.0727	0.0029	873	37	990	79	2240	12.52	990	79
	19ALA I07.111	2.731	0.097	0.2345	0.005	0.0832	0.0026	1357	26	1277	57	249	2.61	1277	57
	19ALA I07.112	1.954	0.058	0.1525	0.0026	0.0922	0.0029	915	14	1464	57	1023	2.05	1464	57
	19ALA I07.113	1.632	0.068	0.1543	0.0042	0.0759	0.003	924	24	1046	80	117.5	2.4	1046	80
	19ALA I07.114	2.181	0.058	0.1892	0.0029	0.0837	0.0026	1116	16	1250	62	140.9	1.262	1250	62
	19ALA I07.115	2.692	0.081	0.2297	0.0037	0.0851	0.0022	1332	19	1293	51	148.4	1.366	1293	51
	19ALA I07.116	1.742	0.063	0.1694	0.003	0.0743	0.0026	1008	17	1019	75	134.2	2.995	1019	75
	19ALA I07.117	1.77	0.035	0.1679	0.0028	0.0768	0.0015	1000	16	1100	39	563	1.728	1100	39
	19ALA I07.12	1.508	0.071	0.1551	0.0037	0.0711	0.0035	929	20	870	110	72.6	0.91	870	110
	19ALA I07.13	1.799	0.043	0.1294	0.0037	0.1012	0.0023	783	21	1634	43	599	0.699	1634	43
	19ALA I07.14	2.728	0.078	0.224	0.0033	0.089	0.0025	1302	17	1383	52	174	2.067	1383	52
	19ALA I07.15	2.183	0.051	0.1927	0.0034	0.0819	0.0013	1135	18	1232	31	625	11.6	1232	31
	19ALA I07.16	1.576	0.065	0.1575	0.0029	0.0727	0.003	942	16	953	95	138	1.503	953	95
	19ALA I07.17	2.654	0.045	0.215	0.0024	0.0898	0.0014	1255	13	1412	30	571	1.43	1412	30
	19ALA I07.18	1.702	0.067	0.1654	0.0029	0.0744	0.0031	986	16	1016	72	182	1.315	1016	72

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	19ALAI07.19	2.704	0.099	0.231	0.0054	0.0842	0.0025	1338	28	1291	59	220	3.75	1291	59
	19ALAI07.20	1.815	0.037	0.1702	0.002	0.0775	0.0015	1013	11	1119	39	468	3.86	1119	39
	19ALAI07.21	2.786	0.095	0.231	0.0057	0.0885	0.0027	1338	30	1374	54	147	1.626	1374	54
	19ALAI07.22	2.12	0.071	0.1939	0.0037	0.08	0.0028	1141	20	1161	69	144.6	1.564	1161	69
	19ALAI07.23	1.755	0.034	0.1619	0.0022	0.0786	0.0014	967	12	1149	35	915	3.08	1149	35
	19ALAI07.24	1.729	0.04	0.1666	0.0024	0.0752	0.002	993	13	1051	57	250	2.82	1051	57
	19ALAI07.25	1.997	0.045	0.1858	0.0033	0.0784	0.0019	1098	18	1147	49	308	5.03	1147	49
	19ALAI07.26	2.039	0.047	0.1887	0.0031	0.0777	0.0012	1113	17	1130	32	644	5.21	1130	32
	19ALAI07.27	2.327	0.043	0.2041	0.0029	0.083	0.0016	1197	16	1265	41	348	2.64	1265	41
	19ALAI07.28	1.798	0.057	0.1756	0.0029	0.0738	0.0024	1044	16	999	71	135.4	1.961	999	71
	19ALAI07.29	2.338	0.077	0.1942	0.0034	0.088	0.004	1143	18	1378	81	338	1.235	1378	81
	19ALAI07.30	57	17	0.71	0.15	0.304	0.048	2910	450	2760	270	201	1.79	2760	270
	19ALAI07.31	2.49	0.16	0.2139	0.0076	0.0844	0.0042	1246	40	1222	90	96	4.99	1222	90
	19ALAI07.32	2.043	0.06	0.1902	0.004	0.0775	0.002	1121	22	1108	52	326	8.08	1108	52
	19ALAI07.33	1.92	0.15	0.1754	0.0049	0.0799	0.0066	1044	28	990	160	33	1.699	990	160
	19ALAI07.34	2.204	0.068	0.1953	0.0033	0.0811	0.0024	1149	18	1207	59	112	1.85	1207	59
	19ALAI07.35	2.3	0.053	0.2061	0.0031	0.0809	0.0019	1208	16	1199	46	236	0.881	1199	46
	19ALAI07.36	1.999	0.055	0.1717	0.0056	0.085	0.0038	1028	29	1278	87	183	1.188	1278	87
	19ALAI07.37	2.113	0.051	0.185	0.0029	0.0826	0.0015	1094	16	1247	35	690	2.39	1247	35
	19ALAI07.38	2.101	0.038	0.1924	0.0024	0.0793	0.0012	1134	13	1174	29	405	1.96	1174	29
	19ALAI07.39	2.889	0.075	0.2212	0.0039	0.0949	0.0013	1287	21	1518	27	651	2.03	1518	27
	19ALAI07.40	1.736	0.062	0.1389	0.0032	0.0924	0.0035	838	18	1451	76	259	1.362	1451	76
	19ALAI07.40	2.222	0.058	0.1891	0.0039	0.0835	0.0022	1116	21	1292	62	383	1.664	1292	62
	19ALA	2.559	0.081	0.2147	0.0045	0.0862	0.0019	1252	24	1331	42	169.4	3.09	1331	42

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	I07.41														
	19ALA I07.42	2.084	0.04	0.1916	0.0025	0.0792	0.0014	1130	13	1164	34	376	2.92	1164	34
	19ALA I07.43	1.809	0.028	0.1738	0.0017	0.0757	0.0012	1032.7	9.5	1080	30	661	8.72	1080	30
	19ALA I07.44	2.388	0.043	0.2022	0.003	0.0868	0.0018	1187	16	1339	41	271.3	1.691	1339	41
	19ALA I07.45	2.083	0.044	0.1892	0.0024	0.0806	0.0015	1117	13	1199	36	424	2.611	1199	36
	19ALA I07.46	2.139	0.053	0.1901	0.0038	0.0818	0.0013	1121	21	1230	31	463	2.59	1230	31
	19ALA I07.47	2.219	0.093	0.1907	0.0033	0.0838	0.0029	1125	18	1263	66	310	6	1263	66
	19ALA I07.48	2.836	0.05	0.2172	0.0037	0.095	0.0011	1266	20	1522	22	642	1.192	1522	22
	19ALA I07.49	1.947	0.068	0.1649	0.0027	0.0856	0.002	983	15	1323	44	630	2.47	1323	44
	19ALA I07.50	1.648	0.045	0.1638	0.0036	0.0733	0.0018	980	19	1003	52	228.4	2.277	1003	52
	19ALA I07.51	1.736	0.039	0.1728	0.0023	0.0732	0.0016	1027	12	1005	45	254	1.169	1005	45
	19ALA I07.52	2.161	0.065	0.1534	0.0047	0.1033	0.0023	919	26	1685	40	550	1.922	1685	40
	19ALA I07.53	3.08	0.1	0.252	0.0057	0.0885	0.0018	1447	30	1384	39	366	3.68	1384	39
	19ALA I07.54	1.852	0.048	0.1767	0.0027	0.0765	0.0023	1051	15	1079	62	108.6	2.722	1079	62
	19ALA I07.55	1.948	0.094	0.1687	0.0042	0.0859	0.0047	1004	23	1240	110	60.4	3.12	1240	110
	19ALA I07.56	1.78	0.047	0.1731	0.0028	0.075	0.0017	1028	16	1047	46	280	1.442	1047	46
	19ALA I07.57	1.871	0.048	0.182	0.0026	0.0745	0.0018	1077	14	1041	45	217	4.67	1041	45
	19ALA I07.58	1.71	0.036	0.161	0.0022	0.0771	0.0014	962	12	1110	36	389	1.429	1110	36
	19ALA I07.59	2.233	0.03	0.1869	0.0031	0.0869	0.0014	1104	17	1347	31	928	1.969	1347	31
	19ALA I07.60	1.612	0.028	0.159	0.0023	0.07353	0.00094	951	13	1025	25	1236	10.92	1025	25
	19ALA I07.61	1.815	0.082	0.1763	0.0036	0.0754	0.0037	1046	20	980	110	44.2	1.313	980	110
	19ALA I07.62	1.718	0.033	0.1697	0.002	0.0732	0.0013	1010	11	1005	37	332.5	2.956	1005	37
	19ALA I07.63	2.004	0.067	0.1892	0.0033	0.0761	0.0018	1116	18	1090	46	411	3	1090	46
	19ALA I07.64	11.72	0.16	0.4638	0.006	0.1818	0.002	2455	27	2665	19	188.7	1.075	2665	19

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	19ALAI07.65	1.911	0.045	0.1829	0.0027	0.0753	0.0018	1082	15	1066	50	235	2.45	1066	50
	19ALAI07.66	2.073	0.056	0.191	0.0033	0.0782	0.002	1126	18	1142	49	177	3.52	1142	49
	19ALAI07.67	3.01	0.64	0.206	0.011	0.104	0.014	1202	58	1500	160	505	2.33	1500	160
	19ALAI07.67	11.2	1.4	0.294	0.017	0.254	0.025	1651	82	3030	200	133	1.781	3030	200
	19ALAI07.68	1.872	0.054	0.1742	0.0031	0.0774	0.0022	1034	17	1125	54	112	2.64	1125	54
	19ALAI07.69	1.721	0.051	0.1663	0.0027	0.074	0.0022	991	15	1024	61	151.9	2.08	1024	61
	19ALAI07.70	2.09	0.043	0.1904	0.0027	0.0788	0.0013	1123	15	1160	32	293.2	2.661	1160	32
	19ALAI07.71	2.54	0.11	0.2152	0.006	0.0847	0.0024	1254	32	1281	55	146	4.56	1281	55
	19ALAI07.72	1.764	0.044	0.1684	0.0034	0.0759	0.0022	1003	19	1061	58	167	3.15	1061	58
	19ALAI07.73	3.055	0.099	0.2453	0.0043	0.0895	0.0023	1413	22	1398	48	84.2	2.27	1398	48
	19ALAI07.74	2.946	0.083	0.2206	0.0034	0.0962	0.0032	1284	18	1522	62	143.4	1.962	1522	62
	19ALAI07.75	1.82	0.038	0.1715	0.0023	0.0764	0.0015	1020	13	1091	38	234	4.09	1091	38
	19ALAI07.76	1.772	0.05	0.1672	0.003	0.0761	0.0022	996	17	1082	60	152.9	1.634	1082	60
	19ALAI07.77	2.134	0.084	0.1888	0.0053	0.0815	0.0018	1113	29	1214	43	333	11.2	1214	43
	19ALAI07.78	1.78	0.057	0.1733	0.0026	0.0744	0.0024	1030	14	1010	65	108.4	3.95	1010	65
	19ALAI07.79	1.379	0.052	0.0921	0.0025	0.1107	0.0051	568	15	1804	86	2340	1.788	1804	86
	19ALAI07.79	2.472	0.057	0.204	0.0038	0.0838	0.0018	1196	21	1286	49	433	2.059	1286	49
	19ALAI07.80	3.1	0.12	0.2328	0.0062	0.0963	0.0021	1347	32	1536	43	145.3	3.31	1536	43
	19ALAI07.81	1.887	0.053	0.1496	0.0049	0.0919	0.0014	897	28	1458	29	1031	1.98	1458	29
	19ALAI07.82	2.143	0.05	0.1593	0.0042	0.0986	0.0021	952	24	1580	40	1210	3.89	1580	40
	19ALAI07.83	4.15	0.23	0.284	0.011	0.1038	0.0026	1606	58	1673	45	240	2.54	1673	45
	19ALAI07.84	1.888	0.056	0.181	0.0028	0.0764	0.0023	1072	15	1092	57	191	3.97	1092	57
	19ALAI07.85	2.135	0.083	0.2012	0.005	0.0769	0.0023	1180	27	1093	59	303	6.2	1093	59
	19ALA	1.69	0.12	0.1573	0.0042	0.0805	0.0057	944	24	1070	160	42.7	2.72	1070	16

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge 206_238	FinalAge206_238_Int2SE	FinalAge 207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	I07.86														0
	19ALAI07.87	1.899	0.034	0.1738	0.0028	0.0799	0.0011	1032	16	1187	27	1106	8.4	1187	27
	19ALAI07.88	13.06	0.2	0.5085	0.0064	0.1879	0.003	2649	27	2716	27	85.7	3.36	2716	27
	19ALAI07.89	1.957	0.044	0.1797	0.0023	0.0793	0.0012	1065	13	1170	31	795	24.7	1170	31
	19ALAI07.90	2.123	0.099	0.164	0.0025	0.0942	0.0048	978	14	1460	87	750	6.59	1460	87
	19ALAI07.91	1.938	0.054	0.1792	0.0031	0.0788	0.0024	1062	17	1141	59	115	2.498	1141	59
	19ALAI07.92	1.771	0.043	0.1693	0.0022	0.0764	0.0019	1008	12	1081	50	214.7	2.859	1081	50
	19ALAI07.93	1.808	0.052	0.1438	0.0037	0.0928	0.0025	865	21	1466	49	822	2.72	1466	49
	19ALAI07.94	1.868	0.034	0.1753	0.002	0.0771	0.0011	1041	11	1119	29	759	4.36	1119	29
	19ALAI07.95	2.146	0.059	0.1177	0.0052	0.1353	0.0042	715	30	2162	54	1250	1.173	2162	54
	19ALAI07.96	1.776	0.062	0.1669	0.0029	0.0773	0.0028	994	16	1098	72	102.5	3.93	1098	72
	19ALAI07.98	2.695	0.063	0.2201	0.0047	0.0886	0.0015	1285	24	1385	34	602	3.361	1385	34
	19ALAI07.99	1.536	0.064	0.1542	0.0038	0.0739	0.0037	923	21	950	110	82.2	2.254	950	110
19ALAI10	19ALAI10.01	2.151	0.042	0.1974	0.0023	0.0788	0.0014	1161	12	1158	37	347	11.7	1161	12
	19ALAI10.02	1.914	0.043	0.1809	0.0026	0.0766	0.0014	1071	14	1104	35	410	3.54	1104	35
	19ALAI10.03	1.791	0.044	0.1763	0.0029	0.0738	0.0013	1046	16	1023	36	440	15.8	1023	36
	19ALAI10.04	2.011	0.042	0.1743	0.0029	0.0833	0.0014	1035	16	1269	34	1280	2.68	1269	34
	19ALAI10.05	2.417	0.087	0.176	0.0078	0.1015	0.0031	1041	43	1654	56	950	0.918	1654	56
	19ALAI10.06	2.596	0.097	0.19	0.01	0.1038	0.0039	1112	56	1652	63	1120	1.263	1652	63
	19ALAI10.07	1.865	0.048	0.1789	0.0021	0.0754	0.0019	1061	11	1054	51	176	0.674	1054	51
	19ALAI10.08	2.05	0.11	0.1614	0.0025	0.0937	0.0043	964	14	1441	74	886	0.917	1441	74
	19ALAI10.09	3.21	0.76	0.185	0.017	0.133	0.022	1079	88	1700	220	647	0.639	1700	220
	19ALAI10.09	9.4	1.6	0.26	0.016	0.232	0.028	1480	79	2710	230	162	0.79	2710	230
	19ALAI10.10	1.614	0.065	0.1268	0.0037	0.0923	0.0029	769	21	1446	58	1144	1.13	1446	58

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	19ALAI10.10	2.83	0.26	0.2352	0.0088	0.087	0.0096	1371	41	1270	180	104	1.339	1270	180
	19ALAI10.11	1.698	0.054	0.1678	0.0032	0.0737	0.0026	999	18	1004	73	106.4	1.856	1004	73
	19ALAI10.12	2.884	0.046	0.2097	0.0026	0.0994	0.0013	1227	14	1606	24	641	1.223	1606	24
	19ALAI10.13	2.05	0.055	0.1939	0.0038	0.0766	0.0015	1142	20	1096	39	360	4.87	1096	39
	19ALAI10.14	1.986	0.037	0.182	0.0025	0.0794	0.0023	1078	13	1171	55	803	8.49	1171	55
	19ALAI10.15	2.148	0.045	0.192	0.0025	0.0809	0.0013	1132	13	1217	32	531	2.65	1217	32
	19ALAI10.16	1.983	0.078	0.1783	0.0035	0.0811	0.0032	1057	19	1174	83	60.9	2.549	1174	83
	19ALAI10.17	1.778	0.03	0.1476	0.0032	0.0879	0.0015	887	18	1375	34	1298	1.75	1375	34
	19ALAI10.18	3.253	0.085	0.2315	0.0039	0.1019	0.0019	1341	20	1652	34	1056	1.49	1652	34
	19ALAI10.19	1.498	0.051	0.1417	0.0042	0.078	0.0036	853	24	1087	87	147	1.513	1087	87
	19ALAI10.20	2.151	0.066	0.1981	0.0039	0.0793	0.0021	1164	21	1152	54	135.4	0.712	1152	54
	19ALAI10.21	2.97	0.069	0.2277	0.0045	0.0954	0.0017	1321	24	1523	34	334.7	1.641	1523	34
	19ALAI10.22	1.609	0.043	0.1651	0.0027	0.0711	0.0018	984	15	947	51	231	2.195	947	51
	19ALAI10.23	4.18	0.49	0.2328	0.0066	0.125	0.011	1347	34	1830	130	119.7	1.781	1830	130
	19ALAI10.24	1.906	0.059	0.1812	0.0031	0.0768	0.0026	1073	17	1083	66	91	2.433	1083	66
	19ALAI10.25	1.732	0.027	0.1753	0.0018	0.072	0.0012	1041	10	979	34	605	10.45	979	34
	19ALAI10.26	1.902	0.072	0.1789	0.0046	0.0783	0.0033	1059	25	1111	89	53.7	2.498	1111	89
	19ALAI10.27	2.206	0.053	0.1901	0.0016	0.0837	0.0015	1121.6	8.7	1279	37	770	8.93	1279	37
	19ALAI10.28	2.49	0.094	0.2158	0.0071	0.0827	0.0019	1256	39	1243	42	483	7.4	1243	42
	19ALAI10.29	1.787	0.049	0.1753	0.0026	0.0741	0.0019	1041	14	1032	52	179	2.941	1032	52
	19ALAI10.30	2.043	0.065	0.1943	0.0048	0.0761	0.0015	1143	26	1082	38	396	8.9	1082	38
	19ALAI10.31	2.007	0.047	0.1919	0.003	0.0768	0.0012	1131	16	1105	33	496	5.47	1105	33
	19ALAI10.32	1.869	0.048	0.174	0.0033	0.078	0.0016	1033	18	1130	41	346	10.4	1130	41
	19ALA	2.215	0.051	0.2048	0.0025	0.0786	0.0015	1201	13	1148	38	254	9.1	1148	38

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	I10.33														
	19ALA I10.34	2.072	0.039	0.1858	0.0031	0.0815	0.0018	1098	17	1221	42	371	1.689	1221	42
	19ALA I10.35	2.135	0.056	0.1999	0.0033	0.0776	0.0022	1174	18	1116	53	114	3.373	1116	53
	19ALA I10.36	2.611	0.093	0.2136	0.0046	0.088	0.0017	1247	24	1369	36	358	3.26	1369	36
	19ALA I10.37	1.816	0.07	0.1731	0.0038	0.0759	0.0026	1028	21	1057	71	160	1.65	1057	71
	19ALA I10.38	2.442	0.066	0.1857	0.003	0.0952	0.0017	1097	17	1521	33	456	1.688	1521	33
	19ALA I10.39	2.015	0.06	0.1932	0.0033	0.0758	0.002	1138	18	1063	54	217	3.93	1063	54
	19ALA I10.40	1.73	0.11	0.1588	0.0044	0.0805	0.0056	949	24	1060	140	28.2	1.254	1060	140
	19ALA I10.41	1.69	0.18	0.1432	0.0043	0.0841	0.0066	862	24	1260	140	720	22.1	1260	140
	19ALA I10.41	2.76	0.27	0.1971	0.0059	0.0988	0.007	1157	32	1530	110	500	5.6	1530	110
	19ALA I10.42	1.913	0.045	0.1808	0.0033	0.0765	0.0013	1071	18	1102	34	442	1.894	1102	34
	19ALA I10.43	2.269	0.08	0.1747	0.0046	0.0946	0.0032	1037	25	1520	66	214	5.61	1520	66
	19ALA I10.43	4.48	0.48	0.312	0.02	0.1062	0.007	1765	89	1680	130	70	2.15	1680	130
	19ALA I10.44	3.4	0.22	0.2234	0.0055	0.1089	0.0055	1298	29	1708	82	356	2.63	1708	82
	19ALA I10.45	2.654	0.075	0.2252	0.0041	0.0853	0.0025	1311	21	1305	59	84.3	2.099	1305	59
	19ALA I10.46	27.4	5.7	0.435	0.057	0.317	0.037	2190	240	3140	210	600	1.988	3140	210
	19ALA I10.47	0.494	0.045	0.0633	0.0052	0.0585	0.005	395	32	510	190	632	43.6	510	190
	19ALA I10.47	1.62	0.11	0.1575	0.0057	0.073	0.0039	941	31	1016	94	137	2.675	1016	94
	19ALA I10.48	2.083	0.091	0.1854	0.0073	0.0807	0.0011	1093	41	1207	28	533	2.11	1207	28
	19ALA I10.49	1.747	0.039	0.17	0.0023	0.0749	0.002	1012	12	1039	52	190.3	2.952	1039	52
	19ALA I10.50	1.593	0.036	0.1635	0.0024	0.071	0.0017	976	13	932	51	189	3.764	932	51
	19ALA I10.51	1.835	0.064	0.175	0.0026	0.0757	0.0029	1039	14	1048	79	85	1.197	1048	79
	19ALA I10.52	1.924	0.05	0.1796	0.0028	0.0777	0.002	1064	15	1123	47	188	2.96	1123	47
	19ALA I10.53	2.538	0.065	0.2223	0.0038	0.0829	0.0015	1293	20	1258	35	283	2.638	1258	35

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	19ALAI10.54	2.33	0.11	0.2039	0.0033	0.0829	0.0037	1196	17	1224	91	85.9	2.015	1224	91
	19ALAI10.55	2.564	0.077	0.1875	0.0033	0.0986	0.0021	1107	18	1582	40	313	0.654	1582	40
	19ALAI10.56	1.869	0.031	0.1847	0.0021	0.0731	0.0011	1092	12	1007	31	601	4.86	1007	31
	19ALAI10.57	2.107	0.058	0.1929	0.0031	0.0788	0.0021	1137	17	1138	52	185	1.963	1138	52
	19ALAI10.58	1.751	0.055	0.1496	0.0038	0.0851	0.0023	898	22	1299	53	530	1.444	1299	53
PGAL20	PGAL20.01	9.75	0.61	0.315	0.023	0.235	0.0057	1740	110	3070	39	1024	3.33	3070	39
	PGAL20.02	3.87	0.12	0.2619	0.0052	0.1082	0.0026	1498	27	1777	39	657	9.1	1777	39
	PGAL20.03	1.625	0.032	0.151	0.002	0.0789	0.0012	906	11	1160	31	917	3.59	1160	31
	PGAL20.04	2.142	0.047	0.1682	0.004	0.0936	0.0016	1001	22	1489	32	757	1.83	1489	32
	PGAL20.05	1.05	0.03	0.1116	0.0025	0.0847	0.0017	682	15	1295	39	626	6.11	1295	39
	PGAL20.06	2.061	0.054	0.1904	0.0036	0.0788	0.002	1123	20	1159	49	243	2.197	1159	49
	PGAL20.07	2.957	0.066	0.2199	0.0047	0.0979	0.0022	1280	25	1575	39	192.6	0.885	1575	39
	PGAL20.08	2.428	0.058	0.2099	0.0036	0.0843	0.0016	1227	19	1285	38	370	2.58	1285	38
	PGAL20.09	1.654	0.045	0.1533	0.0036	0.0764	0.0012	919	20	1095	31	2070	9.14	1095	31
	PGAL20.10	2.443	0.044	0.2075	0.0029	0.0849	0.0012	1215	15	1304	28	883	7.41	1304	28
	PGAL20.11	2.192	0.048	0.195	0.003	0.081	0.0017	1148	16	1209	42	635	7.6	1209	42
	PGAL20.12	1.665	0.04	0.1646	0.0027	0.0727	0.0017	982	15	984	47	389	3.88	984	47
	PGAL20.13	1.933	0.045	0.1725	0.0028	0.0803	0.0018	1025	16	1201	44	690	1.22	1201	44
	PGAL20.14	1.84	0.052	0.1452	0.008	0.0982	0.0047	870	46	1522	79	1810	1.368	1522	79
	PGAL20.15	1.604	0.046	0.1385	0.0026	0.0831	0.0021	835	15	1246	49	490	1.167	1246	49
	PGAL20.16	2.209	0.073	0.15	0.0076	0.1105	0.0066	897	43	1746	96	287	1.057	1746	96
	PGAL20.17	1.664	0.04	0.1627	0.0029	0.0731	0.0014	971	16	1007	37	572	2.629	1007	37
	PGAL20.18	1.624	0.034	0.14	0.004	0.0837	0.0021	843	23	1270	49	910	3.17	1270	49
	PGAL2	2.868	0.078	0.2259	0.0052	0.0913	0.0015	1311	27	1442	33	701	14.9	1442	33

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	0.19														
	PGAL20.20	2.088	0.076	0.1646	0.0031	0.0906	0.0026	981	17	1409	56	510	1.937	1409	56
	PGAL20.21	1.642	0.032	0.1313	0.0019	0.0895	0.0016	795	11	1407	35	821	1.243	1407	35
	PGAL20.22	2.117	0.075	0.1886	0.0059	0.0807	0.0019	1112	32	1194	46	651	7.1	1194	46
	PGAL20.23	0.923	0.048	0.103	0.011	0.0704	0.0044	600	34	850	120	96.2	4.51	850	120
	PGAL20.24	2.596	0.054	0.2146	0.0033	0.0873	0.0017	1253	18	1358	37	433	1.862	1358	37
	PGAL20.25	1.876	0.034	0.1743	0.0033	0.0783	0.0014	1035	18	1141	36	907	3.95	1141	36
	PGAL20.26	1.961	0.053	0.1465	0.0047	0.0981	0.0025	880	27	1565	50	1045	1.157	1565	50
	PGAL20.27	1.908	0.087	0.1782	0.0041	0.0785	0.0037	1056	22	1080	100	66.8	2.582	1080	100
	PGAL20.28	0.51	0.011	0.0593	0.0011	0.0627	0.0011	371.6	6.5	684	38	3880	28.1	684	38
	PGAL20.29	1.893	0.05	0.179	0.0026	0.0768	0.0017	1061	14	1096	46	310.8	3.86	1096	46
	PGAL20.30	1.952	0.069	0.1752	0.0046	0.0791	0.0024	1051	25	1167	51	394	22	1167	51
	PGAL20.31	1.743	0.045	0.1659	0.003	0.0763	0.0013	989	17	1089	36	712	4.188	1089	36
	PGAL20.32	2.438	0.094	0.2067	0.0042	0.0859	0.0027	1214	24	1342	60	228	1.84	1342	60
	PGAL20.33	1.818	0.053	0.1766	0.0033	0.0743	0.0017	1048	18	1042	47	387	4.519	1042	47
	PGAL20.34	1.858	0.034	0.1546	0.0027	0.0862	0.0015	926	15	1332	34	1806	2.76	1332	34
	PGAL20.35	1.824	0.033	0.1586	0.0024	0.0824	0.0012	948	13	1246	28	1442	2.779	1246	28
	PGAL20.36	2.188	0.068	0.1953	0.0031	0.0793	0.0015	1154	15	1175	34	1002	81.2	1175	34
	PGAL20.37	1.848	0.043	0.1688	0.0032	0.0778	0.0013	1008	17	1132	32	1858	21.4	1132	32
	PGAL20.38	1.466	0.047	0.1488	0.0029	0.0705	0.0022	894	16	913	64	306	1.731	913	64
	PGAL20.39	1.917	0.056	0.1662	0.0032	0.0811	0.002	990	17	1209	47	433	2.3	1209	47
	PGAL20.40	2.029	0.051	0.1805	0.0032	0.0792	0.0012	1069	17	1167	31	1124	1.859	1167	31
	PGAL20.41	1.777	0.071	0.0787	0.0042	0.1631	0.0064	487	25	2443	65	3110	0.486	2443	65
	PGAL20.42	1.878	0.068	0.1602	0.0052	0.0832	0.0031	961	30	1231	64	729	3.21	1231	64

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	PGAL20.43	1.63	0.041	0.1244	0.0021	0.0926	0.0018	755	12	1473	35	836	1.398	1473	35
	PGAL20.44	1.579	0.066	0.1511	0.0044	0.0734	0.0024	906	25	983	67	267	1.467	983	67
	PGAL20.45	2.143	0.078	0.166	0.0041	0.0908	0.0023	989	23	1425	50	355	1.569	1425	50
	PGAL20.46	2.021	0.036	0.1846	0.003	0.0761	0.0012	1091	16	1087	32	1016	7.52	1087	32
	PGAL20.47	2.53	0.11	0.1204	0.0088	0.169	0.014	727	50	2350	140	1650	1.46	2350	140
	PGAL20.48	2.51	0.15	0.1759	0.0039	0.104	0.005	1044	21	1657	86	155.8	1.096	1657	86
	PGAL20.49	1.622	0.051	0.1284	0.0038	0.0944	0.003	778	22	1486	63	680	1.929	1486	63
	PGAL20.50	2.213	0.047	0.1817	0.0034	0.0906	0.0017	1076	18	1424	37	839	1.616	1424	37
	PGAL20.51	2.162	0.046	0.1988	0.0037	0.0812	0.0015	1168	20	1212	36	1020	4.66	1212	36
	PGAL20.52	1.661	0.035	0.1352	0.0035	0.0938	0.0023	817	20	1487	47	1223	0.947	1487	47
	PGAL20.53	1.669	0.045	0.1635	0.0027	0.0773	0.0018	976	15	1114	49	314.5	3.61	1114	49
	PGAL20.54	2.308	0.052	0.1896	0.0058	0.0948	0.0029	1117	32	1505	57	1241	1.769	1505	57
	PGAL20.56	1.466	0.048	0.1496	0.0045	0.0764	0.0016	897	25	1089	42	1237	7.94	1089	42
	PGAL20.57	2.014	0.061	0.1991	0.0036	0.0807	0.0027	1170	19	1157	49	312	3.39	1157	49
	PGAL20.58	1.811	0.046	0.1785	0.0026	0.0796	0.0015	1058	14	1172	37	518	2.539	1172	37
	PGAL20.59	1.884	0.075	0.1835	0.0049	0.0813	0.003	1084	27	1201	71	129.4	0.976	1201	71
	PGAL20.60	1.29	0.1	0.1126	0.0095	0.0915	0.0025	681	54	1445	50	1340	0.558	1445	50
	PGAL20.61	1.486	0.032	0.1434	0.0019	0.0829	0.0015	863	11	1254	37	1164	3.7	1254	37
	PGAL20.62	1.931	0.049	0.1884	0.0039	0.0812	0.0016	1112	21	1209	40	1075	36.4	1209	40
	PGAL20.63	2.169	0.07	0.1841	0.0051	0.0932	0.003	1087	28	1478	55	414	2.689	1478	55
	PGAL20.64	2.107	0.079	0.1809	0.0058	0.0916	0.0026	1075	33	1438	53	373	0.953	1438	53
	PGAL20.65	1.365	0.045	0.1019	0.002	0.1034	0.0021	625	12	1672	37	1760	1.317	1672	37
	PGAL20.66	1.849	0.047	0.1749	0.0041	0.0827	0.0013	1038	22	1254	30	1020	2.466	1254	30
	PGAL2	2.814	0.097	0.2229	0.0044	0.0968	0.0021	1296	23	1558	43	870	2.289	1558	43

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	0.67														
	PGAL20.68	1.567	0.06	0.144	0.0028	0.0835	0.0031	867	16	1247	72	276	2.094	1247	72
	PGAL20.69	1.806	0.052	0.1785	0.0036	0.0776	0.0012	1058	20	1126	31	1133	2.916	1126	31
	PGAL20.70	35.1	9.5	0.544	0.099	0.276	0.046	2530	360	2560	280	395	3.86	2560	280
	PGAL20.71	1.682	0.05	0.155	0.0031	0.0828	0.0025	928	17	1242	55	307	3.48	1242	55
	PGAL20.72	1.77	0.045	0.1644	0.0035	0.0813	0.0017	980	19	1212	41	734	5.12	1212	41
	PGAL20.73	1.919	0.044	0.1781	0.0033	0.081	0.0014	1056	18	1215	36	832	1.852	1215	36
	PGAL20.74	1.335	0.039	0.1308	0.0045	0.0765	0.0015	795	25	1097	41	1034	3.92	1097	41
19ALAI57	S57.02	1.285	0.071	0.1334	0.0039	0.0714	0.0038	807	22	930	110	115	0.885	807	22
	S57.08	1.663	0.08	0.1688	0.0058	0.0741	0.0032	1004	32	1029	92	211	0.908	1004	32
	S57.03	0.612	0.016	0.0783	0.0015	0.0567	0.0016	485.6	9	453	60	700	1.114	485.6	9
	S57.04	0.506	0.012	0.0629	0.0012	0.058	0.0013	393.3	7	520	49	807	1.16	393.3	7
	S57.06	3.17	0.11	0.2419	0.0076	0.0948	0.0015	1394	40	1516	30	315	1.43	1516	30
	S57.16	1.458	0.064	0.1508	0.0041	0.0701	0.0032	905	23	929	83	61	1.653	905	23
	S57.05	2.26	0.13	0.1917	0.0061	0.0847	0.0035	1129	33	1354	71	379	1.95	1129	33
	S57.15	1.532	0.044	0.1481	0.0029	0.0749	0.0017	890	16	1050	45	318	2.13	890	16
	S57.09	2.12	0.08	0.195	0.0039	0.0806	0.003	1148	21	1223	53	198	2.24	1148	21
	S57.07	2.017	0.086	0.1777	0.0069	0.0814	0.0013	1052	38	1227	34	587	3.85	1052	38
	S57.12	0.994	0.064	0.1078	0.0039	0.073	0.011	667	20	790	150	161	4.2	667	20
	S57.11	0.557	0.023	0.0679	0.0023	0.0595	0.0025	423	14	539	81	563	5.82	423	14
	S57.10	1.45	0.024	0.1441	0.0023	0.0734	0.0013	868	13	1014	37	602	6.17	868	13
	S57.08	0.46	0.024	0.0506	0.0021	0.0638	0.0023	318	13	719	78	670	10	318	13
	S57.02	0.448	0.025	0.0567	0.0022	0.0565	0.0034	356	13	460	140	334	12.1	356	13
	S57.16	0.552	0.037	0.0624	0.0029	0.0616	0.0029	390	17	670	120	513	12.2	390	17
	S57.05	0.568	0.082	0.0615	0.0069	0.0645	0.0045	384	42	720	160	738	13.7	384	42
	S57.12	0.693	0.074	0.0579	0.002	0.082	0.0067	363	12	1190	130	590	26.3	363	12
19ALAI58	S58.65	1.68	0.15	0.1651	0.0048	0.0756	0.0065	984	27	1070	190	110	0.543	984	27

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	S58.32	0.631	0.012	0.06925	0.00087	0.0659	0.0014	431.6	5.2	786	45	1390	0.737	431.6	5.2
	S58.87	1.539	0.075	0.1302	0.003	0.0858	0.0037	789	17	1301	77	63.8	0.763	789	17
	S58.20	0.603	0.018	0.05802	0.00074	0.0697	0.0022	363.5	4.5	910	60	1295	0.964	363.5	4.5
	S58.28	1.42	0.22	0.1374	0.0052	0.0796	0.0099	829	29	1060	210	69	1.07	829	29
	S58.60	0.557	0.015	0.07249	0.00092	0.0555	0.0015	451.1	5.5	408	61	475	1.073	451.1	5.5
	S58.24	2.27	0.22	0.2107	0.0077	0.0787	0.0082	1231	41	1230	160	113	1.122	1231	41
	S58.79	2.037	0.093	0.1682	0.0054	0.0878	0.0044	1011	23	1353	97	145	1.286	1011	23
	S58.73	0.551	0.012	0.0692	0.001	0.058	0.0013	431.1	6.3	522	49	852	1.304	431.1	6.3
	S58.64	0.561	0.014	0.0696	0.0013	0.0585	0.0016	433.8	7.6	524	59	744	1.307	433.8	7.6
	S58.57	0.592	0.014	0.0719	0.0016	0.0598	0.0018	447.4	9.5	565	66	655	1.32	447.4	9.5
	S58.42	0.617	0.018	0.079	0.0013	0.0563	0.0016	489.8	7.7	438	63	650	1.334	489.8	7.7
	S58.66	2.56	0.11	0.1951	0.0077	0.0966	0.0023	1145	41	1542	44	219	1.344	1145	41
	S58.62	0.567	0.015	0.0728	0.0013	0.0567	0.0015	452.8	8	457	60	610	1.368	452.8	8
	S58.21	0.736	0.021	0.0814	0.0017	0.0654	0.0022	504	10	771	76	431	1.4	504	10
	S58.46	1.29	0.1	0.1253	0.007	0.0773	0.005	759	41	1050	140	124	1.41	759	41
	S58.08	0.513	0.016	0.0663	0.002	0.0563	0.002	414	12	427	77	544	1.424	414	12
	S58.49	3.06	0.12	0.2433	0.0099	0.0905	0.0031	1400	52	1412	89	322	1.425	1412	89
	S58.91	0.834	0.025	0.1001	0.0019	0.0606	0.0023	615	11	602	70	294	1.44	615	11
	S58.83	0.616	0.017	0.06445	0.00094	0.0689	0.002	402.5	5.7	873	64	390	1.5	402.5	5.7
	S58.92	0.548	0.012	0.06508	0.00082	0.061	0.0016	406.4	4.9	613	57	732	1.578	406.4	4.9
	S58.59	2.67	0.11	0.2198	0.0057	0.0879	0.0034	1278	30	1402	56	328	1.59	1402	56
	S58.40	1.912	0.08	0.188	0.01	0.0751	0.0034	1106	52	1000	110	139	1.601	1106	52
	S58.41	0.769	0.048	0.0587	0.0029	0.0985	0.0075	367	18	1450	130	244	1.72	367	18
	S58.44	0.759	0.043	0.0656	0.0011	0.0844	0.0055	409.7	6.4	1170	130	362	1.73	409.7	6.4
	S58.48	0.644	0.019	0.0639	0.0014	0.0732	0.0026	399.1	8.6	979	72	881	1.77	399.1	8.6
	S58.01	2.116	0.089	0.1831	0.0065	0.0835	0.0015	1081	36	1270	35	590	1.778	1081	36
	S58.18	0.746	0.044	0.0774	0.0022	0.0683	0.0028	480	13	854	84	1415	1.79	480	13
	S58.76	2.183	0.062	0.1846	0.0039	0.0857	0.0017	1092	21	1320	39	420	1.97	1092	21

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	S58.70	0.568	0.017	0.06633	0.00096	0.0627	0.0021	414	5.8	672	70	522	1.977	414	5.8
	S58.51	2.609	0.093	0.2147	0.0045	0.0895	0.0032	1253	24	1402	61	251	1.98	1402	61
	S58.53	0.521	0.01	0.05878	0.00098	0.0601	0.0015	368.1	5.9	592	54	1095	2.02	368.1	5.9
	S58.43	2.97	0.1	0.2154	0.0049	0.0917	0.0019	1257	26	1466	38	355	2.023	1466	38
	S58.37	2.283	0.078	0.1995	0.0056	0.0829	0.0018	1171	30	1252	42	312	2.044	1171	30
	S58.17	0.584	0.011	0.0728	0.0014	0.0578	0.0011	452.7	8.6	511	40	2200	2.088	452.7	8.6
	S58.74	1.75	0.065	0.1746	0.0041	0.0725	0.0021	1037	22	1000	51	130	2.146	1037	22
	S58.72	1.428	0.044	0.1475	0.0037	0.0692	0.0023	886	21	953	56	499	2.168	886	21
	S58.09	1.334	0.096	0.1336	0.0073	0.0723	0.0049	807	41	930	150	203	2.18	807	41
	S58.16	2.593	0.097	0.2114	0.0084	0.0905	0.0023	1234	45	1424	49	214	2.25	1234	45
	S58.34	3.106	0.071	0.236	0.0047	0.0957	0.0026	1365	24	1543	43	304	2.359	1543	43
	S58.82	1.031	0.022	0.1023	0.002	0.0731	0.0013	628	12	1004	37	751	2.38	628	12
	S58.07	1.989	0.065	0.192	0.01	0.0748	0.003	1127	52	1056	68	353	2.41	1127	52
	S58.93	1.367	0.066	0.136	0.0041	0.0734	0.0038	821	24	998	84	112	2.47	821	24
	S58.90	0.547	0.018	0.06864	0.00097	0.0578	0.002	427.9	5.8	496	80	284.1	2.5	427.9	5.8
	S58.61	0.518	0.014	0.06411	0.00085	0.0586	0.0018	400.5	5.1	532	63	707	2.53	400.5	5.1
	S58.69	0.51	0.011	0.0667	0.0013	0.0552	0.0011	416.4	7.7	413	45	1400	2.54	416.4	7.7
	S58.04	0.55	0.017	0.0668	0.0013	0.0591	0.0017	417	7.7	551	66	476	2.672	417	7.7
	S58.47	0.47	0.014	0.06184	0.00088	0.0554	0.0018	386.8	5.3	397	72	497	2.719	386.8	5.3
	S58.89	0.517	0.022	0.0665	0.0013	0.0564	0.0022	415.2	8	421	83	181	2.74	415.2	8
	S58.33	0.507	0.018	0.0657	0.0018	0.0559	0.002	410	11	425	81	443	2.79	410	11
	S58.81	1.671	0.057	0.1668	0.0041	0.0727	0.0022	993	23	976	64	102	2.84	993	23
	S58.45	0.545	0.011	0.0646	0.0011	0.0613	0.0013	403.4	6.7	633	47	1141	2.93	403.4	6.7
	S58.54	0.517	0.014	0.064	0.001	0.0588	0.0016	399.8	6.3	535	58	695	2.946	399.8	6.3
	S58.38	1.269	0.026	0.1351	0.0019	0.0678	0.0012	816	11	857	37	625	3.08	816	11
	S58.56	1.431	0.093	0.1435	0.0065	0.0701	0.0028	862	37	939	62	480	3.15	862	37
	S58.25	2.86	0.11	0.2283	0.0082	0.0912	0.0013	1322	44	1444	27	743	3.29	1444	27
	S58.27	3.7	0.11	0.2574	0.0076	0.1032	0.0011	1473	40	1678	21	739	3.29	1678	21

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	S58.14	0.573	0.017	0.0666	0.0011	0.0625	0.0019	415.4	6.9	659	64	698	3.39	415.4	6.9
	S58.58	1.195	0.074	0.1363	0.0065	0.064	0.0036	820	36	723	98	92	3.4	820	36
	S58.94	0.593	0.014	0.0527	0.001	0.0768	0.0022	331.1	6.3	1093	52	1102	3.56	331.1	6.3
	S58.36	1.91	0.11	0.1777	0.0081	0.0799	0.0042	1064	38	1150	100	84	3.77	1064	38
	S58.11	0.88	0.036	0.0937	0.0026	0.0687	0.0019	577	15	863	57	560	3.83	577	15
	S58.78	0.621	0.028	0.0742	0.0024	0.0612	0.0022	461	14	632	72	316	4.03	461	14
	S58.13	1.688	0.058	0.1496	0.0038	0.0822	0.0022	902	20	1232	54	488	4.1	902	20
	S58.95	0.894	0.026	0.0994	0.0022	0.0648	0.0012	610	13	761	39	468	4.3	610	13
	S58.75	1.179	0.059	0.1169	0.0047	0.0728	0.0019	711	27	1005	53	302	4.48	711	27
	S58.23	1.409	0.052	0.1382	0.0051	0.0736	0.0012	833	30	1028	36	605	4.77	833	30
	S58.71	0.963	0.022	0.0905	0.0021	0.0722	0.0012	558	13	981	33	1133	4.88	558	13
	S58.80	1.422	0.047	0.1443	0.0038	0.0714	0.0016	868	22	953	46	199.7	4.89	868	22
	S58.19	1.2	0.025	0.1215	0.0021	0.072	0.0013	739	12	973	38	674	4.98	739	12
	S58.35	0.588	0.071	0.0643	0.0022	0.0632	0.0052	401	13	580	110	485	5	401	13
	S58.84	0.736	0.04	0.0709	0.0029	0.0754	0.0038	441	18	1050	110	290	5	441	18
	S58.30	0.527	0.015	0.0624	0.0015	0.0616	0.0016	390.1	9.2	637	57	918	5.01	390.1	9.2
	S58.63	1.153	0.033	0.0914	0.0027	0.092	0.0024	564	16	1448	49	397	5.07	564	16
	S58.31	1.93	0.076	0.1804	0.0036	0.0793	0.003	1068	20	1145	74	123	5.157	1068	20
	S58.88	0.753	0.02	0.074	0.0016	0.0692	0.0015	459.9	9.4	889	44	775	5.38	459.9	9.4
	S58.86	0.612	0.018	0.0592	0.0018	0.074	0.0028	370	11	1000	74	390	5.43	370	11
	S58.85	0.553	0.012	0.0613	0.0013	0.0655	0.0015	383.6	7.7	780	46	884	6.1	383.6	7.7
	S58.39	1.336	0.056	0.1316	0.0044	0.0732	0.0025	796	25	999	65	196	6.17	796	25
	S58.12	0.663	0.024	0.06112	0.00096	0.0789	0.003	382.4	5.8	1138	78	920	6.42	382.4	5.8
	S58.68	2.43	0.14	0.191	0.0088	0.0917	0.002	1121	48	1451	43	274	6.6	1121	48
	S58.03	1.399	0.079	0.1164	0.0039	0.0851	0.0026	709	22	1288	57	831	6.69	709	22
	S58.10	0.506	0.016	0.0592	0.0012	0.0622	0.0019	370.4	7.3	646	68	554	6.8	370.4	7.3
	S58.22	1.496	0.068	0.153	0.0054	0.0709	0.0031	916	31	936	87	419	6.98	916	31
	S58.87	0.632	0.048	0.0494	0.0033	0.0941	0.0062	311	20	1470	130	482	7.64	311	20
	S58.05	0.441	0.018	0.0565	0.0013	0.0563	0.0023	354.2	8.2	435	89	858	7.78	354.2	8.2

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	S58.15	1.748	0.078	0.1517	0.0068	0.0834	0.0013	908	38	1271	32	1149	8.2	908	38
	S58.06	1.795	0.035	0.1731	0.0024	0.0751	0.0017	1029	13	1052	48	389	8.36	1029	13
	S58.31	1.126	0.079	0.0542	0.0059	0.15	0.011	340	36	2310	130	550	9.01	340	36
	S58.22	1.48	0.45	0.0588	0.0032	0.184	0.057	368	19	2270	500	285	10.72	368	19
	S58.72	0.609	0.057	0.0703	0.0052	0.0614	0.0048	438	31	630	190	520	11.4	438	31
	S58.29	1.54	0.12	0.1424	0.0098	0.0772	0.0023	862	57	1098	59	468	12	862	57
	S58.77	1.461	0.052	0.1445	0.0034	0.0739	0.0025	869	19	1004	66	131.1	12.32	869	19
	S58.05	0.991	0.047	0.0877	0.0022	0.0814	0.0027	542	13	1211	67	563	12.4	542	13
	S58.55	0.624	0.019	0.0621	0.00091	0.0655	0.0014	388.3	5.5	775	44	1274	12.8	388.3	5.5
	S58.68	0.807	0.078	0.0709	0.004	0.0782	0.0038	441	24	1134	96	470	14.15	441	24
	S58.03	0.901	0.027	0.0892	0.0016	0.0721	0.0021	550.6	9.6	977	60	1382	14.19	550.6	9.6
	S58.46	0.455	0.02	0.0596	0.0023	0.0543	0.0021	373	14	373	89	495	14.5	373	14
	S58.02	0.509	0.024	0.0487	0.0013	0.0704	0.0043	306.3	8	870	100	850	16.6	306.3	8
	S58.43	0.508	0.084	0.0439	0.003	0.081	0.015	277	18	1100	300	171	16.8	277	18
	S58.58	0.612	0.031	0.0589	0.0022	0.0744	0.0049	369	13	1020	130	790	19	369	13
	S58.59	0.514	0.056	0.0499	0.0034	0.0685	0.0093	314	21	870	330	183	19.1	314	21
	S58.16	1.13	0.23	0.0596	0.0038	0.143	0.028	373	23	2120	270	430	24.1	373	23
	S58.51	1.06	0.28	0.05	0.0025	0.144	0.033	315	15	2200	410	366	24.7	315	15
	S58.81	0.831	0.084	0.0679	0.0058	0.098	0.021	423	35	1400	370	110	24.8	423	35
	S58.65	0.691	0.069	0.0573	0.0029	0.0844	0.0057	359	18	1220	140	3040	29.4	359	18
	S58.66	0.96	0.2	0.0632	0.0033	0.107	0.02	395	20	1630	300	413	30	395	20
	S58.79	1.09	0.19	0.0658	0.0023	0.118	0.021	411	14	1800	280	392	30.1	411	14
	S58.09	0.488	0.028	0.0564	0.0011	0.0611	0.0034	353.8	6.7	640	130	903	30.3	353.8	6.7
	S58.93	1.17	0.37	0.0626	0.0035	0.129	0.035	391	21	1720	410	188	31.5	391	21
	S58.40	0.504	0.093	0.0522	0.0028	0.068	0.01	328	17	780	310	208	32.8	328	17
	S58.07	0.553	0.041	0.0469	0.0014	0.0816	0.0064	295.6	8.9	1190	160	860	37.2	295.6	8.9
	S58.36	0.537	0.037	0.0457	0.0026	0.0801	0.0048	288	16	1210	130	710	38.9	288	16
	S58.28	0.541	0.066	0.0579	0.0013	0.0669	0.0086	362.7	8	670	220	477	42	362.7	8
	S58.24	0.42	0.027	0.0459	0.0023	0.0609	0.0036	289	14	630	140	360	42.1	289	14

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	S58.13	0.578	0.049	0.0535	0.0028	0.0769	0.0073	336	17	1080	180	836	42.6	336	17
	S58.56	0.426	0.019	0.0433	0.0019	0.0624	0.0022	273	12	672	76	1960	45.7	273	12
	S58.49	0.77	0.17	0.0539	0.0017	0.103	0.023	339	10	1460	330	217	49.1	339	10
	S58.74	0.569	0.045	0.0601	0.004	0.0666	0.0026	375	24	815	90	890	59	375	24
	S58.26	1.97	0.13	0.1752	0.007	0.0799	0.0026	1038	39	1161	66	710	60.7	1038	39
	S58.38	0.483	0.059	0.055	0.0034	0.0657	0.0062	345	20	750	210	94	84	345	20
19ALAI02	S2.01	0.411	0.011	0.04796	0.00063	0.0626	0.0018	302	3.9	667	62	888	0.644	302	3.9
	S2.24	6.4	0.16	0.2828	0.0059	0.1635	0.002	1604	30	2488	21	386	0.91	2488	21
	S2.07	2.483	0.038	0.2049	0.0021	0.0877	0.0013	1203	11	1370	28	495.8	1.249	1203	11
	S2.26	1.683	0.057	0.1663	0.003	0.0734	0.0027	991	17	992	81	154	1.276	991	17
	S2.15	1.785	0.089	0.1783	0.0053	0.0726	0.0023	1056	29	1021	73	222	1.38	1056	29
	S2.09	2.3	0.17	0.1927	0.0081	0.0866	0.0052	1135	44	1360	120	125	2.3	1135	44
	S2.10	3.63	0.15	0.264	0.01	0.0999	0.0023	1507	53	1621	46	322	2.36	1621	46
	S2.28	2.82	0.19	0.1965	0.007	0.1017	0.0039	1154	38	1622	73	414	2.82	1154	38
	S2.22	1.719	0.067	0.1504	0.0051	0.0831	0.0017	902	29	1257	42	429	2.97	902	29
	S2.21	0.867	0.052	0.0913	0.0042	0.0679	0.0018	562	25	840	57	498	3.08	562	25
	S2.02	1.525	0.039	0.1355	0.0031	0.0814	0.0016	819	18	1225	37	473	3.23	819	18
	S2.23	1.451	0.062	0.1365	0.0034	0.0726	0.0047	824	19	1110	110	367	3.5	824	19
	S2.18	1.049	0.046	0.1084	0.003	0.0709	0.003	663	17	908	87	102.8	3.56	663	17
	S2.19	1.047	0.041	0.1067	0.0031	0.071	0.0026	653	18	925	75	392	4.14	653	18
	S2.14	0.789	0.02	0.0801	0.0014	0.071	0.0013	496.6	8.1	946	37	862	5.42	496.6	8.1
	S2.05	1.185	0.055	0.1209	0.0053	0.0729	0.0042	735	31	1010	110	575	5.86	735	31
	S2.03	0.484	0.017	0.0606	0.0012	0.0578	0.0017	379.5	7.4	490	67	385.7	5.9	379.5	7.4
	S2.06	1.802	0.084	0.1666	0.0086	0.0778	0.0022	989	47	1148	59	251	8.1	989	47
	S2.09	0.545	0.052	0.0592	0.0035	0.0649	0.0047	371	21	730	160	246.1	9.6	371	21
	S2.27	1.08	0.1	0.1044	0.0078	0.0734	0.0029	636	46	972	86	326	10.8	636	46
	S2.11	1.152	0.021	0.1129	0.0019	0.07402	0.00099	689	11	1040	26	830	12.23	689	11
	S2.20	1.05	0.12	0.0986	0.009	0.0716	0.0029	601	52	918	88	520	12.8	601	52

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge 206_238	FinalAge206_238_Int2SE	FinalAge 207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	S2.04	1.46	0.11	0.1444	0.0052	0.0753	0.0049	879	29	1090	120	50.4	13.25	879	29
	S2.16	1.111	0.057	0.0832	0.0024	0.0954	0.0032	515	14	1534	68	276	14.4	515	14
	S2.23	0.54	0.035	0.0599	0.0031	0.0638	0.0029	375	19	721	91	487	14.6	375	19
	S2.19	0.419	0.029	0.0539	0.0024	0.0557	0.0045	339	15	380	170	295	15.3	339	15
	S2.15	0.512	0.046	0.0545	0.0038	0.0662	0.0038	342	23	790	110	564	18.3	342	23
	S2.12	0.492	0.017	0.0597	0.0015	0.0595	0.0018	373.7	9.3	554	67	492	18.5	373.7	9.3
	S2.10	0.678	0.083	0.0635	0.0035	0.0751	0.0076	397	21	1040	210	234	26.8	397	21
	S2.08	0.574	0.033	0.0699	0.0026	0.059	0.0021	435	16	528	77	381	28.9	435	16
	S2.18	0.549	0.039	0.0576	0.0033	0.0665	0.0048	360	20	830	190	378	33.8	360	20
	S2.13	0.421	0.012	0.05264	0.00083	0.058	0.0017	330.7	5.1	498	66	393	58.9	330.7	5.1
	S2.04	0.521	0.052	0.0608	0.0039	0.0608	0.004	380	24	640	160	343	69	380	24
	S2.05	0.327	0.038	0.038	0.0025	0.0594	0.0065	240	16	540	250	138	69.1	240	16
	S2.29	0.422	0.015	0.05617	0.00096	0.0545	0.0021	352.2	5.8	354	83	378	91.2	352.2	5.8
19ALAI08	19ALAI08.01	0.558	0.056	0.0599	0.0023	0.0692	0.0072	375	14	820	190	520	38.3	375	14
	19ALAI08.01	1.689	0.043	0.1622	0.0031	0.0751	0.0017	969	17	1054	47	575	2.284	1054	47
	19ALAI08.02	0.534	0.017	0.0674	0.0012	0.058	0.0018	420.4	7.3	497	71	426	2.37	497	71
	19ALAI08.03	0.509	0.017	0.0634	0.0011	0.0583	0.0018	396.3	6.6	519	73	568	3.94	519	73
	19ALAI08.04	2.11	0.12	0.1715	0.008	0.0879	0.0018	1016	45	1383	37	563	1.81	1383	37
	19ALAI08.05	0.43	0.023	0.0582	0.001	0.0544	0.0032	364.4	6.1	300	120	227	8.1	300	120
	19ALAI08.06	0.558	0.019	0.0724	0.0019	0.0564	0.0015	450	11	440	60	677	6.6	440	60
	19ALAI08.07	0.479	0.028	0.0607	0.0012	0.0579	0.0037	379.8	7.5	450	130	183	4.65	450	130
	19ALAI08.08	0.77	0.045	0.0822	0.0039	0.068	0.0021	508	23	829	64	305	3.55	829	64
	19ALAI08.09	0.459	0.038	0.0566	0.0023	0.0628	0.0081	355	14	620	240	526	62	620	240
	19ALAI08.09	1.642	0.06	0.1709	0.0036	0.0702	0.0022	1016	20	910	60	210	5.02	910	60
	19ALAI08.10	0.587	0.018	0.0719	0.0015	0.0565	0.0016	447.7	9	440	61	675	1.257	440	61
	19ALA	0.461	0.014	0.0622	0.0013	0.0539	0.0014	388.6	7.7	343	57	516	7.7	343	57

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	I08.11														
	19ALAI08.12	0.789	0.023	0.0963	0.0018	0.0593	0.0015	592	11	567	60	401.5	1.671	567	60
	19ALAI08.13	0.66	0.072	0.0726	0.0081	0.0686	0.0069	450	49	800	200	397	24.9	800	200
	19ALAI08.13	1.615	0.089	0.1616	0.0044	0.0706	0.0034	964	25	905	74	172	3.2	905	74
	19ALAI08.14	2.11	0.18	0.1587	0.0077	0.0925	0.0049	945	44	1420	93	390	3.91	1420	93
	19ALAI08.15	0.891	0.069	0.0825	0.0042	0.085	0.012	511	25	1190	220	394	20	1190	220
	19ALAI08.15	2.01	0.14	0.1937	0.009	0.0767	0.0031	1136	48	1053	94	170	4.11	1053	94
	19ALAI08.16	0.744	0.023	0.0901	0.0021	0.0594	0.0012	556	12	575	47	540.7	11.78	575	47
	19ALAI08.17	0.73	0.031	0.0698	0.0025	0.0715	0.0011	434	15	961	32	1193	4.739	961	32
	19ALAI08.18	0.834	0.02	0.0873	0.0022	0.0694	0.0016	539	13	888	47	1221	9.42	888	47
	19ALAI08.19	2.132	0.094	0.1943	0.0066	0.0783	0.0015	1142	36	1152	35	426	3.41	1152	35
	19ALAI08.20	0.535	0.043	0.0683	0.0032	0.0569	0.004	425	19	440	150	291	39.9	440	150
	19ALAI08.20	1.67	0.18	0.1637	0.005	0.0722	0.0066	975	28	960	110	107	2.91	960	110
	19ALAI08.21	0.444	0.01	0.0586	0.001	0.0558	0.0015	367.1	6.3	434	59	1498	29.9	434	59
	19ALAI08.21	1.749	0.074	0.1623	0.0048	0.0729	0.0024	969	26	1019	70	377	2.411	1019	70
	19ALAI08.22	0.816	0.045	0.0922	0.0041	0.063	0.0018	567	24	674	63	393	5.22	674	63
	19ALAI08.23	0.631	0.019	0.0726	0.0012	0.0628	0.0019	451.6	7.2	671	66	485	1.335	671	66
	19ALAI08.24	0.429	0.023	0.0597	0.001	0.0515	0.0028	373.7	6.3	210	110	170.4	12.57	210	110
	19ALAI08.25	0.437	0.017	0.0602	0.0011	0.0527	0.002	376.9	6.4	290	87	312	36.4	290	87
	19ALAI08.25	1.03	0.17	0.1187	0.0078	0.0624	0.0083	721	44	540	300	98	3.34	540	300
	19ALAI08.26	0.492	0.049	0.0593	0.0031	0.0555	0.0054	371	19	390	210	413	23.9	390	210
	19ALAI08.26	2.19	0.11	0.2155	0.0041	0.0736	0.0032	1257	22	982	83	101	1.632	982	83
	19ALAI08.27	0.425	0.021	0.0549	0.0012	0.055	0.0026	344.1	7.5	380	100	203.9	2.207	380	100
	19ALAI08.28	1.208	0.02	0.1281	0.002	0.06809	0.00087	777	11	864	26	1137	4.67	864	26

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	19ALAI08.29	0.446	0.026	0.0614	0.0019	0.0535	0.003	384	11	320	120	315	23.1	320	120
	19ALAI08.29	1.294	0.094	0.1283	0.0052	0.0713	0.006	784	27	970	150	490	4.37	970	150
	19ALAI08.30	0.485	0.011	0.04236	0.00094	0.0843	0.0025	267.4	5.8	1271	60	968	9.71	1271	60
	19ALAI08.31	0.541	0.015	0.0703	0.0014	0.0565	0.0016	438.1	8.4	439	60	693	1.579	439	60
	19ALAI08.32	0.596	0.019	0.0741	0.0015	0.0585	0.0016	460.5	8.9	525	61	443	1.009	525	61
	19ALAI08.33	0.58	0.057	0.0687	0.0049	0.0601	0.0031	428	30	600	120	552	27.5	600	120
	19ALAI08.33	2.17	0.14	0.2055	0.0059	0.0752	0.0037	1203	31	1050	90	102	2.87	1050	90
	19ALAI08.34	0.437	0.016	0.05909	0.00076	0.0536	0.0019	370	4.6	324	77	430	15	324	77
	19ALAI08.35	0.438	0.021	0.058	0.001	0.0565	0.0027	363.6	6.1	430	100	493	78.9	430	100
	19ALAI08.35	1.91	0.14	0.1768	0.0078	0.076	0.004	1047	43	1070	110	108	3.01	1070	110
	19ALAI08.36	0.506	0.033	0.0633	0.0024	0.0582	0.0033	395	14	530	140	252	22.3	530	140
	19ALAI08.36	1.632	0.092	0.1634	0.0067	0.0714	0.0019	973	37	954	57	354	17.2	954	57
	19ALAI08.37	1.03	0.12	0.0708	0.0022	0.104	0.011	441	13	1350	190	64.6	7.43	1350	190
	19ALAI08.38	0.491	0.017	0.0567	0.0013	0.0642	0.0026	355.1	7.7	691	89	275	10.42	691	89
	19ALAI08.39	2.66	0.18	0.214	0.012	0.0879	0.0019	1242	67	1367	43	306	2.63	1367	43
	19ALAI08.40	0.5	0.019	0.0639	0.0016	0.0581	0.0022	399	9.4	478	80	310	27.3	478	80
	19ALAI08.41	0.542	0.018	0.0662	0.0013	0.0597	0.0022	413.2	7.7	556	77	244.7	1.632	556	77
	19ALAI08.42	0.848	0.083	0.0638	0.0037	0.097	0.011	398	22	1470	230	178	12	1470	230
	19ALAI08.42	1.4	0.1	0.1438	0.0052	0.0715	0.005	864	29	900	180	167	1.6	900	180
	19ALAI08.43	1.393	0.08	0.1251	0.0057	0.0811	0.0025	757	32	1186	64	138.1	3.42	1186	64
	19ALAI08.44	0.644	0.045	0.0709	0.0036	0.0673	0.003	441	21	815	88	408	20	815	88
	19ALAI08.44	1.98	0.11	0.1676	0.0062	0.0846	0.0037	997	34	1250	100	121	3.12	1250	100
	19ALAI08.45	0.574	0.025	0.0588	0.001	0.0682	0.0033	368.4	6.3	823	95	493	2.52	823	95
	19ALA	0.512	0.024	0.0635	0.0014	0.0586	0.0022	396.8	8.2	496	81	279	8	496	81

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	I08.46														
	19ALA I08.47	0.573	0.025	0.0649	0.0026	0.0638	0.0016	405	16	707	55	633	9.19	707	55
	19ALA I08.48	0.566	0.041	0.0615	0.0019	0.0669	0.0045	385	11	830	150	209	48.3	830	150
	19ALA I08.48	2.22	0.14	0.1873	0.0059	0.0835	0.0046	1105	32	1247	89	125	3.113	1247	89
	19ALA I08.49	0.587	0.011	0.0626	0.0022	0.0688	0.0022	391	13	871	64	1272	3.2	871	64
	19ALA I08.50	0.511	0.015	0.0619	0.0011	0.06	0.0019	387.1	6.6	562	66	398	7.1	562	66
	19ALA I08.51	0.499	0.034	0.0607	0.0024	0.0621	0.003	380	15	650	100	740	12.1	650	100
	19ALA I08.51	1.82	0.13	0.1675	0.0075	0.0774	0.0039	996	41	1077	98	90.4	1.39	1077	98
	19ALA I08.52	1.776	0.09	0.1742	0.0065	0.0733	0.002	1032	36	994	55	149	9.4	994	55
	19ALA I08.53	0.809	0.032	0.0936	0.0026	0.0623	0.0014	576	15	662	49	448.5	5.15	662	49
	19ALA I08.54	0.596	0.045	0.0707	0.0035	0.0616	0.0031	440	21	600	110	250	14.35	600	110
	19ALA I08.54	1.43	0.15	0.149	0.006	0.0679	0.007	894	33	860	190	43.2	4.4	860	190
	19ALA I08.55	0.445	0.017	0.05699	0.00084	0.0567	0.0021	357.3	5.1	419	70	314	15.11	419	70
	19ALA I08.56	1.531	0.061	0.1589	0.0039	0.0707	0.0019	950	22	920	55	157	2.73	920	55
	19ALA I08.57	0.514	0.04	0.0608	0.0018	0.0618	0.0047	380	11	620	170	190	27.8	620	170
	19ALA I08.57	2.01	0.19	0.1802	0.0078	0.0795	0.0078	1066	43	1150	180	105	2.242	1150	180
	19ALA I08.58	2.12	0.1	0.1979	0.0067	0.0763	0.0017	1161	36	1089	46	343	6.9	1089	46
	19ALA I08.59	0.406	0.016	0.0545	0.0011	0.0541	0.0021	342.2	6.7	326	86	256	3.39	326	86
	19ALA I08.60	1.249	0.056	0.1339	0.0037	0.0676	0.0023	809	21	831	70	128	1.85	831	70
	19ALA I08.61	0.425	0.013	0.05993	0.00091	0.0519	0.0017	375.1	5.5	262	72	340	13.1	262	72
	19ALA I08.62	0.614	0.047	0.0735	0.0031	0.0617	0.0034	457	19	630	130	252	14.6	630	130
	19ALA I08.62	1.61	0.073	0.1694	0.005	0.0682	0.0031	1007	27	849	97	67	2.32	849	97
	19ALA I08.63	1.69	0.11	0.1596	0.0081	0.075	0.002	950	46	1036	59	333	3.23	1036	59
	19ALA I08.64	0.648	0.035	0.0689	0.0023	0.0673	0.0018	429	14	833	58	532	7.48	833	58

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	19ALAI08.65	0.678	0.053	0.085	0.004	0.0566	0.0025	525	24	422	96	213	1.54	422	96
	19ALAI08.66	0.552	0.018	0.0724	0.0014	0.0556	0.0015	450.4	8.7	407	60	500	1.51	407	60
	19ALAI08.67	0.421	0.02	0.0577	0.0011	0.0536	0.0028	361.5	6.9	290	110	156	4.46	290	110
	19ALAI08.68	0.481	0.014	0.05879	0.00096	0.0594	0.0016	368.2	5.9	551	60	495.4	11	551	60
	19ALAI08.69	0.942	0.04	0.1023	0.004	0.0674	0.0015	627	24	837	47	622	13.03	837	47
	19ALAI08.70	2.732	0.044	0.2202	0.0028	0.0902	0.0011	1282	15	1427	23	592	7.54	1427	23
	19ALAI08.71	0.424	0.015	0.0562	0.001	0.0547	0.002	352.2	6.3	366	80	391.4	3.77	366	80
	19ALAI08.72	0.483	0.019	0.0584	0.0011	0.0599	0.0023	366.1	6.7	549	86	262.3	8.2	549	86
	19ALAI08.73	1.9	0.16	0.167	0.012	0.0792	0.0024	987	65	1158	66	326	5.3	1158	66
	19ALAI08.74	1.098	0.059	0.0985	0.0034	0.0814	0.0023	605	20	1214	58	654	7.61	1214	58
	19ALAI08.74	3.17	0.28	0.2516	0.0087	0.0909	0.0056	1444	45	1480	120	156	4.66	1480	120
	19ALAI08.75	1.507	0.091	0.1486	0.009	0.0747	0.0022	887	52	1026	59	387	6.6	1026	59
CS198	CS198.35	0.685	0.039	0.0712	0.0035	0.0657	0.002	443	21	784	65	870	0.209	784	65
	CS198.103	1.523	0.042	0.1389	0.0038	0.0801	0.0023	837	21	1168	58	245	0.601	1168	58
	CS198.71	0.806	0.022	0.097	0.0019	0.061	0.0014	596	11	629	46	725	0.7413	629	46
	CS198.111	1.181	0.053	0.1136	0.0033	0.0763	0.0026	693	19	1054	71	192.3	0.783	1054	71
	CS198.49	2.874	0.077	0.2087	0.0048	0.1001	0.0017	1220	26	1616	31	490	0.875	1616	31
	CS198.67	1.703	0.082	0.1663	0.0041	0.0759	0.0032	990	23	1045	92	50.3	0.953	1045	92
	CS198.75	1.478	0.031	0.1329	0.0042	0.0843	0.0026	803	24	1265	57	839	0.97	1265	57
	CS198.16	2.662	0.091	0.2183	0.0046	0.0894	0.0015	1271	24	1402	31	500	0.984	1402	31
	CS198.35	1.63	0.13	0.1611	0.009	0.0753	0.0054	958	49	930	150	48.4	1.02	930	150
	CS198.07	1.472	0.07	0.1541	0.0036	0.0698	0.0034	923	20	870	100	74	1.065	870	100
	CS198.93	1.553	0.045	0.1381	0.0031	0.0796	0.0018	833	18	1172	45	699	1.076	1172	45
	CS198.	1.321	0.032	0.1033	0.0039	0.0928	0.0017	633	23	1476	36	2150	1.115	1476	36

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge 206_238	FinalAge206_238_Int2SE	FinalAge 207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	51														
	CS198.38	1.652	0.037	0.1605	0.003	0.0754	0.0012	959	17	1070	31	963	1.28	1070	31
	CS198.98	1.656	0.053	0.1545	0.0033	0.075	0.0015	926	18	1059	40	556	1.349	1059	40
	CS198.08	1.704	0.062	0.1673	0.0037	0.0749	0.0034	996	21	1008	66	147	1.429	1008	66
	CS198.32	2.22	0.057	0.1994	0.0037	0.081	0.0016	1171	20	1221	42	237	1.438	1221	42
	CS198.02	2.478	0.065	0.2109	0.0038	0.0859	0.0016	1233	20	1321	37	355	1.45	1321	37
	CS198.15	4.91	0.18	0.3045	0.0069	0.1184	0.0034	1721	34	1903	55	91.1	1.45	1903	55
	CS198.62	1.737	0.054	0.1636	0.0038	0.0786	0.0015	976	21	1149	36	354	1.51	1149	36
	CS198.17	1.77	0.096	0.1764	0.004	0.0752	0.0045	1046	22	956	94	59.7	1.532	956	94
	CS198.28	1.64	0.066	0.1687	0.0034	0.0727	0.0028	1004	19	946	81	92.6	1.562	946	81
	CS198.72	1.963	0.068	0.1683	0.0046	0.0844	0.003	1005	25	1277	65	407	1.578	1277	65
	CS198.03	2.089	0.068	0.1959	0.0035	0.0783	0.0021	1153	19	1133	55	189	1.581	1133	55
	CS198.97	2.913	0.076	0.2371	0.0039	0.0872	0.0019	1371	21	1348	42	331	1.63	1348	42
	CS198.34	5.81	0.14	0.3488	0.0066	0.1226	0.003	1927	31	1976	43	86.7	1.688	1976	43
	CS198.56	2.19	0.045	0.2001	0.0029	0.08	0.0011	1175	15	1188	28	559	1.69	1188	28
	CS198.33	3.36	0.1	0.2449	0.0066	0.1009	0.0017	1410	34	1631	31	343	1.695	1631	31
	CS198.95	2.647	0.065	0.2161	0.0035	0.0867	0.0017	1260	18	1340	38	371	1.696	1340	38
	CS198.09	2.191	0.072	0.1973	0.0049	0.0791	0.0019	1159	26	1157	50	350	1.71	1157	50
	CS198.73	1.928	0.06	0.1913	0.0039	0.0749	0.0024	1127	21	1028	64	147.5	1.713	1028	64
	CS198.104	2.867	0.065	0.227	0.004	0.0917	0.0017	1318	21	1455	33	331.8	1.729	1455	33
	CS198.13	3.844	0.094	0.2816	0.005	0.1002	0.0019	1598	25	1620	35	205.6	1.74	1620	35
	CS198.54	1.616	0.073	0.1572	0.0044	0.0761	0.0027	940	24	1054	77	135	1.74	1054	77
	CS198.10	2.53	0.11	0.1887	0.0038	0.0994	0.0039	1113	20	1573	68	238.9	1.771	1573	68
	CS198.92	2.02	0.065	0.1837	0.0038	0.0777	0.0019	1086	21	1124	47	289.8	1.789	1124	47

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	CS198.18	2.459	0.043	0.2137	0.003	0.0854	0.0014	1248	16	1313	31	617	1.79	1313	31
	CS198.21	1.755	0.088	0.1691	0.0042	0.0765	0.0036	1006	23	1051	89	61.6	1.797	1051	89
	CS198.40	2.67	0.15	0.2127	0.0036	0.0907	0.005	1242	19	1393	88	430	1.8	1393	88
	CS198.107	2.804	0.069	0.2267	0.0048	0.0901	0.0016	1316	25	1416	34	770	1.81	1416	34
	CS198.42	3.06	0.21	0.264	0.016	0.0866	0.0053	1497	77	1270	130	35.4	1.81	1270	130
	CS198.48	2.497	0.088	0.2165	0.0054	0.0838	0.0028	1271	23	1254	69	102	1.811	1254	69
	CS198.20	1.518	0.03	0.146	0.0041	0.0773	0.0015	877	23	1120	39	643	1.82	1120	39
	CS198.66	1.686	0.043	0.1632	0.0023	0.0773	0.0018	974	13	1114	49	429	1.863	1114	49
	CS198.53	2.579	0.048	0.221	0.003	0.085	0.0012	1286	16	1307	27	700	1.905	1307	27
	CS198.01	2.51	0.056	0.22	0.0031	0.0837	0.0014	1281	16	1274	32	378	1.91	1274	32
	CS198.25	2.528	0.064	0.2112	0.0043	0.0885	0.0016	1237	22	1386	34	695	1.96	1386	34
	CS198.63	3.006	0.098	0.241	0.0047	0.0923	0.0029	1391	24	1444	62	66.5	2.016	1444	62
	CS198.60	1.465	0.03	0.1419	0.0021	0.0765	0.0013	855	12	1105	35	772	2.06	1105	35
	CS198.85	3.18	0.1	0.2309	0.0035	0.0981	0.0024	1339	18	1567	45	477	2.077	1567	45
	CS198.99	2.397	0.073	0.2035	0.0043	0.0836	0.002	1193	23	1269	47	234	2.08	1269	47
	CS198.79	1.998	0.039	0.1863	0.0028	0.0781	0.0011	1103	15	1142	29	890	2.12	1142	29
	CS198.58	1.581	0.063	0.1455	0.006	0.0802	0.0012	873	33	1197	28	2149	2.15	1197	28
	CS198.11	1.842	0.056	0.1811	0.0034	0.0757	0.0022	1072	19	1078	56	184	2.171	1078	56
	CS198.82	3.014	0.087	0.2386	0.0044	0.0912	0.0021	1378	23	1430	45	154.6	2.181	1430	45
	CS198.29	2.479	0.075	0.1853	0.0062	0.0988	0.002	1093	34	1592	39	1007	2.226	1592	39
	CS198.86	2.263	0.089	0.2038	0.0049	0.0796	0.0029	1194	27	1137	75	119	2.24	1137	75
	CS198.68	1.515	0.063	0.1569	0.0037	0.0721	0.0031	939	20	925	93	88.6	2.245	925	93
	CS198.37	0.935	0.046	0.0789	0.0051	0.0878	0.0018	488	30	1374	40	2340	2.391	1374	40
	CS198.	2.565	0.094	0.2055	0.0063	0.0919	0.0017	1202	34	1452	36	445	2.41	1452	36

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	45														
	CS198.108	1.919	0.058	0.1808	0.0033	0.0772	0.0019	1071	18	1112	53	234.1	2.426	1112	53
	CS198.31	2.736	0.065	0.2266	0.0044	0.0887	0.0017	1316	23	1388	37	479	2.49	1388	37
	CS198.65	3.073	0.071	0.2369	0.0045	0.0955	0.002	1373	24	1528	39	490	2.66	1528	39
	CS198.59	6.78	0.21	0.3583	0.0067	0.1395	0.0036	1972	32	2199	47	298	2.664	2199	47
	CS198.50	1.93	0.049	0.1821	0.0035	0.0775	0.0014	1078	19	1119	37	510	2.741	1119	37
	CS198.23	1.619	0.064	0.1624	0.0036	0.0735	0.0027	969	20	996	75	104	2.756	996	75
	CS198.90	2.575	0.071	0.2137	0.0039	0.0862	0.0022	1247	21	1320	49	216.2	2.81	1320	49
	CS198.76	1.813	0.055	0.174	0.0038	0.0768	0.0025	1033	21	1084	63	140.8	2.822	1084	63
	CS198.100	1.675	0.038	0.1645	0.0028	0.0728	0.0012	981	16	995	35	529	2.833	995	35
	CS198.109	1.702	0.029	0.1631	0.0024	0.0766	0.0012	974	14	1101	32	893	2.9	1101	32
	CS198.06	1.767	0.056	0.1755	0.0028	0.0738	0.0021	1042	15	1002	59	129.5	2.93	1002	59
	CS198.12	2.312	0.061	0.2071	0.0036	0.0811	0.0015	1216	21	1218	34	502	2.93	1218	34
	CS198.36	2.052	0.068	0.1828	0.004	0.0819	0.0028	1081	22	1198	69	114.6	3.02	1198	69
	CS198.52	2.57	0.22	0.234	0.01	0.0807	0.0062	1351	52	1190	150	80	3.09	1190	150
	CS198.81	2.649	0.078	0.2143	0.0046	0.0896	0.0024	1254	25	1398	56	143.7	3.145	1398	56
	CS198.43	2.033	0.09	0.1886	0.0066	0.079	0.0024	1116	37	1131	65	154	3.22	1131	65
	CS198.88	1.974	0.05	0.1774	0.0042	0.0785	0.0015	1052	23	1151	39	1297	3.33	1151	39
	CS198.84	2.002	0.059	0.1838	0.0036	0.0779	0.0019	1087	20	1134	50	168.7	3.546	1134	50
	CS198.61	2.722	0.085	0.2267	0.006	0.0885	0.0019	1315	32	1380	42	592	3.57	1380	42
	CS198.47	1.606	0.036	0.1612	0.0024	0.0727	0.0011	963	13	995	31	751	3.66	995	31
	CS198.77	1.554	0.047	0.1563	0.0031	0.0723	0.0018	936	17	969	52	362.7	3.842	969	52
	CS198.27	1.867	0.047	0.1805	0.0034	0.0762	0.002	1069	19	1075	51	246	3.85	1075	51
	CS198.55	1.924	0.041	0.1815	0.0024	0.0781	0.0016	1075	13	1133	41	326	3.89	1133	41

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	CS198.41	1.919	0.04	0.1818	0.0023	0.0764	0.0014	1077	13	1092	35	442	3.99	1092	35
	CS198.39	2.181	0.056	0.1939	0.0042	0.0824	0.0015	1142	22	1247	34	678	4.01	1247	34
	CS198.64	2.295	0.08	0.1964	0.0038	0.0861	0.0022	1155	20	1316	49	292	4.01	1316	49
	CS198.44	1.684	0.03	0.1618	0.0021	0.0758	0.001	966	12	1082	27	1420	4.12	1082	27
	CS198.91	2.153	0.058	0.1935	0.0042	0.0791	0.002	1139	23	1158	47	255	4.12	1158	47
	CS198.74	2.069	0.063	0.1933	0.0051	0.0787	0.002	1137	27	1145	52	254	4.14	1145	52
	CS198.57	4.24	0.12	0.2951	0.0061	0.1045	0.002	1665	30	1698	37	232	4.32	1698	37
	CS198.96	2.248	0.06	0.1975	0.0033	0.0804	0.0017	1161	18	1189	43	237	4.33	1189	43
	CS198.04	3.337	0.092	0.2573	0.0053	0.0943	0.002	1474	27	1503	39	561	4.76	1503	39
	CS198.26	2.389	0.087	0.208	0.0047	0.0841	0.0026	1217	25	1259	62	232	4.78	1259	62
	CS198.70	1.996	0.062	0.1848	0.003	0.0795	0.002	1092	16	1159	52	236	4.79	1159	52
	CS198.46	1.635	0.034	0.1565	0.0027	0.0759	0.001	937	15	1083	27	1258	4.89	1083	27
	CS198.80	2.247	0.052	0.2074	0.0034	0.0762	0.0016	1214	18	1082	42	284	5.23	1082	42
	CS198.87	1.811	0.04	0.1681	0.003	0.0766	0.0012	1001	17	1102	31	816	5.45	1102	31
	CS198.94	2.283	0.044	0.2034	0.0029	0.0798	0.0016	1193	16	1176	41	352	5.66	1176	41
	CS198.22	1.784	0.041	0.1771	0.0031	0.0744	0.0012	1051	17	1042	32	882	6.272	1042	32
	CS198.101	2.096	0.05	0.1921	0.0037	0.0785	0.0019	1132	20	1138	47	345	6.5	1138	47
	CS198.52	0.966	0.069	0.0992	0.0044	0.0829	0.0019	609	26	1260	45	480	6.6	1260	45
	CS198.78	2.403	0.089	0.2117	0.0054	0.0829	0.0023	1236	29	1236	55	383	6.96	1236	55
	CS198.102	1.643	0.035	0.1598	0.0033	0.0742	0.0013	955	18	1034	37	630	7.15	1034	37
	CS198.24	2.004	0.053	0.19	0.0037	0.0781	0.0014	1121	20	1138	33	915	7.85	1138	33
	CS198.106	1.816	0.028	0.1684	0.0024	0.0779	0.001	1003	13	1144	26	1910	8.9	1144	26
	CS198.69	2.279	0.052	0.2033	0.0032	0.0824	0.0015	1193	17	1247	35	947	9.1	1247	35
	CS198.	1.735	0.029	0.1734	0.0021	0.0740	0.00092	1030	11	1036	26	1142	9.15	1036	26

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	19					5									
	CS198.105	1.683	0.041	0.1637	0.0029	0.0743	0.0015	977	16	1039	40	619	10.01	1039	40
	CS198.14	3.83	0.16	0.2662	0.0075	0.1055	0.0031	1518	39	1697	51	664	10.1	1697	51
	CS198.89	1.781	0.042	0.1717	0.003	0.0733	0.001	1021	17	1013	29	1280	14.2	1013	29
	CS198.30	1.986	0.044	0.1865	0.0033	0.0779	0.0012	1102	18	1139	33	653	14.46	1139	33
	CS198.83	1.693	0.046	0.1581	0.0044	0.07738	0.00088	945	25	1125	23	1740	16.8	1125	23
	CS198.05	2.099	0.035	0.1941	0.0029	0.0795	0.0013	1143	16	1175	32	713	21.5	1175	32
	CS198.110	1.879	0.045	0.1734	0.0036	0.0794	0.0014	1030	20	1171	35	1418	27.5	1171	35
CS221	CS221.09	0.59	0.035	0.0798	0.0028	0.0541	0.0027	494	17	370	100	360	8.1	370	100
	CS221.48	0.7	0.14	0.0797	0.0026	0.061	0.012	494	15	370	150	218	1.64	370	150
	CS221.18	0.55	0.039	0.0692	0.0023	0.0578	0.004	431	14	390	140	64	2.5	390	140
	CS221.61	0.438	0.013	0.0571	0.0012	0.05489	0.00097	358.1	7.5	400	40	3590	345	400	40
	CS221.01	0.782	0.022	0.0648	0.0017	0.088	0.0018	404	10	1365	40	1610	2.291	1365	40
	CS221.36	0.461	0.012	0.06056	0.00093	0.05504	0.00078	379	5.6	404	31	4370	220	404	31
	CS221.56	0.4864	0.0096	0.06234	0.0009	0.0551	0.00091	389.8	5.4	408	38	3170	42.5	408	38
	CS221.41	0.486	0.011	0.06237	0.00093	0.05574	0.00088	390	5.6	435	36	2760	65.2	435	36
	CS221.81	0.4625	0.0079	0.05834	0.00074	0.05672	0.00082	365.5	4.5	470	32	3480	52.2	470	32
	CS221.51	0.4428	0.0079	0.05532	0.00093	0.05686	0.00085	347	5.7	475	34	3650	160	475	34
	CS221.03	0.551	0.027	0.0679	0.0027	0.0573	0.0014	423	16	490	56	2950	66	490	56
	CS221.77	0.53	0.018	0.0634	0.0012	0.0576	0.0018	396.1	7.3	499	65	4100	100	499	65
	CS221.43	0.4909	0.0083	0.0612	0.00072	0.05754	0.00091	382.9	4.4	505	35	2620	23.2	505	35
	CS221.65	0.4332	0.0086	0.05413	0.00096	0.05762	0.00097	339.8	5.9	512	34	3020	9.3	512	34
	CS221.31	0.4627	0.0067	0.05857	0.00069	0.05808	0.00095	366.9	4.2	520	36	3886	128	520	36
	CS221.50	0.495	0.01	0.06038	0.00088	0.0581	0.0011	377.8	5.3	523	42	1950	12.2	523	42

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	CS221.46	0.655	0.056	0.0736	0.0028	0.0642	0.0055	457	17	530	180	39	1170	530	180
	CS221.38	0.565	0.031	0.067	0.0016	0.0608	0.003	417.9	9.6	540	110	152	1.427	540	110
	CS221.23	0.523	0.037	0.0614	0.0048	0.0589	0.0017	384	29	549	65	3210	65	549	65
	CS221.70	0.542	0.034	0.0643	0.0027	0.0611	0.0032	401	16	550	120	1090	5.7	550	120
	CS221.24	0.496	0.015	0.06033	0.00073	0.0597	0.0021	377.6	4.5	553	64	2530	36.9	553	64
	CS221.73	0.493	0.017	0.0598	0.0015	0.0593	0.0014	374.4	9.2	555	49	3960	42.1	555	49
	CS221.84	0.493	0.011	0.05976	0.00083	0.0593	0.0011	374.1	5.1	561	41	3100	51.2	561	41
	CS221.15	0.509	0.014	0.06245	0.00086	0.0588	0.0012	390.4	5.2	562	46	3690	45.7	562	46
	CS221.26	0.4281	0.0094	0.05265	0.00098	0.05908	0.00094	330.7	6	563	36	4100	56.2	563	36
	CS221.33	0.489	0.015	0.0596	0.001	0.0596	0.001	373.3	6.1	576	36	3492	40.1	576	36
	CS221.89	0.495	0.01	0.0591	0.001	0.0598	0.0012	369.9	6.3	581	42	3130	39.1	581	42
	CS221.88	0.543	0.014	0.0646	0.0011	0.05989	0.00099	403.6	6.7	597	37	3646	14.99	597	37
	CS221.12	0.485	0.013	0.0595	0.0012	0.05996	0.00093	372.3	7.3	598	34	3530	25.3	598	34
	CS221.40	0.501	0.012	0.0603	0.0012	0.0606	0.0015	377.1	7.5	598	54	2620	98.4	598	54
	CS221.66	0.452	0.016	0.0538	0.0016	0.0603	0.0011	337.7	9.6	598	40	3410	21.8	598	40
	CS221.83	0.5187	0.0081	0.06052	0.00089	0.0611	0.0011	378.7	5.4	631	38	2930	21.6	631	38
	CS221.55	0.4666	0.0097	0.0543	0.0011	0.0615	0.0012	340.6	6.4	639	42	3020	78.6	639	42
	CS221.72	0.568	0.03	0.0648	0.0026	0.0626	0.0015	404	16	670	50	2520	7.84	670	50
	CS221.02	0.621	0.031	0.0725	0.0028	0.063	0.0014	451	16	684	49	2040	4.79	684	49
	CS221.76	0.4393	0.0076	0.04974	0.00063	0.0631	0.00081	312.9	3.8	708	28	3000	1.53	708	28
	CS221.29	0.545	0.013	0.0628	0.0011	0.0636	0.001	392.3	6.8	722	35	3160	39.3	722	35
	CS221.25	0.521	0.017	0.0585	0.0014	0.0644	0.0017	366.4	8.3	726	54	2930	15.7	726	54
	CS221.54	0.593	0.021	0.0647	0.0016	0.0641	0.0014	403.7	9.6	732	47	3190	24.8	732	47
	CS221.	0.644	0.025	0.0739	0.002	0.0647	0.0016	459	12	738	53	2170	21.4	738	53

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	04														
	CS221.34	0.55	0.031	0.0625	0.0014	0.0631	0.0033	390.6	8.4	740	130	1780	15.1	740	130
	CS221.08	0.642	0.011	0.0746	0.0017	0.0647	0.0011	464	10	757	34	2920	16.5	757	34
	CS221.27	0.838	0.026	0.0945	0.0033	0.0651	0.0013	581	19	761	42	850	3.22	761	42
	CS221.20	0.535	0.016	0.0582	0.0011	0.0655	0.0013	364.9	6.5	772	41	2810	14.4	772	41
	CS221.67	0.729	0.036	0.0788	0.0039	0.0655	0.0017	488	23	772	54	1850	19.5	772	54
	CS221.19	0.4885	0.0077	0.0531	0.0012	0.0663	0.0017	333.5	7.3	788	54	3420	29.8	788	54
	CS221.11	0.564	0.052	0.0613	0.0052	0.0665	0.0027	383	31	799	84	2270	3.07	799	84
	CS221.30	0.754	0.024	0.0766	0.0017	0.068	0.0011	472	10	803	23	954	23.4	803	23
	CS221.30	0.754	0.024	0.0766	0.0017	0.068	0.0011	472	10	803	23	946	23.4	803	23
	CS221.70	0.765	0.021	0.0768	0.0015	0.0752	0.0025	470	8.5	812	37	780	20	812	37
	CS221.10	0.5066	0.0084	0.0571	0.0013	0.0666	0.0016	358.1	8.1	816	50	3230	10.9	816	50
	CS221.58	0.549	0.022	0.0565	0.0012	0.0682	0.0034	354.4	7.2	823	79	1830	4.04	823	79
	CS221.64	0.592	0.015	0.0636	0.0013	0.067	0.0013	397.5	8.1	830	38	2350	25.6	830	38
	CS221.87	0.566	0.021	0.0587	0.001	0.0682	0.0017	367.7	6.3	849	51	4190	27.2	849	51
	CS221.78	0.685	0.016	0.0722	0.0015	0.0684	0.0012	449	9.1	866	38	2270	10.12	866	38
	CS221.14	0.551	0.011	0.0571	0.001	0.0689	0.0019	358.1	6.3	877	56	2630	4.38	877	56
	CS221.57	0.549	0.02	0.0557	0.001	0.0694	0.0017	349.4	6.4	883	53	2430	12.71	883	53
	CS221.69	0.556	0.025	0.05613	0.00096	0.0706	0.0027	352	5.8	901	66	2660	10.45	901	66
	CS221.28	0.524	0.012	0.05471	0.00087	0.0705	0.0018	343.3	5.4	918	48	2120	3.18	918	48
	CS221.52	0.579	0.0093	0.05875	0.00086	0.0702	0.0015	368	5.2	920	47	2380	20.9	920	47
	CS221.42	0.5051	0.0086	0.05205	0.00083	0.0703	0.0012	327	5.1	925	36	2550	9.58	925	36
	CS221.74	0.732	0.035	0.073	0.0018	0.0706	0.0017	454	11	928	50	1785	5.53	928	50
	CS221.21	0.755	0.049	0.074	0.0029	0.0717	0.0025	459	17	929	71	2030	4.9	929	71

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	CS221.53	1.087	0.075	0.1055	0.0055	0.0716	0.0022	644	32	937	63	2500	5.9	937	63
	CS221.59	0.688	0.021	0.0692	0.0018	0.0707	0.0012	431	11	948	34	1790	8.12	948	34
	CS221.80	0.634	0.013	0.0635	0.0012	0.0712	0.0013	396.6	7.5	950	37	1756	14.92	950	37
	CS221.11	1.61	0.094	0.1718	0.0056	0.0742	0.0049	1020	31	960	140	38.1	3.21	960	140
	CS221.71	0.464	0.012	0.047	0.0012	0.0716	0.0013	296.1	7.6	965	38	2340	3.09	965	38
	CS221.17	0.549	0.016	0.05403	0.00067	0.0723	0.0017	339.2	4.1	972	47	2740	7.53	972	47
	CS221.75	0.514	0.014	0.0512	0.0013	0.0715	0.0021	321.5	7.7	977	62	1580	2.85	977	62
	CS221.32	0.612	0.018	0.0619	0.0011	0.0724	0.0018	386.9	6.7	979	50	1269	2.98	979	50
	CS221.60	0.603	0.02	0.0573	0.0012	0.0721	0.0023	359	7.4	979	69	1380	4.5	979	69
	CS221.63	0.73	0.046	0.0692	0.0023	0.076	0.0042	431	14	1000	100	403	5.9	1000	100
	CS221.03	1.607	0.054	0.1683	0.005	0.0729	0.0013	1002	28	1001	37	556	15.7	1001	37
	CS221.14	1.459	0.085	0.1515	0.0085	0.0732	0.0027	907	47	1008	88	234	3.64	1008	88
	CS221.37	0.589	0.021	0.0581	0.0014	0.0737	0.0018	363.9	8.5	1009	52	2530	5.17	1009	52
	CS221.39	1.162	0.07	0.1137	0.0063	0.0767	0.004	691	36	1019	50	900	2.89	1019	50
	CS221.35	0.572	0.014	0.0569	0.0011	0.0736	0.0012	356.7	6.8	1020	32	2370	4.41	1020	32
	CS221.30	0.861	0.042	0.0846	0.0036	0.0744	0.0015	522	21	1036	40	1570	2.194	1036	40
	CS221.34	1.238	0.054	0.1265	0.0052	0.0747	0.004	767	30	1040	100	259	8.15	1040	100
	CS221.77	1.647	0.069	0.1651	0.004	0.0757	0.0033	984	22	1057	81	147	3.302	1057	81
	CS221.49	1.282	0.073	0.1138	0.0051	0.0784	0.002	693	30	1131	53	1810	20.6	1131	53
	CS221.22	1.013	0.062	0.0918	0.0045	0.0793	0.0028	564	26	1133	70	720	1.96	1133	70
	CS221.16	0.872	0.042	0.0802	0.0036	0.0778	0.0016	496	21	1140	48	1660	3.6	1140	48
	CS221.79	0.683	0.035	0.061	0.0012	0.0802	0.0043	381.6	7.3	1140	100	1140	3.6	1140	100
	CS221.44	0.572	0.028	0.05129	0.00095	0.0807	0.0038	322.3	5.8	1158	72	2080	6.88	1158	72
	CS221.	0.672	0.032	0.0597	0.0017	0.0816	0.0034	374	10	1170	84	2510	7.31	1170	84

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	45														
	CS221.07	0.62	0.013	0.05791	0.00091	0.0804	0.0018	362.8	5.6	1188	43	1596	4.14	1188	43
	CS221.60	1.215	0.084	0.1108	0.0066	0.0816	0.0028	675	38	1218	96	441	3.48	1218	96
	CS221.85	0.62	0.019	0.0537	0.0017	0.0851	0.004	337	10	1233	97	920	2.25	1233	97
	CS221.68	0.843	0.055	0.071	0.0034	0.0835	0.0027	441	20	1246	68	1370	2.8	1246	68
	CS221.13	1.58	0.1	0.1365	0.0075	0.0838	0.0021	821	43	1262	52	1340	12.22	1262	52
	CS221.47	0.837	0.018	0.0706	0.0022	0.0836	0.0017	440	13	1274	38	1740	4.36	1274	38
	CS221.23	1.99	0.1	0.1713	0.0067	0.0847	0.0043	1019	37	1297	99	660	7.1	1297	99
	CS221.62	1.832	0.05	0.1435	0.0034	0.0917	0.0011	864	19	1455	23	1315	3.91	1455	23
	CS221.86	1.3	0.054	0.1016	0.0049	0.0923	0.0018	622	29	1458	38	1230	2.369	1458	38
	CS221.82	0.535	0.023	0.0392	0.0017	0.0999	0.0036	247	10	1579	69	850	0.92	1579	69
19ALAI54	ALAIS4.13	0.597	0.029	0.0764	0.0015	0.0566	0.0028	474.6	9.2	410	100	303	1.194	474.6	9.2
	ALAIS4.23	1.691	0.096	0.1569	0.0051	0.0783	0.0049	938	29	1050	130	67.5	1.353	938	29
	ALAIS4.19	1.684	0.053	0.164	0.0032	0.0755	0.0028	978	18	1048	74	136	2.199	978	18
	ALAIS4.14	1.76	0.45	0.0773	0.0044	0.132	0.027	479	26	1260	300	478	2.28	479	26
	ALAIS4.17	3.191	0.062	0.2496	0.0032	0.0927	0.0017	1436	16	1473	34	326.5	2.54	1473	34
	ALAIS4.08	1.771	0.053	0.1706	0.0037	0.0747	0.0024	1015	21	1030	64	357	2.667	1015	21
	ALAIS4.22	1.576	0.052	0.1575	0.003	0.0729	0.0023	942	17	981	67	236.4	3	942	17
	ALAIS4.12	2.204	0.05	0.1993	0.003	0.0805	0.0016	1171	16	1203	38	526	3.16	1171	16
	ALAIS4.16	1.597	0.084	0.1607	0.0063	0.0716	0.0023	959	35	961	64	255	3.32	959	35
	ALAIS4.05	1.647	0.077	0.1582	0.0035	0.076	0.0032	946	19	1087	77	194	3.335	946	19
	ALAIS4.15	1.576	0.047	0.1601	0.0031	0.0713	0.002	957	17	948	60	420	3.4	957	17
	ALAIS4.06	1.649	0.072	0.1573	0.0061	0.0756	0.0016	940	35	1071	43	638	3.43	940	35
	ALAIS4.18	2.05	0.1	0.1866	0.0066	0.0798	0.0025	1100	36	1161	63	229	3.58	1100	36

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	ALAIS 4.20	0.446	0.033	0.0607	0.0012	0.0539	0.0041	380	7.3	240	120	274.1	3.86	380	7.3
	ALAIS 4.03	2.17	0.11	0.2	0.0073	0.0789	0.0032	1172	40	1132	81	231	4.22	1172	40
	ALAIS 4.11	2.019	0.073	0.1902	0.0046	0.0775	0.0025	1121	25	1125	59	209	4.69	1121	25
	ALAIS 4.02	1.69	0.11	0.1538	0.0055	0.0794	0.0053	921	31	1150	130	90	5.87	921	31
	ALAIS 4.21	0.508	0.027	0.0658	0.0015	0.0556	0.0029	410.5	8.9	370	110	307	7.5	410.5	8.9
	ALAIS 4.09	1.33	0.1	0.1317	0.0078	0.0718	0.003	794	45	922	89	263	9.7	794	45
	ALAIS 4.01	0.418	0.019	0.0577	0.0016	0.0527	0.0025	361.7	9.8	288	94	608	41	361.7	9.8
	ALAIS 4.05	0.469	0.037	0.0598	0.0019	0.0558	0.0039	375	11	400	150	490	90	375	11
	ALAIS 4.10	0.472	0.018	0.0599	0.0013	0.057	0.0019	375	8	456	76	530	150	375	8
19ALAI01	S1.81	2.805	0.057	0.237	0.003	0.0857	0.0017	1371	16	1324	38	268	0.8648	1324	38
	S1.91	1.515	0.062	0.1522	0.004	0.0747	0.003	913	22	1046	77	118	0.957	913	22
	S1.17	2.17	0.14	0.2031	0.0077	0.0778	0.0039	1189	41	1140	110	54	0.99	1189	41
	S1.61	2.811	0.073	0.2308	0.0052	0.0886	0.0012	1337	27	1388	27	386	1.216	1388	27
	S1.109	1.59	0.14	0.1496	0.0046	0.0768	0.0067	898	25	1020	140	74	1.217	898	25
	S1.79	2.52	0.2	0.2238	0.0088	0.0819	0.0078	1300	46	1230	170	71	1.247	1230	170
	S1.22	2.71	0.22	0.2228	0.0099	0.0879	0.0058	1293	53	1364	88	119	1.285	1364	88
	S1.73	2.445	0.098	0.2085	0.006	0.0844	0.0033	1219	33	1270	84	95	1.3	1219	33
	S1.02	3.38	0.088	0.2639	0.0051	0.0926	0.0019	1509	26	1467	38	177	1.306	1467	38
	S1.28	1.101	0.062	0.1168	0.0061	0.0683	0.0016	710	35	867	46	369	1.34	710	35
	S1.87	2.146	0.039	0.1833	0.0027	0.0849	0.0014	1085	15	1303	33	455	1.341	1085	15
	S1.66	1.94	0.13	0.1978	0.0061	0.0708	0.0045	1162	33	900	160	251	1.354	1162	33
	S1.113	3.12	0.37	0.249	0.015	0.091	0.012	1429	77	1540	220	156	1.374	1540	220
	S1.38	2.87	0.17	0.2359	0.0069	0.0909	0.004	1364	36	1419	96	185	1.414	1419	96
	S1.13	3.6	0.1	0.2746	0.0085	0.0953	0.0017	1560	43	1538	30	361	1.47	1538	30
	S1.105	1.493	0.06	0.1546	0.0053	0.0709	0.0017	925	30	965	60	626	1.519	925	30
	S1.115	2.09	0.1	0.1756	0.0047	0.0869	0.0039	1042	26	1350	100	230	1.53	1042	26

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	S1.108	1.82	0.24	0.1744	0.009	0.0788	0.0054	1035	49	1110	150	81	1.628	1035	49
	S1.98	1.88	0.11	0.1848	0.0059	0.0741	0.0035	1092	33	1045	82	70	1.63	1092	33
	S1.40	3.035	0.056	0.2383	0.0037	0.0921	0.0016	1377	19	1460	34	330	1.686	1460	34
	S1.103	2.117	0.063	0.1805	0.0039	0.0852	0.0017	1069	21	1308	38	291	1.708	1069	21
	S1.74	2.32	0.17	0.1958	0.0085	0.0859	0.0059	1163	40	1290	180	85	1.714	1163	40
	S1.48	1.597	0.03	0.1583	0.0016	0.0727	0.0015	947.2	9.1	1002	39	395	1.729	947.2	9.1
	S1.47	1.71	0.073	0.1665	0.0065	0.0738	0.0015	991	36	1023	43	418	1.77	991	36
	S1.122	3.55	0.22	0.292	0.01	0.0884	0.0057	1649	52	1430	100	82	1.79	1430	100
	S1.54	2.24	0.19	0.1958	0.0083	0.0838	0.0052	1151	44	1260	100	157	1.802	1151	44
	S1.72	1.635	0.078	0.1581	0.0046	0.0747	0.0032	945	25	1026	77	106.8	1.88	945	25
	S1.04	3	0.23	0.235	0.011	0.093	0.0062	1367	50	1498	87	370	1.9	1498	87
	S1.68	1.57	0.11	0.1622	0.0066	0.0736	0.0038	976	40	1000	130	92	1.903	976	40
	S1.32	3.086	0.074	0.2436	0.0047	0.0919	0.0019	1404	24	1453	39	184.8	1.964	1453	39
	S1.41	0.516	0.015	0.06405	0.0009	0.0582	0.0017	400.2	5.4	518	65	506	1.971	400.2	5.4
	S1.71	1.71	0.098	0.1707	0.0054	0.0712	0.0045	1014	30	940	110	73.9	2.033	1014	30
	S1.46	3.04	0.17	0.2591	0.0058	0.0854	0.0042	1504	48	1296	92	171	2.035	1296	92
	S1.69	2.4	0.14	0.2035	0.0063	0.0838	0.0034	1192	34	1319	70	196	2.07	1192	34
	S1.70	2.28	0.12	0.213	0.0052	0.0772	0.0038	1244	27	1130	77	218	2.109	1244	27
	S1.30	1.512	0.082	0.148	0.0056	0.0757	0.005	888	31	1010	140	136	2.118	888	31
	S1.35	2.46	0.14	0.2057	0.0093	0.0875	0.0055	1204	49	1340	150	187	2.147	1204	49
	S1.88	1.967	0.046	0.1702	0.0039	0.0833	0.0012	1012	22	1269	28	778	2.206	1012	22
	S1.115	1.372	0.037	0.1278	0.002	0.0766	0.0018	775	11	1103	48	444	2.21	775	11
	S1.25	2.63	0.12	0.2243	0.0064	0.0847	0.0045	1303	34	1355	86	72	2.252	1355	86
	S1.07	2.24	0.11	0.1885	0.0042	0.0874	0.0034	1118	25	1364	59	177	2.339	1118	25
	S1.31	1.729	0.072	0.1737	0.0061	0.0729	0.0033	1031	33	1012	78	448	2.4	1031	33
	S1.56	1.9	0.099	0.183	0.0061	0.0751	0.0036	1082	33	1037	92	95	2.4	1082	33
	S1.58	2.3	0.15	0.1976	0.0097	0.0846	0.0039	1159	51	1316	78	126	2.403	1159	51
	S1.50	1.743	0.062	0.1711	0.0062	0.0744	0.0018	1018	34	1059	44	860	2.47	1018	34

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	S1.23	0.736	0.017	0.0911	0.0016	0.0587	0.0011	562.2	9.5	543	43	1260	2.49	562.2	9.5
	S1.42	0.792	0.023	0.0924	0.0011	0.0621	0.0018	569.5	6.8	656	63	331	2.49	569.5	6.8
	S1.05	1.536	0.096	0.157	0.008	0.0706	0.0032	936	45	913	86	183	2.54	936	45
	S1.14	2.19	0.19	0.1889	0.0081	0.0815	0.0057	1112	45	1100	120	103	2.59	1112	45
	S1.102	1.217	0.068	0.1233	0.0046	0.0709	0.0026	748	27	925	79	181	2.65	748	27
	S1.20	1.678	0.063	0.1661	0.0057	0.0733	0.0012	989	32	1014	32	903	2.68	989	32
	S1.24	1.33	0.15	0.1128	0.0099	0.0863	0.0086	687	57	1220	230	134	2.71	687	57
	S1.43	2.27	0.15	0.194	0.011	0.083	0.0019	1134	62	1253	46	580	2.73	1134	62
	S1.06	2.68	0.12	0.2166	0.007	0.089	0.0024	1261	38	1381	50	327	2.78	1381	50
	S1.21	3.113	0.048	0.2473	0.0027	0.0916	0.0014	1424	14	1452	29	515	2.791	1452	29
	S1.52	1.456	0.094	0.136	0.0052	0.0785	0.0035	820	30	1109	77	295	2.88	820	30
	S1.18	2.73	0.11	0.2151	0.0081	0.0906	0.001	1252	44	1432	22	1094	2.9	1432	22
	S1.89	1.27	0.1	0.1232	0.0039	0.0751	0.0063	749	22	1060	160	225	2.926	749	22
	S1.10	2.25	0.14	0.1847	0.0078	0.0875	0.0035	1088	43	1359	61	274	2.96	1088	43
	S1.36	2.438	0.063	0.1995	0.0055	0.0887	0.0018	1172	29	1403	44	355	2.96	1172	29
	S1.99	1.82	0.13	0.1659	0.0091	0.0754	0.0023	985	51	1059	72	449	2.97	985	51
	S1.08	3.83	0.11	0.2895	0.0074	0.0964	0.0036	1637	36	1549	73	79	2.99	1549	73
	S1.107	1.329	0.062	0.1256	0.0042	0.0767	0.0033	762	24	1063	86	135	3	762	24
	S1.59	2.2	0.092	0.1785	0.0062	0.0883	0.0017	1057	34	1376	37	259.2	3.11	1057	34
	S1.118	2.149	0.09	0.1894	0.0068	0.0821	0.0017	1116	37	1233	41	278	3.11	1116	37
	S1.11	1.652	0.081	0.1655	0.0049	0.0749	0.0027	986	27	1039	80	354	3.13	986	27
	S1.09	1.469	0.077	0.1504	0.0085	0.0715	0.0026	899	46	973	74	360	3.18	899	46
	S1.104	1.555	0.041	0.1464	0.0034	0.077	0.0012	880	19	1111	32	571	3.35	880	19
	S1.82	0.535	0.013	0.0665	0.001	0.0581	0.0013	415.2	6.3	516	48	990	3.41	415.2	6.3
	S1.90	1.338	0.072	0.1432	0.0062	0.0689	0.003	860	35	886	72	356	3.46	860	35
	S1.86	1.695	0.081	0.1688	0.0049	0.0734	0.0023	1004	27	1030	69	260	3.49	1004	27
	S1.64	1.973	0.056	0.1803	0.0041	0.0796	0.0017	1075	19	1179	42	352	3.51	1075	19
	S1.37	11.02	0.51	0.444	0.018	0.1816	0.0034	2372	80	2659	31	97	3.51	2659	31
	S1.78	2.031	0.052	0.1916	0.0033	0.0769	0.0016	1130	18	1112	41	651	3.52	1130	18

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	S1.44	1.244	0.083	0.1256	0.0069	0.0701	0.0019	760	40	904	60	334	3.57	760	40
	S1.25	1.586	0.091	0.1426	0.0055	0.0798	0.0026	858	31	1171	63	226	3.59	858	31
	S1.51	2.016	0.059	0.178	0.0032	0.0819	0.0018	1055	18	1233	43	412	3.61	1055	18
	S1.15	1.217	0.038	0.1177	0.0028	0.0745	0.0015	717	16	1042	40	687	3.71	717	16
	S1.63	1.51	0.17	0.147	0.024	0.078	0.01	870	120	930	290	191	3.73	870	120
	S1.84	1.67	0.089	0.1712	0.0081	0.0702	0.0043	1027	40	900	130	282	3.76	1027	40
	S1.100	2.011	0.043	0.1877	0.0035	0.0775	0.0014	1108	19	1128	38	437	3.85	1108	19
	S1.65	6.55	0.2	0.283	0.011	0.1689	0.0046	1600	57	2514	61	257	3.91	2514	61
	S1.101	0.474	0.012	0.05573	0.00093	0.056	0.0013	349.5	5.7	432	53	805	4	349.5	5.7
	S1.75	1.446	0.051	0.141	0.0029	0.0739	0.0023	850	16	1041	63	337	4.03	850	16
	S1.34	1.45	0.15	0.1087	0.0067	0.0897	0.0071	664	39	1400	120	200	4.08	664	39
	S1.49	0.818	0.029	0.0939	0.0024	0.0631	0.0016	578	14	690	53	460	4.09	578	14
	S1.19	1.84	0.1	0.1566	0.0031	0.0847	0.0041	937	18	1251	85	473	4.09	937	18
	S1.27	1.021	0.048	0.105	0.0032	0.0703	0.0027	643	18	886	82	222	4.14	643	18
	S1.106	0.686	0.024	0.0753	0.0017	0.0663	0.0022	470	11	796	69	430	4.219	470	11
	S1.109	0.7	0.033	0.0748	0.0024	0.0668	0.0034	465	14	800	110	311	4.38	465	14
	S1.110	1.567	0.046	0.1572	0.0019	0.0725	0.0021	941	10	982	61	414	4.61	941	10
	S1.30	0.662	0.045	0.0685	0.0046	0.0679	0.0047	427	28	870	170	930	4.93	427	28
	S1.45	1.034	0.035	0.1081	0.0033	0.0689	0.0015	661	19	888	46	502	5.3	661	19
	S1.77	1.05	0.14	0.1156	0.0089	0.066	0.0058	702	52	810	130	156	5.49	702	52
	S1.68	0.65	0.039	0.0671	0.0025	0.0699	0.0034	418	15	910	100	513	5.6	418	15
	S1.62	0.536	0.014	0.0696	0.0016	0.056	0.0016	433.8	9.4	439	66	482	5.79	433.8	9.4
	S1.38	0.603	0.034	0.0664	0.002	0.0655	0.0026	414	12	782	83	1270	5.8	414	12
	S1.16	1.482	0.042	0.1495	0.0034	0.0719	0.0018	898	19	967	51	547	6.65	898	19
	S1.119	1.949	0.064	0.2026	0.0062	0.071	0.0023	1188	33	947	85	391	6.8	1188	33
	S1.03	3.103	0.058	0.2489	0.0031	0.0905	0.0017	1432	16	1424	36	218.1	7.29	1424	36
	S1.79	0.734	0.035	0.0719	0.0034	0.0727	0.0032	447	21	1010	100	560	7.35	447	21
	S1.80	1.659	0.098	0.1495	0.0047	0.0776	0.0039	903	24	1090	110	679	9.1	903	24

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	S1.95	1.613	0.071	0.1584	0.0064	0.073	0.0011	945	36	1011	32	1023	9.1	945	36
	S1.01	2.71	0.15	0.219	0.0055	0.0897	0.0024	1275	30	1442	63	670	9.7	1442	63
	S1.94	1.667	0.044	0.1659	0.0029	0.0737	0.0018	989	16	1017	49	604	9.71	989	16
	S1.122	0.467	0.03	0.0521	0.0053	0.0634	0.005	327	32	710	180	2251	10.84	327	32
	S1.24	0.424	0.035	0.0368	0.0014	0.0809	0.0036	232.9	8.8	1215	99	555	14	232.9	8.8
	S1.58	0.594	0.054	0.062	0.0041	0.0679	0.005	387	25	830	150	516	14.1	387	25
	S1.121	0.492	0.013	0.0634	0.001	0.0555	0.0016	396.2	6.3	425	62	932	14.5	396.2	6.3
	S1.98	0.631	0.083	0.0572	0.002	0.0753	0.0077	358	12	1030	190	516	14.96	358	12
	S1.12	1.55	0.12	0.139	0.006	0.0822	0.0061	837	34	1150	87	340	15.38	837	34
	S1.57	1.166	0.029	0.1164	0.0016	0.0722	0.0016	709.6	9.3	975	46	556	15.6	709.6	9.3
	S1.07	0.5	0.025	0.0573	0.0032	0.0619	0.0038	359	19	660	130	778	15.9	359	19
	S1.119	0.594	0.067	0.0541	0.0038	0.073	0.0084	340	23	1030	240	608	18	340	23
	S1.08	0.665	0.043	0.0588	0.0041	0.0764	0.0062	368	25	1130	180	892	18.9	368	25
	S1.11	0.684	0.038	0.0705	0.0066	0.0695	0.0049	439	40	880	140	550	19.3	439	40
	S1.77	0.352	0.025	0.0401	0.002	0.0609	0.0026	253	12	627	98	990	25.7	253	12
	S1.22	0.473	0.051	0.0509	0.0012	0.0661	0.007	320.1	7.1	760	200	523	29.9	320.1	7.1
	S1.110	0.487	0.05	0.0558	0.002	0.0623	0.0064	350	12	690	270	232	30.2	350	12
	S1.89	0.503	0.069	0.0437	0.0011	0.0785	0.0092	275.4	6.7	1100	230	318	31.2	275.4	6.7
	S1.54	0.56	0.1	0.0551	0.0021	0.072	0.012	346	13	820	310	397	35	346	13
	S1.34	0.659	0.051	0.0494	0.0017	0.0896	0.0058	311	10	1410	140	477	43.7	311	10
	S1.102	0.77	0.16	0.058	0.0018	0.093	0.019	363	11	1330	320	106	43.7	363	11
	S1.16	1.09	0.33	0.0556	0.0031	0.131	0.034	349	19	1820	470	208	48	349	19
	S1.53	0.461	0.02	0.0605	0.0013	0.0558	0.0024	378.6	7.7	389	95	307.2	51	378.6	7.7
	S1.113	0.485	0.022	0.0563	0.0011	0.0627	0.0026	352.8	6.6	666	85	608	54.9	352.8	6.6
	S1.35	0.458	0.029	0.054	0.0013	0.06	0.0035	338.8	7.8	560	120	750	62	338.8	7.8
	S1.66	0.415	0.044	0.0461	0.0012	0.0656	0.0091	290.4	7.5	720	250	455	66.9	290.4	7.5
	S1.73	0.518	0.074	0.0562	0.0023	0.065	0.0089	352	14	730	290	595	69	352	14
	S1.74	0.451	0.036	0.0472	0.0013	0.0649	0.0053	297.4	7.9	730	180	460	74	297.4	7.9
	S1.108	0.428	0.03	0.0508	0.0037	0.0616	0.0058	319	23	620	210	620	91	319	23

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge 206_238	FinalAge206_238_Int2SE	FinalAge 207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	S1.46	0.404	0.049	0.0438	0.0033	0.0635	0.0067	276	20	710	210	552	105.2	276	20
	S1.69	0.487	0.033	0.0556	0.0019	0.0617	0.0042	349	12	700	190	361	117	349	12
	S1.70	0.43	0.034	0.0512	0.002	0.0577	0.0035	322	12	480	130	393	133	322	12
	S1.93	0.498	0.033	0.057	0.0013	0.0632	0.0041	357.5	8.2	720	150	406	174	357.5	8.2
	S1.116	0.44	0.02	0.0585	0.0016	0.0545	0.0023	366.2	9.6	365	88	425	184	366.2	9.6
19ALAI53	S53.75	0.625	0.03	0.0759	0.0022	0.0595	0.003	471	13	530	100	261	0.884	471	13
	S53.101	0.453	0.01	0.0595	0.0012	0.0548	0.0013	374.4	5.8	384	53	853	1.034	374.4	5.8
	S53.27	0.583	0.021	0.0731	0.001	0.0577	0.0022	454.8	6.3	475	73	530	1.133	454.8	6.3
	S53.77	0.569	0.018	0.07309	0.00098	0.0565	0.0017	454.7	5.9	443	68	477	1.217	454.7	5.9
	S53.48	0.738	0.052	0.06097	0.00098	0.0882	0.0063	381.4	6	1280	120	620	1.22	381.4	6
	S53.76	0.565	0.017	0.0724	0.0013	0.0567	0.0018	450.5	8	447	72	616	1.226	450.5	8
	S53.03	0.466	0.018	0.05103	0.00086	0.0665	0.0026	320.8	5.3	787	78	419	1.233	320.8	5.3
	S53.90	1.825	0.095	0.1769	0.0063	0.0728	0.0046	1048	35	980	120	218	1.33	1048	35
	S53.09	1.587	0.036	0.1499	0.0029	0.0767	0.0013	900	16	1102	35	519.5	1.453	900	16
	S53.08	2.389	0.066	0.2153	0.0046	0.0796	0.0021	1256	24	1192	48	342	1.496	1192	48
	S53.41	1.689	0.056	0.1542	0.0041	0.0798	0.0031	923	23	1172	62	416	1.527	923	23
	S53.43	1.441	0.053	0.1504	0.0031	0.0706	0.0025	903	18	945	76	267	1.574	903	18
	S53.25	0.529	0.045	0.0529	0.0012	0.0727	0.0064	332.2	7.1	890	110	226.7	1.626	332.2	7.1
	S53.20	0.591	0.019	0.0744	0.0014	0.0568	0.0018	462.5	8.3	473	70	576	1.66	462.5	8.3
	S53.98	2.8	0.12	0.2374	0.0047	0.0843	0.0032	1378	26	1287	70	192	1.696	1287	70
	S53.78	2.689	0.092	0.205	0.0057	0.094	0.0033	1201	30	1552	66	655	1.699	1201	30
	S53.53	0.743	0.057	0.0576	0.0018	0.0917	0.0057	361	11	1410	140	457	1.771	361	11
	S53.79	2.12	0.14	0.196	0.011	0.0829	0.0067	1150	60	1240	110	530	1.791	1150	60
	S53.108	0.456	0.02	0.0536	0.001	0.0618	0.0028	336.5	6.2	603	99	266	1.806	336.5	6.2
	S53.56	0.418	0.014	0.0555	0.001	0.0539	0.0019	348.1	6.1	331	79	587	1.83	348.1	6.1
	S53.33	0.415	0.019	0.0551	0.0013	0.0545	0.0025	345.4	7.8	338	98	301	1.836	345.4	7.8
	S53.21	0.545	0.064	0.052	0.0021	0.0744	0.0089	327	13	970	220	211	1.84	327	13

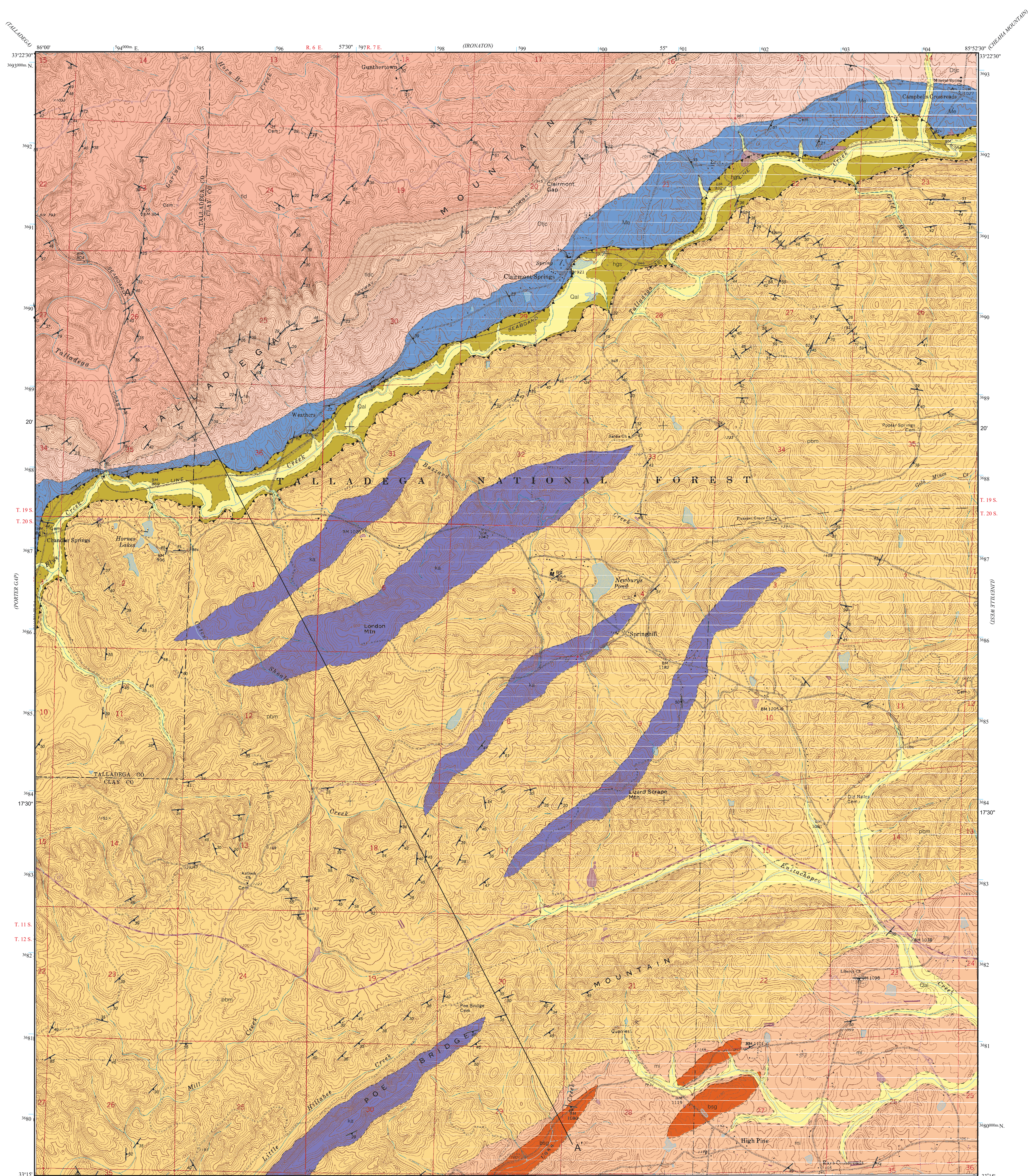
Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	S53.71	0.54	0.017	0.0683	0.0019	0.0583	0.0018	426	11	536	75	561	1.85	426	11
	S53.99	0.511	0.014	0.0658	0.0013	0.0561	0.0012	411.9	7.8	442	50	894	1.863	411.9	7.8
	S53.62	0.413	0.018	0.0545	0.0013	0.0555	0.0024	341.9	8	391	96	262.7	1.89	341.9	8
	S53.45	0.513	0.033	0.0547	0.0018	0.0671	0.0036	343	11	770	110	179	1.895	343	11
	S53.22	2.54	0.15	0.193	0.01	0.0948	0.0041	1136	56	1526	92	510	1.915	1136	56
	S53.07	1.712	0.065	0.1455	0.0034	0.0856	0.0036	875	19	1306	78	240	1.949	875	19
	S53.59	0.583	0.02	0.0745	0.0016	0.0565	0.002	463.3	9.6	435	76	518	1.98	463.3	9.6
	S53.04	1.57	0.1	0.1548	0.0071	0.074	0.0044	926	40	1100	110	409	1.98	926	40
	S53.81	0.447	0.022	0.0593	0.0016	0.0547	0.003	371	9.5	370	110	185	1.992	371	9.5
	S53.107	0.577	0.02	0.0734	0.0015	0.0573	0.0022	456.7	8.9	456	81	341	2.03	456.7	8.9
	S53.34	4.06	0.54	0.291	0.011	0.103	0.017	1656	49	1520	200	296	2.03	1520	200
	S53.97	0.407	0.028	0.0531	0.0012	0.0567	0.0041	333.2	7.4	380	140	156	2.05	333.2	7.4
	S53.21	1.52	0.11	0.1517	0.0048	0.0742	0.0066	910	27	1040	110	490	2.056	910	27
	S53.36	0.389	0.031	0.0522	0.0013	0.0545	0.0039	327.8	7.8	290	120	233	2.06	327.8	7.8
	S53.50	0.412	0.014	0.05076	0.0008	0.0586	0.0021	319.1	4.9	512	80	500	2.09	319.1	4.9
	S53.68	0.427	0.03	0.0566	0.0014	0.0559	0.004	354.7	8.7	340	140	183	2.151	354.7	8.7
	S53.35	0.43	0.035	0.054	0.0026	0.0602	0.0056	339	15	470	150	261	2.182	339	15
	S53.106	0.396	0.016	0.05383	0.00091	0.0537	0.0025	337.9	5.6	322	95	336	2.3	337.9	5.6
	S53.12	2.343	0.086	0.2115	0.0056	0.0796	0.0034	1236	30	1197	62	182.7	2.345	1236	30
	S53.80	0.478	0.023	0.0534	0.0013	0.0642	0.0039	335.2	7.7	730	130	1630	2.4	335.2	7.7
	S53.28	0.398	0.027	0.0536	0.002	0.0538	0.0035	336	12	270	140	155	2.4	336	12
	S53.66	0.437	0.04	0.0615	0.0041	0.0551	0.0056	384	24	250	170	103.5	2.44	384	24
	S53.57	1.52	0.15	0.1426	0.0082	0.076	0.011	858	46	980	290	139	2.54	858	46
	S53.88	2.23	0.17	0.2014	0.0076	0.0827	0.0064	1181	41	1290	110	243	2.55	1181	41
	S53.86	0.385	0.018	0.0527	0.0014	0.0537	0.003	331	8.6	290	120	249	2.6	331	8.6
	S53.72	0.435	0.041	0.0542	0.002	0.0622	0.0064	340	12	480	210	82.6	2.603	340	12
	S53.70	0.384	0.033	0.0493	0.0015	0.0565	0.0049	310.1	9	340	150	146	2.649	310.1	9
	S53.13	0.411	0.016	0.05561	0.00096	0.053	0.0018	348.8	5.9	309	77	329	2.68	348.8	5.9

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	S53.103	0.409	0.03	0.0545	0.003	0.0559	0.0049	342	18	330	170	113	2.71	342	18
	S53.42	2.61	0.12	0.2055	0.0084	0.0923	0.0023	1200	45	1457	48	505	2.72	1200	45
	S53.105	1.407	0.056	0.155	0.017	0.0693	0.0026	914	73	943	52	1170	2.747	914	73
	S53.85	1.077	0.079	0.1212	0.009	0.0646	0.0051	735	50	800	180	110.7	2.76	735	50
	S53.40	0.9	0.15	0.0645	0.0014	0.101	0.015	402.8	8.6	1470	240	610	2.77	402.8	8.6
	S53.94	2.287	0.075	0.2047	0.0037	0.0809	0.0023	1200	20	1189	62	240	2.84	1200	20
	S53.67	0.594	0.014	0.0771	0.0012	0.0563	0.0015	478.6	7.4	440	61	718	2.911	478.6	7.4
	S53.47	2.176	0.045	0.1946	0.0026	0.0809	0.0016	1146	14	1209	37	404	2.92	1146	14
	S53.82	0.446	0.027	0.0558	0.0012	0.0584	0.0038	349.9	7.6	440	130	202	2.94	349.9	7.6
	S53.80	1.04	0.14	0.1081	0.004	0.07	0.011	661	23	790	230	219	2.943	661	23
	S53.01	0.594	0.072	0.0688	0.0017	0.0624	0.007	429	10	530	120	447	3.05	429	10
	S53.29	1.607	0.035	0.1567	0.0035	0.0747	0.0019	938	19	1054	50	326	3.114	938	19
	S53.31	0.42	0.014	0.0545	0.00095	0.0555	0.0016	342	5.9	402	65	813	3.21	342	5.9
	S53.96	0.859	0.023	0.0869	0.002	0.0712	0.0016	537	12	960	48	1240	3.21	537	12
	S53.26	0.484	0.035	0.0543	0.0018	0.0641	0.0053	341	11	630	150	289	3.24	341	11
	S53.49	1.287	0.071	0.1341	0.0065	0.0684	0.0038	810	37	870	150	181	3.37	810	37
	S53.74	0.471	0.018	0.0547	0.001	0.0621	0.0024	343.5	6.3	629	85	552	3.4	343.5	6.3
	S53.24	0.52	0.16	0.0506	0.0014	0.076	0.021	318.3	8.6	490	230	109	3.55	318.3	8.6
	S53.18	1.93	0.15	0.164	0.011	0.0911	0.0053	976	58	1420	110	450	3.65	976	58
	S53.11	1.632	0.032	0.1539	0.0026	0.0761	0.0014	923	15	1086	37	542	3.69	923	15
	S53.65	0.561	0.019	0.0617	0.002	0.0667	0.0024	385	12	819	72	668	3.8	385	12
	S53.104	0.521	0.015	0.0599	0.0012	0.0619	0.0015	375.2	7	650	53	1613	3.81	375.2	7
	S53.32	0.514	0.026	0.0644	0.0011	0.058	0.0028	402.1	6.6	457	79	756	3.89	402.1	6.6
	S53.69	1.805	0.043	0.1654	0.0033	0.079	0.0015	986	18	1163	37	685	3.91	986	18
	S53.40	0.823	0.057	0.0861	0.0028	0.0683	0.0049	532	16	910	140	260	3.92	532	16
	S53.05	1.89	0.13	0.1633	0.0073	0.0889	0.0076	974	40	1400	160	257	3.96	974	40
	S53.04	0.594	0.069	0.0601	0.0027	0.071	0.0076	376	16	880	230	222	4.2	376	16
	S53.15	0.44	0.015	0.05395	0.00077	0.0586	0.002	338.7	4.7	540	79	681	4.32	338.7	4.7

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	S53.95	0.406	0.031	0.0514	0.0016	0.0569	0.0042	322.6	9.9	400	130	289	4.34	322.6	9.9
	S53.44	0.684	0.036	0.0674	0.0023	0.0724	0.0038	420	14	952	92	428	4.38	420	14
	S53.83	0.392	0.021	0.0516	0.0011	0.0553	0.0027	324	6.4	370	100	281	4.43	324	6.4
	S53.84	0.401	0.025	0.0523	0.0011	0.0574	0.0041	328.4	6.7	440	150	334	4.53	328.4	6.7
	S53.85	0.538	0.059	0.0574	0.0019	0.0668	0.0087	359	11	720	180	548	4.97	359	11
	S53.18	0.525	0.043	0.0553	0.0015	0.0677	0.0058	346.8	8.9	830	170	410	5.29	346.8	8.9
	S53.23	0.559	0.078	0.0554	0.0019	0.072	0.011	348	11	870	300	440	5.3	348	11
	S53.37	0.485	0.017	0.0576	0.0012	0.0607	0.0018	360.8	7.3	605	68	617	5.34	360.8	7.3
	S53.39	0.945	0.037	0.0856	0.0026	0.07477	0.00099	529	16	1056	26	2394	5.52	529	16
	S53.57	1.1	0.13	0.0571	0.0026	0.136	0.016	358	16	2140	200	510	5.53	358	16
	S53.02	1.948	0.094	0.1782	0.0056	0.0794	0.0031	1056	31	1181	73	269	6.4	1056	31
	S53.100	0.466	0.012	0.06128	0.00076	0.055	0.0014	383.4	4.6	389	58	584	6.7	383.4	4.6
	S53.51	0.55	0.028	0.055	0.002	0.0725	0.0039	345	12	940	100	338	6.95	345	12
	S53.105	0.498	0.072	0.0513	0.0027	0.0684	0.0094	322	16	830	280	480	7.2	322	16
	S53.61	2.71	0.18	0.2119	0.0093	0.0962	0.0035	1236	50	1543	84	329	7.31	1236	50
	S53.89	0.419	0.016	0.0552	0.001	0.0553	0.0025	346.6	6.2	371	97	378	7.5	346.6	6.2
	S53.06	1.071	0.031	0.1042	0.0022	0.0741	0.0012	639	13	1035	32	1143	8.04	639	13
	S53.91	0.405	0.022	0.0516	0.0015	0.0566	0.0029	324.3	9.5	400	110	333	8.2	324.3	9.5
	S53.63	1.058	0.074	0.0993	0.0027	0.0768	0.005	610	16	1010	77	830	8.62	610	16
	S53.60	0.465	0.043	0.0549	0.0011	0.0613	0.0055	344.2	7	470	130	244	9.06	344.2	7
	S53.19	2.056	0.066	0.1857	0.0048	0.0799	0.0016	1097	26	1182	39	452	9.3	1097	26
	S53.16	0.483	0.073	0.0568	0.0033	0.061	0.01	356	20	400	290	114	9.9	356	20
	S53.38	0.452	0.011	0.05874	0.00095	0.0556	0.0014	367.9	5.8	412	59	1038	9.9	367.9	5.8
	S53.98	0.56	0.08	0.0515	0.0019	0.077	0.011	324	12	1100	290	540	10	324	12
	S53.10	0.415	0.021	0.0541	0.0014	0.0551	0.0028	339.3	8.4	360	110	272	11.15	339.3	8.4
	S53.55	0.504	0.019	0.0568	0.0011	0.0639	0.0022	356.3	7	699	71	1495	11.5	356.3	7
	S53.46	0.43	0.015	0.0578	0.001	0.054	0.0018	362.1	6.4	336	73	655	15.6	362.1	6.4
	S53.52	0.418	0.012	0.05604	0.00089	0.0539	0.0015	351.4	5.4	361	68	775	16	351.4	5.4

Sample Name	Source File	Final207_235	Final207_235_Int2SE	Final206_238	Final206_238_Int2SE	Final207_206	Final207_206_Int2SE	FinalAge206_238	FinalAge206_238_Int2SE	FinalAge207_206	FinalAge207_206_Int2SE	Approx_U_PPM	Final_U_Th_Ratio	Best Age (Ma)	BA err
	S53.49	1.04	0.41	0.0581	0.0036	0.114	0.036	364	22	1350	440	444	17.2	364	22
	S53.29	0.67	0.12	0.0567	0.0024	0.083	0.016	356	15	1210	290	260	18.9	356	15
	S53.23	1.798	0.052	0.17	0.0046	0.077	0.0014	1011	25	1127	41	1091	20.8	1011	25
	S53.58	0.516	0.022	0.05759	0.00094	0.0649	0.0026	360.9	5.7	724	75	784	26.1	360.9	5.7
	S53.64	0.463	0.018	0.05869	0.00098	0.0577	0.0023	367.6	5.9	488	78	500	26.7	367.6	5.9
	S53.14	0.408	0.015	0.0531	0.001	0.0569	0.002	333.4	6.3	448	74	447	28.8	333.4	6.3
	S53.87	0.398	0.01	0.05236	0.00053	0.055	0.0015	329	3.2	389	62	709	30.1	329	3.2
	S53.88	0.504	0.024	0.0567	0.0018	0.0639	0.0038	356	11	720	120	1002	32.3	356	11
	S53.93	0.3842	0.0069	0.05188	0.00056	0.05359	0.00093	326	3.4	342	39	2042	33.7	326	3.4
	S53.90	0.501	0.03	0.0579	0.0033	0.0606	0.0035	363	20	630	150	690	34.6	363	20
	S53.22	0.635	0.073	0.0588	0.0016	0.0765	0.0083	368.1	9.6	1030	190	332	36.5	368.1	9.6
	S53.109	0.434	0.011	0.05706	0.00097	0.0551	0.0012	357.6	5.9	409	48	1450	40	357.6	5.9
	S53.47	0.599	0.059	0.0607	0.0012	0.0701	0.0071	379.7	7.3	920	190	550	49.9	379.7	7.3
	S53.17	0.4448	0.0091	0.06	0.00064	0.0537	0.0011	375.6	3.9	342	45	1182	52.68	375.6	3.9
	S53.02	0.51	0.032	0.0572	0.0026	0.064	0.0049	358	16	690	170	260	56.8	358	16

Appendix B: Geologic Map of the Clairmont Springs 7.5-Minute Quadrangle



Base topographic map U.S. Geological Survey 1980. Revised 1987.
Produced in cooperation with the U.S. Geological Survey, National Cooperative Geologic Mapping Program

Transverse Mercator projection. 1927 North American datum
10,000-foot grid based on Alabama (East) rectangular coordinate system

Map rotated 0.5 degrees clockwise for display

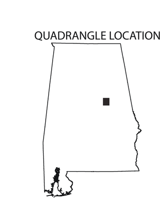
This geologic map was funded in part by the USGS National Cooperative Geologic Mapping Program under EDMAP award number G20AC00298.

UTM Grid and 2014 Magnetic North Declination at Center of Sheet

SCALE 1:24,000

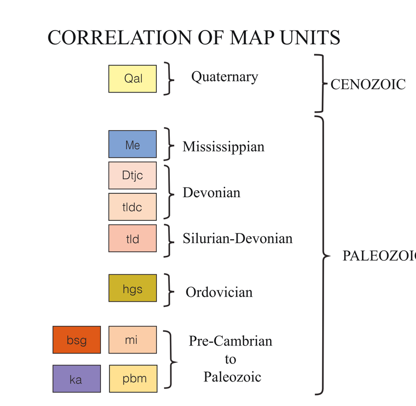
CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

QUADRANGLE LOCATION



Digital database by A. Ionescu

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Qal — **Alluvium and low terrace deposits (Quaternary):** Unconsolidated deposits of sand, silt, clay, and gravel.

Me — **Erin Slate (Lower Mississippian):** grey to black graphitic phyllite and chlorite-sericite phyllite interbedded with occassional beds of black slate

Dtjc — **Jemison Chert and Chulafinnee Schist undifferentiated (Devonian):** gray-white to orange-red medium-grained, fissile quartz sandstone and schist interbedded with light to dark greenish-grey chlorite-sericite ± graphite phyllite with occassional quartzite

tldc — **Cheaha Quartzite (Devonian):** white to light-gray, medium to coarse grained quartz sandstone, quartzite, and metaconglomerate with occassional chlorite-sericite phyllite. Metaconglomerate quartz clasts range from 2 to 20 cm in length.

tld — **Lay Dam Formation (Silurian to Devonian):** foliated green-gray or tan-orange chlorite-sericite ± graphite phyllite with minor layers of dark green metagraywacke and occassional interbedded graphitic slate

hgs — **Hillabee Greenstone (Ordovician):** foliated mafic phyllite with minor interlayers of light green-brown, fine-grained greenstone

mi — **Mad Indian Group (Pre-Cambrian to Paleozoic):** medium to coarse-grained feldspathic muscovite-biotite-garnet schist with local kyanite and sillimanite and occassional beds of micaceous quartzite; also includes pegmatite and deformed tonalite inliers correlated with the Bluff Springs Granite

pbm — **Poe Bridge Mountain Group (Pre-Cambrian to Paleozoic):** feldspathic graphite schist, garnet-muscovite-biotite schist, graphitic quartzite, and garnet quartzite; irregular pockets of garnetiferous mafic rock and calc-silicate gneiss with a garnet + clinopyroxene + hornblende + plagioclase assemblage are present but uncommon; also includes irregular lenses of orthoamphibolite associated with the Ketchepedrakee Amphibolite

MAFIC AND ULTRAMAFIC ROCKS

ka — **Ketchepedrakee Amphibolite (Pre-Cambrian to Paleozoic):** dark green to black layered to massive orthoamphibolite; includes all amphibolite associated with the Poe Bridge Mountain Group

INTRUSIVE ROCKS

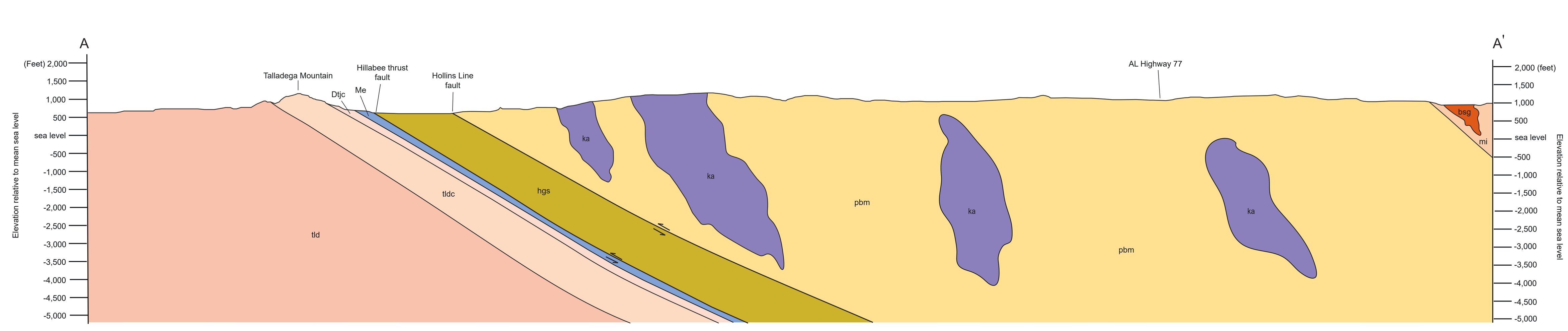
bsg — **Bluff Springs Granite:** leucocratic quartz diorite (tonalite) associated with the Mad Indian Group

SYMBOLS FOR GEOLOGIC MAP

- Contact, located very approximately
- Contact, concealed beneath mapped units
- Thrust fault, located very approximately, sawteeth on upper plate
- Thrust fault, concealed beneath mapped units
- Strike and dip of bedding
- Strike and dip of metamorphic foliation

SYMBOLS FOR CROSS SECTION A-A'

- Stratigraphic contact
- Fault showing relative movement



GEOLOGIC MAP AND CROSS SECTION OF THE CLAIRMONT SPRINGS 7.5-MINUTE QUADRANGLE, TALLADEGA AND CLAY COUNTIES, ALABAMA

by
Adelie Ionescu, Tessa C. Mills, Matthew P. McKay

2021

Missouri State UNIVERSITY