Pamphlet to accompany:

NCGS Open File Report 2026-01

Compiled bedrock geologic map of the northern portion of the Southern Pines 30' x 60' Quadrangle (Southern Pines 100K), North Carolina – Manuscript Map (version 4/24/2026)

New data collection and compilation work by: Philip J. Bradley, Garett J. Thompson, Qingxin Zhang, Douglas B. Hill, Ezra T. Becker, and Katherine E. Pelt

Cartographic representation by Garett J. Thompson, Philip J. Bradley, and Michael A. Medina

New geochronology data reduction and interpretation by Adam C. Curry

2026

Reference:

Bradley, P.J., Thompson, G.J., Zhang, Q., Becker, E.T., Hill, D.B., and Pelt, K.E., 2026, Compiled Bedrock Geologic Map of the northern portion of the Southern Pines 30' x 60' Quadrangle (Southern Pines 100K), North Carolina, North Carolina Geological Survey Open-file Report 2026-01, scale 1:100,000, in color, with accompanying pamphlet.

BACKGROUND

This compiled bedrock geologic map, partially supported by the U.S. Geological Survey (USGS) National Cooperative Geologic Mapping Program under STATEMAP, completes year 1 of a 2-year project to compile the entire bedrock portion of the Southern Pines 30'x 60' Quadrangle (Southern Pines 100K) in support of the USGS US Geoframework Initiative's (USGI) vision for a nation-wide, seamless geologic map.

The goal of this compilation effort is to produce a new 1:100,000-scale digital geologic map of the study area using the USGS Geologic Mapping Schema (GeMS). When available, geologic data at scales more detailed than 1:100,000-scale were used (i.e. 1:24,000-scale data). The FY24 phase of the compilation effort compiled legacy data at scales ranging from 125K- to 24K-scale in the northern part of the Southern Pines 100K. From May 2024 to June 2025, NCGS staff conducted targeted foot and vehicle traverses to validate contacts from legacy sources and to collect new field data. Close attention was paid to rectifying edge-match issues between legacy data and recent 24K-scale mapping to allow accurate transitions of map units from areas with detailed data to areas of legacy data collected at smaller scales (e.g. 48K). More detailed and closer-spaced traverses targeted areas of structural or stratigraphic complexity. Less detailed and wider spaced traverses were used in areas of less complex structure or rock types (e.g. areas underlain by homogenous plutons received less attention). LiDAR data displayed as hillshade was used to help identify lineaments along with possible faults and dikes that may be groundwater sources or preferred pathways for groundwater contaminants.

PAST WORKERS

Specific data sources are listed in the DataSources table in the geodatabase. Major data sources are provided in the index of workers figure on the map layout.

GEOLOGIC SETTING

Exposed bedrock and sediments in the Southern Pines 100K includes several major geologic elements (see figure on map). From west to east, they are: the Carolina terrane, Deep River Triassic basin (Sanford- and Wadesboro-sub-basins), the Carolina terrane east of the Wadesboro sub-basin, the Lilesville, Millstone Lake and newly identified Pinebluff plutons, the Ellerbe Triassic sub-basin, the easternmost Carolina terrane, the newly identified Upper Little River terrane and large areas of Coastal Plain sedimentary deposits. Bedrock of the Crabtree terrane and Spring Hope terrane are interpreted to be present in the southeastern portion of the map area and buried by Coastal Plain sedimentary deposits. Older alluvium deposits are present along major drainages in addition to modern floodplain deposits. This map is a compiled bedrock map surficial sediments are not displayed.

Interpretation of Sub-Coastal Plain Geology

Large portions of the Southern Pines 100K are overlain by Atlantic Coastal Plain sediments – see inset figure on geologic map. For areas in which the bedrock is covered by Coastal Plain sediments, data from the NC Department of Transportation Geotechnical Engineering Unit, boring data (NCDOT, 2026) and Lawrence and Hoffman (1993) - Geology of basement rocks beneath the North Carolina Coastal Plain - were utilized. The sub-Coastal Plain geology of Lawrence and Hoffman (1993) was based on widely spaced drilled data and geophysical data that included aeromagnetic maps (Zietz et al., 1984) and Bouguer gravity maps (Black, 1986; Daniels and Leo, 1985). Additionally, the locations of some diabase dikes and terrane boundaries were modified from Lawrence and Hoffman (1993) after review of the preliminary magnetic survey map from the Piedmont Bridge South Magnetic and Radiometric Survey (USGS Piedmont Bridge, 2025). Additional edits to the sub-Coastal Plain geology in the map area will likely occur after the official release and review of the new Piedmont Bridge data.

CAROLINA TERRANE

The Carolina terrane underlies the northwest portion of the map area. The Carolina terrane is composed of Neoproterozoic to Cambrian metamorphosed volcanic, volcano-sedimentary, sedimentary and intrusive rocks (Hibbard et al., 2002; and Hibbard et al., 2006). The Carolina terrane is separated into three lithotectonic units: 1) the Hyco arc, 2) the Aaron Formation of the redefined Virgilina sequence (Hibbard et al., 2013) and 3) the Albemarle arc (Hibbard et al., 2013).

COMPILED GEOCHRONOLOGY DATES FOR THE CAROLINA TERRANE IN THE SOUTHERN PINES 100K

As part of the compilation efforts within the Southern Pines 100K, crystallization age and detrital zircon age data was compiled. Additionally, through STATEMAP support (FY24), new samples were collected and analyzed. Geochronologic data is summarized in Table 1 with references. Sample locations are identified and labeled on the geologic map. Geochronology plots and tables of NCGS collected samples are provided in Appendix A.

Table 1: Summary of available age dates in the Southern Pines 100K. Refer to main map for sample locations. Geochronology plots and tables of NCGS collected samples are provided in Appendix A.

Label	Sample ID	Rock Type	Unit	Date	Source	Comments
A	SB-9	rhyolitic tuff	Albemarle Arc-Uwharrie Volcanic Complex	554 ± 15 Ma weighted average of six $^{206}Pb/^{238}U$ ages for zircon grains by SHRIMP methods	U-Pb zircon crystallization age (Ingle et al., 2003)	Location resampled by NCGS – See sample B.
B	NCGS Station SP100K-550027	rhyodacite	Albemarle Arc-Uwharrie Volcanic Complex	537.6 ± 2.8 Ma (MSWD = 1.8)	U-Pb zircon dates by AZ LaserChron with data interpretation by A. Curry (2025), preliminary data	Abner Mountain area. Resample of Ingle et al. (2003) SB-9.
C	NCGS Station SP100K-550264	rhyodacite	Albemarle Arc-Morrow Mountain Rhyodacite	553.2 ± 2.5 Ma (MSWD = 1.6)	U-Pb zircon dates by AZ LaserChron with data interpretation by A. Curry (2025), preliminary data	Troy landfill area
D	NCGS Station SP100K-550946	tuffaceous pebbly sandstone	Albemarle Arc	MDA - ca. 524 Ma	Detrital zircon dates (AZ LaserChron). Data interpretation by A. Curry (2025), preliminary data	Seagrove formation of the Robbins area - volcaniclastic sedimentary rock
E	NCGS Station SP100K-550363	conglomeratic sandstone	Albemarle Arc	MDA - ca. 543 Ma	Detrital zircon dates (AZ LaserChron). Data interpretation by A. Curry (2025), preliminary data	Seagrove formation of the Biscoe area - volcaniclastic sedimentary rock

F	Lemon Springs Quarry sample	Metagranite	Easternmost Carolina terrane	Rb-Sr date of 429+-10 Ma	Kish and Campbell, 1986	Minimum age. Rock is likely older.
G	NCGS Station SP100K-551063	rhyodacite	Albemarle Arc-Morrow Mountain Rhyodacite	550.4 ± 4.2 Ma (MSWD = 0.44)	U-Pb zircon dates by AZ LaserChron with data interpretation by A. Curry (2025), preliminary data	Rhyodacite dome in Robbins area

HYCO ARC AND THE HYCO FORMATION

In the map area and adjacent Chapel Hill 100K, the Hyco Arc consists of the Hyco Formation which includes ca. 633 to 612 Ma (Wortman et al., 2000; Bowman, 2010; Bradley and Miller, 2011 and Bowman et al., 2013) metamorphosed layered volcaniclastic rocks and plutonic rocks. Dating by Barefoot (2015), indicates that magmatism in the lower portions of the Hyco Formation may be as old as ca. 650 Ma. Available age dates (Wortman et al., 2000; Bradley and Miller, 2011) indicate the Hyco Formation may tentatively be divided into lower (ca. 630 Ma) and upper (ca. 615 Ma) portions with an apparent intervening hiatus of magmatism.

Map units of metavolcanic and metavolcaniclastic rocks include various lithologies that, when grouped together, are interpreted to indicate general environments of deposition. The dacitic lavas and tuffs unit is interpreted to represent dacitic domes and proximal pyroclastics. The andesitic to basaltic lavas (with tuffs or conglomerates) units are interpreted to represent eruption of intermediate to mafic lava flows and associated pyroclastic and/or epiclastic deposits. The epiclastic/pyroclastic units are interpreted to represent deposition from the erosion of dormant and active volcanic highlands. Deposition of the primary volcanics ranged from subaerial to subaqueous with concomitant deposition of various types and volumes of volcanic-derived sediments. Some of the metavolcaniclastic units within the map area display lithologic relationships similar to dated units present in northern Orange and Durham Counties. Due to these similarities, the metavolcanic and metavolcaniclastic units have been tentatively separated into upper and lower portions of the Hyco Formation; geochronologic data in the map area is needed to confirm this interpretation.

Generally, rock units of the Hyco Formation consist of packages of metamorphosed volcanic rocks and their volcano-sedimentary detritus. Hyco Formation volcanic rocks and sedimentary rocks are quartz crystal *poor* or quartz is absent in hand sample. In contrast (discussed in a later section), the Seagrove formation sedimentary rocks and Uwharrie Volcanic Complex (Uwharrie Formation) volcano-sediments and volcanic rocks range from quartz crystal-rich to having quartz locally present.

Within the Southern Pines 100K, Hyco Formation related units outcrop in three locations: 1) The main outcrop area of the Hyco Formation is present in the north-central portion of the map in the High Falls area (north of Robbins). This area is the southwest extension of the bulk of the Hyco Formation that forms continuous map units north and northeast to the VA-NC State line. 2) Northeast of Troy is an outlier of Hyco Formation rocks that is disconnected from the main outcrop pattern. This area marks the northeast end of the Troy anticline. Complexly deformed rocks that are locally hydrothermally altered are present. The area is home to the Cottonstone Mountain hydrothermal deposit, the Star mine and the Carter mine. The Hyco units are likely part of a dome structure with a high-angle reverse fault marking part of the map unit's eastern boundary. 3) West of Jugtown is another outlier of Hyco Formation rocks that was likely exhumed in an anticline that is disrupted by a thrust fault.

ALBEMARLE ARC UNITS

Age relationships between rocks mapped as the Uwharrie Formation (Conley and Bain, 1965; Stromquist and Sundelius, 1969) and the Albemarle Group (Milton, 1984) are unclear. Traditionally, the Uwharrie Formation has been viewed as being the older substrate to the Albemarle Group (e.g. Butler and Secor, 1991); this interpretation is supported by recent models of intra-arc rifting (Moye, 2023). However, radiometric ages from rocks mapped as Uwharrie Formation suggest that rocks of the Uwharrie Formation and Albemarle Group overlap in age, forming a time transgressive sequence (Pollock et al., 2010 and Hibbard et al., 2013). Before the mapping and new geochronology of this study, the stratigraphic relationships of the rocks yielding younger-than-expected ages compared to the bulk of the Uwharrie Formation were not confidently established. The goals of this new mapping and compilation work was to compile existing maps, rectify edge-match issues, and to collect rock samples for modern geochronologic analysis to start to better define the Uwharrie Formation and its relationship to adjacent units.

Stratigraphically, the main outcome of this new study is the redefinition of the Uwharrie Formation to the Uwharrie Volcanic Complex - a package of lithodemic units that includes metamorphosed: extrusive and shallow intrusive volcanic rocks, volcaniclastic pyroclastic rocks, volcaniclastic sedimentary rocks and sedimentary rocks. Additionally, as part of this study, the Seagrove formation is established and the nomenclature of the Morrow Mountain Rhyodacite Suite is adopted (discussed below in more detail) (Figures 1 and 2). Refinement of the stratigraphy is ongoing.

MORROW MOUNTAIN RHYODACITE SUITE

The Morrow Mountain Rhyodacite Suite is a suite of intrusions with a range of ages and textures that are likely magmatically linked (Boorman et al., 2013 and Moye, 2023b). For this mapping, isolated bodies of rhyodacite surrounded by volcano-sedimentary rocks were grouped as part of the suite. Texturally similar bodies are present in areas mapped as part of the rhyodacitic lavas and tuffs unit of the Uwharrie Volcanic Complex (discussed below).

A summary of existing and new age dates within the Southern Pines 100K map are provided in Table 1. For a summary of existing and new age dates in the Chapel Hill 100K, see the Open-file report of the Chapel Hill 100K (Bradley et al., 2025a).

Ingle et al. (2003) reported TIMS $^{207}Pb/^{206}Pb$ ages of 539±5 Ma for the Morrow Mountain rhyodacite in the Charlotte 100K. Bradley et al. (2025b), reported LA-ICP-MS $^{206}Pb/^{238}U$ weighted mean ages for two samples in the Chapel Hill 100K: A sample from the Seagrove area yielded an age of 536.4 ± 6.1 Ma (MSWD =4.5) and a sample from Caraway Mountain yielded an age of 542.7 ± 5.3 Ma (MSWD = 0.5).

New and unpublished, LA-ICP-MS $^{206}Pb/^{238}U$ weighted mean ages completed in 2025 from samples from the suite include: 548.8 ± 2.8 Ma (MSWD = 1.4) for a sample collected from Daves Mountain in Asheboro, in the Chapel Hill 100K (Bradley et al., 2025a); 550.4 ± 4.2 Ma (MSWD = 0.44) for a sample collected from the Robbins area in the Southern Pines 100K (geochronology data location G); and 553.2 ± 2.5 Ma (MSWD = 1.6) for a sample collected near the landfill in the Troy area in the Southern Pines 100K (geochronology data location C). Two samples were analyzed from the eastern portion of the Charlotte 100K in the vicinity of Dennis Mountain in the Uwharrie National Forest. LA-ICP-MS $^{206}Pb/^{238}U$ weighted means ages from the samples yielded: 539.4 ± 1.8 Ma (MSWD = 1.6) (sample CLT100k_BoormanE7_CGS6) and 546.0 ± 3.1 Ma (MSWD = 1.6) (sample CLT100k_BoormanE9_CGS7).

The previously existing and new age data indicate that volcanism of the Morrow Mountain Rhyodacite Suite spanned from ca. 553 Ma to ca. 536 Ma and was contemporaneous with the Uwharrie Volcanic Complex (discussed below) and deposition in the Albemarle Group.

REDEFINITION OF THE UWHARRIE FORMATION TO UWHARRIE VOLCANIC COMPLEX

Seiders (1981) separated the Uwharrie Formation into multiple units that include metamorphosed felsic lavas, dikes and volcanic necks of varying textures along with associated coarse-grained volcaniclastic, pyroclastic and sedimentary rocks. The volcaniclastic rocks include metamorphosed tuffaceous sandstones, conglomeratic sandstones, and siltstones with lesser amounts of fine- to coarse tuff. Fiamme-like shaped clasts are common in the conglomerates, sandstones and tuffs. Quartz and feldspar crystal fragments are common in the sedimentary components, tuffs and lavas. Subordinate amounts of intermediate to mafic volcanic and volcano-sedimentary rocks and find grained clastics (siltstones and mudstones) are present in the Uwharrie Formation units of Seiders (1981).

Previous geochronological data indicated that the Uwharrie Formation is ca. 550 Ma (Ingles et al., 2003). Pollock et al. (2010), reported a youngest detrital zircon age of ca. 545 Ma from a sample reportedly from the oldest portions of the Formation. Hibbard et al. (2013) speculated that the Uwharrie Formation may be time transgressive or previous mapping was in error and that additional geochronologic and mapping work is needed to properly determine the extent and nature of the Uwharrie Formation. Recent geochronologic data from rocks assigned to the Uwharrie Formation indicate that problems exist with the definition of the Formation. Detrital zircon and crystallization ages from this study indicate that units previously interpreted as intrusive into surrounding volcaniclastic units are in disconformable contact (e.g. - Daves Mountain in the Asheboro area in the Chapel Hill 100K is older than the surrounding clastic unit). Additionally, a sample of rhyodacite from the “core” of the Uwharrie Formation in the Chapel Hill 100K yields a crystallization age of ca. 537 Ma (Bradley, et al., 2025a) which is inconsistent with the area being the oldest portions of the Formation. According to the

North American Stratigraphic Code, a Formation should have a defined stratigraphic position. Geochronologic data indicates that rocks mapped as part of the Uwharrie Formation are packages of rocks that represent volcanic centers and related volcaniclastic debris that vary in age. As such, the Uwharrie Formation may be better defined as a package of lithodemic units. While additional investigation into the stratigraphic nomenclature continues, for this map, the Formation nomenclature is dropped and Uwharrie Volcanic Complex is used to emphasize the volcanic origin and restricted regional distribution of the package of rocks.

Uwharrie Volcanic Complex (Uwharrie Formation) legacy and new geochronology data

A summary of existing and new age dates within the Southern Pines 100K map are provided in Table 1. For a summary of existing and new age dates in the Chapel Hill 100K, see the Open-file report of the Chapel Hill 100K (Bradley et al., 2025a).

Ingle et al. (2003) reported the weighted average of six $^{206}Pb/^{238}U$ ages for zircon grains by SHRIMP methods of 554 ± 15 Ma for a sample from the Uwharrie Formation (SB-9) in unit Zurlt in the Southern Pines 100K (geochronology data location A). This location was resampled as part of this study and yielded LA-ICP-MS $^{206}Pb/^{238}U$ weighted means ages of 537.6 ± 2.8 Ma (MSWD = 1.8) (geochronology data location B). Goliber and Coleman (2023) reported a CA-ID-TIMS weighted mean age of 548.7 ± 1.1 Ma from a felsic volcanic rock in the unit in the Chapel Hill 100K. A new and unpublished LA-ICP-MS $^{206}Pb/^{238}U$ weighted mean age yielded 537.4 ± 5.7 Ma (MSWD = 0.86) for a sample collected from Luther Place trail area in the Uwharrie Volcanic Complex in the Chapel Hill 100K.

New and unpublished LA-ICP-MS U-Pb detrital zircon ages from the Chapel Hill 100K include: maximum depositional ages (MDA) of 533 Ma for sample CH100K-3675; MDA of 526 Ma for sample CH100K-3834; and MDA of 552 Ma for sample CH100K-Ben-165.

The previously existing and new age data indicates that volcanism and sedimentation of the Uwharrie Volcanic Complex spanned from ca. 552 Ma to ca. 526 Ma and was contemporaneous with the deposition of the Seagrove formation and deposition in the Albemarle Group (Figures 1 and 2).

ESTABLISHMENT OF THE SEAGROVE FORMATION (informal name)

New mapping in the Chapel Hill and Southern Pines 100Ks, where the Albemarle arc overlaps the Hyco arc, has confirmed the interpretation by Harris (1984) of the presence of a coarse-grained (sand-rich) submarine fan system that is contemporaneous with volcanism. Harris and Glover (1988) assigned their submarine fan deposits to the Aaron Formation. While Harris (1984) links the submarine fan to the Hyco arc, the new mapping of this study, coupled with new crystallization and detrital zircon ages, link the deposits to the Albemarle arc. This study establishes the Seagrove formation and defines its source as the volcanic rocks of the Uwharrie Volcanic Complex with a smaller component from the Hyco arc.

Extensive areas identified as Aaron Formation by Harris (1984) and Harris and Glover (1988) have been tentatively assigned to the newly defined Seagrove formation (this map). Additionally, some areas previously mapped as Uwharrie Formation are included in the Seagrove formation. Additional work is needed on the nature of the Aaron Formation, if the Aaron Formation turns out to be wholly Albemarle arc related, the Seagrove formation nomenclature can be abandoned.

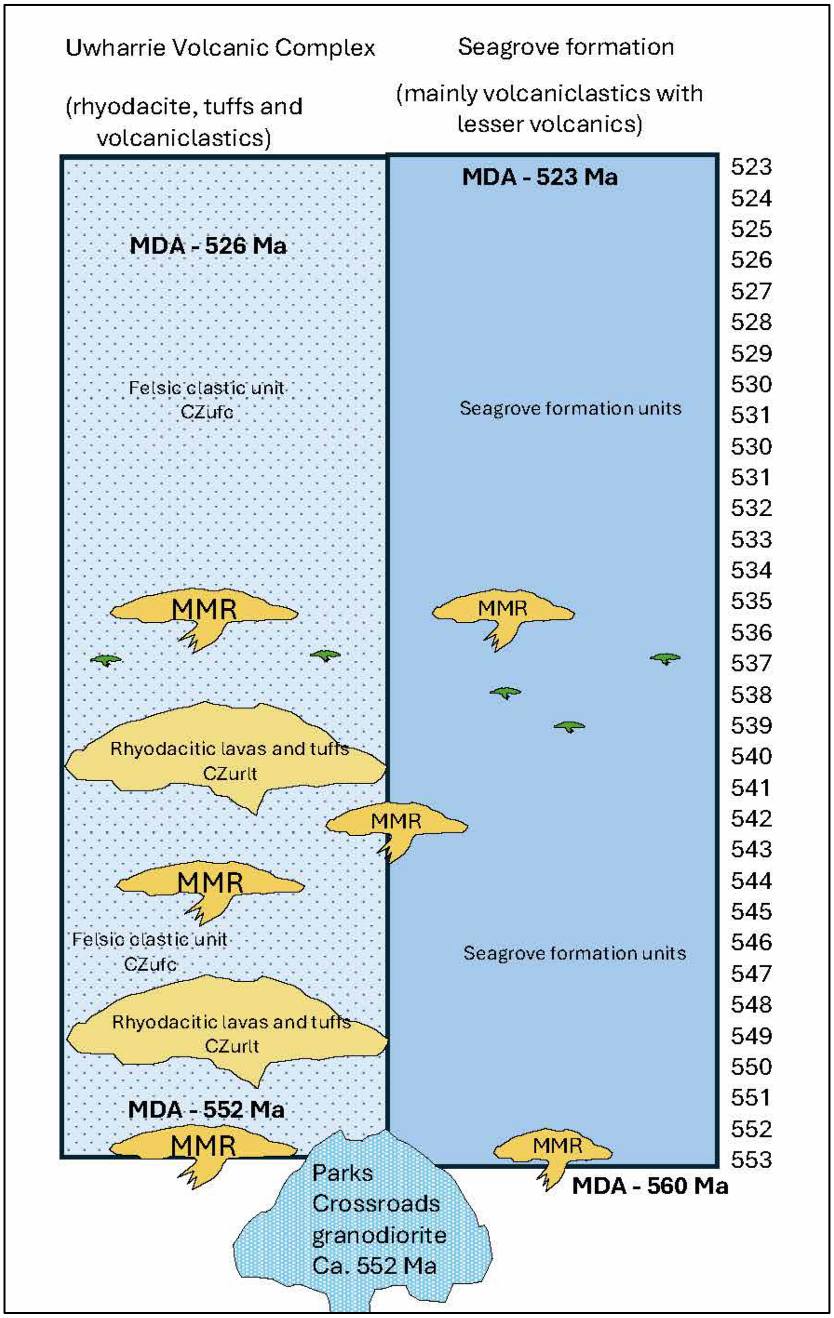

Figure 1: Generalized stratigraphy of the Uwharrie Volcanic Complex and Seagrove formation.

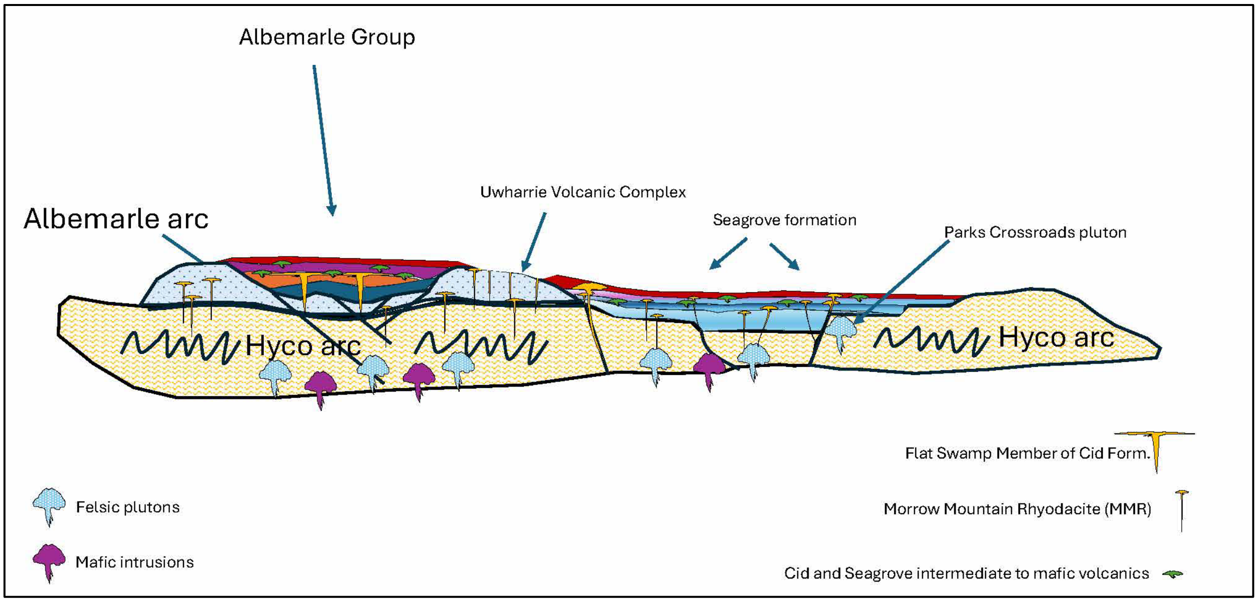

Figure 2: Sketch of proposed redefined Uwharrie Volcanic Complex and newly defined Seagrove formation and their relationship to the Albemarle Group - ca. 560 to 523 Ma.

SEAGROVE FORMATION (informal name)

An overall defining characteristic of the Seagrove formation is the presence of quartz-bearing conglomerates, conglomeratic sandstones and sandstones interlayered with varying amounts of finer-grained volcaniclastic sediments that include bedded siltstones and mudstones. Individual units of the Seagrove formation are generally defined by the abundance of coarse-grained clastic sediments with respect to fine-grained clastic sediments. Proximal facies (proximal to Uwharrie Volcanic Complex units) are dominated by immature tuffaceous conglomerates, conglomeratic sandstones and sandstones with abundant clasts of rhyodacite and crystal fragments of plagioclase and quartz. Quartz crystal content varies locally. Medial to distal facies are dominated by conglomeratic siltstones (graywacke), sandy siltstones, siltstones, bedded siltstones and mudstones. Lenses of quartz-bearing conglomeratic sandstones and sandstones are locally present (Figure 3).

Data from Seiders's (1981) map in the Asheboro area was utilized in the compilation effort for the Chapel Hill 100K and for on-strike units in the Southern Pines 100K. Following accepted regional stratigraphy, Seiders (1981) separated his units from oldest to youngest, into the Uwharrie Formation and the Tillery and Cid Formations of the Albemarle Group (Stromquist and Sundelius, 1969 and Milton, 1984). The units of Seiders (1981) were maintained for the most part except in areas where new or recent age dates required modifications (ex. portions of the unit CZufc (felsic volcaniclastic rocks) on the east side of the Seiders (1981) map were reassigned to the Seagrove formation and CZups (porphyritic felsite near Seagrove) was reassigned to the Morrow Mountain Rhyodacite).

SEAGROVE FORMATION NEW GEOCHRONOLOGY DATA

Pollock et al. (2010) reported a youngest detrital zircon of ca. 545 Ma from the Erect member of the Uwharrie Formation (now included in the Seagrove formation). Recent LA-ICP-MS U-Pb zircon analyses from sandstones from Seagrove formation units in the Chapel Hill 100K indicate the presence of abundant detrital zircons associated with the Albemarle arc (Bradley, 2023; Pelt and Bradley, 2023). A re-evaluation of these zircon analyses yields the following: for NCGS sample Coleridge-3055, there is a distinct age distribution that is < 600 Ma and all MDAs are between ca. 545 Ma and ca. 549 Ma; for NCGS sample Bear Creek-626, all MDAs are between ca. 551 Ma and ca. 560 Ma (T. LaMaskin, personal communication, 2025).

New and unpublished LA-ICP-MS U-Pb zircon analyses from additional Seagrove formation unit samples in the Chapel Hill and Southern Pines 100K map areas includes: MDA of 559 Ma for sample COL-8005 in the Chapel Hill 100K; MDA of 554 Ma for sample COL-472 in the Chapel Hill 100K; MDA of 543 Ma for sample SP100K-550363 in the Southern Pines 100K; MDA of 533 Ma for sample CH100K-3675 in the Chapel Hill 100K; MDA of 526 Ma for sample CH100K-3834 in the Chapel Hill 100K; MDA of 524 Ma for sample SP100K-550946 in the Southern Pines 100K; and MDA of 523 Ma for sample CH100K-3839 in the Chapel Hill 100K. A summary of existing and new age dates within the Southern Pines 100K map are provided in Table 1. For a summary of existing and new age dates in the Chapel Hill 100K, see the Open-file report of the Chapel Hill 100K (Bradley et al., 2025a).

The previously existing and new age data indicate that sedimentation of the Seagrove formation spanned from ca. 560 Ma to ca. 523 Ma and was contemporaneous with the Uwharrie Volcanic Complex and deposition in the Albemarle Group.

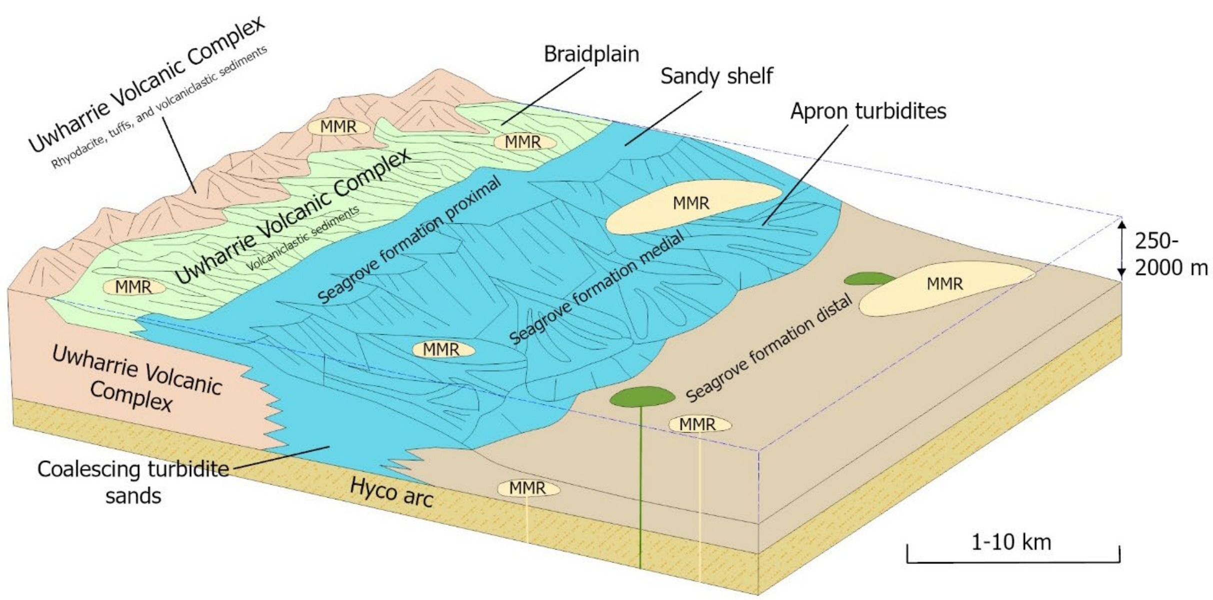

Figure 3: Preliminary interpretation of the environment of deposition of the newly defined Seagrove formation with respect to the Uwharrie Volcanic Complex. Base figure after Stow and Mayall (2000) and Reading and Richards (1994) of a sand-rich submarine fan system. Green units are andesitic to basaltic volcanics.

ALBEMARLE GROUP

TILLERY FORMATION

Tillery Formation mudstones (CZtm) and intermediate to mafic volcanics (CZtimv) are present in the northwest corner and west-central portion of the map area. These map areas are immediately on strike with mapped units in the Charlotte 250K (Goldsmith et al., 1988) and the more detailed maps of Stromquist and Henderson (1985) and Conley (1962a). Detailed mapping by Upchurch (1968) interpreted the contact of the Tillery Formation (argillite facies unit of Upchurch (1968)) and units to the east (tuffaceous-sediment facies of Upchurch (1968) now mapped as part of the Seagrove formation) as gradational. Mapping of this study interprets the contact between the Tillery Formation and Seagrove formation as gradational.

ALBEMARLE ARC RELATED PLUTONIC ROCKS

Three small outcrop areas of fine-to medium-crystalline granodiorite (Zagd-p), interpreted to be related to the Parks Crossroads pluton, are present in the map area. Two of the outcrop areas are located northwest of Ether. One is surrounded by the CZsehc unit, the other is surrounded by unit CZmmr-ps. The third, and largest of the outcrop areas, is located southwest of Dover and is surrounded by unit CZseb.

The main outcrop area of the Parks Crossroads pluton (Zagd-p) is located in the west-central portion of the Chapel Hill 100K. Morrison and Coleman (2023) reported a new U-Pb zircon age for the Parks Crossroads pluton of ca. 552 Ma. Metamorphosed volcaniclastic rocks of the Seagrove formation have MDAs between ca. 551 Ma and ca. 560 Ma (T. LaMaskin, personal communication, 2025). As such, the Seagrove formation units were likely disconformably deposited on top of the exhumed and eroded plutonic rocks. Unit CZmmr-ps has a crystallization age of ca. 536 Ma (Bradley et al., 2025); as such, the outcrop area is likely a xenolith of older rock in the younger rhyodacite.

FOLDS IN THE CAROLINA TERRANE

Folds in Hyco and Aaron Formations

The Hyco Arc and Aaron Formation lithologies were folded and subjected to low grade metamorphism during the ca. 578 to 554 Ma (Pollock, 2007; Pollock et al., 2010) Virgilina deformation (Glover and Sinha, 1973; Harris and Glover, 1985; Harris and Glover, 1988; and Hibbard and Samson, 1995). In the Chapel Hill 100K, original layering of Hyco Formation lithologies is observed, ranging from shallowly to steeply dipping. The range of structural attitude is interpreted to be a result of open to tight folds that are locally overturned.

Rocks in the map area were also subjected to the ca. 450 Ma Cherokee deformation and low-grade metamorphism (Hibbard et al., 2010 and 2012). Evidence of Cherokee deformation in the map area is scarcely seen in Hyco Formation units. Evidence is best exposed in area pyrophyllite mines where outcrop-scale folds deform an earlier foliation (see field trip stop 7 in Clark et al., 2011). This folding is associated with local deformation along several identified high-angle reverse faults in the map area (e.g. Glendon Fault and Robbins Fault).

In general, Hyco Formation rock units have been affected by the Virgilina and Cherokee deformations. Both deformations were generally co-planar, and as such, the metamorphic foliations in most locations are indistinguishable. The typical close-to-tight fold geometry of Hyco related units may be the result of the tightening of Virgilina deformation folds by the Cherokee deformation.

Folds in Albemarle arc units

Albemarle arc units have been affected by the Cherokee deformation. Folds attributed to the Cherokee deformation are generally open folds and include the well-known Silver Valley Syncline, Denton Anticline, New London Syncline and Troy Anticline in the western portions of the terrane. The hinge line of the Troy Anticline enters the map area near the west-central edge of the map and extends toward the northeast and ends within a Hyco Formation unit interpreted as a local culmination of the Troy Anticline. The anticline then enters a depression, extending to the northeast where it exposes additional Hyco Formation rocks. The southeastern limb of the Troy Anticline is disrupted by high-angle reverse and thrust faulting. The Peachland syncline (Randazzo, 1972 and Moye, 2018) is a parasitic fold located south of the Troy anticline, which plunges southwest and exposes Tillery Formation metasediments to the south of Wadesville. The hinge of the Peachland syncline is traced discontinuously northeast for a few miles.

FAULTS

High-angle reverse faults

Several terrane-internal ductile faults have been recognized in Chatham, Moore and Montgomery counties within the Carolina terrane. The best known are the Glendon and Robbins faults, which have long been recognized by past workers (e.g. Stuckey, 1928 and Conley, 1962b). The Glendon Fault is a high angle reverse fault that is discontinuous and a locus of pyrophyllite alteration for multiple miles from northeast Moore County into southern Chatham County. Portions of the Glendon Fault are interpreted to be parallel to the axial surfaces of regional-scale overturned folds and locally disrupting an anticline near its crest (Green et al., 1982 and Klein, 1985). In general, the Glendon Fault is a zone of intense deformation ranging from 10 to 50 meters wide with abundant small-scale folds and fractures along with deformed and undeformed quartz veins, indicating a complicated movement history (Klein, 1985). Quartz veins may be folded and high-strain foliations are present within the fault zone, overprinting and/or transposing primary bedding and regional foliation. The Robbins Fault, present in the Robbins area, is well documented by Powers (1993), and like the Glendon Fault, is a zone of pyrophyllite alteration and complex deformation. Main movement on the Glendon and Robbins faults is speculated to be related to the Cherokee deformation.

Several other high-angle reverse faults with varying degrees of hydrothermal alteration were identified during mapping. In Chatham County, metamorphic foliation data indicates that the dip of the foliation progressively becomes shallower to the southeast approaching the high-angle faults. In the immediate area of the faults, sericite (± pyrophyllite) phyllites and schistose phyllites with composite-like fabrics are common. It is interpreted that the older foliation has been transposed to a younger phyllonitic foliation within the fault zones.

Thrust faulting in the Carolina terrane?

Newly collected structural data by NCGS staff and compiled structural data from Carpenter (1999) and Hibbard (unpublished field data) in the Erect 7.5-Minute Quadrangle area of the Chapel Hill 100K, indicate abundant anomalous shallow dipping foliations and primary beddings consistently dipping northwest. The foliations typically dip less than 54 degrees to the northwest with a significant population of dips between 18-36 degrees. Mineral lineation data is sparse but indicates possible stretching in a northwest to southeast parallel orientation. The nature of these low-lying foliations is not well understood but may be related to thrust faulting and the presence of thrust duplexes(?). Tentatively, a thrust fault has been mapped separating hydrothermally altered volcaniclastic rocks of the Hyco Formation and Seagrove formation rock types. If it's an accurate interpretation, other un-mapped thrust faults may be present in the surrounding areas.

Other faulting

Abundant evidence of brittle faulting is present at the outcrop-scale and map-scale as well as large-scale lineaments (as interpreted from hillshade LiDAR data). Brittle faults and lineaments are interpreted to be associated with arc rifting (Moye, 2023b) and Mesozoic extension. Numerous northwest-southeast trending brittle faults are mapped within the Carolina terrane portion of the map. It is speculated that these faults may have formed during arc-rifting in the Neoproterozoic to Paleozoic and were later reactivated during the Mesozoic. Within the Triassic basin of the map area, there are several named major Mesozoic brittle normal faults, which include the: Jonesboro Fault, Governors Creek Fault and Crawley Creek Fault. Numerous map-scale relay ramps have been mapped by Reinemund (1955) on the west and east sides of the basin.

LiDAR LINEAMENTS

Linear geomorphic features interpreted from hillshade LiDAR are included on the map. The inclusion of LiDAR lineaments is an outgrowth from an NCGS derivative publication – *Groundwater Features Map of Chatham County and Surrounding Areas* (Bradley and Bolich, 2022).

The hillshade LiDAR dataset displays a visually striking network of lineaments that are parallel to diabase dikes and known orientations of brittle faults. Some of these lineaments can be traced for multiple miles across the map area. The lineaments are interpreted to be fracture zones; however, field observations could not confirm the presence of each potential brittle fault. The map area has hundreds of lineaments when viewed at varying scales. Only the major lineaments that are easily visible at 1:50,000- to 1:100,000-scale are identified on the map.

Multiple unmarked geomorphic lineaments are visible when viewed at 1:24,000- to 1:50,000-scale on the elevation data from LiDAR. These minor lineaments extend for short distances (100's to 1000's of feet). Minor lineaments are not indicated on the map but can be identified by a close inspection of the LiDAR data. These minor lineaments may have important implications for site-specific investigations. Site specific studies should review lineaments at the 1:24,000-scale or greater. Like brittle faults, lineaments can widely vary in length and width. Major lineaments extend for miles and have linear topographic expressions that are 100's to greater-than 500 feet wide in some locations.

EASTERNMOST CAROLINA TERRANE

The Easternmost Carolina terrane is located east of the Jonesboro Fault and west of the Upper Little River terrane. In the map area, the terrane is underlain by metamorphosed crystalline rocks of the Cary sequence (Parker, 1979; Farrar, 1985) and meta-intrusive units. The Cary sequence is interpreted to be part of the Carolina terrane but separated from the rest of the terrane by the Triassic basin (Hibbard et al., 2002). One of the main rock units is the Big Lake-Raven Rock schist. In the Cary Quadrangle in the Raleigh 100K, a sample from the unit yielded discordant $^{207}Pb/^{206}Pb$ zircons ages of 573, 574, and 579 Ma, and an upper intercept age of 575 ± 12 Ma, interpreted as the time of crystallization (Goldberg, 1994).

The terrane also includes metamorphosed intrusive rocks that are interpreted to be subvolcanic feeders to the volcanic rocks of the Cary Sequence (Blake et al., 2001). The Lemon Springs pluton is an example of metamorphosed intrusive rocks present in the terrane. A Rb-Sr date of 429±10 Ma (Kish and Campbell, 1986) for the Lemon Springs pluton likely indicates a minimum age.

UPPER LITTLE RIVER TERRANE

Compilation work using unpublished data from Robert J. Butler and new data collected by NCGS staff have identified a map scale body of schist with garnet porphyroblasts up to 4 mm in diameter. The map unit is interpreted to be amphibolite facies and separated from the Easternmost Carolina terrane by a ductile fault. Large outcrops are exposed on Upper Little River. The unit extends into the Fayetteville 100K. Additional work is needed to confirm the presence of a ductile fault (tentatively named Barbeque Creek fault(?) after the nearby Barbeque Creek and the community of Barbeque) along the western boundary of the terrane. To the east, the terrane is bounded by the Nutbush Creek Fault.

CRABTREE TERRANE

The Crabtree terrane is present in the subsurface covered by Coastal Plain Sedimentary deposits. Generally, the Crabtree terrane includes amphibolite facies schists and phyllites. The rock unit in the map area is interpreted as sericite phyllite using geophysical and boring data from Lawrence and Hoffman (1993). The Crabtree terrane is bounded on the west by the Nutbush Creek Fault. The Neuse River Fault separates the Crabtree terrane from the Spring Hope terrane to the east.

SPRING HOPE TERRANE

The Spring Hope terrane is present in the subsurface covered by Coastal Plain Sedimentary deposits. Generally, the Spring Hope terrane includes metamorphosed sedimentary and volcano-sedimentary rocks. The rock units in the map area are interpreted using geophysical and boring data from Lawrence and Hoffman (1993). The Spring Hope terrane is separated from the Crabtree terrane by the Neuse River Fault.

DEEP RIVER TRIASSIC BASIN

A significant portion of the central area of the map is underlain by Triassic-aged sedimentary rocks of the Deep River Triassic basin. A review of the basin geology is provided in Clark et al. (2001). The basin is separated into three sub-basins: Durham, Sanford and Wadesboro. The Colon cross-structure (Campbell and Kimball, 1923 and Reinemund, 1955), located on the Chapel Hill 100K map, is a constriction zone in the basin characterized by crystalline rocks overprinted by complex brittle faulting. The Colon cross-structure marks the transition between the Durham and Sanford sub-basins. The Sanford and Wadesboro sub-basins are present on the Southern Pines 100K map and are interpreted to be continuous but separated by the Pekin cross-structure and under Coastal Plain sedimentary deposits (Olsen et al., 1991). The Ellerbe basin, located in the southern portion of the Southern Pines 100K, is separated from the Wadesboro sub-basin by crystalline rock and Coastal Plain sedimentary deposits. The Ellerbe basin is probably the remnant of Triassic basin fill on top of an exhumed rider block system (Olsen et al., 1991). The Jonesboro Fault is interpreted to bound the Ellerbe basin to the east.

SANFORD AND WADESBORO SUB-BASINS AND ELLERBE BASIN MAP UNITS

In the Sanford sub-basin, three stratigraphic units have been identified and formalized from oldest to youngest as the Pekin, Cumnock and Sanford Formations (Campbell and Kimball, 1923 and Reinemund, 1955). For this STATEMAP FY24 deliverable, a majority of the geologic contacts within the Sanford sub-basin in the northern portion of the Southern Pines 100K were digitized as presented by Reinemund (1955).

STATEMAP FY25 planned compilation work in the southern portion of the Southern Pines 100K will include the digitization of existing maps of Randazzo and Copeland (1976) and Brazell (2013) in the Wadesboro sub-basin and mapping by Dineen (1982) in the small Ellerbe sub-basin. Two stratigraphic units are identified in the Wadesboro sub-basin, which include the Pekin Formation and the newly defined Wadesboro formation (Brazell, 2013). The community of Pekin is located within the Wadesboro sub-basin and is the type locality of the Pekin Formation (Cambell and Kimball, 1923).

The Ellerbe sub-basin was mapped by Dineen (1982) and includes sedimentary breccias, conglomerates, sandstones and mudstones that are not formally linked to known formations.

POST-TRIASSIC ROCK UNITS and COASTAL PLAIN SEDIMENTARY DEPOSITS

Dikes of Jurassic diabase intrude the Triassic sedimentary and older crystalline rocks of the map area. Coastal Plain Sedimentary deposits cover a majority of the bedrock in the Southern Pines 100K. The general distribution of Coastal Plain deposits is provided on an inset figure on the map. Thin residual Coastal Plain deposits are common in locations away from the main outcrop area. In the extreme southeast of the quadrangle, Coastal Plain deposits may be as thick as 240 feet (well data from CD-P-1-67 reported in Lawrence and Hoffman (1993)).

Quaternary alluvium is present in most modern river valleys, with at least two levels of fluvial terraces along the major drainages. These terraces, where preserved, likely mark the location and elevation of ancestral river systems, prior to incision to the modern floodplain levels (Grimley, 2023).

GEOCHEMISTRY

Geochemical analyses were carried out on 22 samples to characterize key unit lithologies. Eight (8) samples were analyzed by Bureau Veritas and 14 samples were analyzed by UNC-Chapel Hill. Digital data is available upon request and/or available through download from the NCGS website. The locations of the analyses are indicated on the geologic map.

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The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

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DESCRIPTION OF MAP UNITS

UNMETAMORPHOSED INTRUSIVE BODIES

Jd **Diabase (Jurassic)—**Black to greenish-black, fine- to medium-crystalline, dense, consists primarily of plagioclase, augite and may contain olivine. Locally has gabbroic texture. Occurs as dikes up to 100 ft wide. Diabase typically occurs as spheriodally weathered boulders with a grayish-brown weathering rind. Red station location indicates outcrop or boulders of diabase. Purple station locations indicate outcrop or boulders of gabbroic textured diabase.

MZlamp **Lamprophyre (Mesozoic to Neoproterozoic)—**Gray to pinkish gray, fine- to medium-crystalline, exceptionally dense, with alkali-feldspar, plagioclase and amphibole. The groundmass consists of alkali feldspar and plagioclase, with alkali feldspar more abundant than plagioclase. Plagioclase crystals (>1 cm) also occur are subhedral and commonly zoned. Locally, amphibole occurs in elongate slender prismatic habit (1-4 mm) and is randomly oriented. Sparse amygdules of quartz(?) up to 5 mm present locally. The rock is unmetamorphosed but may have magmatic and/or hydrothermal alteration. Occurs as dikes that are coincident with diabase. Outcrop and boulders are typically spheriodally weathered with reddish-brown weathering rind. Red square station locations mark outcrops or boulders.

TRIASSIC SEDIMENTARY ROCKS OF THE NEWARK SUPERGROUP

DEEP RIVER BASIN

SANFORD SUBBASIN

Trs **Sanford Formation (Triassic)—**Mainly red to brown, locally purple, coarse-grained, arkosic sandstones and conglomerates. Subordinate amounts of claystone, siltstone and fine-grained sandstone (Reinemund, 1955).

Trsc **Conglomerate of the Sanford Foramation (Triassic)—**Mainly conglomerates with fragments of metamorphic rock and quartz embedded in and interbedded with red mudstone, siltstone and sandstone (Reinemund, 1955). Equivalent to Trcc of Lithofacies Association III in the Cokesbury Quadrangle.

Trc **Cumnock Formation (Triassic)—**Gray and black claystone, shale and siltstone. Gray sandstone. Contains beds of coal and carbonaceous (organic-rich) shale (Reinemund, 1955). Includes coal horizons.

Trp **Pekin Formation (Triassic)—**Gray, Brown to maroon, white mica bearing, interbedded mudstones, siltstones and arkosic sandstones. Outcrops and boulders of float identified as part of Pekin Formation are strongly indurated compared to conglomerates identified as part of Chatham Group. Identified as the Pekin Formation by Reinemund (1955).

Trpc **Conglomerate of the Pekin Formation (Triassic)—**Reddish-brown to dark brown to purplish-red, irregularly bedded, poorly sorted, cobble to boulder conglomerate. Clasts are chiefly miscellaneous felsic and intermediate metavolcanic rocks and quartz. Typically present adjacent to border faults. Outcrops and boulders of float identified as part of Pekin Formation are strongly indurated compared to conglomerates identified as part of Chatham Group. Identified as the Pekin Formation-basal conglomerate by Reinemund (1955).

Trpwpp **Zone of wind polished and faceted pebbles in the Pekin Formation (Triassic)—**Area in Pekin Formation with wind polished and faceted pebbles. Interpreted by Reinemund (1955) as an indication of environment of deposition in which pebbles exposed on the surface during dry seasons were wind polished and faceted.

CRABTREE TERRANE

METAVOLCANIC AND METASEDIMENTARY UNITS

CZsph-gpb **Sericite phyllite interpreted from geophysical methods and boring data (Cambrian to Neoproterozoic)—**Area in subsurface interpreted as sericite phyllite using geophysical and boring data from Lawrence and Hoffman (1993). Located in the Crabtree terrane (?) in between the Nutbush Creek and Neuse River faults. Covered by Coastal Plain sedimentary deposits.

EASTERNMOST CAROLINA TERRANE

METAINTRUSIVE UNITS

BUCKHORN DAM META-INTRUSIVE SUITE

CZbg **Meta-granitoid rocks of the Buckhorn Dam intrusive suite (Cambrian to Neoproterozoic)—**Dark-colored (CI=15-30), medium- to fine- crystalline, metatonalite, metagranodiorite and metagranite with variably developed foliation; composed mainly of plagioclase, quartz, epidote, microcline, biotite, and opaque minerals, with minor amounts of sericite, sphene, chlorite, and garnet. The more felsic granitoid rocks are mineralogically and chemically similar to the felsic metavolcanic rocks described below, and are probably the intrusive equivalents. The unit includes a number of small granitoid bodies, probably originally dikes and plugs, intruding felsic metavolcanic rocks northeast of the main outcrops of Buckhorn Dam intrusive suite.

CZbg-lsp **Lemon Springs pluton of the Buckhorn Dam intrusive suite (Cambrian to Neoproterozoic)—**Leucocratic to mesocratic, medium- to fine-crystalline, metamorphosed alkali granite with variably developed foliation. In hand-sample, mineral boundaries are not well defined except for those of tabular albite crystals and small (0.5 to 2.0 mm) pods of dark minerals that are acicular stilpnomelane (Campbell, 1984). According to Campbell (1984), the average major mineral constituents from point counts are microcline (34%), quartz (31%), and albite (27%). Minor amounts of epidote, stilpnomelane, biotite, chlorite, white mica, garnet, opaques, sphene, calcite, apatite, allanite, and pyrite are present, in order of decreasing abundance (Campbell, 1984). The Lemon Springs quarry also hosts, low-silica, high-potassium dikes that may represent metamorphosed lamprophyre and metamorphosed felsic and basaltic dikes (Campbell, 1984).

CZbg-rd **Rhyodacite to dacite of the Buckhorn Dam intrusive suite (Cambrian to Neoproterozoic)—**Gray, aphanitic, vitiric-like, flow-banded metamorphosed rhyodacite to dacite. May be an apophysis of the Lemon Springs pluton (?).

CARY METAMORPHIC SUITE

CZbr3 **Big Lake-Raven Rock schist 3 (Cambrian to Neoproterozoic)—**Light tan to orange-brown, fine- to medium- crystalline, white mica schist, phyllite and gneiss. Locally preserves primary volcanic texture, either fragmental or porphyritic. Inferred to have a dacitic volcanic and/or volcaniclastic protolith. Locally includes intermediate to mafic composition rocks that have been metamorphosed to mica phyllite.

CZbr-py **Phyllite and argillite (Cambrian to Neoproterozoic)—**Fine- to medium-crystalline phyllite and metamorphosed siltstones. Locally preserves primary sedimentary textures (bedding and crystal fragments). Tuffaceous interlayers present. May be a more distal and finer-grained facies related to Big Lake-Raven Rock schist units. Large portions of unit covered by Coastal Plain sedimentary deposits.

CZsphs-gpb **Sericite phyllite and metamorphosed sedimentary rocks interpreted by geophysical methods and boring data (Cambrian to Neoproterozoic)—** Area in subsurface interpreted as mainly sericite phyllite using geophysical and boring data from Lawrence and Hoffman (1993). Includes lesser amounts of fine-grained metamorphosed sedimentary rocks and metamorphosed granitoid. Northeast contact of unit is questionable and designates apparent contact between rocks of lower magnetic intensity to the southwest from rocks of higher magnetic intensity to the northeast. Outcrops in limited exposed areas include: phyllite, meta-rhyodacite, schistose phyllite and gneissic granitoid. Majority of unit is covered by Coastal Plain sedimentary deposits.

CZmas **Mafic schist and phyllite and sericite phyllite (Cambrian to Neoproterozoic)—**Green, chlorite-actinolite schist, chlorite schist and sericite phyllite. Schist grade into dark green intermediate to mafic crystal tuffs. intercalated lithologies include epidosite, hematite rich epidote-quartzite breccia and chlorite phyllite. Small pyrite crystals are commonly found along the fine-grained quartz laminae. Hematite also commonly present. Small lenses of quartzo-feldspathic gneiss are intercalated with the unit. (Modified from Hicks, 1982)

UPPER LITTLE RIVER TERRANE

CZulrs **Upper Little River schist (Cambrian to Neoproterozoic)—**Silvery-gray, fine - to medium- crystalline, garnet + white mica schist. Garnets porphyroblasts up to 4 mm. Large portions of unit covered by Coastal Plain sedimentary deposits.

CAROLINA TERRANE

ALBEMARLE ARC

ALBEMARLE ARC PLUTONS

CZagb-sm **Stony Mountain Gabbro (Cambrian to Neoproterozoic)—**Massive, grayish-green to dark-greenish-gray, fine to coarse crystalline. Composed of secondary amphibole, in part with cores of clinopyroxene, calcic plagioclase, epidote, chlorite, and quartz, with accessory sphene, apatite, calcite, phlogopite, and opaque minerals. Occurs as sheets, dikes, and irregular intrusive bodies; most common within well-bedded sedimentary and volcanic rocks. The sheet exposed west of Back Creek Lake has a basal zone rich in serpentine pseudomorphs after olivine; "comb layering" (Moore and Lockwood, 1973) is well exposed in the quarry at the top of the same sheet (Seiders and Wright, 1977). A sample collected from Ridges Mountain (west of Asheboro) in the unit yielded an age of ca. 545 Ma (DeDecker et al., 2013).

Zagd-p **Granodiorite of the Parks Crossroads pluton (Neoproterozoic)**—Leucocratic (CI=5) , fine- to medium- crystalline, equigranular metamorphosed, granodiorite. Mineral assemblage includes quartz, plagioclase, and green hornblende +/- chlorite, +/- epidote. Locally foliated in the Southern Pines 100K. A sample collected from an abandoned quarry in the unit in the Chapel Hill 100K yielded a weighted mean age of ca. 552 Ma (Morrison and Coleman, 2023). Contact with Hyco arc units interpreted as an intrusive contact. Contact with Seagrove formation units is interpreted as unconformatity.

MORROW MOUNTAIN RHYODACITE SUITE

CZmmr-ps **Morrow Mountain rhyodacite – porphyritic felsite near Seagrove (Cambrian to Neoproterozoic)**—Gray, rhyodacite (felsite of Seiders, 1981) with phenocrysts of albite and quartz. Occurs in a 3 km-wide belt and in small bodies on both sides of the belt. At the south end of the belt the felsite is flow layered, locally spherulitic, and the phenocrysts are relatively smaller and less abundant. To the north, in Randolph County, phenocrysts are larger (1-3 mm) and more abundant; flow layering and spherulites are generally absent. Both extrusive and shallow intrusive rocks may be represented. A sample collected from the southbound I-73/74 visitor center approximately 1.9 miles southwest of Seagrove in the Chapel Hill 100K yielded a LA-ICP-MS 206Pb/238U weighted means age of ca. 536 Ma (Bradley et al., 2025).

CZmmr-psa **Altered Morrow Mountain rhyodacite – porphyritic felsite near Seagrove (Cambrian to Neoproterozoic)**—Light gray quartzose sericite phyllite; locally contains pyrite; commonly iron oxide-stained where weathered. Pyrophyllite locally present. Interpreted as hydrothermally altered CZmmr-ps unit.

CZmmr-f **Morrow Mountain rhyodacite – felsite (Cambrian to Neoproterozoic)**—Light-gray to dark-gray rhyodacite (felsite of Seiders, 1981), aphanitic to porphyritic with phenocrysts of albite and quartz. Locally spherulitic and flow layered. May include lava flows, domes, necks, and dikes. Bradley et al. (2025), reported LA-ICP-MS 206Pb/238U weighted means age for a sample from Caraway Mountain in the Chapel Hill 100K of ca. 543 Ma.

ALBEMARLE GROUP

TILLERY FORMATION

CZtm **Laminated to thin-bedded graded mudstone (Cambrian to Neoproterozoic)**—Typically grayish-green, less commonly gray, in beds 1 mm to 4 cm thick. Beds grade upward from lighter colored siltstone to darker claystone. Beds are extremely regular, laterally persistent, and show no crossbedding. Thick-bedded mudstone is uncommon. Rare beds of graded sandstone consist of volcanic rock and mineral fragments of diverse composition in an abundant argillaceous matrix. Contains biotite porphyroblasts

CZtfm **Felsite, felsic volcaniclastic rocks and interbedded, laminated- to thin-bedded mudstone (Cambrian to Neoproterozoic)—**Felsite, felsic volcaniclastic rocks, and interbedded, laminated- to thin-bedded mudstone

CZtimv **Intermediate to mafic volcanics in the Tillery Formation (Cambrian to Neoproterozoic)—**Map scale bodies of metamorphosed gray-green, dark green and greenish-gray; typically unfoliated to weakly foliated, amygdaloidal, plagioclase porphyritic and aphanitic; andesitic to basaltic lavas and shallow intrusions. Hyaloclastic texture is common and imparts a fragmental texture on some outcrops and float boulders. Correlated with Ctb (basaltic rocks) of Stromquist and Henderson (1985).

CZtmc **Mafic volcaniclastic rocks (Cambrian to Neoproterozoic)—**Thin- to very thick bedded, grayish-green tuff, lapilli tuff, and tuff breccia. In addition to mafic volcanic debris, many rocks contain subordinate amounts of mudstone and felsic volcanic rock clasts

SEAGROVE FORMATION (INFORMAL)

CZsfc **Seagrove formation felsic volcaniclastic rocks (Cambrian to Neoproterozoic)—**Thin- to very thick bedded, light- to dark-gray, in part pale-green, tuff, lapilli tuff, and tuff breccia. The most abundant rock types are very thick bedded tuff, lapilli tuff, and tuff breccia, but in many parts of the map unit subordinate amounts of well-bedded, thin- to thick-bedded, in part graded, tuff, tuffaceous sandstones, tuffaceous conglomeratic sandstones and felsic volcanic mudstone are interbedded. In many rocks the principal clasts are dense felsite, like that occurring in the numerous felsite bodies of the formation. Clasts are angular to subrounded, very rarely well rounded. Other rocks have clasts with poorly preserved textures that are strongly suggestive of pumice. Such rocks occur throughout the unit but are especially abundant in a 3 km wide belt, extending from south of Center Cross Church to Purgatory Mountain and located just west of the belt of porphyritic felsite at Seagrove (CZmmr-ps) in the Chapel Hill 100K. These rocks generally lack interbeds of well-bedded tuff and may represent thick ashflow deposits. The probable pumice fragments are commonly much flattened but the flattening is in the plane of the regional cleavage or foliation and may be tectonic. Textural details are too poorly preserved to record most features that would clearly indicate welding.

CZsehc **Seagrove formation epiclastic rocks of the Harpers Crossroads area (Cambrian to Neoproterozoic)—**Metasedimentary package that ranges from fine-grained siltstones to coarse-grained sandstones, pebbly sandstones and conglomerates. The sandstones, pebbly sandstones and conglomerates commonly contain rounded to subangular clasts of quartz ranging from sand- to gravel-sized. In the sandstones, feldspar is the most prominent mineral grain; quartz varies from sparse to abundant in hand sample. Lithic clasts are typically prominent and range from sand- to gravel-size. A sample from the unit was collected adjacent to the Siler City Airport for detrital zircon analysis (NCGS sample COL-3055). The four youngest detrital zircons are: ca. 534, 538, 538 and 538. Previously mapped as part of the Aaron Formation on open file maps of western Chatham County.

CZsehc-a **Altered Seagrove formation epiclastic rocks of the Harpers Crossroads area (Cambrian to Neoproterozoic)—**Area of Seagrove formation epiclastic rocks of the Harpers Crossroads area that is mildly to moderately hydrothermally altered. Alteration consists of silicified, sericitized and pyrophyllitized rock. Chloritoid locally present.

CZseb **Seagrove formation epiclastic rocks of the Biscoe area (Cambrian to Neoproterozoic)—**Metasedimentary package that is dominantly fine- to medium-grained siltstones and sandy siltstones with local quartz bearing sandstones and pebbly sandstones. Lesser amounts of conglomerate. The sandstones and pebbly sandstones commonly contain rounded to subangular sand-size grains of quartz. Quartz grains appear to be less abundant than in CZsehc. In the sandstones, feldspar is the most prominent mineral grain; quartz varies from sparse to abundant in hand sample. When present, lithic clasts range from sand- to gravel-size and locally include pink-colored, angular clasts of altered (?) rhyodacite. Minor andesite to basalt lavas and/or shallow intrusions.

CZseb-a **Altered Seagrove formation epiclastic rocks of the Biscoe area (Cambrian to Neoproterozoic)—**Mixed unit of altered volcaniclastic sedimentary rocks within the CZseb unit. Alteration consists of silicified, sericitized and pyrophyllitized rock. Sulfides locally present. Vuggy quartz boulders and cobbles abundant throughout unit. Includes altered rhyodacite (CZmmr-f) that was likely emplaced as dikes.

CZsebimv **Seagrove formation epiclastic rocks of the Biscoe area with local intermediate to mafic volcanics (Cambrian to Neoproterozoic)—**Metasedimentary package that is dominantly fine- to medium-grained siltstones and sandy siltstones with local quartz bearing sandstones and pebbly sandstones identical to CZseb with local to abundant metamorphosed andesite to basalt lava and/or shallow intrusions. Local occurrence of metarhyodacite of CZmmr-f present.

CZsebimv-a **Altered Seagrove formation epiclastic rocks of the Biscoe area with local intermediate to mafic volcanics (Cambrian to Neoproterozoic)—**Variably altered metasedimentary package that is dominantly fine- to medium-grained siltstones and sandy siltstones with local quartz bearing sandstones and pebbly sandstones with local to abundant metamorphosed andesite to basalt lava and/or shallow intrusions identical to CZsebimv. Includes phyllitic siltstone. Altered rock includes: sericite +- pyrophyllite phyllite and abundant vuggy quartz veins. Includes areas of the historic

Golconda, Uwarra, Iola and Martha Washington gold mines. Area is deeply weathered with only the most resistant rocks forming outcrops.

CZsimv **Seagrove formation intermediate to mafic volcanic rocks (Cambrian to Neoproterozoic)**—Map scale bodies of metamorphosed light green, gray-green, gray, and dark gray; typically unfoliated to weakly foliated, amygdaloidal, plagioclase porphyritic and aphanitic; andesitic to basaltic lavas and shallow intrusions. Hyaloclastic texture is common and imparts a fragmental texture on some outcrops and float boulders.

CZsimvc **Seagrove formation intermediate to mafic volcanic and volcaniclastic rocks (Cambrian to Neoproterozoic)**—Map scale bodies of metamorphosed andesitic to basaltic lavas and shallow intrusions (like CZsimv) with interlayered volcaniclastic rocks consisting of phyllitic siltstone to conglomerate.

CZsmd **Seagrove formation mudstones (Cambrian to Neoproterozoic)**—Grayish-green, light gray to dark gray, locally with distinctive reddish-gray or maroon to lavender coloration, metamorphosed, thinly bedded mudstone, siltstone and sandy siltstone. Mudstone bedding ranges from mm-scale up to 10 cm, bedding layers traceable for several feet locally, may exhibit soft sediment deformation. Locally tuffaceous with a relict vitric texture. When present, crystal fragments are usually plagioclase with rare quartz. Deposition interpreted as distal from volcanic center.

CZse/pl **Seagrove formation epiclastic and pyroclastic rocks with rhyrodacitic domes of the Robbins area (Cambrian to Neoproterozoic)**—Gray to greenish-gray, metamorphosed tuffaceous sandstones, conglomeratic sandstones, siltstones and local interbeds of mudstone. Contains lesser amounts of fine- to coarse tuff, welded tuff and rhyodacitic lavas/shallow intrusions. The siltstones typically are weakly phyllitic. Fiamme-like shaped clasts are common in the conglomeratic sandstones, sandstones and tuffs. Quartz and feldspar crystal fragments are common in the sedimentary components, tuffs and lavas. Silicified and/or sericitized altered rock and quartz veining present. Interpreted as a felsic sedimentary package deposited contemporaneous with local felsic volcanism. Correlates to Unit 2 of Powers (1993).

CZshar **Seagrove formation hydrothermally altered rocks (Cambrian to Neoproterozoic)**—Areas within the Seagrove formation of moderate to intense hydrothermally altered rock. Alteration consists of silicified, sericitized and pyrophyllitized rock. Chloritoid locally present. Sulfides are common. Primary sedimentary or volcanic textures are commonly obliterated. Includes the moderate argillic (sericite) alteration zone in the Robbins area as described by Powers (1993).

CZshar-pqs **Pyrophyllite-quartz-sericite hydrothermally altered rocks (Cambrian to Neoproterozoic)**—Zones of intense hydrothermally altered rock with pyrophyllite. Include zones of pyrophyllite-quartz +-sericite alteration. Primary sedimentary or volcanic textures are obliterated. Includes active, inactive and abandoned pyrophyllite mines and prospects. After Powers (1993).

CZshar-qsh **Quartz-sericite-hematite hydrothermally altered rocks (Cambrian to Neoproterozoic)—**Zones of intense hydrothermally quartz-sericite-hematite altered rock. Includes silicified rock that may form resistant ridges in the Robbins area. According to Powers (1993), hematitic rocks have low to no detection of gold.

CZshar-qsp **Quartz-sericite-pyrite hydrothermally altered rocks (Cambrian to Neoproterozoic)—**Zones of intense hydrothermally quartz-sericite-pyrite altered rock. Includes silicified rock that may form resistant ridges in the Robbins area. According to Powers (1993), pyritic rocks have moderate (>100 ppb) to high (>1000 ppb) gold occurrence.

CZq **Quartz veins (Cambrian to Neoproterozoic)—**Area of abundant quartz present in a vein or set of veins. May include silicic alteration of country rock. Often vuggy texture present with terminating crystals.

UWHARRIE VOLCANIC COMPLEX

Zurlt **Uwharrie volcanics rhyodacitic lavas and tuffs (Neoproterozoic)—**Gray to dark gray, siliceous, aphanitic rhyodacites and tuffs, quartz-bearing tuffs and quartz-rhyodacite porphyry. Rhyodacites and tuffs are vitric-like and weakly to moderately foliated. Rhyodacites are locally flow layered and(or) spherulitic. Phenocrysts of albite are generally present, commonly accompanied by quartz. The size and abundance of phenocrysts varies widely. Tuffs locally contain fiamme-shaped clasts. May include lava flows, domes, necks , and dikes. Zuf, Felsite unit, of Seiders (1981).

Zufc **Felsic volcaniclastic rocks (Neoproterozoic)—**Thin- to very thick bedded, light- to dark-gray, in part pale-green, tuff, lapilli tuff, and tuff breccia. The most abundant rock types are very thick bedded tuff, lapilli tuff, and tuff breccia, but in many parts of the map unit subordinate amounts of well-bedded, thin- to thick-bedded, in part graded, tuff, tuffaceous sandstones, tuffaceous conglomeratic sandstones and felsic volcanic mudstone are interbedded. In many rocks the principal clasts are dense felsite, like that occurring in the numerous felsite bodies. Clasts are angular to subrounded, very rarely well rounded. Other rocks have clasts with poorly preserved textures that are strongly suggestive of pumice. These rocks generally lack interbeds of well-bedded tuff and may represent thick ashflow deposits. The probable pumice fragments are commonly much flattened but the flattening is in the plane of the regional cleavage or foliation and may be tectonic. Textural details are too poorly preserved to record most features that would clearly indicate welding.

Zuimcl **Intermediate to mafic volcaniclastic rocks and lavas (Neoproterozoic)—**Thin- to very thick-bedded, grayish-green tuff, lapilli tuff, and tuff breccia. Local occurrence of andesitic to basaltic lavas with hyaloclastic textures. Commonly contains scattered clasts of felsic volcanic rock. Modified equivalent of CZumc of Seiders (1981).

Zuiml **Intermediate to mafic lavas (Neoproterozoic)—**Small bodies of metamorphosed andesite to basalt exposed chiefly in the northeastern part of the Seiders (1981) map area. Commonly amygdaloidal. Pillow lava occurs northeast of Asheboro, along the dead end road 1.5 km east of Oakie Mountain. May include some shallow intrusive rocks. Modified equivalent of CZuml of Seiders (1981).

Zuhar **Uwharrie volcanics hydrothermally altered rocks (Neoproterozoic)—** Areas within the Uwharrie Formation of moderate to intense hydrothermally altered rock. Alteration consists of silicified, sericitized and pyrophyllitized rock. Chloritoid locally present. Sulfides are common. Primary sedimentary or volcanic textures are usually obliterated.

HYCO ARC

HYCO FORMATION - UPPER PORTION

HYDROTHERMALLY ALTERED UNITS

Zhhar **Hydrothermally altered rocks (Neoproterozoic)—**Mixed unit of hydrothermally altered rocks consisting of: dense siliceous cryptocrystalline rock; quartz-pyrophyllite rocks, +- kaolinite, andalusite, chloritoid, sericite, paragonite and iron oxides; quartz-sericite rocks, +- paragonite, k-feldspar and iron oxides; and quartz-chloritoid-chlorite rocks, +- sericite and hematite. Described in detail by Hughes (1987) and Schmidt et al. (2006).

Zhat/vcs **Altered tuffs and volcaniclastic sedimentary rocks (Neoproterozoic)—** Mixed unit of altered volcaniclastic rocks and volcaniclastic sedimentary rocks. Alteration consists of silicified, sericitized and pyrophyllitized rock. Chloritoid locally present. Volcaniclastic sedimentary rocks include conglomeratic siltstone to conglomerate that may be variably altered. Includes area of quartz-sericite-paragonite rock (Zvqs) of Schmidt et al. (2006). Andesitic to basaltic lavas and massive quartz locally present.

Zhe/pl-a **Altered mixed epiclastic-pyroclastic rocks with interlayered dacitic lavas (Neoproterozoic)—**Area of unit Zhe/pl that is mildly to moderately hydrothermally altered. Alteration consists of silicified, sericitized and pyrophyllitized rock. Intensity of alteration varies locally.

VOLCANOCLASTIC-SEDIMENTARY UNITS

Zhe/pl **Mixed epiclastic-pyroclastic rocks with interlayered dacitic lavas (Neoproterozoic)—**Mixed epiclastic-pyroclastic rocks with interlayered dacitic lavas: Grayish-green to greenish-gray, locally with distinctive reddish-gray or maroon to lavender coloration; metamorphosed: conglomerate, conglomeratic sandstone, sandstone, siltstone and mudstone. Lithologies are locally bedded; locally tuffaceous with a cryptocrystalline-like groundmass. Siltstones are locally phyllitic. Locally contain interbedded dacitic lavas identical to Zhdlt unit. Contains lesser amounts of fine- to coarse tuff and lapilli tuff with a cryptocrystalline-like groundmass. Pyroclastics, lavas, and epiclastics are mainly felsic in composition. Minor andesitic to basaltic lavas and tuffs present. Silicified and/or sericitized altered rock are locally present. Conglomerates and conglomeratic sandstones typically contain subrounded to angular clasts of dacite in a clastic matrix. Portions of the Zhe/pl unit are interpreted to have been deposited proximal to active volcanic centers represented by the Zhdlt unit but are also interpreted to record the erosion of proximal volcanic centers after cessation of active volcanism.

FELSIC TO INTERMEDIATE VOLCANIC UNITS

Zhdlt (u) **Dacitic lavas and tuffs of the upper portion of the Hyco Formation (Neoproterozoic)—**Greenish-gray to dark gray, siliceous, aphanitic dacite, porphyritic dacite with plagioclase phenocrysts, and flow banded dacite. Dacite with hyaloclastic textures are common. Welded and non-welded tuffs associated with the lavas include: greenish-gray to grayish-green, fine tuff, coarse plagioclase crystal tuff and lapilli tuff. Locally, interlayers of immature conglomerate and conglomeratic sandstone with abundant dacite clasts are present. The dacites are interpreted to have been coherent extrusives or very shallow intrusions associated with dome formation. The tuffs are interpreted as episodic pyroclastic flow deposits, air fall tuffs or reworked tuffs generated during formation of dacite domes. The unit occurs as map scale pods surrounded by clastic rocks of Zhe/pl unit. Wortman et al. (2000) reports an age of 615.7+3.7/-1.9 Ma U-Pb zircon date for a dacitic tuff from the unit in the Rougemont quadrangle.

INTERMEDIATE TO MAFIC VOLCANOCLASTIC-SEDIMENTARY UNITS

Zhime/pl **Mixed intermediate to mafic epiclastic-pyroclastic rocks with interlayered intermediate to mafic lavas (Neoproterozoic)—**Grayish-green to green, locally with distinctive reddish-gray or maroon to lavender coloration; metamorphosed: conglomerate, conglomeratic sandstone, sandstone, siltstone and mudstone. Lithologies are locally bedded; locally tuffaceous with a cryptocrystalline-like groundmass. Siltstones are locally phyllitic. Locally contain interbedded intermediate to mafic lavas identical to Zhablt, Zhabl, and Zhablc units. Contains lesser amounts of fine- to coarse tuff and lapilli tuff with a cryptocrystalline-like groundmass. Pyroclastics, lavas, and epiclastics are mainly intermediate to mafic in composition. Minor dacitic lavas and tuffs present. Silicified and/or sericitized altered rock similar to Zhat unit are locally present. Conglomerates and conglomeratic sandstones typically contain subrounded to angular clasts of andesite and basalt in a clastic matrix. Generally interpreted to have been deposited proximal to active intermediate to mafic composition volcanic centers and/or record the erosion of proximal intermediate to mafic composition volcanic centers after cessation of active volcanism. May be related to Green et al. (1982) unit C - Intermediate to Mafic Volcanics and Graywacke.

INTERMEDIATE TO MAFIC VOLCANIC UNITS

Zhabl **Andesitic to basaltic lavas (Neoproterozoic)—**Green, gray-green, gray, dark gray and black; typically unfoliated, amygdaloidal, plagioclase porphyritic, amphibole/pyroxene porphyritic and aphanitic; andesitic to basaltic lavas and shallow intrusions. Hyaloclastic texture is common and imparts a fragmental texture on some outcrops and float boulders. Conglomeratic rocks consisting of angular clasts of andesite and/or basalt occur locally and are interpreted as resedimented hyaloclastite.

Zhable **Andesitic to basaltic lavas with interlayered epiclastic rocks (Neoproterozoic)—**Light green, gray-green, gray, and dark gray; typically unfoliated, amygdaloidal, plagioclase porphyritic, amphibole/pyroxene porphyritic and aphanitic; metamorphosed: andesitic to basaltic lavas and shallow intrusions. Hyaloclastic texture is common and imparts a fragmental texture on some outcrops and float boulders. Contains lesser amounts of grayish-green, light green, and light gray to white; metamorphosed conglomerate, conglomeratic sandstone, sandstone, siltstone and mudstone.

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Appendix A
Geochronology plots and tables

Geochronology data reduction and interpretation by Adam C. Curry

Analyses of zircon for U-Pb geochronology were conducted using laser ablation inductively-coupled plasma mass spectrometry (LA-ICP-MS) at the Arizona LaserChron Center according to methods described in previous publications (Gehrels *et al.*, 2008; Gehrels and Pecha, 2014; Horstwood *et al.*, 2016; Pullen *et al.*, 2018; Sundell *et al.*, 2021). Zircon U-Pb isotope data were reduced using IsoplotR to calculate a weighted mean age and assess degree of concordance (Vermeesch, 2018, 2021a, 2021b). We used the concordia distance filter (d_c) of (Vermeesch, 2021a) to filter data for degree of concordance, discarding values outside of the range $-2 < d_c < 4.6$. Zircon U-Pb analyses were also excluded in cases where Pb loss was apparent (too young ages) or U/Th ratios were anomalous. Igneous crystallization ages reported here are zircon $^{238}U/^{206}Pb$ weighted mean ages, with errors reported at a 95% confidence interval. Outliers were not included in the weighted mean ages, using Chauvenet's Criterion in IsoplotR. Estimations of maximum depositional ages (MDAs) for detrital zircon ages are based on the Maximum Likelihood Age (MLA) developed by Galbraith and Laslett (1993) for fission track thermochronology and extended to zircon U-Pb detrital zircon geochronology by Vermeesch (2021b).

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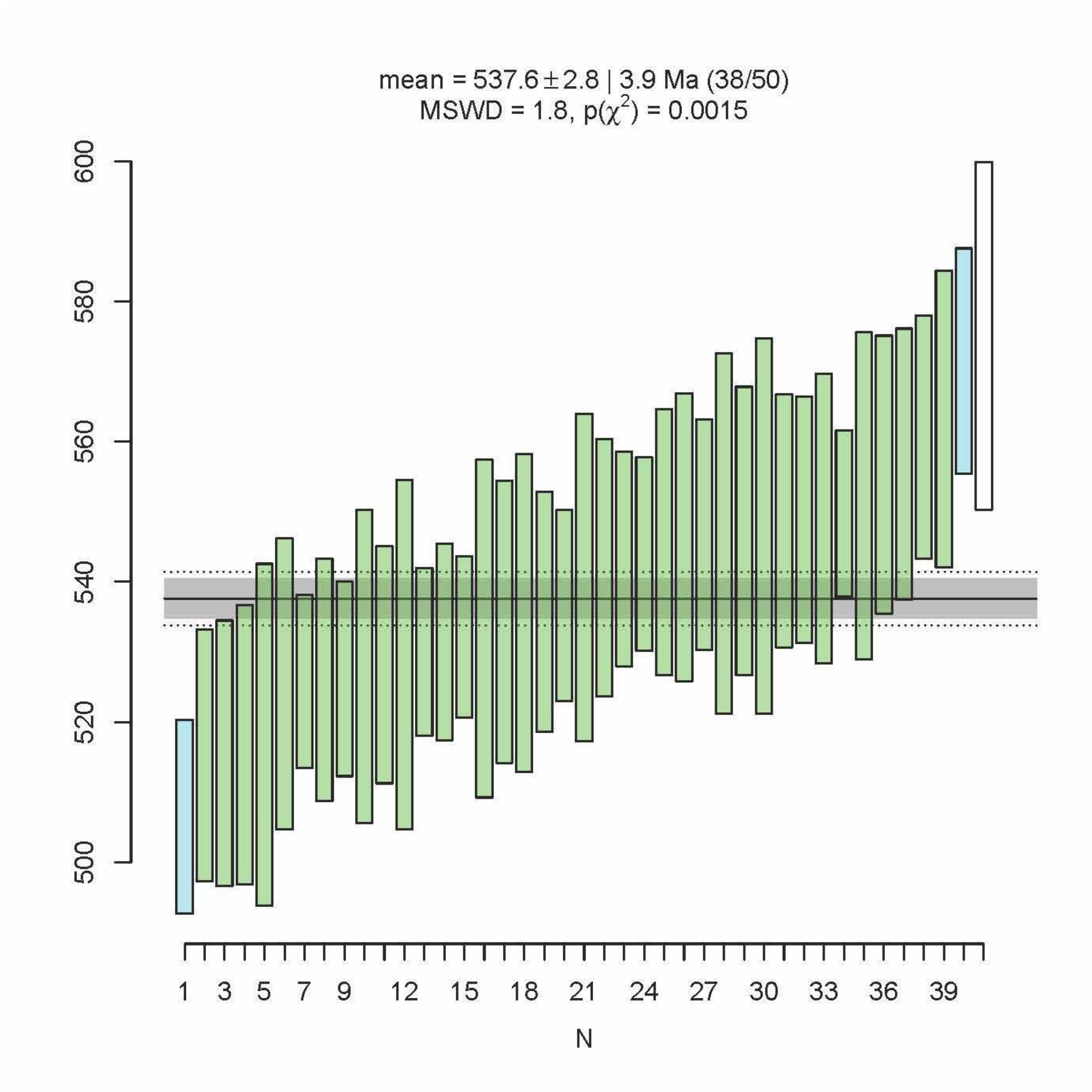
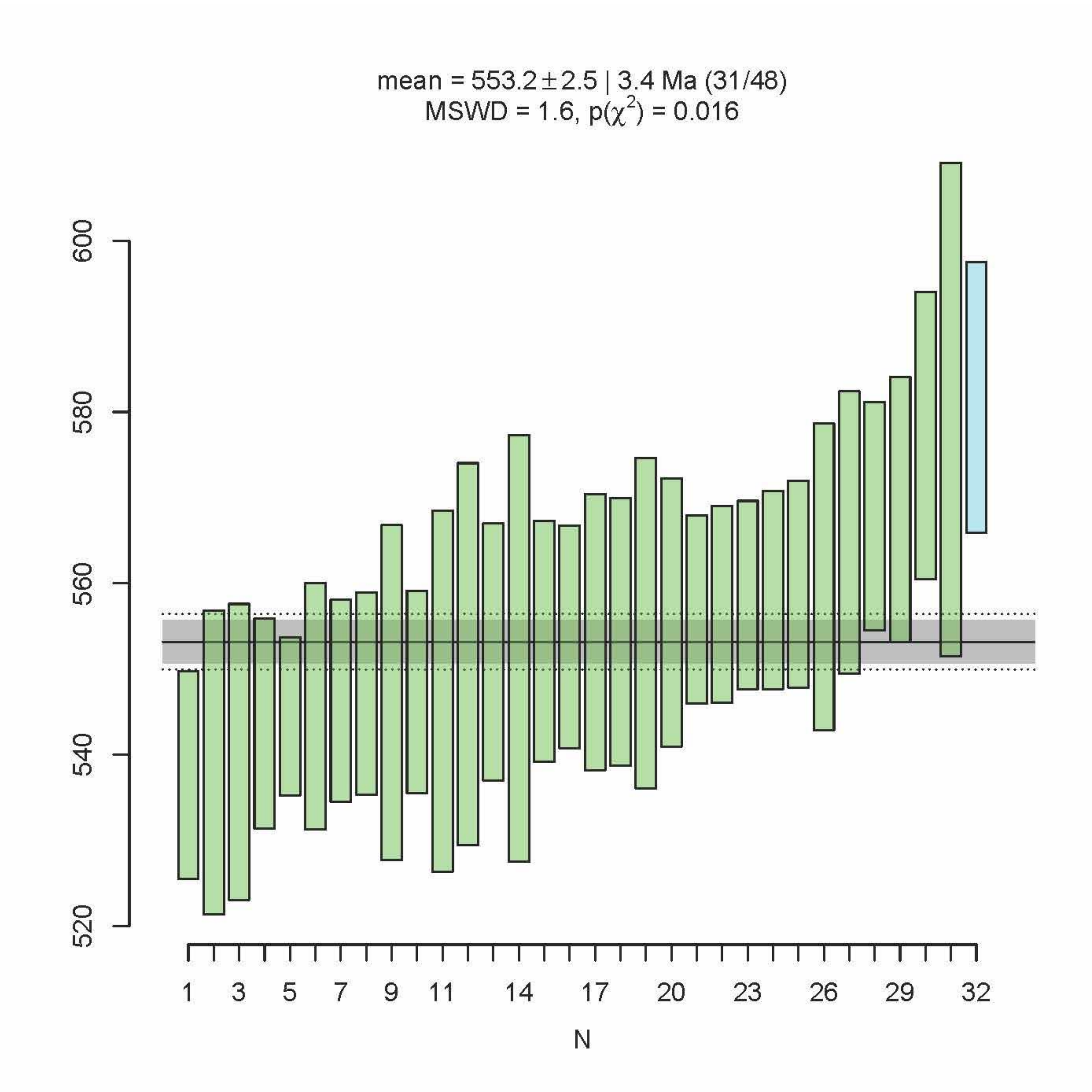
NCGS Station SP100K – 550027
Rhyodacite (metamorphosed)
Crystallization age



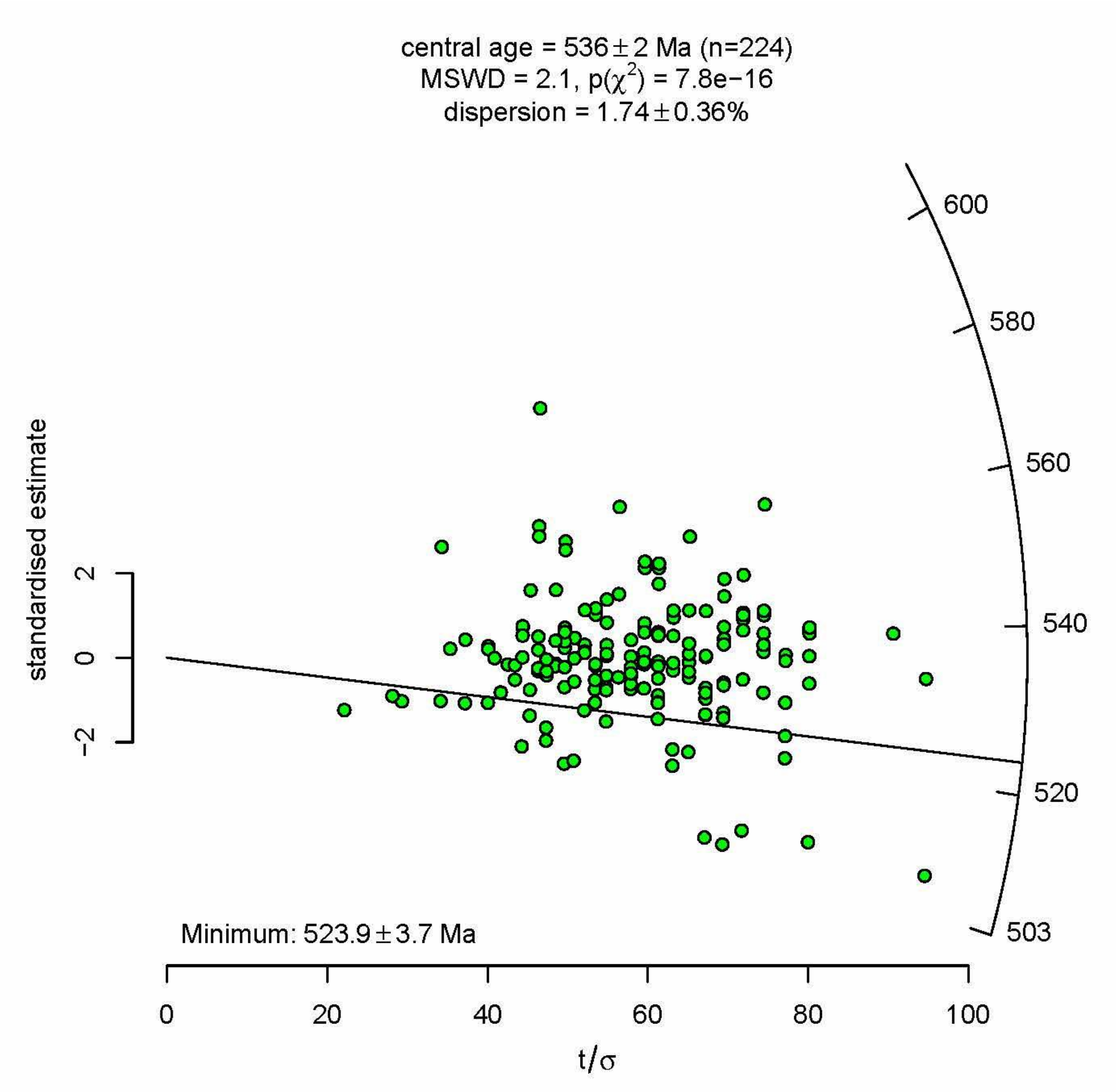
Sample SP100K-550027 has outlying ages of 506.5 ± 14.1 Ma, 560.6 ± 17.6 Ma, 563.2 ± 21.7 Ma, 571.5 ± 16.1 Ma, and 575.1 ± 25.4 Ma.

NCGS Station SP100K – 550264
Rhyodacite (metamorphosed)
Crystallization age



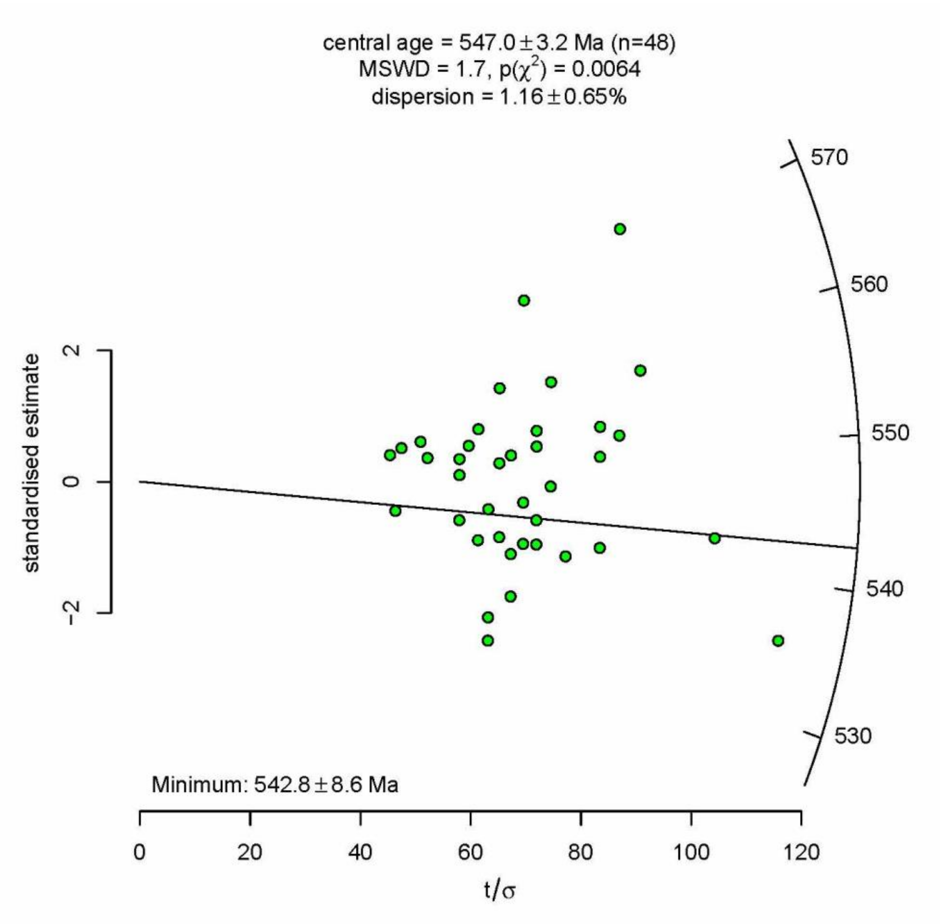
Sample SP100K-550264 has two outlying ages of 580.3 ± 29.4 Ma and 581.7 ± 15.9 Ma.

NCGS Station SP100K-550946
Tuffaceous pebbly sandstone (metamorphosed)
Detrital age

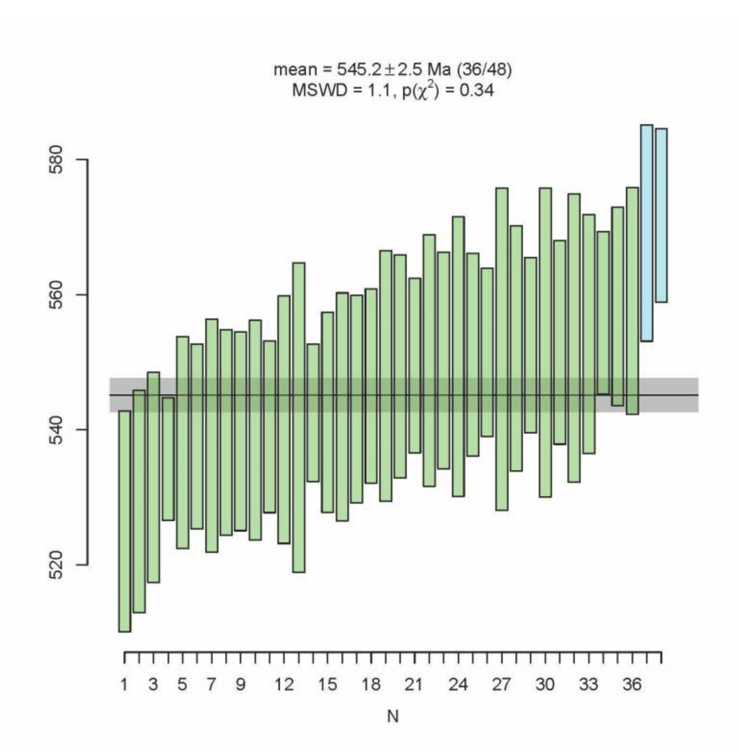


The MDA for sample SP100K-550946 is 523.8 ± 3.7 Ma (n = 175).

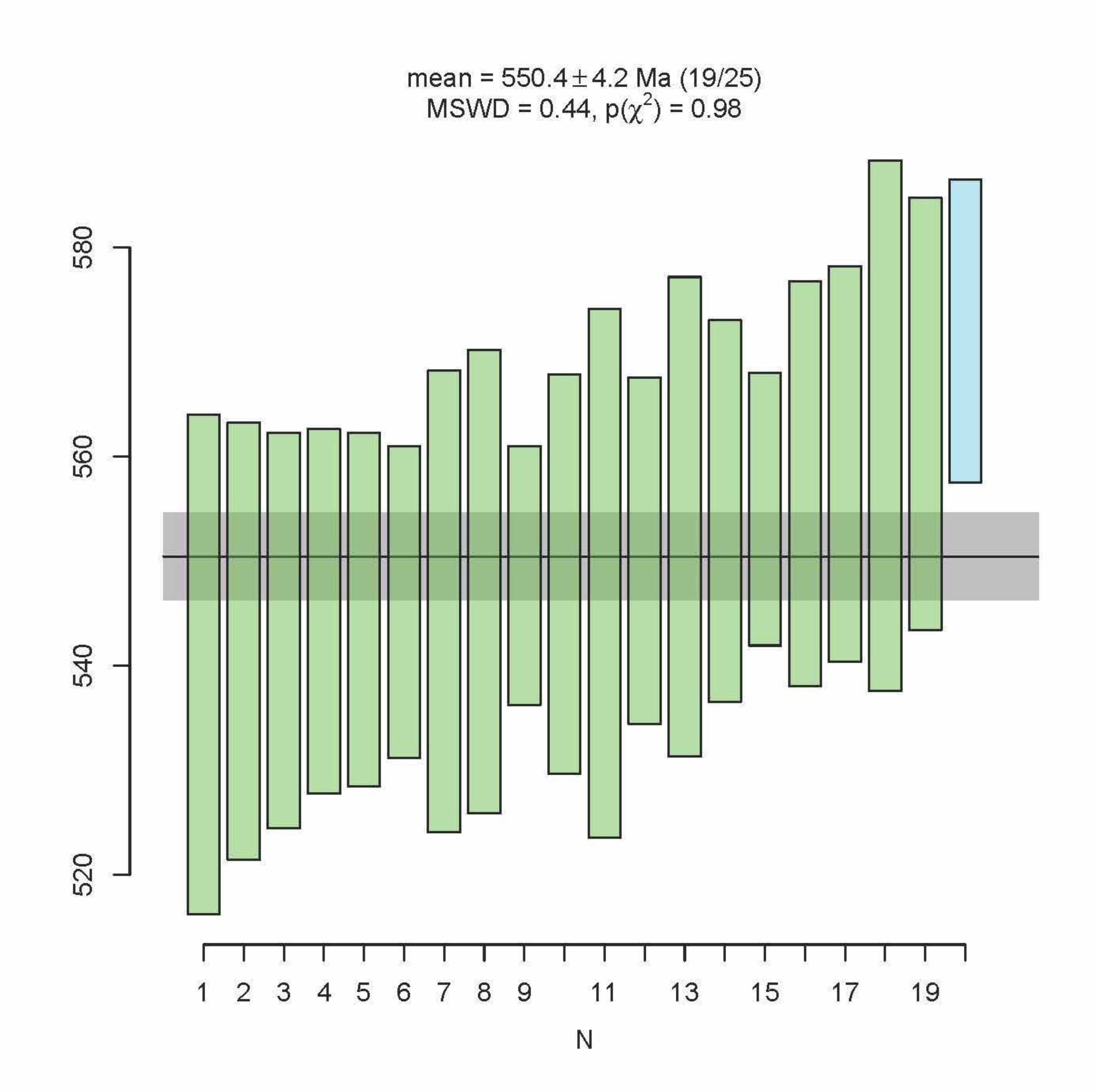
NCGS Station SP100K-550363
Conglomeratic sandstone (metamorphosed)
Detrital age



The MDA for sample SP100K-550363 is 542.8 ± 8.6 Ma (n = 38). It should be noted that this sample has a zircon age spectrum similar to an igneous crystallization age. It has low dispersion (see the ranked age plot for this sample). When a weighted mean age is calculated, it is 545.2 ± 2.5 Ma with an MSWD of 1.1, with two outliers (n=36).



NCGS Station SP100K-551063
Rhyodacite (metamorphosed)
Crystallization age



Sample SP100K-551063 (n=19) has a weighted mean age of 550.4 ± 4.2 Ma, with an MSWD of 0.44. Sample SP100K-551063 has an outlying age of 572 ± 15 Ma.

Table 1. LA-ICP-MS U-Pb zircon data for the Southern Pines 100 K (crystallization ages)

	Composition		Isotopic Ratios									Ages (Ma)					
ID	U (ppm)	U/Th	$^{206}Pb/^{204}Pb$	$^{206}Pb/^{207}Pb$	Error (%)	$^{207}Pb/^{235}U$	Error (%)	$^{206}Pb/^{238}U$	Error (%)	error correlation	concordia distance (d_c)[a]	$^{206}Pb/^{238}U$	Error (Ma)	$^{207}Pb/^{235}U$	Error (Ma)	$^{206}Pb/^{207}Pb$	Error (Ma)
Southern Pines 100k																	
550264																	
1 B	448	1.14	44894	17.2676	2.4	0.72023	3.2	0.090239	2.1	0.658	-1	557	11.1	550.8	13.5	525.5	52.3
2	454	1.13	60113	17.5307	2.8	0.70727	4.6	0.089966	3.7	0.791	-1.8	555.3	19.5	543.1	19.5	492.2	62.5
3 B	96	1.69	16792	17.3069	4.5	0.71247	6.6	0.08947	4.8	0.731	-0.99	552.4	25.5	546.2	27.9	520.4	98.8
5 A	3001	0.45	6871915	16.8844	1.2	0.73145	2.9	0.089611	2.7	0.907	0.71	553.2	14.1	557.4	12.6	574.4	27
16 D	111	2.44	10977	17.4929	4.4	0.70401	6.2	0.089358	4.3	0.698	-1.7	551.7	22.8	541.2	25.9	496.9	97.3
6 A	454	1.19	1018356	16.8792	2.2	0.72337	4.3	0.088595	3.8	0.867	0.8	547.2	19.7	552.7	18.5	575.1	47
6 B	520	1.32	212769	17.0452	2.7	0.70316	3.6	0.086966	2.4	0.667	0.54	537.6	12.4	540.7	15.1	553.8	58.6
6 E	532	0.9	62733	17.2087	1.9	0.72573	2.9	0.090619	2.2	0.765	-0.8	559.2	11.8	554	12.3	532.9	40.7
15 B	261	2.02	26412	17.4325	3.2	0.70996	4.4	0.089803	3	0.693	-1.6	554.4	16.2	544.7	18.5	504.6	69.7
15 C	449	2.01	26194	17.3234	2.4	0.70109	3	0.088125	1.8	0.592	-0.88	544.4	9.2	539.4	12.5	518.3	52.9
15 D	432	2.17	60104	16.8945	2.8	0.71776	3.7	0.087987	2.4	0.657	1	543.6	12.6	549.3	15.6	573.1	60.3
14 E	823	1.41	112202	17.2829	2.2	0.72355	3.2	0.090736	2.3	0.734	-1.1	559.9	12.5	552.8	13.6	523.5	47.4
14 F	812	1.15	19792	16.9523	2.3	0.74862	3.4	0.092084	2.5	0.734	-0.065	567.9	13.6	567.4	14.8	565.7	50.4
13 E	109	1.26	14537	17.3673	4.3	0.74746	6.8	0.094192	5.3	0.775	-2	580.3	29.4	566.7	29.7	512.8	94.8
7 A	181	2.24	8277	17.4627	3.1	0.71723	4.6	0.090879	3.4	0.735	-1.8	560.7	18.2	549	19.6	500.7	68.8
7 B	1308	1.01	152313	16.8846	1.8	0.72184	2.9	0.088436	2.3	0.777	0.83	546.3	11.9	551.8	12.5	574.4	40.2
8 D	209	2.88	57456	17.3162	3.3	0.71387	4.2	0.089695	2.5	0.607	-1.2	553.7	13.5	547	17.7	519.3	73.1
8 A	411	2.19	86621	16.936	1.9	0.7115	3.9	0.087434	3.4	0.87	0.79	540.3	17.7	545.6	16.6	567.8	42.3
8 B	323	1.39	61058	17.2763	2.7	0.70464	3.9	0.088331	2.8	0.712	-0.67	545.7	14.6	541.6	16.4	524.3	60.1
12 B	867	0.77	488045	17.0969	2.3	0.72821	3.2	0.090338	2.2	0.68	-0.34	557.5	11.6	555.5	13.6	547.2	50.9
10 B	564	1.69	1286746	17.1749	3	0.71118	5.1	0.088627	4.1	0.808	-0.3	547.4	21.7	545.4	21.6	537.2	66.1
10 A	407	1.82	589720	17.0432	1.9	0.74566	3.4	0.092211	2.9	0.83	-0.41	568.6	15.6	565.7	15	554	42
12 A	897	0.73	239259	16.9237	1.9	0.72135	2.9	0.08858	2.3	0.774	0.67	547.1	11.9	551.5	12.5	569.4	40.4
12 D	719	0.86	74762	17.1815	2.2	0.71074	3.2	0.088607	2.3	0.736	-0.35	547.3	12.3	545.2	13.5	536.4	47.3
8 C	310	1.38	22655	17.1563	2.6	0.72132	4	0.089793	3.1	0.765	-0.44	554.3	16.4	551.4	17.1	539.6	56.8
13 B	295	1.25	174812	17.1984	2.5	0.75066	4	0.093676	3.1	0.782	-1.3	577.2	17.2	568.6	17.3	534.2	54.1
13 A	472	1.1	61888	17.1584	2.4	0.73705	3.9	0.091764	3.1	0.79	-0.77	566	16.5	560.7	16.6	539.4	51.8
14 D	413	1.57	145640	17.3853	2.3	0.7176	3.2	0.090523	2.1	0.679	-1.6	558.6	11.5	549.2	13.4	510.5	51
14 B*	521	1.85	37874	16.2042	3.6	0.8031	4.6	0.094426	2.9	0.617	2.8	581.7	15.9	598.6	21	663.2	78.2
14 A	440	1.72	18688	17.482	2.5	0.71095	3.9	0.090183	3	0.766	-1.7	556.6	16.1	545.3	16.6	498.3	55.7
15 A	400	2.3	419812	16.955	2.7	0.70894	4.4	0.087217	3.5	0.788	0.78	539.1	18	544.1	18.6	565.4	59.4
6 D	480	0.91	53177	17.2256	1.8	0.71525	3.4	0.089397	2.9	0.842	-0.6	552	15.1	547.9	14.4	530.8	40
551063																	
1 R	113	1.63	18347	17.3389	3.3	0.7062	5	0.088847	3.7	0.747	-1	548.7	19.6	542.5	21	516.4	73
3 R	69	1.88	19452	17.384	4.1	0.72339	6.3	0.091247	4.8	0.764	-1.6	562.9	25.9	552.7	26.8	510.7	89.2
3 C	149	1.17	6828	17.5172	6.3	0.68754	7.9	0.087389	4.7	0.598	-1.6	540.1	24.6	531.3	32.8	493.9	139.9
6 R	87	1.31	14491	17.187	3.3	0.71991	5.5	0.089779	4.4	0.797	-0.54	554.2	23.2	550.6	23.3	535.7	72.6
8*	114	2.15	24997	17.3059	4	0.73888	4.9	0.092782	2.7	0.565	-1.8	572	15	561.8	21	520.6	87.9
11 C	134	1.38	9723	17.4824	4.2	0.69571	5.4	0.088251	3.4	0.632	-1.5	545.2	17.8	536.2	22.5	498.3	92.1
13	244	1.23	24668	17.1319	2.7	0.72322	3.7	0.089902	2.5	0.671	-0.4	555	13.1	552.6	15.6	542.7	59.5
14	158	1.29	24304	17.4692	3.3	0.70396	4.6	0.089231	3.2	0.704	-1.6	551	17.1	541.2	19.3	500	71.9
16 R	266	1.2	13381	17.1193	3.1	0.71175	5.4	0.088412	4.3	0.812	-0.047	546.1	22.7	545.8	22.6	544.3	68.2
17	136	1.71	14890	16.9466	3.8	0.73443	5.3	0.090309	3.7	0.697	0.29	557.4	19.6	559.2	22.6	566.5	82.2
18 C	95	2.03	7970	17.4356	5.4	0.72274	6.7	0.091436	3.9	0.584	-2	564	21.1	552.3	28.5	504.2	119.4
18 R	228	2.35	22653	17.1076	3.1	0.71115	4.6	0.088276	3.3	0.73	0.017	545.3	17.5	545.4	19.3	545.8	68.5
20 C	121	1.7	6793	17.0323	5.5	0.72722	6.5	0.089874	3.5	0.533	0.025	554.8	18.4	554.9	27.7	555.5	119.6
20 R	81	2.07	39407	16.4472	4.7	0.74348	6.4	0.088727	4.3	0.669	2.8	548	22.5	564.4	27.7	631.2	102.3
23	101	1.3	52768	17.0676	4.2	0.70869	5.9	0.087765	4.1	0.703	0.28	542.3	21.4	544	24.7	550.9	91
24	205	1.59	28539	17.1556	2.5	0.71011	3.8	0.088395	2.9	0.754	-0.2	546	15	544.8	16	539.7	54.6
26	59	1.67	35517	17.0343	5	0.71147	6.2	0.087937	3.7	0.594	0.41	543.3	19.3	545.6	26.3	555.2	109.3
28	129	1.33	13453	17.3147	4.4	0.70725	6.6	0.088855	4.9	0.746	-0.9	548.8	26	543.1	27.9	519.4	96.8
29	181	1.29	26141	17.0586	3.1	0.71767	3.9	0.088831	2.4	0.601	0.12	548.6	12.4	549.3	16.6	552.1	68.4
30	112	1.52	13197	17.2086	4.2	0.72582	5.5	0.090629	3.6	0.649	-0.86	559.3	19.2	554.1	23.5	532.9	91.6
32	116	1.3	12468	17.0614	4.3	0.69618	5.6	0.086185	3.7	0.648	0.62	532.9	18.7	536.5	23.5	551.7	93.8
33	176	1.13	9355	17.2876	4.2	0.70318	5.1	0.088206	2.9	0.564	-0.75	544.9	15.1	540.7	21.4	522.9	92.5
34 C	432	0.85	51130	16.9898	2.7	0.71723	4.2	0.088418	3.2	0.759	0.45	546.2	16.8	549	17.9	560.9	59.9
34 R	135	1.48	49246	16.4048	3.5	0.75612	5.3	0.090003	3.9	0.738	2.6	555.6	20.6	571.8	23	636.8	76.4
37	121	1.17	13270	17.5481	3.7	0.69099	5.3	0.087982	3.8	0.714	-1.7	543.6	19.7	533.4	22	490	81.8
38 C	204	2.18	22022	17.2142	2.8	0.73311	4.1	0.091569	3	0.724	-1	564.8	16.1	558.4	17.6	532.3	62
40	186	1.11	24987	17.2966	2.6	0.70509	4.1	0.088491	3.1	0.772	-0.76	546.6	16.4	541.8	17	521.7	56.6
41	90	2.02	157068	16.9735	4.4	0.71573	6.6	0.088148	4.9	0.742	0.57	544.6	25.5	548.1	27.9	563	96.2
42	162	1.17	30633	17.3758	2.9	0.71339	5	0.089943	4	0.805	-1.3	555.2	21.3	546.8	21	511.7	64.7
43	124	2.17	7240	17.5039	6.2	0.70443	7.1	0.089468	3.5	0.495	-2	552.4	18.6	541.4	29.7	495.6	135.7
44	224	1.13	33780	17.078	2.6	0.71076	3.8	0.088076	2.8	0.735	0.17	544.1	14.5	545.2	15.9	549.6	55.9
6 C	200	1.44	11458	17.5633	4.1	0.69199	5	0.088186	2.8	0.565	-1.9	544.8	14.8	534	20.8	488.1	91.2
7 C	208	1.62	60351	17.0643	2.3	0.71647	4	0.088712	3.2	0.813	0.11	547.9	17	548.6	16.8	551.3	50.4
10 C	251	0.9	29627	17.2149	2.6	0.70721	4	0.088339	3	0.762	-0.42	545.7	15.8	543.1	16.7	532.2	56.2
48	139	1.07	33133	17.3112	3.5	0.71961	5	0.09039	3.6	0.716	-1.2	557.8	19.1	550.4	21.2	519.9	76.5
49	211	1.05	11900	17.3619	3.1	0.71617	4.6	0.090221	3.4	0.734	-1.3	556.8	18	548.4	19.5	513.5	68.6
50	163	1.31	32081	16.9852	2.8	0.72664	4.5	0.089553	3.5	0.787	0.26	552.9	18.6	554.6	19.1	561.5	60

Table 1. LA-ICP-MS U-Pb zircon data for the Southern Pines 100 K (crystallization ages)

	Composition		Isotopic Ratios									Ages (Ma)					
ID	U (ppm)	U/Th	$^{206}Pb/^{204}Pb$	$^{206}Pb/^{207}Pb$	Error (%)	$^{207}Pb/^{235}U$	Error (%)	$^{206}Pb/^{238}U$	Error (%)	error correlation	concordia distance (d_c)[a]	$^{206}Pb/^{238}U$	Error (Ma)	$^{207}Pb/^{235}U$	Error (Ma)	$^{206}Pb/^{207}Pb$	Error (Ma)
_550027_																	
1	120	2.59	6277	17.0258	8.1	0.6775	9.5	0.083697	5	0.521	1.3	518.1	24.7	525.3	39.1	556.3	177.8
3	304	0.96	255501	17.2168	3.7	0.68053	5.1	0.085015	3.5	0.692	0.18	526	17.8	527.1	20.9	531.9	80.4
4	205	1.15	156219	17.1901	3.2	0.68889	4.3	0.085926	2.8	0.65	0.13	531.4	14.1	532.1	17.6	535.3	70.7
5	119	1.67	269850	16.7469	3.1	0.73106	4.7	0.088835	3.5	0.754	1.4	548.6	18.6	557.2	20.1	592.2	66.8
6	150	2.98	17373	17.6622	4.5	0.67427	6.1	0.086412	4	0.661	-1.9	534.3	20.5	523.3	24.8	475.7	100.6
7 R	158	2.06	15713	17.4038	4.6	0.68604	6.4	0.086634	4.5	0.698	-0.87	535.6	23.1	530.4	26.6	508.2	101.6
9	204	1.4	23622	17.373	3.5	0.70954	5.7	0.089443	4.5	0.788	-1.2	552.2	23.8	544.5	24	512.1	77.1
10	212	2.19	50760	17.5352	2.9	0.69422	4.7	0.088329	3.7	0.786	-1.6	545.6	19.2	535.3	19.5	491.6	63.8
11	279	1.35	42367	17.1117	2.5	0.69785	4.3	0.086646	3.4	0.806	0.29	535.7	17.6	537.5	17.8	545.3	55.1
12 R	229	1.31	10708	17.5417	3.2	0.68921	4.9	0.087724	3.6	0.745	-1.6	542.1	18.8	532.3	20.1	490.8	71.4
13	194	1.54	67328	17.0459	3.4	0.68756	4.4	0.085041	2.8	0.638	0.94	526.1	14.2	531.3	18.3	553.7	74.2
14 C	189	1.16	33074	17.4348	3.5	0.65973	5.4	0.083459	4.1	0.765	-0.39	516.7	20.5	514.4	21.8	504.3	76.7
14 R*	191	1.76	6882	17.6229	6.3	0.63927	6.9	0.081743	2.9	0.421	-0.92	506.5	14.1	501.9	27.3	480.6	138.4
16	143	1.85	12942	17.5342	5	0.69521	6.4	0.08845	4	0.629	-1.8	546.4	21.2	535.9	26.7	491.8	110.2
18	122	1.72	11793	17.5151	4.9	0.69813	7.2	0.088724	5.2	0.725	-1.7	548	27.3	537.7	29.9	494.1	109
20	239	2.26	65804	17.3285	2.3	0.70797	3.2	0.089016	2.3	0.702	-1	549.7	11.9	543.5	13.6	517.7	50.4
21	158	2.09	10180	17.4701	4.5	0.66994	6.1	0.084923	4.2	0.687	-0.83	525.4	21.3	520.7	25	499.8	98.3
22 R	184	1.64	21854	17.3874	3.5	0.70464	5.3	0.088899	4	0.75	-1.2	549	21	541.6	22.3	510.3	77.2
22 C	211	1.22	14928	17.4725	3.5	0.69815	4.7	0.088512	3.2	0.675	-1.5	546.7	16.7	537.7	19.7	499.5	76.6
24 C	485	0.82	75440	17.3036	2.3	0.68534	3.2	0.086047	2.3	0.705	-0.36	532.1	11.5	530	13.2	520.9	49.8
24 R	251	1.43	264591	17.4477	2.5	0.67129	3.5	0.084984	2.5	0.709	-0.73	525.8	12.6	521.5	14.4	502.7	54.9
25	58	1.64	20477	16.7764	6.2	0.70336	8	0.085619	5	0.631	2	529.6	25.7	540.8	33.6	588.4	134.7
26	149	2.37	20567	17.5752	3.7	0.65252	5.2	0.083213	3.7	0.714	-0.91	515.3	18.5	510	21	486.6	81.2
27	152	3.14	37090	17.4951	3.5	0.69796	5.3	0.088601	4	0.754	-1.5	547.3	20.9	537.6	22.1	496.7	76.5
28*	485	1.37	1127079	17.0919	2.2	0.74746	3.7	0.092698	3	0.802	-0.68	571.5	16.1	566.7	16	547.8	48
29	220	1.48	28149	17.2024	3.4	0.71201	4.8	0.088872	3.4	0.707	-0.48	548.9	17.8	545.9	20.2	533.8	74.1
7 C	123	1.48	40803	17.1169	3.8	0.72433	5.4	0.089961	3.8	0.702	-0.34	555.3	20.1	553.2	22.9	544.6	83.6
31	76	1.71	56752	17.3321	5	0.70401	7.1	0.088537	5	0.714	-0.94	546.9	26.5	541.2	29.7	517.2	108.7
32	272	1.35	77384	17.2151	2.7	0.70479	3.8	0.088036	2.7	0.709	-0.38	543.9	14.1	541.6	15.9	532.1	58.6
33	316	1.63	66010	17.107	3	0.69032	3.8	0.085687	2.4	0.635	0.53	530	12.4	533	15.9	545.9	64.7
12 C	188	1.16	162653	17.1769	3.9	0.70189	6	0.087479	4.6	0.756	-0.11	540.6	23.6	539.9	25.2	537	86.4
35	214	1.51	106587	16.952	3.5	0.69381	5.7	0.085341	4.5	0.789	1.1	527.9	22.7	535.1	23.7	565.8	76.1
37	319	1.18	18115	17.3556	4	0.6893	4.8	0.086804	2.7	0.558	-0.76	536.6	13.9	532.4	20	514.3	88
38	204	1.67	58994	17.007	4.2	0.69894	6.4	0.086251	4.8	0.748	0.79	533.3	24.4	538.2	26.6	558.7	92.1
39	113	2.36	104950	17.3438	4.1	0.72549	5.7	0.0913	4	0.705	-1.5	563.2	21.7	553.9	24.4	515.8	89
40	89	1.91	7067	17.801	6.6	0.64462	7.7	0.083261	3.9	0.515	-2	515.6	19.5	505.2	30.5	458.3	145.6
41	254	1.78	49251	17.2972	3.7	0.68025	5	0.085377	3.4	0.668	-0.21	528.1	17	526.9	20.7	521.7	82.1
42	195	1.63	26180	17.5525	2.9	0.69041	4.2	0.087931	3	0.716	-1.7	543.3	15.7	533	17.5	489.5	65
43*	573	13.25	66476	16.8498	2.3	0.76324	5.2	0.093314	4.6	0.895	0.11	575.1	25.4	575.9	22.6	578.9	50
44 C	532	1.19	70375	17.2618	2.3	0.72022	4.4	0.090208	3.7	0.846	-0.87	556.8	19.8	550.8	18.7	526.2	51.4
44 R	441	1.28	31693	17.3674	2.9	0.72104	4.4	0.090863	3.3	0.751	-1.4	560.6	17.6	551.3	18.6	512.8	63.2

Notes:

[a]Concordia distance (d_c) was calculated using IsoplotR (Vermeesch, 2018), and we discarded analyses outside of the range $-2 < d_c < 4.6$ (Vermeesch, 2021).

*Analyses with an asterisk were considered outliers according to Chauvenet's Criterion in IsoplotR (Vermeesch, 2018). They were not included in the weighted mean.

Table 2. LA-ICP-MS U-Pb zircon data for the Southern Pines 100 K (detrital ages)

	Composition		Isotopic Ratios										Ages (Ma)					
ID	U (ppm)	U/Th	$^{206}Pb/^{204}Pb$ [a]	$^{206}Pb/^{207}Pb$	Error (%)	$^{207}Pb/^{235}U$	Error (%)	$^{206}Pb/^{238}U$	Error (%)	error correlation	concordia distance (d_c) [b]	$^{206}Pb/^{238}U$	Error (Ma)	$^{207}Pb/^{235}U$	Error (Ma)	$^{206}Pb/^{207}Pb$	Error (Ma)
								Southern Pines 100k									
Sample 550363																	
1	118	1.64	13120	17.4363	3.6	0.70791	5.7	0.089563	4.4	0.774	-1.4	552.9	23.4	543.5	24	504.1	79.4
2	326	1.31	44148	17.1592	2.6	0.69927	4	0.087064	3.1	0.772	0.039	538.1	16.1	538.4	16.9	539.3	56.3
3	239	1.45	21299	17.4325	3	0.69071	4.4	0.087368	3.2	0.733	-1.1	540	16.7	533.2	18.2	504.6	65.6
7	161	1.74	18580	17.1979	2.9	0.71482	4.9	0.0892	4	0.81	-0.48	550.8	21.1	547.6	20.9	534.3	63.3
9	139	1.73	35147	17.1477	2.8	0.72145	4.4	0.089765	3.4	0.775	-0.4	554.1	18.1	551.5	18.7	540.7	60.9
10	175	1.51	16594	17.2449	3.1	0.71325	4.2	0.089247	2.9	0.681	-0.72	551.1	15.1	546.7	17.8	528.4	67.5
11	499	0.81	51596	16.889	2.6	0.69433	4.2	0.085087	3.3	0.787	1.4	526.4	16.5	535.4	17.3	573.9	55.7
12	195	1.35	7999	17.3921	3.9	0.71678	4.8	0.090455	2.8	0.579	-1.6	558.2	14.7	548.8	20.1	509.7	85.2
13	387	1.42	675910	16.9065	1.7	0.71848	3.5	0.088138	3	0.87	0.77	544.5	15.9	549.8	14.8	571.6	37.4
15	207	1.38	40264	17.0144	2.8	0.70978	4.6	0.087626	3.6	0.786	0.49	541.5	18.6	544.6	19.2	557.7	61.5
17	324	1.8	73473	17.1241	2.3	0.74638	3.3	0.092738	2.4	0.728	-0.87	571.7	13.3	566.1	14.5	543.7	50.1
19	328	1.49	339864	16.9454	2	0.7235	3.8	0.088958	3.2	0.843	0.49	549.4	16.7	552.7	16.1	566.6	44.1
20	369	1.35	316154	16.7858	2.2	0.73474	3.3	0.089489	2.5	0.744	1.1	552.5	13.1	559.3	14.3	587.2	48.2
21	182	1.91	85209	16.8705	3.1	0.72797	4.8	0.089112	3.6	0.755	0.82	550.3	19.1	555.4	20.5	576.3	68.2
22	197	1.68	98823	17.2337	2.5	0.71155	3.5	0.088977	2.5	0.717	-0.62	549.5	13.4	545.7	14.9	529.8	54.1
23	209	1.48	20550	17.1652	2.6	0.70017	3.8	0.087206	2.7	0.724	-0.018	539	14.1	538.9	15.8	538.5	56.8
24	205	2.43	105942	16.9957	3.2	0.725	4.7	0.089406	3.5	0.744	0.25	552	18.7	553.6	20.3	560.1	69.1
26	171	1.07	9950	16.933	5.9	0.69661	6.8	0.085589	3.3	0.493	1.4	529.4	17	536.8	28.2	568.2	128.2
29	124	1.17	89727	16.8363	4.2	0.75551	5.1	0.092296	3	0.588	0.39	569.1	16.5	571.4	22.5	580.7	90.4
31	75	1.17	9227	17.1787	5.2	0.7034	6.9	0.087677	4.5	0.657	-0.17	541.8	23.5	540.8	28.9	536.7	113.7
32	133	1.38	24839	17.437	2.3	0.68121	3.8	0.086188	3.1	0.796	-0.84	533	15.6	527.5	15.8	504	51.1
33	90	2.33	27339	17.2735	4.8	0.69596	5.9	0.087229	3.4	0.582	-0.49	539.1	17.7	536.4	24.5	524.7	105
34	153	1.57	24071	17.3082	3.3	0.71179	5.6	0.089392	4.6	0.81	-0.9	551.9	24.2	545.8	23.8	520.3	72.5
36	190	1.71	13921	17.4346	3.1	0.71619	4.5	0.090601	3.2	0.718	-1.7	559.1	17.2	548.4	19	504.3	68.7
37	203	1.3	95157	17.2333	2.8	0.71623	4	0.08956	2.9	0.713	-0.72	552.9	15.2	548.4	17.1	529.8	61.9
42	300	1.81	78339	16.9923	2.8	0.73242	3.6	0.090303	2.3	0.626	0.11	557.3	12.1	558	15.5	560.6	61.4
45	88	1.28	28829	17.3807	4	0.70346	5.4	0.088716	3.6	0.673	-1.2	547.9	19.1	540.9	22.7	511.1	88
49	607	1.04	29178	16.6539	3.5	0.73209	4.4	0.088466	2.8	0.625	2	546.5	14.5	557.8	19	604.2	74.9
50	271	1.27	17589	17.0472	3.1	0.70609	4.2	0.087339	2.9	0.687	0.45	539.8	15	542.4	17.7	553.6	66.9
52	183	1.28	13607	16.385	3.3	0.7512	4.1	0.089309	2.4	0.586	3.1	551.4	12.6	568.9	17.7	639.4	71
54	144	1.57	250903	17.0615	2.9	0.7104	4.4	0.087945	3.3	0.749	0.25	543.4	17.1	545	18.5	551.7	63.5
57	149	1.49	75987	17.1006	3.5	0.71819	4.7	0.089113	3.1	0.666	-0.11	550.3	16.5	549.6	20	546.7	76.8
62	60	1.67	19071	17.1123	5.1	0.72214	6.6	0.089666	4.1	0.629	-0.29	553.6	22	551.9	28.1	545.2	112.1
63	186	1.9	11050	17.3571	4.1	0.69329	5.1	0.087314	3	0.591	-0.86	539.6	15.6	534.8	21.2	514.1	90.2
64	1047	1.43	137012	16.8588	1.5	0.70832	2.3	0.086647	1.8	0.763	1.3	535.7	9.2	543.7	9.8	577.7	32.8
65	516	1.88	487445	17.0102	2.8	0.70852	3.7	0.08745	2.5	0.668	0.58	540.4	12.9	543.9	15.7	558.3	60.4
67	284	1.33	12237	17.3902	3.4	0.6958	3.9	0.087798	2	0.511	-1.1	542.5	10.5	536.3	16.4	509.9	74.3
68	288	1.22	53502	17.2321	2.9	0.7023	4.1	0.087811	2.9	0.716	-0.4	542.6	15.3	540.2	17.2	530	62.6
Sample 550946																	
2	112	2.49	87034	17.4781	4.1	0.70459	5.4	0.089356	3.4	0.636	-1.8	551.7	18	541.5	22.5	498.8	91.2
4	249	1.29	21778	17.0961	3.8	0.66054	4.6	0.081938	2.6	0.562	1.4	507.7	12.8	514.9	18.8	547.3	84
5	207	1.14	9089	16.806	8.8	0.70853	10.1	0.0864	4.9	0.487	1.8	534.2	25.3	543.9	42.6	584.6	191.7
7	218	1.18	18156	17.6355	2.9	0.6849	4.5	0.087641	3.4	0.753	-1.9	541.6	17.5	529.7	18.4	479	65
9	284	1.45	33336	17.2032	3.3	0.69364	4.6	0.086584	3.2	0.696	-0.054	535.3	16.3	535	18.9	533.6	71.7
13	198	1.58	34178	17.3189	4.2	0.69158	5	0.086907	2.8	0.556	-0.63	537.2	14.5	533.7	21	518.9	92.2
15	206	1.85	22811	17.4336	4.2	0.68034	5.5	0.086061	3.6	0.659	-0.92	532.2	18.6	527	22.7	504.4	91.5
16	167	1.66	141050	17.3995	3.3	0.6481	9.9	0.081822	9.4	0.944	0.075	507	45.8	507.3	39.7	508.7	72.1
17	122	1.38	6961	17.4323	7	0.68919	8.2	0.087174	4.2	0.513	-1.2	538.8	21.8	532.3	34	504.6	155.1
18	288	1.4	28197	17.5028	2.9	0.68875	3.9	0.08747	2.6	0.66	-1.4	540.6	13.3	532	16.1	495.7	64.5
19	123	1.37	47393	17.3625	4.2	0.71273	6	0.089791	4.3	0.722	-1.3	554.3	23	546.4	25.4	513.4	91.4
22	540	0.99	135300	16.9069	2.1	0.68601	6	0.084157	5.6	0.938	1.9	520.9	28.2	530.4	24.8	571.5	45.4
24	178	1.92	381241	16.9112	2.8	0.6966	4.8	0.085478	3.9	0.806	1.3	528.7	19.5	536.8	19.9	571	61.6
25	91	1.45	60559	17.3569	4	0.68243	5.9	0.085946	4.4	0.737	-0.54	531.5	22.3	528.2	24.4	514.1	87.9
26	254	1.51	35449	17.5617	2.6	0.68517	3.5	0.087308	2.3	0.663	-1.7	539.6	11.9	529.9	14.3	488.3	57.3
27	197	1.15	10508	16.7929	5.5	0.68171	7.1	0.083065	4.4	0.629	2.5	514.4	21.9	527.8	29	586.2	118.9
29	340	1.29	16242	16.5515	4.6	0.70463	5.7	0.084623	3.4	0.601	3.3	523.7	17.2	541.5	24	617.6	98.5
33	208	2.02	44463	17.347	2.7	0.66726	3.8	0.083987	2.7	0.696	-0.14	519.9	13.2	519	15.5	515.4	60.1
36	165	1.26	34859	17.3885	2.6	0.69723	3.8	0.08797	2.8	0.744	-1	543.5	14.8	537.1	16	510.1	56.1
40	315	0.84	77630	17.373	2.1	0.6737	3.8	0.084925	3.1	0.823	-0.39	525.5	15.6	523	15.3	512.1	46.9
41	172	1.76	71534	17.423	3.2	0.71183	5.6	0.089989	4.6	0.822	-1.4	555.5	24.6	545.8	23.7	505.8	70.3
42	129	1.72	10309	17.6266	5.1	0.67558	6.5	0.086405	3.9	0.606	-1.8	534.2	20.1	524.1	26.5	480.1	113.7
45	206	1.53	63036	17.2174	2.8	0.69828	4.7	0.087236	3.8	0.809	-0.22	539.2	19.9	537.8	19.8	531.8	61.1
46	129	1.76	20084	17.5054	4	0.70803	5.3	0.089932	3.4	0.643	-2	555.1	18	543.6	22.2	495.4	89.1
50	284	1.49	12047	17.4727	2.3	0.67442	3.5	0.085503	2.7	0.765	-0.88	528.9	13.7	523.4	14.4	499.5	50
51	127	1.87	16529	17.4198	3.5	0.69792	5.9	0.088216	4.7	0.8	-1.1	545	24.7	537.6	24.6	506.2	77.9
52	139	1.95	13323	17.5147	3.8	0.67699	5.3	0.086036	3.8	0.708	-1.2	532.1	19.2	525	21.8	494.2	82.8
53	163	1.73	35390	17.2689	4	0.69029	5.4	0.086495	3.5	0.658	-0.32	534.8	18.1	533	22.2	525.3	88.4
55	143	1.59	9537	17.1248	4.7	0.70303	7	0.087357	5.2	0.743	0.11	539.9	27.1	540.6	29.5	543.6	103.1
56	148	1.67	16840	16.4813	6.6	0.72226	8.1	0.086373	4.8	0.587	3.3	534.1	24.4	552	34.5	626.7	141.5
57	135	1.32	60095	17.3604	4.4	0.6744	5.4	0.084952	3.1	0.572	-0.41	525.6	15.6	523.4	22	513.7	97.1
58	244	1.28	37499	17.426	3.1	0.69978	5	0.088482	3.9	0.781	-1.2	546.6	20.4	538.7	20.8	505.4	68.4
59	157	2.05	99203	17.4623	3.1	0.68253	5.3	0.08648	4.3	0.813	-0.98	534.7	22.1	528.3	21.8	500.8	67.9
61	103	1.74	13155	17.3626	5.3	0.73553	6.5	0.092664	3.7	0.573	-2	571.3	20.4	559.8	28.1	513.4	117.4
62	186	1.79	16819	17.4342	3.6	0.70502	5.1	0.089186	3.7	0.714	-1.4	550.7	19.4	541.8	21.6	504.3	79.2
64	244	1.49	24984	17.2151	3.1	0.70482	5.2	0.08804	4.2	0.808	-0.35	543.9	22	541.7	21.9	532.1	67.2
65	158	1.77	70785	17.3935	3.3	0.69097	4.6	0.087205	3.2	0.694	-0.94	539	16.4	533.4	19	509.5	72.4
66	235	1.89	25262	17.297	3.1	0.66673	4.5	0.083679	3.3	0.732	0.11	518	16.4	518.7	18.3	521.7	67.2
67	129	1.98	333733	16.9914	2.7	0.71038	5	0.087582	4.1	0.835	0.57	541.2	21.5	545	20.9	560.7	59.5
68	186	1.26	13313	17.7133	3.8	0.6659	5.3	0.085586	3.6	0.683	-1.9	529.4	18.3	518.2	21.4	469.3	85.2
69	256	1.21	130658	16.6831	5.4	0.70579	6.2	0.085437	3.1	0.503	2.6	528.5	15.9	542.2	26.1	600.4	116.4
70	175	2	33978	16.7239	5.1	0.71511	5.7	0.086777	2.6	0.464	2.1	536.4	13.6	547.8	24.2	595.2	109.7
75	199	2.04	13600	17.5312	3.6	0.67621	5	0.086017	3.4	0.687	-1.3	531.9	17.6	524.5	20.5	492.1	80.2
77	110	1.93	34189	17.3684	3.9	0.67825	5.7	0.085476	4.2	0.733	-0.5	528.7	21.3	525.7	23.5	512.7	85.6
84	155	1.24	69619	17.527	4.3	0.69117	5.2	0.0879	2.9	0.568	-1.7	543.1	15.3	533.5	21.5	492.7	94.1
87	194	1.75	22924	17.6613	3	0.677	4.3	0.086757	3.1	0.719	-1.9	536.3	16	525	17.8	475.8	66.6
88	212	1.49	132068	17.0381	3.4	0.70815	4.8	0.087547	3.4	0.705	0.44	541	17.6	543.6	20.3	554.7	74.4
89	200	1.75	65644	17.4796	3.1	0.68456	4.2	0.086823	2.7	0.661	-1.3	536.7	14.2	529.5	17.2	498.6	68.8
90	156	1.94	47486	16.9933	2.5	0.69406	4.6	0.08558	3.8	0.832	0.91	529.3	19.3	535.2	19	560.4	55.2
92	250	1.26	327999	17.469	3.4	0.68846	5.3	0.087265	4	0.762	-1.2	539.3	20.9	531.9	21.9	500	75.4
95	260	1.35	65331	16.9763	2.4	0.74602	4.8	0.091895	4.2	0.873	-0.12	566.7	22.8	565.9	20.9	562.6	51.3
97	307	1.63	76119	16.7906	3.5	0.66618	4.6	0.081161	3	0.647	2.9	503.1	14.4	518.4	18.7	586.5	76
98	165	1.99	23493	17.1608	3.5	0.69694	5	0.086782	3.6	0.718	0.079	536.5	18.6	537	21	539.1	76.5
99	241	1.85	27476	17.5224	3.2	0.70031	5	0.089038	3.8	0.761	-1.7	549.8	19.9	539	20.7	493.2	70.9
100	187	1.79	22984	17.3702	3.8	0.68478	5	0.086308	3.3	0.658	-0.7	533.7	16.8	529.7	20.6	512.4	82.5
103	277	1.6	208749	17.1091	2.7	0.69351	4.2	0.086094	3.2	0.756	0.41	532.4	16.2	534.9	17.4	545.6	60
104	161	1.55	15560	17.5074	4.1	0.69482	6.3	0.088265	4.7	0.759	-1.5	545.3	24.8	535.7	26	495.1	89.7
105	178	1.94	144310	17.3912	3.6	0.69538	5	0.087749	3.5	0.69	-1	542.2	18.1	536	21	509.8	80.2

Table 2. LA-ICP-MS U-Pb zircon data for the Southern Pines 100 K (detrital ages)

	Composition		Isotopic Ratios									Ages (Ma)					
ID	U (ppm)	U/Th	$^{206}Pb/^{204}Pb$[a]	$^{206}Pb/^{207}Pb$	Error (%)	$^{207}Pb/^{235}U$	Error (%)	$^{206}Pb/^{238}U$	Error (%)	error correlation	concordia distance (d_c)[b]	$^{206}Pb/^{238}U$	Error (Ma)	$^{207}Pb/^{235}U$	Error (Ma)	$^{206}Pb/^{207}Pb$	Error (Ma)
106	167	1.87	262707	17.3661	3.7	0.68986	5.1	0.086928	3.5	0.685	-0.78	537.3	17.9	532.7	21	513	81.1
107	141	1.93	32495	17.264	3.7	0.69131	5	0.086599	3.4	0.682	-0.31	535.4	17.6	533.6	20.9	525.9	80.7
110	382	0.72	27658	16.6325	2.9	0.82063	5.3	0.099037	4.5	0.839	-0.053	608.8	26	608.4	24.4	607	62.9
112	205	1.78	43012	17.5082	3.4	0.6936	4.7	0.088114	3.3	0.699	-1.5	544.4	17.1	535	19.5	495	74.1
113	152	1.57	34776	17.7648	3.3	0.6682	5.5	0.08613	4.5	0.805	-2	532.6	22.8	519.6	22.5	462.9	72.9
115	132	1.46	122657	17.4232	3.2	0.73584	5.5	0.093026	4.5	0.817	-1.9	573.4	24.7	560	23.7	505.7	69.7
117	253	1.06	16210	17.4972	3.3	0.69895	5.1	0.088738	3.9	0.757	-1.5	548.1	20.3	538.2	21.3	496.4	73.4
118	116	1.86	54597	17.3671	3.3	0.69691	5.7	0.087821	4.7	0.82	-0.85	542.6	24.4	536.9	23.9	512.8	71.9
119	403	1.5	778976	17.1678	2.3	0.69108	3.7	0.086087	2.9	0.788	0.17	532.4	14.8	533.4	15.2	538.1	49.4
121	209	1.54	28403	16.6274	4.3	0.67918	4.9	0.081942	2.2	0.451	3.6	507.7	10.7	526.3	19.9	607.7	93.8
122	328	1.21	71973	17.4582	2.4	0.69078	4.2	0.087505	3.4	0.822	-1.1	540.8	17.7	533.3	17.3	501.3	52.1
125	240	1.58	25472	17.1889	3.5	0.70109	4.5	0.087442	2.8	0.627	-0.16	540.4	14.7	539.4	18.9	535.5	77
128	262	1.5	137118	17.485	2.6	0.66266	6.6	0.084071	6.1	0.923	-0.76	520.4	30.5	516.2	26.8	497.9	56.3
129	229	1.73	8811	17.6891	5	0.66403	6.8	0.085229	4.6	0.678	-1.8	527.3	23.5	517.1	27.7	472.3	111.4
132	161	1.4	47218	17.3374	3.6	0.67906	5	0.085426	3.4	0.686	-0.39	528.4	17.4	526.2	20.5	516.6	79.9
133	172	1.58	38065	17.3906	3.5	0.69983	4.7	0.088308	3.2	0.682	-1.2	545.5	16.9	538.7	19.7	509.8	75.9
135	200	1.22	22790	17.4358	3.9	0.67769	5.6	0.085737	4.1	0.724	-0.81	530.3	20.7	525.4	23.1	504.1	85.3
136	215	2.14	24149	17.288	2.8	0.6666	7.6	0.083619	7.1	0.933	0.19	517.7	35.5	518.6	31.1	522.8	60.4
138	146	1.83	27458	17.6312	3.4	0.68675	5.4	0.087857	4.2	0.775	-1.9	542.8	21.8	530.8	22.3	479.6	75.4
141	274	1.47	33425	17.3315	2.6	0.67642	4	0.085064	3	0.763	-0.27	526.3	15.4	524.6	16.3	517.3	56.6
142	195	1.8	32869	17.4073	3.3	0.69306	4.8	0.087538	3.4	0.721	-1.1	541	17.8	534.6	19.8	507.8	72.5
143	239	1.42	95995	17.2011	2.4	0.71468	3.9	0.0892	3	0.777	-0.51	550.8	15.8	547.5	16.3	533.9	53.2
145	83	1.42	13547	17.1943	5.3	0.69955	7.9	0.087276	5.9	0.742	-0.14	539.4	30.4	538.5	33.1	534.8	116.3
146	267	1.21	86327	17.222	2.5	0.68861	3.6	0.08605	2.6	0.714	-0.029	532.1	13.3	532	15.1	531.3	55.9
148	232	1.68	18938	17.3585	3.7	0.68794	4.6	0.086648	2.7	0.579	-0.75	535.7	13.6	531.6	18.9	513.9	82
149	161	1.36	21873	17.3622	3.3	0.67142	4.3	0.084585	2.7	0.625	-0.34	523.4	13.4	521.6	17.5	513.4	73.4
151	385	1.42	45832	17.1566	2.3	0.70337	3.7	0.08756	2.9	0.78	-0.042	541.1	15.2	540.8	15.7	539.6	51.3
154	291	0.99	28750	17.4039	2.3	0.65846	4	0.083151	3.3	0.824	-0.19	514.9	16.3	513.7	16.1	508.2	49.6
155	130	2.07	40283	17.5438	4.9	0.68343	6.3	0.086998	4	0.636	-1.6	537.8	20.7	528.8	26	490.5	107.3
159	162	1.15	23310	17.3435	3.3	0.68339	5	0.086	3.7	0.752	-0.5	531.8	19	528.8	20.4	515.8	71.8
160	149	1.77	16500	17.601	3.9	0.67221	5.5	0.08585	3.9	0.712	-1.5	530.9	19.9	522.1	22.4	483.4	85.2
161	659	0.91	134731	17.1709	2.3	0.72261	4.2	0.090031	3.5	0.841	-0.51	555.7	18.8	552.2	17.8	537.7	49.5
162	186	1.53	127808	17.4364	3.1	0.69636	4.2	0.088101	2.8	0.672	-1.3	544.3	14.8	536.6	17.6	504.1	68.7
163	228	1.27	59846	17.1391	2.6	0.71287	4	0.088653	3	0.758	-0.17	547.6	15.8	546.5	16.8	541.8	56.6
167	191	1.7	37467	17.4563	2.6	0.68847	5.8	0.087203	5.2	0.891	-1.1	539	26.9	531.9	24.2	501.6	58.3
168	119	1.96	43962	17.5647	3.7	0.67071	5.3	0.08548	3.8	0.721	-1.3	528.8	19.3	521.1	21.5	487.9	80.7
169	118	1.51	5942	16.5319	6.8	0.71411	8.3	0.08566	4.8	0.576	3.2	529.8	24.4	547.2	35.2	620.1	146.7
171	202	1.06	15573	16.7191	3.8	0.74855	5	0.090809	3.2	0.648	1.2	560.3	17.3	567.4	21.6	595.8	82
172	204	1.57	63503	17.3782	3.1	0.68179	4.3	0.085971	3	0.699	-0.65	531.7	15.5	527.9	17.9	511.4	68.4
173	170	1.78	51605	17.4976	3.4	0.68477	5.2	0.08694	4	0.765	-1.2	537.4	20.5	529.7	21.5	496.3	73.9
174	151	1.9	249909	17.2968	3.4	0.70105	4.8	0.087985	3.5	0.715	-0.68	543.6	18	539.4	20.2	521.7	74.2
178	147	1.81	16043	17.5617	3.9	0.66863	5.2	0.085201	3.4	0.651	-1.3	527.1	17.1	519.9	21.1	488.3	86.7
179	120	1.89	11891	17.6027	4.8	0.68006	5.8	0.08686	3.2	0.552	-1.8	536.9	16.4	526.8	23.7	483.2	106
181	167	1.91	61590	17.2937	3.1	0.70198	4.2	0.088086	2.9	0.675	-0.71	544.2	14.9	540	17.8	522.1	68.7
182	123	1.9	62342	17.2017	3.8	0.70027	5.2	0.087403	3.6	0.691	-0.2	540.2	18.7	539	21.8	533.8	82.6
183	147	1.77	64812	17.1781	3.5	0.70154	5.5	0.087442	4.2	0.765	-0.11	540.4	21.8	539.7	23	536.8	77.5
184	194	1.52	284438	17.5654	3	0.69235	4.3	0.088242	3.1	0.719	-1.8	545.1	16	534.2	17.7	487.8	65.2
185	162	1.8	63235	17.4254	2	0.69119	3.3	0.087392	2.6	0.796	-1	540.1	13.5	533.5	13.6	505.5	43.5
186	134	1.48	11956	17.6937	3.8	0.67544	6.4	0.086716	5.1	0.803	-1.9	536.1	26.5	524	26.2	471.7	84.6
188	200	1.7	513440	17.4089	2.4	0.6872	4.5	0.086805	3.8	0.846	-0.83	536.6	19.4	531.1	18.4	507.6	52.2
189	191	1.81	24380	17.4944	3.1	0.71101	4.6	0.090255	3.5	0.748	-1.8	557	18.5	545.3	19.5	496.8	67.5
191	179	2.04	17652	17.5136	3.6	0.6854	5.7	0.087099	4.5	0.782	-1.3	538.4	23.2	530	23.7	494.3	78.9
192	176	1.48	9113	17.426	4.9	0.70578	5.6	0.08924	2.9	0.51	-1.6	551	15.2	542.2	23.7	505.4	106.8
195	79	1.51	14011	17.4478	5.7	0.65203	7.4	0.082548	4.7	0.64	-0.3	511.3	23.2	509.7	29.6	502.7	125
196	220	1.56	39559	17.4289	2.5	0.71239	4.2	0.090092	3.4	0.805	-1.5	556.1	18	546.2	17.7	505	54.7
199	170	1.89	171301	17.018	3.7	0.69464	4.9	0.085775	3.1	0.645	0.9	530.5	16	535.6	20.3	557.3	81.3
201	173	1.75	14424	17.5352	4.4	0.68943	6.3	0.08772	4.5	0.719	-1.6	542	23.4	532.5	26	491.6	96.1
203	149	1.86	76730	17.443	3.2	0.6839	4.6	0.086558	3.3	0.714	-1	535.1	16.8	529.1	18.9	503.2	70.5
205	47	1.49	15170	16.765	5.6	0.68955	9.3	0.083881	7.4	0.8	2.2	519.2	37.1	532.5	38.6	589.9	121.3
208	155	1.75	29573	17.3292	3.8	0.69346	5	0.087196	3.2	0.646	-0.71	538.9	16.8	534.9	20.9	517.6	84.3
210	195	1.3	74753	16.8582	2.2	0.72035	4.4	0.088115	3.8	0.862	0.95	544.4	19.6	550.9	18.5	577.8	48
214	308	0.99	29461	16.8792	2.8	0.66728	4	0.081725	2.9	0.719	2.2	506.4	14	519.1	16.2	575.1	60.2
218	193	1.06	54466	17.3454	2.7	0.70496	4.8	0.088724	4	0.831	-0.92	548	21.1	541.7	20.3	515.6	59.1
219	159	1.4	46533	17.1047	4	0.70494	5.9	0.087491	4.3	0.731	0.17	540.7	22.2	541.7	24.6	546.2	87.2
223	208	1.84	30170	17.1164	3.1	0.6955	4.7	0.086379	3.6	0.759	0.32	534.1	18.2	536.1	19.5	544.7	66.7
224	144	1.12	45754	17.5995	3.4	0.68041	5.1	0.086889	3.8	0.743	-1.6	537.1	19.3	527	20.8	483.6	74.7
225	194	1.84	123513	16.7807	3.5	0.71027	5.3	0.086482	3.9	0.741	1.7	534.7	20.1	544.9	22.3	587.8	77
228	170	1.88	139136	17.3834	2.9	0.6688	6	0.084358	5.2	0.875	-0.33	522.1	26.2	520	24.3	510.8	63.5
229	122	1.31	7756	17.5936	6.1	0.68816	7.4	0.087849	4.2	0.566	-2	542.8	21.8	531.7	30.7	484.3	134.8
231	185	1.61	47581	17.2199	2.4	0.70448	3.8	0.088023	2.9	0.777	-0.37	543.8	15.3	541.5	15.8	531.5	51.9
233	145	2.11	54967	17.6624	2.9	0.66823	4.6	0.085638	3.5	0.772	-1.6	529.7	17.9	519.6	18.5	475.7	64
234	221	1.32	41870	17.1654	2	0.68753	3.7	0.085633	3.1	0.839	0.25	529.7	15.9	531.3	15.4	538.4	44.5
235	317	1.07	158781	17.2693	2.5	0.69689	3.9	0.087324	3	0.768	-0.43	539.7	15.4	536.9	16.1	525.2	54.3
236	142	1.99	27665	17.7123	3.6	0.66106	5.3	0.084959	3.9	0.733	-1.7	525.7	19.6	515.3	21.4	469.4	79.7
237	141	1.26	10123	17.4236	5.5	0.6666	6.7	0.084275	3.8	0.572	-0.55	521.6	19.1	518.6	27.1	505.7	120.5
240	153	1.25	48063	17.245	4.4	0.69023	6.2	0.086368	4.3	0.696	-0.19	534	22.1	532.9	25.7	528.3	97.3
243	306	0.98	83593	17.2066	2.8	0.73097	3.9	0.091262	2.8	0.699	-0.92	563	14.9	557.1	16.9	533.2	61.7
244	146	2.03	13610	17.5114	4.5	0.67881	6.4	0.08625	4.5	0.703	-1.2	533.3	23	526.1	26.2	494.6	100.2
248	151	1.23	118557	17.223	3.8	0.67695	5.6	0.084598	4	0.721	0.25	523.5	20.1	524.9	22.8	531.1	84.3
249	127	1.61	13904	17.4267	4.6	0.68394	6.1	0.086483	3.9	0.65	-0.98	534.7	20.2	529.2	25	505.3	101.6
251	132	1.39	208845	16.8385	2.7	0.70173	3.9	0.085737	2.8	0.728	1.6	530.3	14.4	539.8	16.2	580.4	57.7
252	140	1.97	43929	17.1448	3.1	0.68942	4.7	0.085765	3.6	0.756	0.32	530.4	18.1	532.5	19.5	541.1	67.2
255	93	2.92	6449	17.5196	7.1	0.64726	8.3	0.08228	4.2	0.509	-0.56	509.7	20.6	506.8	32.9	493.6	156.8
259	177	1.99	41057	17.2858	3.9	0.67742	6.3	0.084965	5	0.791	-0.082	525.7	25.2	525.2	25.9	523.1	84.8
262	206	1.44	16086	17.1094	4.2	0.70614	5.5	0.087664	3.5	0.645	0.13	541.7	18.3	542.5	22.9	545.6	91
266	133	1.32	25796	17.4683	3.9	0.67977	5.3	0.08616	3.6	0.675	-1.1	532.8	18.4	526.6	21.9	500.1	86.6
268	233	1.78	11201	17.537	2.7	0.68806	3.8	0.087554	2.6	0.702	-1.6	541.1	13.7	531.6	15.5	491.4	58.9
271	159	1.25	19443	17.5681	3.3	0.67927	4.9	0.086588	3.5	0.726	-1.5	535.3	18.1	526.3	19.9	487.5	73.6
272	117	1.8	44060	17.1303	4.1	0.67615	6.1	0.084043	4.6	0.749	0.72	520.2	23	524.4	25.1	542.9	88.7
273	101	1.5	204398	17.325	3.8	0.73605	5.8	0.092528	4.5	0.767	-1.5	570.5	24.5	560.1	25.2	518.1	82.4
275	197	1.86	50473	17.3304	3.1	0.68304	4.3	0.085891	3	0.686	-0.44	531.2	15.1	528.6	17.8	517.5	68.8
277	111	1.25	30244	17.5812	4.2	0.68814	7	0.087784	5.6	0.796	-1.6	542.4	28.9	531.7	28.9	485.9	93.5
279	224	1.6	19983	17.3674	3.1	0.68447	3.8	0.086255	2.2	0.591	-0.71	533.4	11.5	529.5	15.7	512.8	67.3
280	103	1.84	13437	17.666	3.9	0.67189	5.9	0.086125	4.4	0.756	-1.8	532.6	22.7	521.9	24	475.2	85.3
284	194	1.52	67825	17.2575	2.8	0.6929	5.5	0.086764	4.7	0.862	-0.27	536.4	24.3	534.5	22.8	526.7	61
285	157	1.13	75681	17.14	3.5	0.68265	4.7	0.084899	3	0.652	0.56	525.3	15.3	528.4	19.2	541.7	77.2
287	873	0.92	434337	17.1901	1.9	0.69837	3.4	0.087108	2.8	0.83	-0.089	538.4	14.7	537.8	14.3	535.3	41.9
288	263	1.29	73675	16.9674	3.5	0.67931	5.6	0.083634	4.4	0.781	1.4	517.8	22	526.4	23.2	563.7	76.8
289	166	1.23	29287	16.5668	2.8	0.72948	4.1	0.087689	3	0.727	2.4	541.9	15.6	556.2	17.7	615.6	61.1

Table 2. LA-ICP-MS U-Pb zircon data for the Southern Pines 100 K (detrital ages)

	Composition		Isotopic Ratios									Ages (Ma)					
ID	U (ppm)	U/Th	$^{206}Pb/^{204}Pb$[a]	$^{206}Pb/^{207}Pb$	Error (%)	$^{207}Pb/^{235}U$	Error (%)	$^{206}Pb/^{238}U$	Error (%)	error correlation	concordia distance (d_c)[b]	$^{206}Pb/^{238}U$	Error (Ma)	$^{207}Pb/^{235}U$	Error (Ma)	$^{206}Pb/^{207}Pb$	Error (Ma)
290	194	1.97	60107	17.3141	2.3	0.69636	4	0.087483	3.3	0.826	-0.6	540.6	17.2	536.6	16.8	519.5	49.8
291	166	2.01	8929	17.521	5.3	0.63862	6.2	0.081189	3.1	0.505	-0.35	503.2	15.1	501.5	24.5	493.4	117.7
292	146	1.91	135674	17.0848	4.2	0.68705	5.4	0.085171	3.4	0.632	0.74	526.9	17.4	531	22.5	548.7	92.1
293	268	1.83	20134	17.4282	3.4	0.68231	4.7	0.086284	3.2	0.68	-0.91	533.5	16.2	528.2	19.2	505.1	75.2
297	174	1.47	45351	17.2822	3.5	0.66739	4.8	0.08369	3.2	0.672	0.18	518.1	15.9	519.1	19.3	523.6	77.2
298	314	1.51	53197	17.0387	2.7	0.70208	4.1	0.0868	3.1	0.755	0.56	536.6	15.9	540	17.2	554.6	58.6
305	184	1.46	37490	17.3643	3.7	0.70118	5	0.088345	3.3	0.672	-1.1	545.7	17.4	539.5	20.7	513.2	80.7
308	162	1.63	45349	17.2823	3.8	0.68846	5.7	0.086333	4.2	0.745	-0.31	533.8	21.7	531.9	23.5	523.6	83.1
309	149	1.92	82216	17.0111	3	0.70206	5.4	0.086656	4.4	0.827	0.66	535.7	22.8	540	22.5	558.1	65.7
310	233	1.17	34723	17.4773	2.9	0.68726	4.2	0.087154	3	0.714	-1.2	538.7	15.4	531.2	17.3	498.9	64.5
311	397	0.74	50596	17.1088	2.8	0.66458	5	0.082502	4.1	0.824	1	511	20.1	517.4	20.2	545.6	61.6
312	200	1.17	55043	17.1406	3.1	0.7555	6.8	0.093962	6.1	0.889	-1.1	578.9	33.6	571.4	29.8	541.6	68.2
313	153	1.21	103967	17.092	3.1	0.73789	5.2	0.091512	4.2	0.801	-0.48	564.5	22.7	561.2	22.6	547.8	68.4
314	167	2.07	55448	17.1168	4.1	0.69817	5.8	0.086711	4.1	0.707	0.28	536.1	21.1	537.7	24.2	544.6	89.7
315	235	1.63	57934	17.2365	3	0.69125	4.5	0.086453	3.4	0.744	-0.15	534.5	17.2	533.6	18.7	529.4	65.9

Notes:

[a]The $^{206}Pb/^{204}Pb$ ratios were not provided for data acquired in Dr. David Barbeau's lab at the University of South Carolina

[b]Concordia distance (d_c) was calculated using IsoplotR (Vermeesch, 2018), and we discarded analyses outside of the range $-2 < d_c < 4.6$ (Vermeesch, 2021).