U-Pb ages from the Davyville Complex, southernmost Appalachians, eastern Alabama: an accreted Taconic arc

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ABSTRACT

The Inner Piedmont of Alabama is a tectonic terrane of high-grade metasedimentary, metamorphic, and magmatic rocks that extends throughout the southern Appalachians, in eastern Alabama, the proven age and tectonic affinity of this is not well defined. Some units previously correlated to the Inner Piedmont in Alabama are in fact a part of the eastern Blue Ridge terrane (i.e., the Opelika Complex) or now only the Davyville Complex is considered to have a true Inner Piedmont affinity. The Davyville Complex is a package of interlayered amphibolite and felsic schist (Waresville Formation), layered to massive amphibolite and tonalitic gneiss (Waverly Gneiss), two different felsic intrusions suites (the Blue Hill Gneiss and the Rock Mills Granite), and a rhyolitic aluminous schist (Agricola Schist). The only previously reported age for Davyville Complex rocks is a Rb-Sr whole-rock isochron age of 444 ± 4 Ma for the Franklin Gneiss in western Georgia (i.e., the Rock Mills Granite in Alabama). Samples were collected from the type localities of six constituent units comprising the Davyville Complex and their zircons were analyzed for U-Pb (LA-ICP-MS and SHRIMP) dating in order to resolve the nature of the age discrepancy and to improve understanding of the Davyville Complex geochronology. Samples 2WLB07-1, 2WLB07-2, and 2WLB12-1 from the Waverly Gneiss, 2WLB07-5 from the Waresville Formation, and 2WLB07-8 from the Agricola Schist yielded U-Pb ages of 487 ± 3 Ma, 472 ± 3 Ma, and 451 ± 3 Ma for the Waverly Gneiss, 470 ± 2 Ma for the Waresville Formation, 467 ± 2 Ma for the Waverley Gneiss, and 468 ± 2 Ma for the Agricola Schist, respectively. These ages are interpreted to represent the time of peak amphibolite facies metamorphism, and the results indicate that early amphibolite facies amphibolite-gneiss assemblages were reactivated at ~487 Ma during the Austroalpine (Late Neoproterozoic) accretion. The development of new amphibolite facies mineral assemblages at ~472 Ma indicates the subsequent development of a Grenvillian orogeny. The U-Pb ages of 451 Ma from the Agricola Schist indicate the occurrence of a younger metamorphic event at ~451 Ma, which is interpreted as the time of exhumation of the Inner Piedmont in Alabama.

METHODS

Samples for U-Pb/Zr dating were collected from their respective type localities within the Davyville Complex. Zircons were extracted using standard heavy mineral separation techniques, and staged using scanning electron microscopy (SEM) cathodoluminescence. The age dating was performed using the facilities in the U-Pb AMS Lab at California State University, Northridge following the methodology of Fryer et al. (1999). The 207/206 Pb/Sr ratios were normalized to the values of Sr standard Palisade (Sr601, 400 Ma) and plotted using Isoplot v. 3.75 (Ludwig, 2003). U-Pb ages that were more than 10% discordant were excluded from the data set.

REFERENCES


CONCLUSIONS

The conclusions for this investigation of the Davyville Complex are four-fold:

1. The magmatic ages obtained during our analyses are compatible with the previously reported age for the Franklin Gneiss and confirm that the Davyville Complex contains volcanic and plutonic rocks of an Early to Middle Ordovician age.
2. Detrital zircon populations for the Agricola Schist do not coincide with the typical gneissic source rocks found along the present-day southeastern Laurentian margin. The Agricola Schist comes from a source that is more similar to the Upper Ordovician to Lower Silurian rocks of the Canadian Shield.
3. The detrital zircon signature from the Agricola Schist is similar to the Silurian rocks of the Canadian Shield and is interpreted as being evidence for Laurentian metamorphism.
4. Both the Agricola Schist and the Waverly Gneiss are interpreted as being evidence for Taconian metamorphism.

DETRITAL ANALYSIS

Detrital zircons from the Agricola Schist yielded 207/206 Pb/Sr dates spanning ~476 to 443 Ma, with peaks at ~500 Ma, ~525 Ma, ~480 Ma, and ~420 Ma. These zircon populations, with the exception of the 485 Ma population, are not typical of Laurentian sources. The discrepancy in age populations and the absence of a prominent Grenvillian signature in the Agricola Schist indicates the Davyville Complex is an exotic terrane that developed during the Taconian orogeny.

GEologic SETTING

The Davyville Complex comprises a tectonic terrane of high-grade metasedimentary, metamorphic, and magmatic rocks that extends throughout the Inner Piedmont of eastern Alabama. These rocks contain peak amphibolite facies metamorphic mineral assemblages that were locally reactivated at upper greenschist facies conditions during ductile shearing associated with Alleghanian deformation within the crust of the southern Piedmont (Steltenpohl and Moore, 2000; Steltenpohl and Kraft, 1993; Avery, 2000). Geochronological analyses of amphibolites and ultramafics by Nelson and Storey (1986), Hall (1991), and Sterling (2000) indicate that these rocks evolved in an arc setting in the framework of a Neotethyan oceanic domain. The granitic protoliths to these amphibolite facies schists were emplaced in a volcanic arc, and these interpretations are supported by the Late Neoproterozoic age of U-Pb detrital zircons in the Agricola Schist, which indicates the Taconian orogeny.

MAGNATIC ANALYSIS

Samples for U-Pb/Zr dating were collected from their respective type localities within the Davyville Complex. Zircons were extracted using standard heavy mineral separation techniques, and staged using scanning electron microscopy (SEM) cathodoluminescence. The age dating was performed using the facilities in the U-Pb AMS Lab at California State University, Northridge following the methodology of Fryer et al. (1999). The 207/206 Pb/Sr ratios were normalized to the values of Sr standard Palisade (Sr601, 400 Ma) and plotted using Isoplot v. 3.75 (Ludwig, 2003). U-Pb ages that were more than 10% discordant were excluded from the data set.

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