EVIDENCE OF ORDOVICIAN VOLCANIC ARC IN THE SOUTHERN APPALACHIAN FROM U-Pb AGES OF ZIRCON

R. Das (FSU, Geochemistry)

Introduction

A major problem in the Appalachian geology is to quantify a realistic causative mechanism for Taconian deformation in the Southern Appalachian. As in the central Appalachian, it is difficult to appeal to subduction beneath a proved Ordovician Arc as a deformation mechanism for the Southern Appalachian as no Ordovician volcanic rocks have been recognized. This study will use geochronological data to investigate whether Pumpkinvine Creek Formation (PVC), a sequence of bimodal volcanics with intercalated aluminous sediments can qualify for the Ordovician Arc. Zircons separated from two samples of the felsic unit of the PVC were analyzed by LA-ICPMS technique. Detrial zircons were also separated from the metasediments that are interlayered with the PVC to evaluate the provenance crustal affinity of the terranes from which the samples were collected.

Experiment

Heavy mineral concentrates of the <350 microns fraction were separated magnetically. Inclusion-free zircons from the non-magnetic fraction were then handpicked under a binocular microscope at the Geochemistry facility of NHMFL. At least fifty zircons from each sample were mounted in epoxy and polished for laser ablation analyses at University of Arizona. Zircon crystals were analyzed in polished section with a Micromass Isoprobe multi-collector ICPMS equipped with nine Faraday collectors, an axial Daly detector, and four ion-counting channels. The Isoprobe is equipped with an ArF Excimer laser, which has an emission wavelength of 193 nm. Analyses were conducted on 50 micron spots with an output energy of ~32 mJ (at 22kV) and a repetition rate of 9 Hz. Each analysis consisted of one 20-second integration on peaks with no laser firing and twenty 1-second integrations on peaks with the laser firing. Hg contribution to the ^{204}Pb mass position is accordingly removed by subtracting the on-peak background values. The depth of each ablation pit was ~15-20 microns. Total measurement time was ~90 s per analysis. The collectors were configured for simultaneous measurement of ^{204}Pb in an ion-counting channel while ^{206}Pb, ^{207}Pb, ^{208}Pb, ^{232}Th, and ^{238}U are measured with Faraday detectors. All analyses were conducted in static mode. Inter-element fractionation was monitored by analyzing fragments of SL-1, a large concordant zircon crystal from Sri Lanka with a known (ID-TIMS) age of 564 ± 4 Ma (2σ) (Gehrels, unpublished data). This reference zircon was analyzed once for every three unknown samples.

Results and Discussion

206Pb/238U ages of the zircons separated from the PVC formation gave an average age of 460 m.y. Older Cambrian (495 – 516 m.y) core was identified in some grains. More than 80% of 103 detrital zircon grains analyzed from the sedimentary sample were derived from a billion year old crust.

Conclusion

Thus the PVC formation qualifies as the Ordovician Arc in the Southern Appalachian. The sediments interlayered with the volcanics were derived from a billion year old crust most probably, Laurentia. The arc was building for about 45 to 50 m.y. The Cambrian cores of the zircons might have been inherited from the base of the arc. So the inferred tectonic setting is that the Ordovician Arc was building on the Laurentian crust or at the edge for the continent for about 50 m.y. and receiving detritus from the continent.

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