

VERSATILE MONAZITE: RESOLVING GEOLOGICAL RECORDS AND SOLVING CHALLENGES IN MATERIALS SCIENCE

Monazite age constraints on the tectono-thermal evolution of the central Appalachian Piedmont

HOWELL BOSBYSELL^{1,*}, LEEANN SROGI¹, AND GALE C. BLACKMER²

¹Department of Geology and Astronomy, West Chester University, West Chester, Pennsylvania 19383, U.S.A.

²Pennsylvania Geological Survey, 3240 Schoolhouse Road, Middletown, Pennsylvania 17057, U.S.A.

ABSTRACT

The central Appalachian Piedmont lies in the critical juncture between the northern and southern Appalachians, portions of the orogen with distinct middle to late Paleozoic accretionary histories. Orogen-scale compilation maps link the central and southern Appalachians, but until recently, limited geochronological data prevented robust tectonic comparisons between high-grade metamorphic rocks in different parts of the orogen. We report the results of in situ U-Th-total Pb monazite geochronology that date significant deformation and metamorphism as middle Silurian (~425 Ma) through middle Devonian (~385 Ma) and demonstrate the diachronous nature of orogen development. The Rosemont Shear Zone is identified as a major tectonic boundary in southeastern Pennsylvania and northern Delaware separating the rifted Laurentian margin from younger rock units that formed in a magmatic arc setting. The Laurentian margin rocks occur in a series of nappes in which the metamorphic grade decreases from the structurally highest nappe to the lowest. The in situ monazite ages show that maximum temperature in the lowest nappe may have been attained some 15 million years after maximum temperature in the highest nappe. We interpret this to be the result of successive nappe emplacement, with the warmer overriding sheets contributing heat to lower levels. Combining geochronologic and thermobarometric results with the geometry of deformation results in a new picture of the tectonic development of the central Appalachian Piedmont that further links the evolution of the southern and northern Appalachians. For the Laurentian margin rocks, tectonism resulted from the approach and collision of peri-Gondwanan terranes during the Silurian to early Devonian in a dominantly sinistral, transpressive tectonic regime. This portion of the Pennsylvania-Delaware Piedmont inboard of the Rosemont Shear Zone is contiguous with comparable rocks in the southern Appalachians. In contrast, arc-related rock units outboard of the Rosemont Shear Zone experienced primarily thermal metamorphism in the Silurian, while crustal thickening and associated regional metamorphism is middle Devonian in age and likely the result of the accretion of Avalonia during the Acadian orogeny. These arc-related and younger rocks probably originated to the north of their present location as part of the northern Appalachians. They were ultimately emplaced in a right-lateral transcurrent regime sometime after the middle Devonian. Thus, it is in this portion of the central Appalachian Piedmont that the northern and southern Appalachians are joined.

Keywords: Geochronology, metamorphic petrology, monazite, garnet