Monazite U-Th-Pb dating by electron microprobe: a powerful new tool for constraining tectonothermal models

R.J. Tracy,[1] C. Loehn,[1] and D.P. Moecher[2]
1. Department of Geosciences, Virginia Tech, Blacksburg, VA, 24061 USA. ¶ 2. Department of Earth and Environmental Sciences, University of Kentucky, Lexington, KY, 40506 USA.

The relatively new technique of "chemical" (non-isotopic) dating of monazite (REE phosphate) by electron microprobe (EMP) has been demonstrated to produce geochronologic results with precision comparable to U-Pb and Th-Pb isotopic techniques, but with advantages of superior spatial resolution and capability to date individual thermal and deformational episodes within a metamorphic continuum. Under appropriate circumstances, monazite partially re-crystallizes and undergoes partial age resetting, potentially providing a near-complete "tape recording" of the chronology of an orogenic event. Spatial resolution of less than 3 µm has an advantage over SHRIMP and ion microprobe analyses (minimum of about 15 The relatively new technique of "chemical" (non-isotopic) dating of monazite (REE phosphate) by electron microprobe (EMP) has been demonstrated to produce geochronologic results with precision comparable to U-Pb and Th-Pb isotopic techniques, but with advantages of superior spatial resolution and capability to date individual thermal and deformational episodes within a metamorphic continuum. Under appropriate circumstances, monazite partially re-crystallizes and undergoes partial age resetting, potentially providing a near-complete "tape recording" of the chronology of an orogenic event. Spatial resolution of less than 3 µm has an advantage over SHRIMP and ion microprobe analyses (minimum of about 15We have done much monazite dating in the Appalachians, but will focus in this presentation on two case studies from New England that illustrate the value of EMP dating: Acadian (broadly defined) to Alleghanian metamorphism from central Massachusetts and northeastern Connecticut, and Taconic, Acadian and Alleghanian metamorphism in western Connecticut and adjacent New York and Massachusetts. In both examples, patterns of ages from monazite EMP analysis indicate that the standard accepted tectonic models have significant problems, and may point the direction toward new models based on reinterpreta-

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tion of structural and stratigraphic observations. We emphasize that these new dates are mainly of use in interpreting ambiguous field data and regional correlations.

In central Massachusetts and adjacent areas (from the Bronson Hill arc eastward to the high-grade zones of the Sturbridge area), the conventional view has been of a principal Acadian tectonothermal event at ca. 400 Ma (Robinson's "classic Acadian") with a successor event at ca. 360 Ma (his "neo-Acadian"). Targeted monazite dating indicates highest-grade (near-granulite) metamorphism at ca. 435 Ma, with additional events at 400 Ma and 360 Ma. Abrupt age breaks across strike suggest major regional east-west shortening with cryptic major faults. To the west, approaching the Bronson Hill arc, a major belt of late recrystallization at 330 Ma indicates early onset of Alleghanian effects, and post-300 age resetting is seen as main-phase Alleghanian.

In western Connecticut (west of the Mesozoic basin), the conventional model is of a Taconic fore-arc allochthonous on Laurentian margin (Grenville) with *in situ* post-Taconic sedimentary basins, all metamorphosed to kyanite-sillimanite grade in the Acadian, and with minor Alleghanian overprint to the south near Long Island Sound. Our dating shows a complex pattern of intermixed Taconic ages (ca. 520, 470–480 and 445–450 Ma) with multi-stage Acadian ages (> 420, 385–390 and 355–360 Ma), but some locations in older rocks within the supposed Acadian belt show no evidence of preceding Taconic metamorphism. Cameron's Line, a notable tectonic break highlighted by Rodgers on his 1985 Connecticut geologic map, has been interpreted as the western limit of imbricated Taconic thrust slices containing deep-water rocks. Our dating shows that numerous locations in assumed Cambro–Ordovician rocks east of Cameron's line did not experience Taconic metamorphism at all, and thus these rocks may have originated east of the Bronson Hill arc prior to the Acadian (broadly defined). This would basically require that Cameron's line marks the western limit of a major detachment zone rather than the western limit of far-travelled Taconic thrusts.