Duration of regional kyanite-staurolite grade metamorphism during the Acadian Orogeny: Preliminary results of diffusion modeling of garnet zoning in the Wissahickon Schist, SE Pennsylvania

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ABSTRACT

We estimate the duration of maximum temperatures in amphibolite grade rocks of the Wissahickon Schist in the Central Appalachian Orogen. Modeling diffusion modifications of a kyanite-staurolite grade garnet from the Wissahickon Schist (Bosbyshell et al., 2016) yielded a maximum temperature of 575°C, 484-472 Ma, apparently less than 5 Myr. The preservation of such high-grade metamorphism requires a transient heat source that is, at present, unidentified.

Diffusion modeling

Figure 6. Diffusivity is a function of composition and temperature. The graph above compares the diffusivity used in the calculations below. Garnet compositions are given at right. Diffusivity for garnet is given within the unit cell dimension of garnet.

Conclusions

This short duration regional metamorphism requires a transient heat source that is, at present, unidentified. This study focuses on the Wissahickon Schist in Philadelphia and Delaware counties of SE Pennsylvania. The Wissahickon is a proton-TDMA schist that thins amphibolite. Wissahickon schists were derived by a subduction zone setting based on amphibolite geochemistry and isogradic relationship with magnetic arc rocks of the Wissahickon Schist. The garnet used in this study was published by Bosbyshell et al. (2016). The garnet was used in this study because it is a representative of kyanite-staurolite grade. This study is based on the garnet zoning in the Wissahickon Schist that was published by Bosbyshell et al. (2016).

Figure 1. This study focuses on the Wissahickon Schist in Philadelphia and Delaware counties of SE Pennsylvania. The Wissahickon is a proton-TDMA schist that thins amphibolite. Wissahickon schists were derived by a subduction zone setting based on amphibolite geochemistry and isogradic relationship with magnetic arc rocks of the Wissahickon Schist. The garnet used in this study was published by Bosbyshell et al. (2016). The garnet was used in this study because it is a representative of kyanite-staurolite grade. This study is based on the garnet zoning in the Wissahickon Schist that was published by Bosbyshell et al. (2016).

Figure 2. Schematic “Philadelphian” pressure–temperature–deformation time path. Ages are in Ma: t1, t2, t3, t4, t5, t6, t7. PHM requires modifications of: (1) 40Ar/39Ar dating of the biotite of t6 (840 ± 20 Ma) and (2) the cooling age of the biotite that underlies the garnet core of 380 ± 5 Ma. The t5 and t6 ages are constrained by the presence of metamorphosed garnet and the 380 ± 5 Ma biotite age. This study focuses on the Wissahickon Schist in Philadelphia and Delaware counties of SE Pennsylvania. The Wissahickon is a proton-TDMA schist that thins amphibolite. Wissahickon schists were derived by a subduction zone setting based on amphibolite geochemistry and isogradic relationship with magnetic arc rocks of the Wissahickon Schist. The garnet used in this study was published by Bosbyshell et al. (2016). The garnet was used in this study because it is a representative of kyanite-staurolite grade. This study is based on the garnet zoning in the Wissahickon Schist that was published by Bosbyshell et al. (2016).