Petrological, Geochemical, and Structural Investigation of Alteration Zones in the Youngsford Road Ultramafic Body, Southeastern Pennsylvania

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Abstract

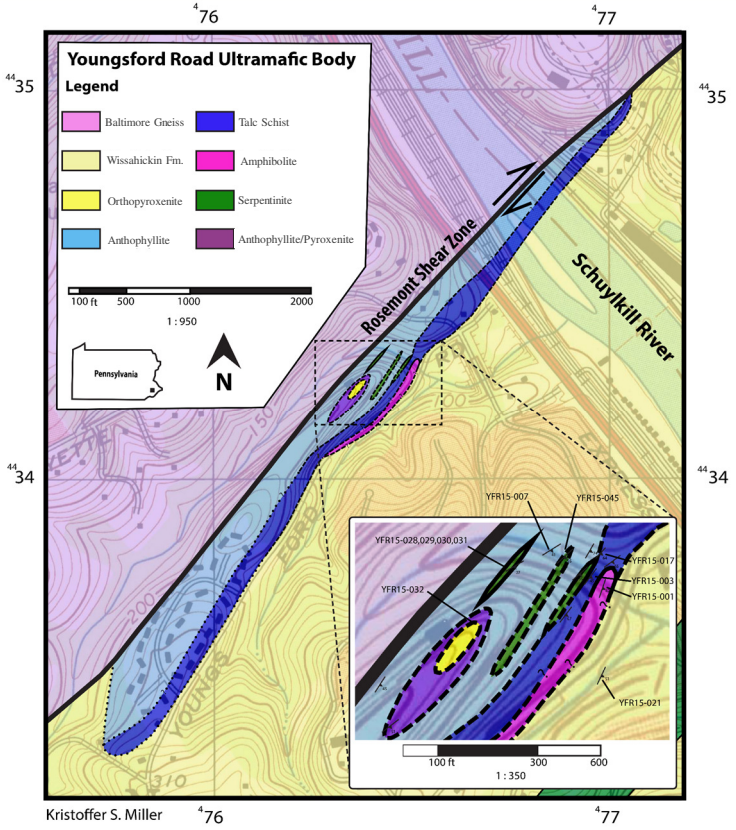
The Youngsford Road ultramafic body, located in northwest Philadelphia, is an elongate body (~1.5 by 0.2 miles) striking approximately southwest to northeast consisting of three distinct lithologic zones and conformably occurs within the Wissahickon Formation. The Piedmont Province of the Central Appalachian Mountains in southeastern Pennsylvania contains numerous ultramafic pods within the Grenville (1100 Ma) gneisses to Taconic (485 Ma) schists (Crawford, 1980). While much is known about the geologic history of the Appalachian Piedmont, the origin of the ultramafic bodies remains unresolved. The conformable relationship seen in the field suggests that the ultramafic body was emplaced in the Wissahickon Formation prior to peak metamorphism of amphibolite facies (~415 Ma) (Bosbyshell et al. 2015). The northwest side of the body is fault bound by the Rosemont Shear Zone separating it from the Baltimore Gneiss. On the south side of the ultramafic pod is an elongate amphibolite body (0.3 miles long) between the country rock and the ultramafic pod. The Youngsford road ultramafic body contains the following three major concentric lithologic zones: a relatively unaltered pyroxenite core grading to an anthophyllite schist containing serpentinite pods which then grades to an outer zone of talc schist before contact with the country rock.

The current project included the production of a detailed geologic map of the Youngsford Road ultramafic body including structural, petrological, and geochemical investigation of the ultramafic body and its zones. Thin section analyses show the pyroxenite core to contain fractured orthopyroxenes with small amounts of talc. Whole rock geochemistry revealed the core to be mostly anhydrous. These data suggest only minor relative alteration while the other zones appear to be fairly hydrous and with textures suggesting complete recrystallization. SiO_2 and MgO decrease from the core to the surrounding zones while water content increases along the same transect. Serpentinite pods have a gradational chemistry with adjacent zones and exhibit alteration mesh textures surrounding relict olivine grains suggesting a peridotite protolith (Amenta et al, 1974). Petrological and geochemical examination of the lithologic zones within the Youngsford ultramafic pod could allow for determining its origin.

Methods & Materials

- Field samples and structural data were collected from the Youngsford Road ultramafic body
- A geologic map of the ultramafic body was produced identifying contacts between differing metamorphic zones
- Petrographic and geochemical analyses were conducted on eleven samples representative of metamorphic zones and transitions
- Petrographic thin-sections were point counted (> 600 points per section) to determine modal mineral abundances
- Whole-rock geochemistry of major and trace elements was obtained
- Petrographic and electron microscopy were utilized to examine metamorphic fabrics present in the rocks
- Major element concentrations from individual minerals were obtained using quantitative EDS and WDS analyses

Field Data



Orthopyroxenite Core Transitioning into Anthophyllite Talc Schist

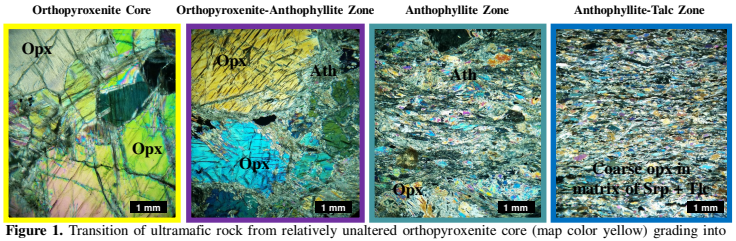


Figure 1. Transition of ultramafic rock from relatively unaltered orthopyroxenite core (map color yellow) grading into anthophyllite-talc schist (map color blue).

Petrography, Mineralogy, and Geochemistry

Serpentinite Pod Transitioning into the Anthophyllite Zone

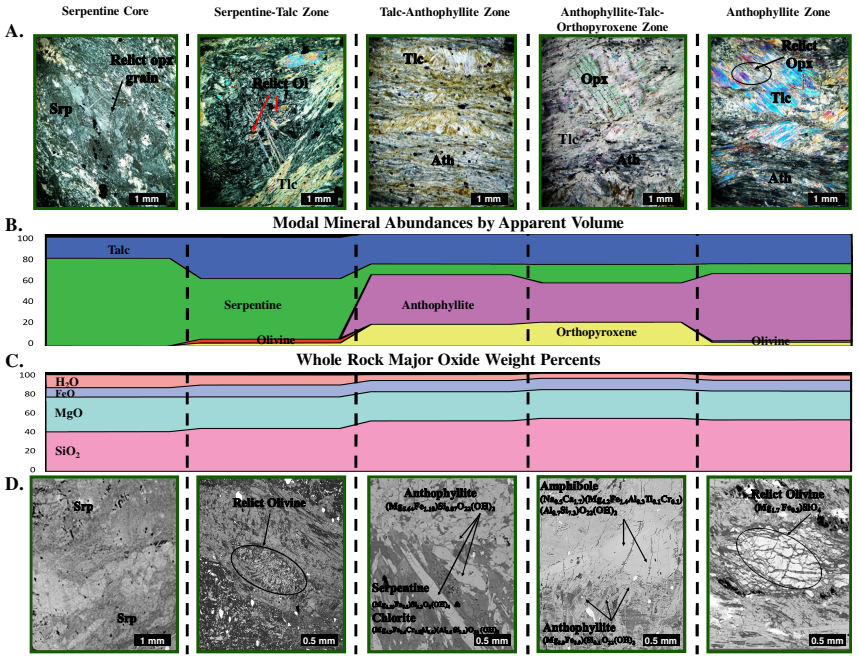


Figure 2. Mineralogical and geochemical transect from the core of a serpentinite pod (map color green) into the adjacent anthophyllite zone (map color light blue). **A.** Photomicrographs of thin-sections in cross polarized light across the transect. **B.** Modal mineral abundances with accessory minerals and opaques represented in black. **C.** Whole rock oxide weight percents across transect with accessory oxides grouped and represented in black. **D.** Backscatter electron images across the transect.

Conclusions

- The Youngsford Road ultramafic body represents an ultramafic protolith with zones of increasing hydration toward the Wissahickon country rock
- The core of the Youngsford Road ultramafic body is an orthopyroxenite exhibiting well-defined cumulate textures with minimal alteration/deformation
- The body transitions from a nominally anhydrous orthopyroxenite core to zones of increasingly hydrous mineral phases approaching the country rock
- Several serpentinite pods containing relict olivines are present within the anthophyllite zone perhaps suggesting a different protolith than the core
- Field data, petrographic, and geochemical analyses suggest the Youngsford Road body may be a layered mafic cumulate
- Future research is planned to determine whether the origin of the Youngsford Road body is related to: Taconic ophiolites, arc differentiates, or diapiric mantle rise

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