Geochemistry of sedimentary rocks affected by contact metamorphism from the intrusion of the Palisades Sill

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Abstract

An outcrop of the contact between the base of the Palisades Sill and the Stockton Formation of the Newark Basin sedimentary sequence has been exposed by recent construction at North Bergen, NJ. We have collected samples from several transects through the metamorphic aureole from close to the contact with the sill, into unaltered sedimentary rocks. Previous studies have concluded that there has been Na-metasomatism in rocks in contact with the Palisades Sill, and that this has resulted in the mobilization of other elements, including rare earth elements. However, none have investigated a full suite of major, trace and rare earth elements in small contiguous transects from the contact into unaltered sedimentary rock. This locality provides the perfect field site for such an investigation.

Field investigations also revealed some interesting structures within the altered sedimentary rocks at this site. While in some places the original sedimentary structures, such as channel deposits, are clearly visible right up to the contact, at other locations the sediments have clearly been remobilized as the sill was intruded. This has resulted in the formation of at least one clastic dike. Analysis of major, trace and rare earth elements reveal changes resulting from the metamorphism, while mineralogical changes are interpreted from thin sections. Sedimentary logging during sample collection in the field, allows us to separate variations due to metamorphism from sedimentological variation within the Lockatong Formation, and to compare the sections where there has been sediment remobilization with those where there has not.

1.Introduction

Construction in North Bergen, NJ has exposed the contact between the Palisades Sill and underlying sedimentary rocks of the Newark Basin (Figures 1 and 2). Although the rocks retain many sedimentary structures, such as channels, they have experienced contact metamorphism from the intrusion of the sill, as well as some soft sediment remobilization.

Figure 1. Location of Field Area

Figure 2. Locations studied

2. Section 1

Section 1 is located at the northern end of the outcrop (Figure 2). Samples of metaquartzite were collected from the lower 2 m of the cliff face. The contact with the base of the Palisades Sill at this location is at a height of 10 m, so samples were between 8 and 10 m from the contact (Figure 3).

On first inspection, the rocks of this section show clear sedimentary structures. However, examination of hand specimens and thin sections indicates extensive recrystallization to a metaquartzite, with the minor clay matrix being altered to cordierite and biotite. Most of the darker minerals seen in the field are actually quartz. This smoky quartz suggests the presence or introduction of aluminum during recrystallization, as well as a source of radiation such as uranium. (Figures 4 and 5)

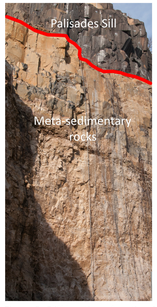

Figure 3. Cliff location of section 1

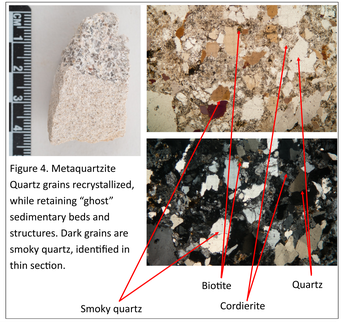

Figure 4. Metaquartzite
Quartz grains recrystallized, while retaining "ghost" sedimentary beds and structures. Dark grains are smoky quartz, identified in thin section.

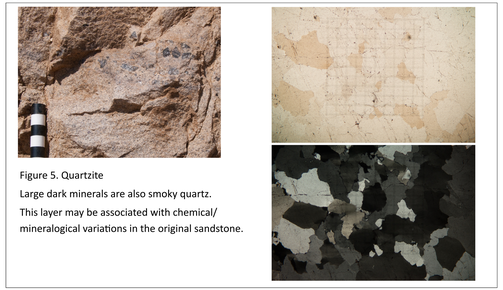

Figure 5. Quartzite
Large dark minerals are also smoky quartz.
This layer may be associated with chemical/ mineralogical variations in the original sandstone.

3. Section 2

Section 2 is located towards the southern end of the outcrop, approximately 100 m south of section 1 (Figure 2). At this location the contact with the sill is not visible due to extensive soil and vegetation cover. However, the similar topography to the other end of the outcrop would suggest that the contact is between 1 and 2 meters above the top of the 5 m high cliff. Samples collected here are therefore between 2 and 7 m from the contact (Figures 6 and 7).

Mineralogically, the samples collected from section 2 are indistinguishable from those of section 1, despite their closer proximity to the contact with the sill (Figures 8 and 9). Geochemical analyses are in progress to determine if there are any differences in the distribution of major, trace and rare earth elements with distance from the contact.

Figure 6. Cliff location of section 2

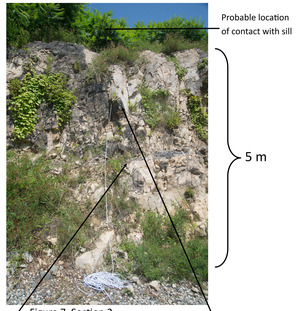

Figure 7. Section 2

Figure 8. Sample of medium grained metaquartzite

Figure 9. Sample of coarse grained metaquartzite. Dark grains are smoky quartz. Vug contains crystalline quartz, possibly with a coating of sulfur.

4. Zone with remobilized sediments

In some places there is evidence of sediment remobilization, particularly the more sandy layers, as the sill was intruded (Figure 10). This would suggest that the sediments were not fully lithified at the time of this event. Similar structures have been reported in Fort Lee by Merguerian and Sanders (1995).

The texture of the clastic dyke suggests that the coarser grains from the sandstone were suspended in a fluid containing more fine grained sediments from the underlying unit (Figures 11 and 12).

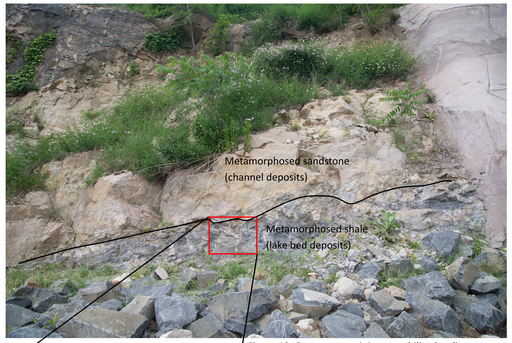

Figure 10. Outcrop containing remobilized sediments

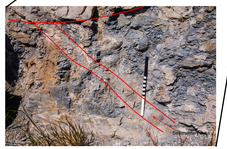

Figure 11. Clastic dyke
More coarse grained sediment had been re-mobilized into the fine layer of lake-bed sedi-ments below.

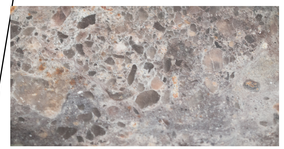

Figure 12. Sample from area of clastic dyke.
Large grains are suspended in more fine-grained matrix during remobilization. All have subsequently been metamorphosed. Large dark grains are smoky quartz.

5. Conclusions and Future Work

Previous studies have concluded that there has been Na-metasomatism in rocks in contact with the Palisades Sill, and that this has resulted in the mobilization of other elements, including rare earth elements (e.g. Van Houten, 1971; van de Kamp and Leake, 1996; Greenhut, 2001).

This preliminary mineralogical study supports such metasomatism, and suggests that a number of elements, including aluminum and possibly uranium, were mobilized at the time the sill was intruded. These samples are currently being prepared for analysis of major, trace and rare earth elements to ascertain the chemical variations in more detail.

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