PROVENANCE OF A GARNET-RICH BEACH PLACER DEPOSIT, MONTAUK POINT, LONG ISLAND, NY

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Project Summary

Garnet and magnetite-rich beach sand, also enriched in monazite, tourmaline, rutile, and zircon, has been observed and sampled near Montauk Point, Long Island. The sediment is derived from the till and stratified drift of the Ronkonkoma Moraine (early Wisconsin, Stage 4 – the initial phase of the Wisconsin glacier that culminated between 90,000 to 70,000 BP; in Geology of the New York City Region: A Preliminary Regional Field-Trip Guidebook, United States Geological Survey Publication; http://3dparks.wr.usgs.gov.nyc , 2005) by mechanical weathering and erosion due to wave action at Montauk Point, the headland on the eastern tip of Long Island. Sand-sized sediment is moved westward along the southern shore of Long Island by longshore transport. The garnet and magnetite components of this sediment are significantly denser than the quartzo-feldspathic constituents. This allows for hydraulic sorting of these components, by wave action, producing a placer deposit of beach sand enriched in garnet and magnetite. Although the proximal source of the sediment is obviously the Ronkonkoma Moraine, the ultimate source remains to be determined. In order to determine the ultimate source, the chemical composition of selected minerals in the placer deposit was compared with respect to same minerals and rocks of the till (mostly composed of granite, gneiss, schist, and quartzite derived from the New England Highlands region) and stratified drift. Preliminary results indicate similar garnet compositions, for the most part, in the beach placer deposit and the sand-sized fraction of the till and stratified drift. However, the possibility of a mixed provenance for some of the beach sand minerals exists. For example, stratified drift in the Montauk Point area may, in part, be derived from the Harbor Hill Moraine (Stage 2 - the most recent advance of the Wisconsin Glacier which culminated about 20,000 BP); as well as from the Ronkonkoma Moraine. Rocks belonging to the till component may come from different source areas as well.

INTRODUCTION

Montauk Point is a small peninsula that juts into the Atlantic Ocean on the end of Long Island (Figure 1 through 4). Garnet and magnetite-rich sand, also enriched in monazite and zircon, has been observed near Montauk Point, Long Island. The sediment is derived from the till and stratified drift of the Ronkonkoma Moraine (early Wisconsin, Stage 4 – the initial phase of the Wisconsin glacier that culminated between 90,000 to 70,000 BP; in Geology of the New York City Region: A Preliminary Regional Field-Trip Guidebook, United States Geological Survey Publication; http://3dparks.wr.usgs.gov.nyc , 2005) by mechanical weathering and erosion due to wave action at Montauk Point, the headland on
the eastern tip of Long Island. Sand-sized sediment is moved westward along the southern shore of Long Island by longshore transport. The garnet and magnetite components of this sediment are significantly denser than the quartzo-feldspathic constituents. This allows for hydraulic sorting of these components, by wave action, producing a placer deposit of sand enriched in garnet and magnetite. **Although the proximal source of the sediment is obviously the Ronkonkoma Moraine, the ultimate source remains to be determined.** In order to determine the ultimate source, the chemical composition of selected minerals in the placer deposit needs to be compared with respect to same minerals and rocks of the till (mostly composed of granite, gneiss, schist, and quartzite derived from the New England Highlands region) and stratified drift (Foster et al., 2000; Williams and Morgan, 1993; Fire Island – [http://www2.nature.nps.gov/geology](http://www2.nature.nps.gov/geology) 2006). The possibility of a mixed provenance for some of the beach sand minerals exists. For example, stratified drift in the Montauk Point area may, in part, be derived from the Harbor Hill Moraine (Stage 2 - the most recent advance of the Wisconsin Glacier which culminated about 20,000 BP [http://3dparks.wr.usgs.gov.nyc](http://3dparks.wr.usgs.gov.nyc), 2005); as well as from the Ronkonkoma Moraine. Rocks belonging to the till may come from different source areas as well.

**PROJECT DESIGN**

Restricting the aerial and geologic scope of this study to Montauk Point, Long Island, will allow more precise observations to be made on a much smaller scale than was feasible in more regional investigations (Figure 1 through 7). The increased details of this study promise to lend a greater resolution to the general conclusions made in previous studies (Figure 8-13). Previous studies did not adequately incorporate detailed geochemical investigations and could not provide a clear understanding of the provenance scenario with respect to concentrating garnet-magnetite beach placer deposit at Montauk Point (Figure 14-17).

**Critical Questions:**

*How do beach placer deposits, stratified drift and till lithology compare in terms of exhibiting distinctive geochemical signature?*

*How does trace-element geochemistry of single mineral reflect ultimate provenance of the garnet-rich beach placer deposit in Montauk Point?*

The distribution of trace elements in garnet, zircon, magnetite, rutile, and monazite is usually controlled by the original magma composition and certain trace elements such as Zr, Cr, Ti, Nb (High-field-strength elements: HFSE) are usually considered to be immobile during alteration (Pearce & Norry, 1979). Post-burial alteration can easily obliterate the pristine chemical condition of the source rocks by easily allowing fluid-flow during diagenesis. The introduction of new elements or secondary enrichment of due to post-burial changes may provide compositional data not reflecting the true chemistry of the original parent rocks (Pearce & Norry, 1979).
Trace elements including Rb, Ba, Sr, Nb, Zr, Y, Ni, La, Ce, Ti, Mn, Cu, and Zn were selected for this study. Abundances of the large-ion lithophile elements (LILE) (i.e., Rb, Ba, Sr, La, and Ce) are useful in petrogenetic studies because their relative enrichment, with the exception of Sr, do not greatly depend on the source mineralogy or on their crystallization phases. Hence the relative abundances of these elements should reflect source region characteristics. However, some of these elements, such as Rb and Sr can be highly mobile during alteration (Jeans et al. 2000). In order to precisely document the individual trace element, several well-known United States Geological Survey (USGS) standard sample were used for comparison. To better document the trace element distribution, the combination of in-house facilities at York College including XRF6600 was used in chemical analysis of tills, beach placer, and stratified drift.

The similarities among beach placer deposits, stratified drift and till lithology can be explored more fully using multi-element plots. Overall elemental abundances and patterns of individual element enrichment or depletion can be directly comparable; however the levels of most mobile elements such as Rb and Ba tend to be distinctly variable considering the effect of post-burial diagenesis or chemical weathering involving source materials (Amajor, 1985; Batchelor, 2003; Huff et. al., 2000; Yalcin & Gumuser, 2000).

**Laboratory Investigation**

For sample preparation and routine petrological investigation, the available facilities at York College of CUNY were fully utilized. Mineral separation was performed by using Sodium Polytungstate: Na₆(H₂W₁₂O₄₀).H₂O; available from www.sometu.com; safer than bromoform in terms of health hazard). Mineral separates were isolated by a combination of conventional heavy liquid, magnetic, and hand picking methods.

The sand fraction (63-250 microns) of the till and stratified drift was recovered during textural analysis and utilized for providing an important means of supplying alternative data on source-region characteristics. A significant emphasis of this research is to refine the provenance and depositional interpretations made by other workers.
Figure 1
Map of Montauk Point, eastern Long Island (after http://3dparks.wr.usgs.gov/nyc)
Figure 2
Pleistocene Glacial Deposits Showing Typical Advances of Ronkonkoma and Harbor Hill Moraines.
http://3dparks.wr.usgs.gov.nyc, 2005
Figure 3
Field inspection of till (Khandaker) capped by stratified drift.
Figure 4
Location showing the study area of late Pleistocene terminal moraines on Long Island, NY.
http://3dparks.wr.usgs.gov.nyc, 2005
Figure 5
Mixed assemblages of granite, schist, and quartzite along the beach front, Montauk Point, Long Island, New York.
Figure 6
Contact between the till (underlying) and stratified drift (capping unit) showing deformed beddings with oxidation.
Figure 7
Geology students (left: Mario Jo-Ramirez; right: Ryan McPherson) gather samples of purple colored, garnet-rich beach sand at Montauk Point, Long Island. Prominently exposed during the low tide regime.
PHOTOMICROGRAPHS (8 through 13)

Figure 8
Crossed Polar view of K-spar showing alteration to sericite (coarse sand-sized).
Figure 9
Plane Polarized view of poorly sorted, irregularly fractured quartz; mostly medium to coarse sand-sized.
Figure 10
Crossed Polar view of poorly sorted, both inclusion-rich and inclusion-poor, undulatory quartz (possibly first cycle); coarse-grained sand.
Figure 11
Plane Polarized view of fractured garnet (white) and strongly pleochroic tourmaline (brown to dark brown); mostly medium to coarse-grained sand-sized particles.
Figure 12
Crossed Polarized view of garnet (black), rutile (red), and tourmaline (green); mostly medium sand-sized.
Figure 13
Plane Polarized view of well-fractured and etched garnet (mostly coarse sand sized).
CHEMICAL ANALYSIS (Figure 14-17)

Red: Beach Sand  Yellow: Till  Blue: Stratified Drift

Figure 14 and 15: Representative Trace Element Distribution
Figure 16: Representative Bulk Oxides

Red: Beach Sand   Yellow: Till   Blue: Stratified Drift
Summary

Preliminary results indicate similar garnet compositions, for the most part, in the beach placer deposit and the sand-sized fraction of the till and stratified drift. However, the possibility of a mixed provenance for some of the beach sand minerals exists. For example, stratified drift in the Montauk Point area may, in part, be derived from the Harbor Hill Moraine (Stage 2 - the most recent advance of the Wisconsin Glacier which culminated about 20,000 BP); as well as from the Ronkonkoma Moraine. Rocks belonging to the till component may come from different source areas as well.

Literature Cited

http://www2.nature.nps.gov/geology. 2006


