RESEARCH PROJECT FINAL REPORT

INVESTIGATION OF CHLORINE-RICH MINERALS ASSOCIATED WITH MAGNETITE CONCENTRATIONS AT BLACK ROCK FOREST, CORNWALL, NY

Investigators: James Webster and Albert Léger, Department of Earth and Planetary Sciences, American Museum of Natural History, New York, NY, 10024

Dates of operation: April 15, 1994 - April 15, 1995

Research Goals

The stated goals of the study were to:

1) conduct a field survey of the southern half of Black Rock Forest,
2) conduct a petrographic study of rock samples from the southern half of the forest,
3a) determine the compositions of chlorine-bearing minerals in rock samples collected throughout the forest,
3b) study the effects of other compositional parameters (such as the iron to magnesium ratio of the amphiboles) on their extreme chlorine enrichments, and
4) determine, experimentally, the stability of chlorine-rich amphiboles at high pressure and temperature.

Summary of Results

Rock samples were collected and studied, many amphiboles were analyzed, a manuscript summarizing the analytical results has been written and submitted for publication, a geology/mineralogy display was prepared and installed at the Stone House at Black Rock Forest, and experimental study of the stability of amphibole and of the rock themselves at high temperature and pressure has been initiated. Details on the results of this study are provided below.

Rocks Studied

New rock samples were collected in the forest and along its boundaries. Detailed sketches were made and photographs of the sampled outcrops were taken. The mineralogy of the new samples was determined by studying the hand samples, and through microscopic examination of the samples. For this purpose, polished thin sections and grain mounts were prepared.

Mineral Analysis

The chemical compositions of amphiboles and other minerals in the samples were determined by electron microprobe analyses conducted at the American Museum of Natural History. Analysis of amphiboles and biotites revealed that these minerals contained some of the highest chlorine contents ever reported in the literature. The minerals with the highest Cl-contents are also very iron-rich. We speculate that the fluids responsible for depositing the magnetite deposits within the forest were iron and chlorine rich. We are at the early stages of investigating the correlations between fluid composition and transport of iron into the forest. We describe the mineral composition of the amphiboles and biotites in a research paper submitted to *American Mineralogist*, one of the premier journal in mineralogy (see pre-print enclosed). We are continuing our research in the chemical aspect of these high-Cl minerals, and will complement chemical analyses with x-ray diffraction data on the same specimens this year.

Geology Display at the Stone House

A geology/mineralogy display was prepared at the American Museum and installed at the Stone House in the forest. The display includes 6 rock samples collected in the forest and within Harriman State Park; the samples were cut and polished to facilitate viewing of fresh mineral surfaces within the samples. The sample surfaces were photographed, and the photographs were

labeled to identify the mineralogy of the samples. In addition, thin sections of rock were cut from the samples and viewed microscopically. Photomicrographs of the major minerals in the rocks were prepared, labeled, and included in the display.

The text that accompanies the samples describes the major rock types in the forest, the dominant mineralogy of the rocks, a brief geologic history of the metamorphic rocks of the Hudson Highlands, the geology of the magnetite deposits, a brief mining history of the Hudson Highlands, and the ongoing research of geologists at the forest. The text was submitted as hardcopy and on disk; hence, Black Rock Forest personnel can modify and use the text of the display as needed.

Experimental Research

The final objective of our study was to determine, experimentally, the stability of the amphiboles at high pressure and temperature. To this end, we have chosen and prepared a natural sample of ferrochlorohastingsite-bearing gneiss from the forest outcrops. The sample was prepared by crushing and grinding it to a fine powder.

The sample has been studied experimentally by subjecting the rock powder to high temperatures (up to 850° centigrade) and pressures up to 5000 bars (72520 psi). In these experiments we have begun to determine the behavior of the amphibole (ferrochlorohastingsite) when melting and dehydration occur. At this time there are insufficient data to present or publish, but the experiments will be continued and the final results published.

Expenditures

The BRF grant award totaled $3800. Actual expenditures amount to $3760. Expected and actual expenditures are listed in the table below:

	Budgeted	**Actual**
Electron microprobe	$1500	$1450
Expendable supplies	$1200	$1225
Travel to BRF	$ 200	$ 120
Sample preparation	$ 900	$ 965
Total	**$3800**	**$3760**

Abstracts and Publications Resulting From Award

We have submitted one abstract and one paper describing our results so far on the chemically unusual minerals from the Black Rock Forest. The abstract was accepted and will be presented by Léger at the annual meeting of the American Geophysical Union in Baltimore, May 30, 1995. The paper was submitted to *American Mineralogist* and is now in the review process. Copies of the abstract and the paper are attached.

Future Plans

Investigators from the Department of Earth and Planetary Sciences plan to continue their studies of the rocks, minerals, and mineral deposits of Black Rock Forest. The compositions of the amphiboles in the forest are extremely interesting and chemically unusual, and consequently, they require further examination. Moreover, the results of these studies have a broader applicability than simply improving our understanding of the geology of rocks from the forest, because similar rocks (containing Cl-enriched amphiboles) have been observed at other localities around the world.