Characterization of Ore from the Island Queen Iron Deposit in Puerto Rico

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The purpose of this project was to characterize the magnetite ore from the Island Queen iron deposit in Puerto Rico. By using a suite of geochemical methods and microscopic observation, we can determine how the Island Queen deposit formed. Studying metal-rich deposits increases our understanding of how and where Earth's resources are created. This knowledge is significant because metals like iron are necessary for the construction of renewable energy sources and many everyday items.

Island Queen is located on the eastern side of Puerto Rico and is classified as an iron skarn deposit based on the minerals observed in its rocks (Krushensky and Schellekens, 2001). Skarns form when magma releases heat and fluid into a rock layer rich in carbonate, usually limestone (Meinert et al., 2005). This results in new minerals, potentially economic ore, and changes in the physical characteristics of the area surrounding the intrusion. This new cooked and altered rock can contain higher concentrations of metals, and in the case of Island Queen, iron is present in the form of the minerals magnetite (Fe_3O_4) and hematite (Fe_2O_3).

To study the deposit before major field work, samples were collected by our collaborators at the University of Puerto Rico, Mayagüez. Four samples of ore were made into thin section slides, which were analyzed using a petrographic microscope. Mineral proportions were estimated and spatial relationships between different minerals were described. This helped us identify the most common minerals and their potential sequence of formation. Petrographic analysis showed that the Island Queen ore rocks are mostly magnetite, hematite, and quartz (Figure 1). There are also trace amounts of epidote and garnet, which are common skarn minerals.

Next, the elemental compositions of the ore minerals (magnetite, hematite) were measured using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS).

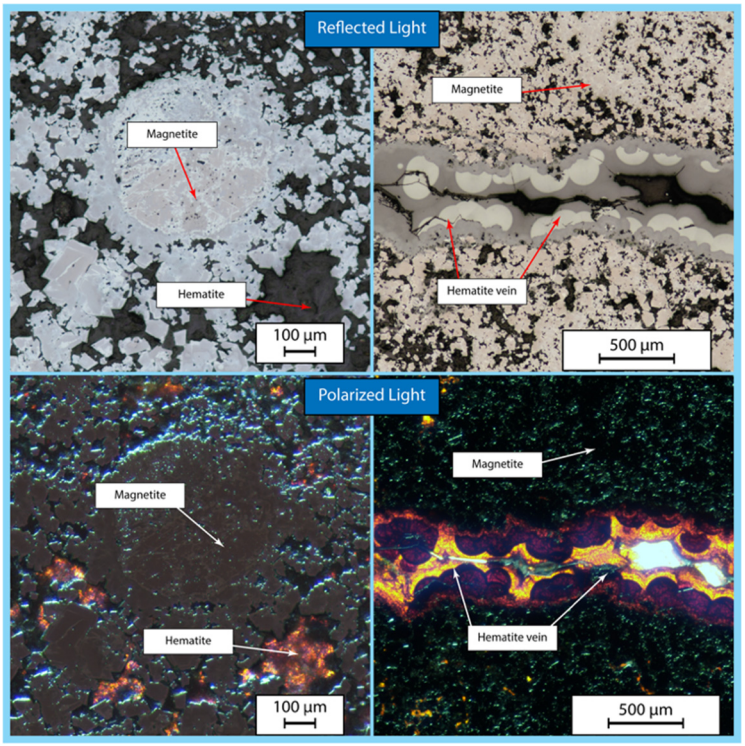

Fig. 1 Island Queen iron ore minerals under the microscope. The upper two photos show magnetite and hematite under reflected light and the same town photos below in transmitted polarized light. The photos on the right show a vein of hematite that has formed in between the magnetite crystals.

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Electron microprobe analysis (EMPA) was performed to measure iron concentrations to calibrate the LA-ICP-MS data and create element concentration maps using backscattered electron (BSE) imaging. In the maps of Figure 2, relative concentrations of aluminum (Al), calcium (Ca), iron (Fe), and silicon (Si) are displayed across mineral grains. Brighter blues indicate higher concentrations of the element measured. Lastly, all the compositional data were compared to other deposits around the world, whose origins are well-studied based on the approach of Nadoll et al. (2014).

The composition and properties of Island Queen ore is consistent with what is expected for iron skarn deposits. The element concentration map created using EMPA showed some mineral grains had higher levels of aluminum than expected from the minerals observed. This may be due to later natural alteration by fluids that traveled through the area.

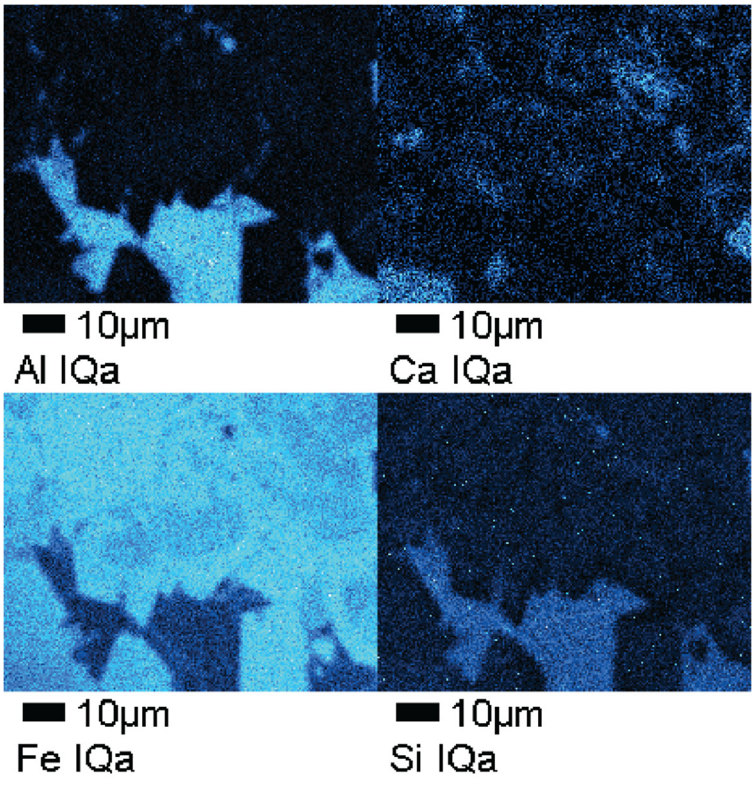

Fig. 2 Elemental concentration maps of Island Queen minerals. The brighter blue indicates higher elemental composition counts.

The calcium content of the ore was relatively low in the analyzed grains, which means that this sample formed relatively close to the magma intrusion.

These observations and measurements lay the important groundwork for characterizing the Island Queen iron deposit, especially to determine sampling and investigation strategies for future field work. This project also refined the analytical methods that we will use to study more Island Queen samples. Future data will provide insight into the exact formation processes that resulted in the Island Queen deposit, which can be applied to the other iron deposits in Puerto Rico and locations around the world.

Statement of Research Advisor

Sam's semester-long fellowship began with him tackling the obscure geological literature of Puerto Rico and papers on iron mineral geochemistry, which was not a simple task. For his research, Sam utilized three diverse analytical methods (microscopy, EMPA, LA-ICP-MS) and successfully learned the pertinent skills in a short period of time. He was also active in our Economic Geology & Geochemistry research group meetings, contributing two presentations and regularly engaging in discussion. Sam's characterization of the properties and composition of Island Queen ore will play an important role in field work strategy this summer and in future research on new samples.

- *Laura Bilenker, Department of Geosciences*

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Authors Biography

Samuel Warren is a recent graduate of Auburn University as of May 2022 with a B.S. Degree in Geology.

Laura Bilenker is an Assistant Professor in the Department of Geosciences and heads the Economic Geology & Geochemistry research group.