ABSTRACT

Brecia pipes are a common host of many precious metals, base metal and rare earth elements (REE) mineral deposits because they provide conduits for fluid flow and open spaces for mineral precipitation, hence are a focus area for exploration. The Gallinas Mountains district in Lincoln County, New Mexico, produced copper, lead, silver, and iron, REE (asbastinite) and gold from 1960 to 1980, but no production has been reported from the breccia pipes. However, some magmatic-hydrothermal breccia pipes in the Gallinas Mountains host high concentrations of fluorspar and REE and gold. Previous studies have described the occurrence of REE in breccia pipes, but the controls for their transportation and deposition are still unclear. The purpose of this research is to characterize the magmatic-hydrothermal breccia pipes in order to understand the geochemical and physical conditions of deposition of REE and gold in the breccia pipes found in the Gallinas Mountains. A total of 66 samples were subjected to various analysis. Chemically, the breccia pipes exhibit light REE-enriched chondrite-normalized patterns, some high concentrations of REE (8% TRE) and Au (175 ppb), carbonates rich hydrothermal fluids and fluorite overprint the breccia pipes causing precipitation and mineralization along the breccia pipes edges.

INTRODUCTION

The rare earth elements (REE) are the 15 lanthanides on the periodic table, plus scandium and yttrium which have the same ionic radius, similar chemical properties and can easily substitute for each other. There is high demand for REE because of their unique magnetic, phosphorescent, physical and catalytic properties that make them useful when mixed or alloyed in small quantities with some other commonly available metals, at a reduced overall cost in terms of energy consumption, efficiency, durability, speed, thermal stability hence their wide application (figure 1). REE are found to occur in various deposits types. These deposits are divided into two classifications, the ones formed infill through the magmatic, hydrothermal or metamorphic process listed as primary rocks (carbonatites, syenites, and alkaline igneous rocks) and the secondary deposits formed through erosion and weathering processes. Other common target areas for REE explorations are breccia pipes. These vertical pipe-like columns of broken rocks, provide a porous column, which forms conduits and open spaces for minerals precipitation (figure 2).

PURPOSE

• Examine the magmatic-hydrothermal breccia pipes in the Gallinas Mountains in order to understand the geochemical and physical conditions of deposition of the REE and gold.
• Evaluate the economic potential for REE and gold.

PROJECT AREA AND GEOLOGY

• The Gallinas Mountains are located in Cibola National Forest, Lincoln County, New Mexico.
• It is one of several mining districts that form part of the North American Cordilleran alkaline-igneous belt and extends from the Alaska and British Columbia southwards into Mexico (Fig. 3; from McLemore et al., 2021)
• Production of Cu, Pb, Ag, Au, F, Fe, and REE’s (as bastnäsite) from 1900-1980.

GEOLOGY

• The oldest rocks in Gallinas Mountains are the altered Proterozoic gneisses and granites. These rocks are overlain by quartz sandstones, shales, arkoses, and limestones of the Abo, Yeso, and the Glenola, formations (McLemore et al., 2021). A simplified geologic map is in figure 4.
• A northwest-trending fault (Red Cloud fault) divides the area into two areas, west area with approximately 20 exposed magmatic-hydrothermal breccia pipes and veins and the west area with no exposed breccia pipes, only veins.
• The area is further offset by two additional faults, the Conqueror fault and the Pride fault as shown in figure 5.

METODOLOGY

Petrography, mineralogy, and chemistry analysis were done through;
• Hand description.
• Microscopic examination.
• Chemical analysis.

RESULTS AND DISCUSSION

• Most of the breccia pipes are brown to tan gray in color, matrix supported with fragments of granite, sandstone, limestone, trachyte, and syenite.
• A significant number of these breccia pipes are altered and weathered, consisting of secondary hematite and local calcite, fluorite and quartz.
• Breccia pipes are magmatic and intruded into the host rocks and, subsequently, hydrothermal fluids precipitated fluorite-REE along the edges of some breccia pipes, gold is disseminated in the breccia matrix. The breccia pipes are enriched in light REE in chondrite-normalized patterns.
• Some breccia pipes contain as much as 8% total REE and 175 ppb Au.

GEOCHEMISTRY

• The breccia pipe sample can be classified into 3 groups
  • First group is least altered and not mineralized, with original magmatic minerals.
  • The second group is the slightly altered materials which depicts the introduction of hydrothermal fluids into the system, these samples have elevated gold concentrations.
  • The last group is highly altered, highly mineralized, with high concentrations of REE and fluorite samples that contain REE-bearing minerals like bastnäsite and zircon.
• Chemically, the breccia pipes exhibit light REE-enriched chondrite-normalized patterns.
• Some breccia pipes have high REE (8% TRE) and Au (175 ppb), but are not currently economically viable.
• REE is superimposed on breccia pipes—related event, gold possibly primary with the breccia pipe.

PRELIMINARY CONCLUSIONS

• The breccia pipe sample can be classified into 3 groups
  • First group is least altered and not mineralized, with original magmatic minerals.
  • The second group is the slightly altered materials which depicts the introduction of hydrothermal fluids into the system, these samples have elevated gold concentrations.
  • The last group is highly altered, highly mineralized, with high concentrations of REE and fluorite samples that contain REE-bearing minerals like bastnäsite and zircon.
• REE is superimposed on breccia pipes—related event, gold possibly primary with the breccia pipe.

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