Characterization and Origin of the REE-bearing Magmatic-Hydrothermal Breccia Pipes in the Gallinas Mountains, Lincoln County, New Mexico

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Presentation Outline

- Acknowledgement
- Introduction
- Project area
- Objectives
- Results and Discussion
- Conclusion

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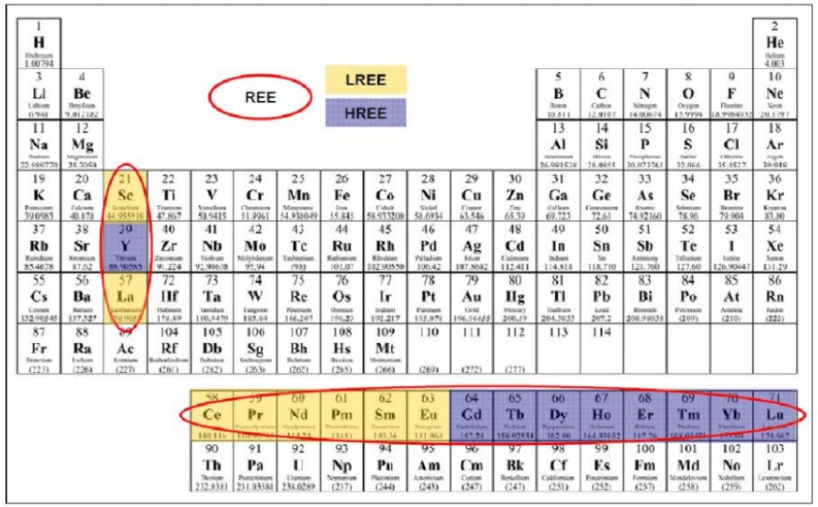
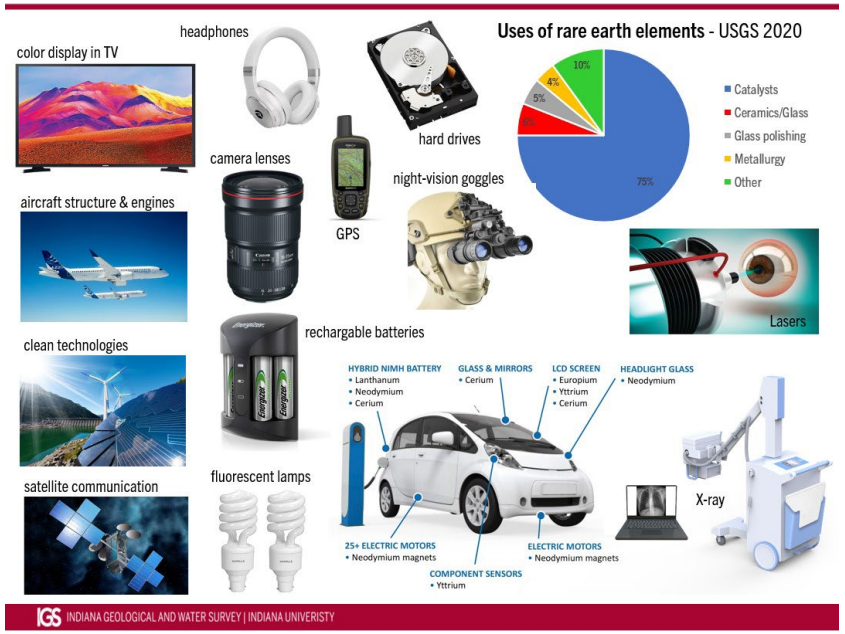
Introduction

- Rare earth elements (REE) are a set of 17 metallic element,15 lanthanides, scandium, and yttrium

- Applications of REE
  - Transportation
  - Communication
  - Manufacturing



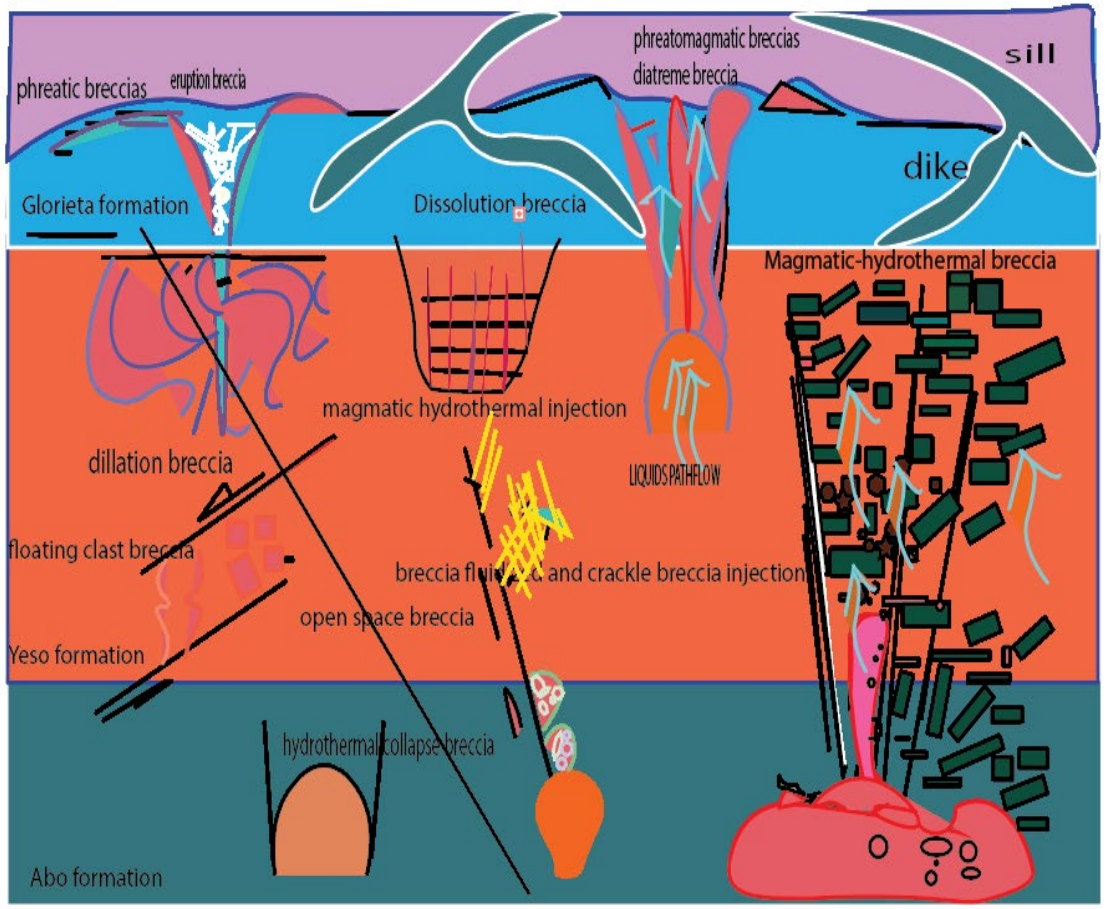
Rare earths elements in the periodic table. Source: Öko-Institut e.V.(2011): https://www.researchgate.net/figure/Rare-earths-elements-and-their-position-in-the-periodic-table-Source-Oeko-Institut-eV_fig1_292144237



Some applications of REE in various sectors as listed by Clifford, 2022

What are breccias?

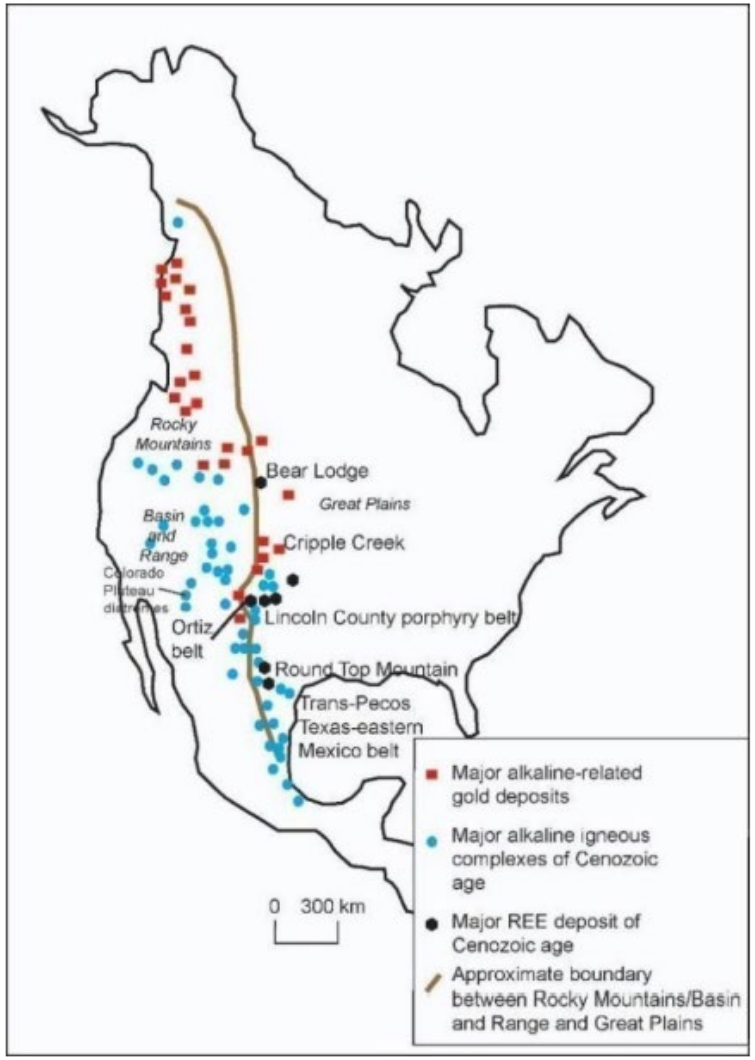
- Breccia: large broken fragments of minerals or rocks cemented by a fine grained matrix
- Breccia pipe: a vertical pipe like column of broken rocks
- Importance of Breccia pipes in explorations



Schematic representation of various breccia types modified from Corbett (2018)

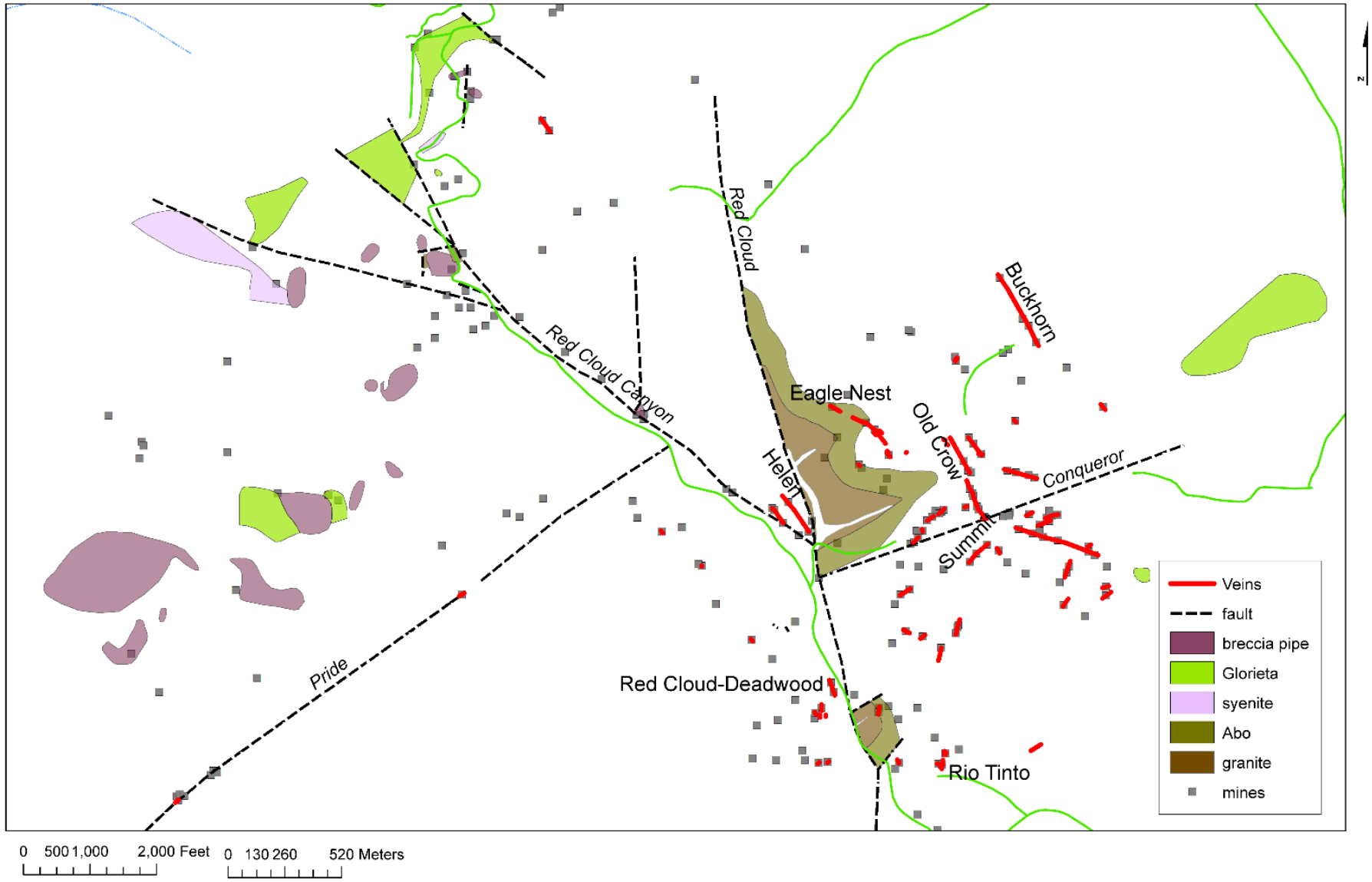
Project area

- Located in Cibola National Forest in Central New Mexico
- Forms part of the North American Cordilleran alkaline-igneous belt extending from Alaska and British Colombia southwards into Mexico (McLemore, 2018)
- Production of Cu, Pb, Ag, Au ,F, Fe, and REE (as bastnäsite) from 1902-1980



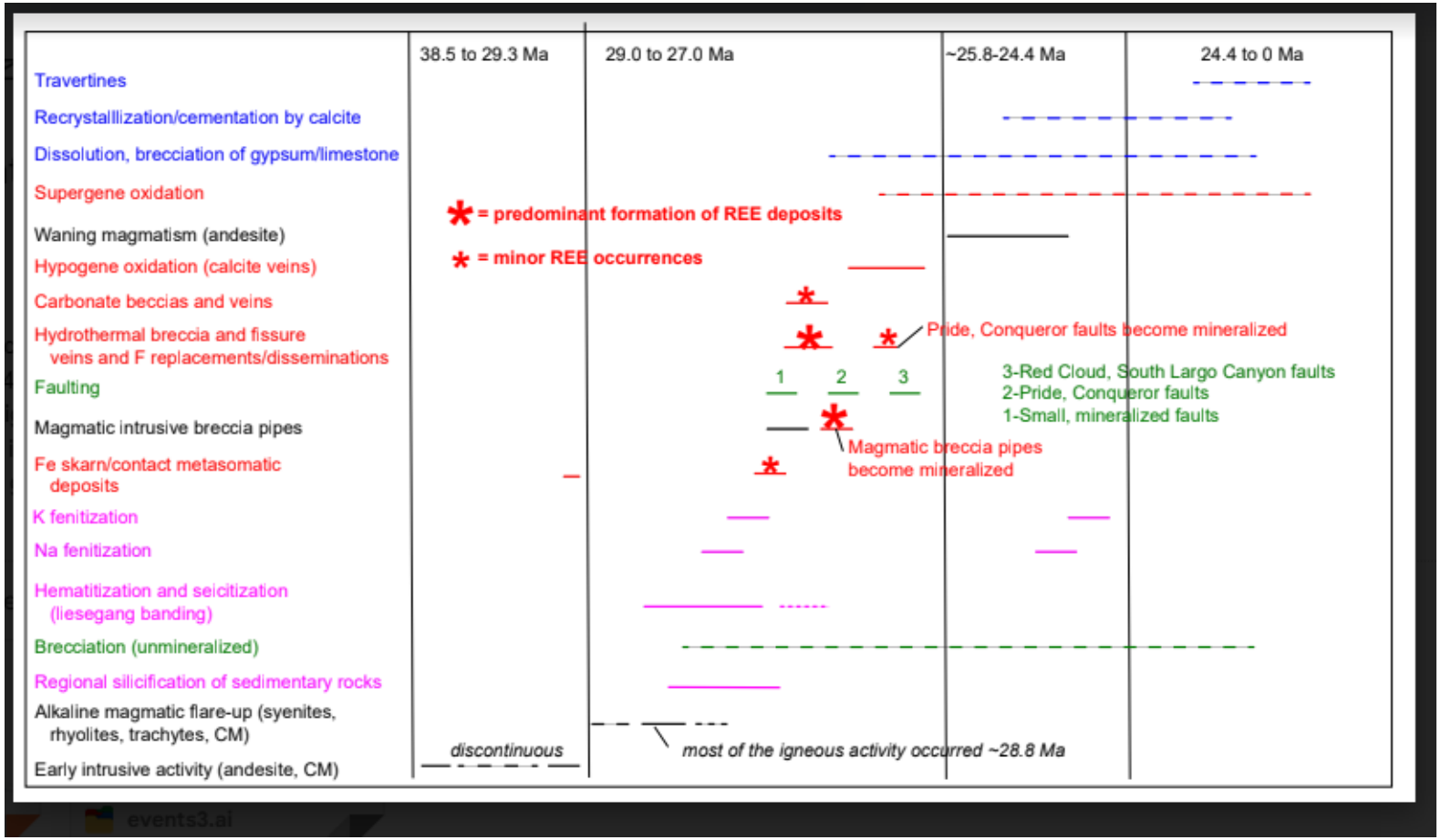
Simplified map showing the extent of the North American-Cordilleran alkaline igneous belt (modified from Mutschler et al., 1991; McLemore, 1996, 2015, 2018)

Breccia pipes in Gallinas Mountain



The magmatic-hydrothermal breccia pipes are shown as maroon polygons. Most pipes are north of the Pride fault from McLemore et al. (2020)

Sequence of events at Gallinas Mountain



Sequence of event in Gallinas Mountains ; Black=magmatic events, red=mineralizing events, green=faulting, purple=alteration, and blue=dissolution and recrystallization, McLemore et al. (2021)

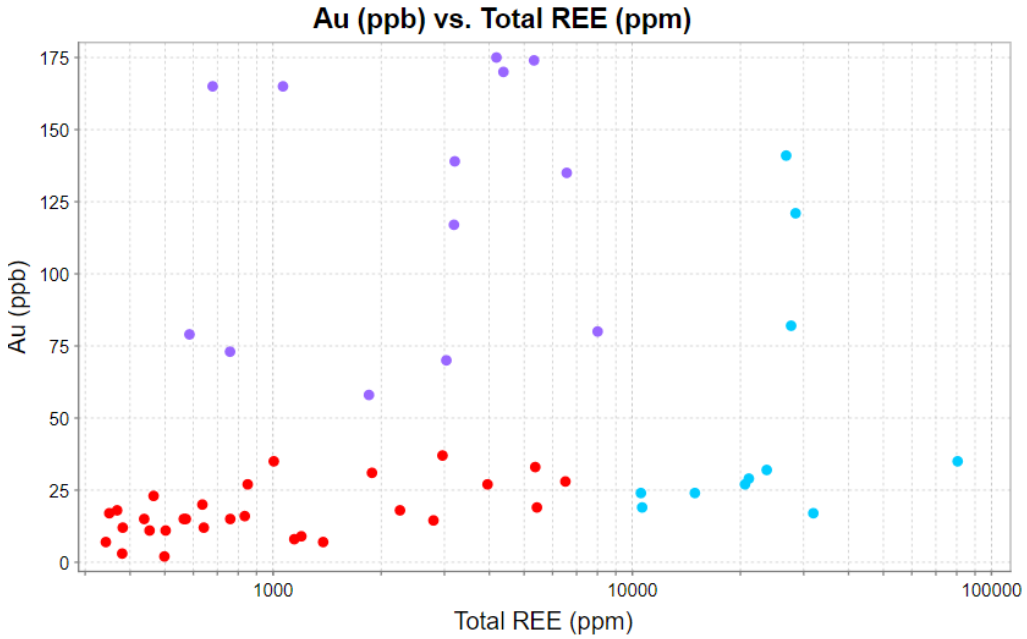
Objectives

- Characterize the magmatic-hydrothermal breccia pipes in Gallinas Mountains
  - Chemical composition
  - Petrography
- Evaluate the economic potential for REE and gold

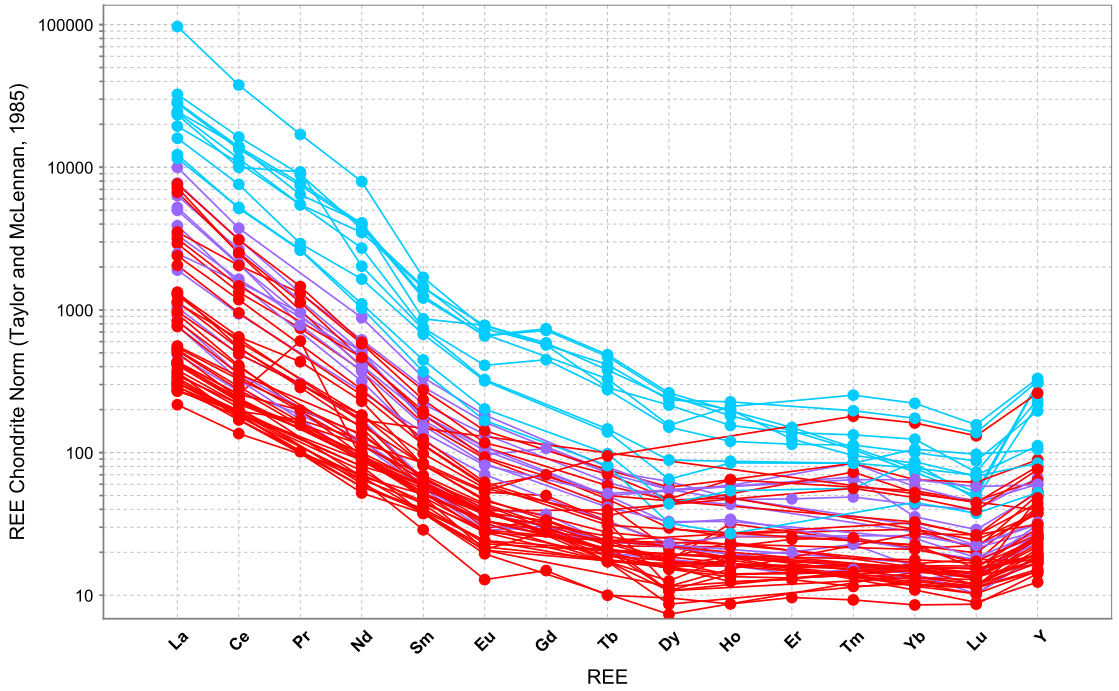
Results and discussion

- 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

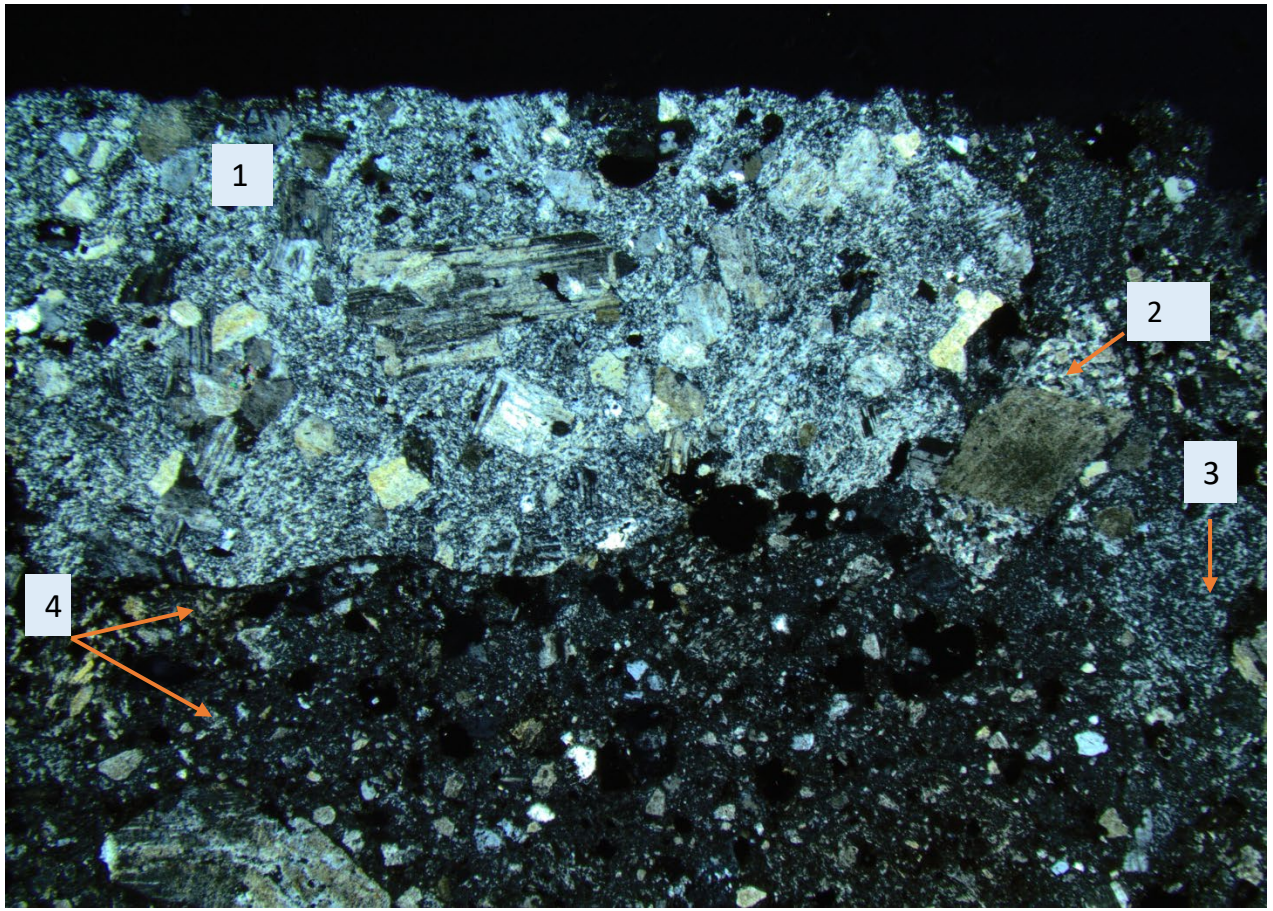


The total REE vs Au graph shows no relationship between the concentrations of Au and REE, samples with high REE concentrations are low in Au and vice versa ,the red circle shows sample with low Au and REE concentration, this are the unmineralized breccia samples



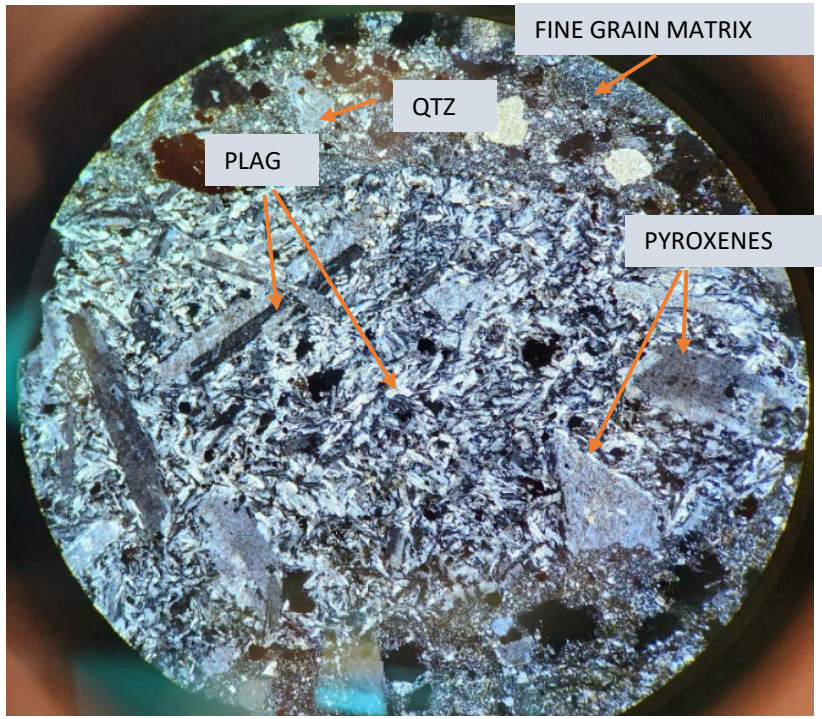
REE Chondrite normalized pattern of the breccia pipes, the breccia are enriched in light REE

Group 1:Unmineralized, magmatic breccia pipe

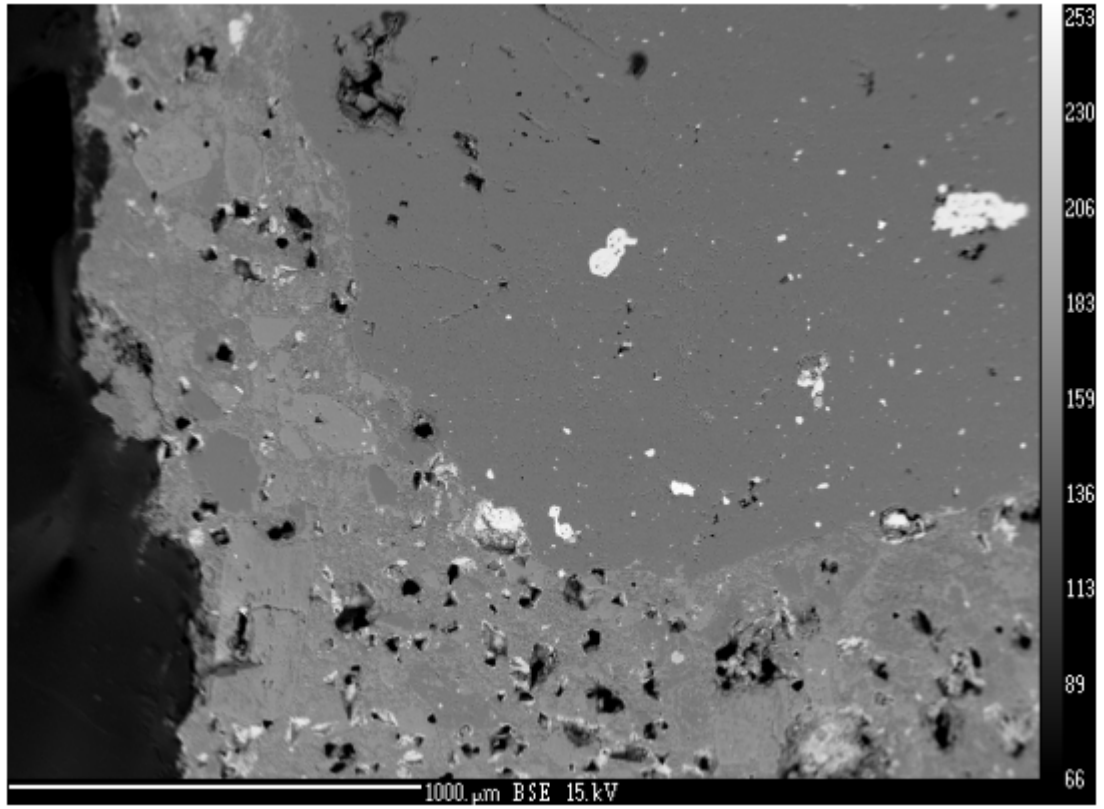


Gal 4909 thin section with Various rock fragments clusters syenite (1), trachyte(2), sandstone (3) and granite (4) cemented by a fine matrix

Hand sample of Gal 4909



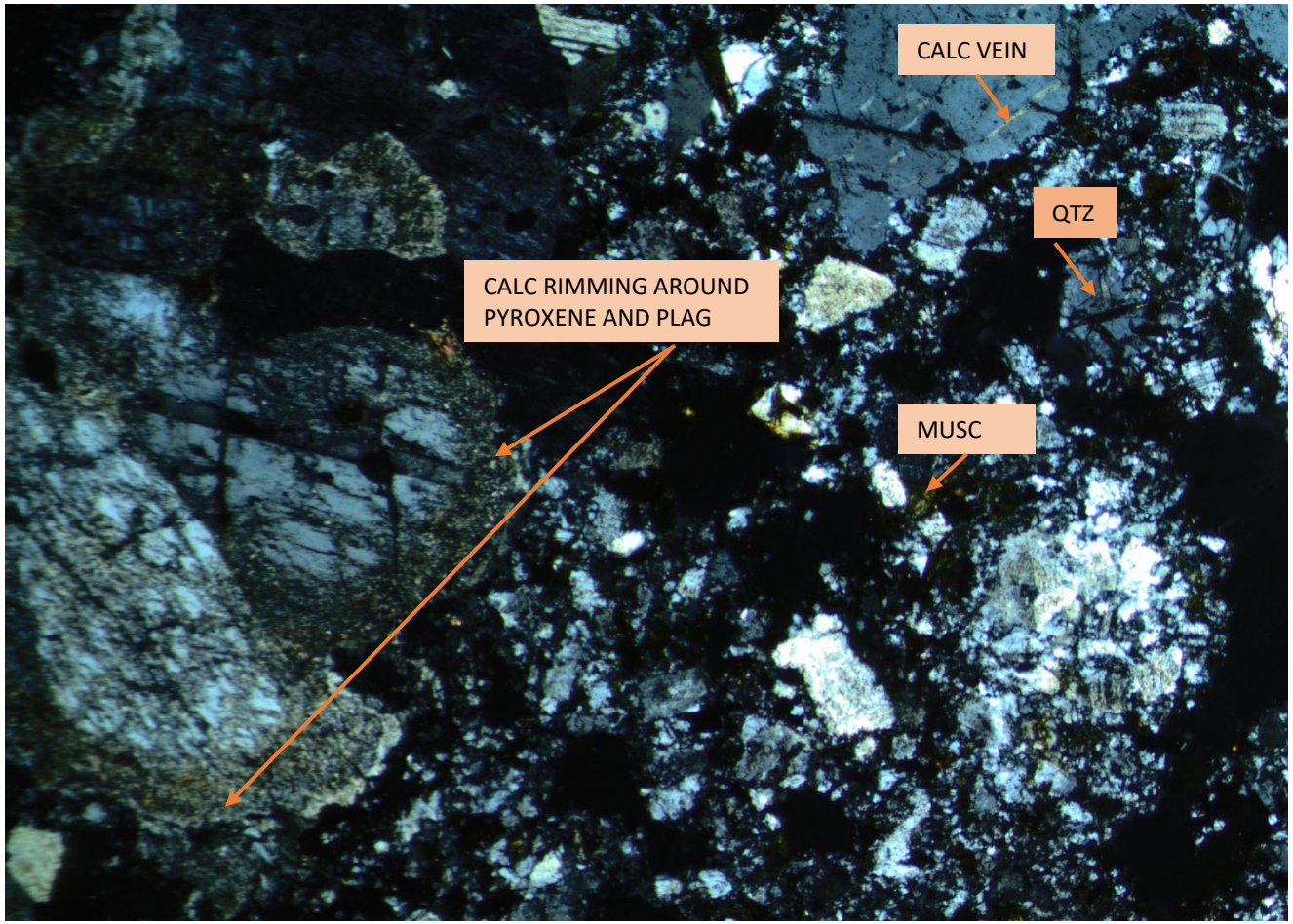
Gal 4909,mineral composition and texture of the unmineralized group one breccia



Backscattered electron photomicrograph of a typical matrix from a magmatic intrusive breccia pipe showing secondary K-feldspar replacing albite (K-fenitization). The fine-grained matrix consists of primary, magmatic albite (Gal252-01), with a field photo

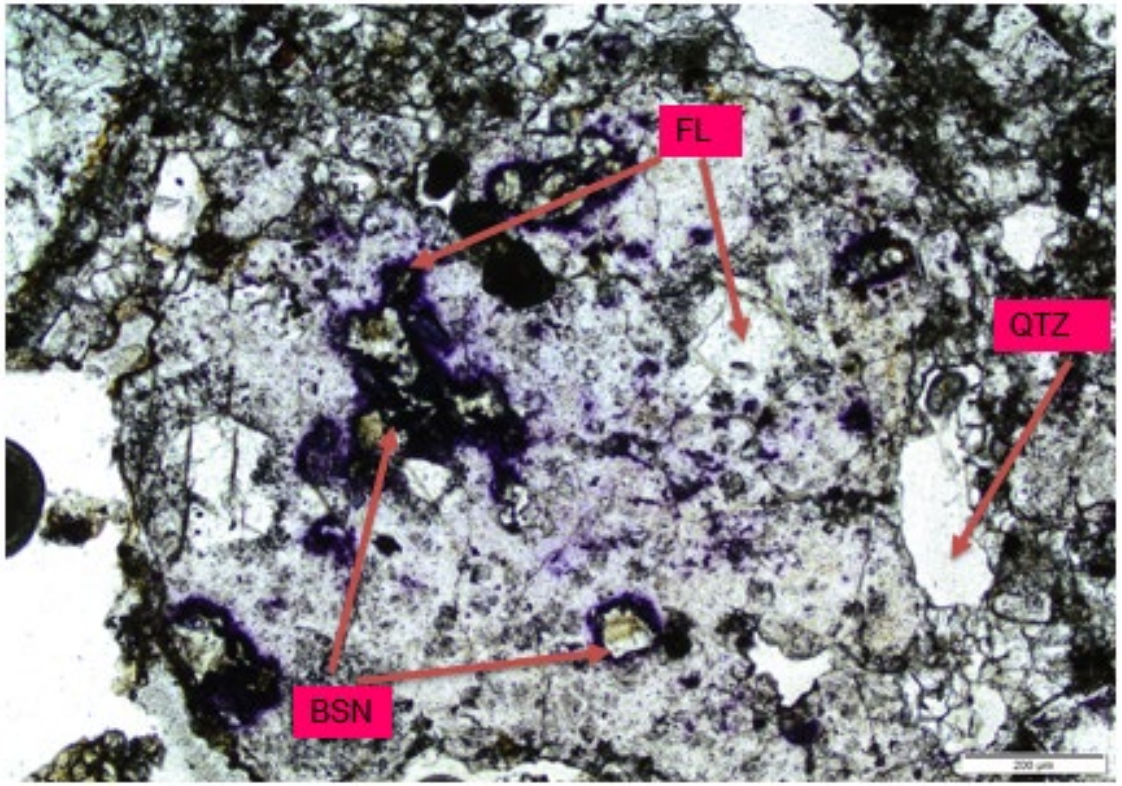
Group 2: Elevated in gold concentration (50-175 ppb)

A hand sample of Gal 4901, vugs and veins filled with hematite forms in the fine grain rock fragments that cement the breccia and around the coarse grained rocks



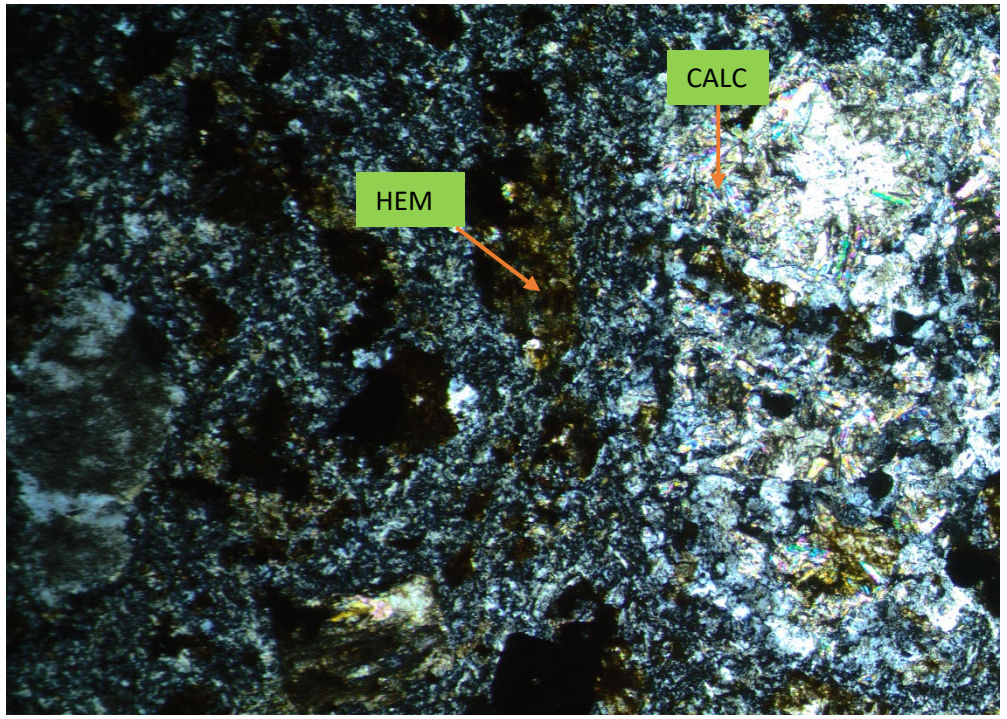
Gal 4903: hydrothermal fluids enter the system and start altering the rock as shown by the rimming on the plagioclase and pyroxene by calcite and calcite veins cutting through quartz grains, trace amount of muscovite can be seen along with hematite

Group 3: Elevated REE-F (1-8% TREE)



Purple fluorite forming around bastnäsite (bsn) in Gal 4907, bastnäsite formed as inclusion in this sample filled with fluorite (fl) and quartz (qtz), an example of group 3 samples, which are highly altered and contain high concentrations of REE

Gal 4911 hand sample with visible fluids pathways/vugs, this sample is filled with hematite and calcite



Gal 4911: the sample has been altered and the magmatic minerals have been replaced by calcite (calc), hematite (hem) and REE bearing minerals

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, mostly with high percentage of fine to medium grained quartz, pyroxenes and few amphiboles, quartz and calcite veins.
  - 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% TREE) and Au (175 ppb), but are not currently economically viable

- REE is superimposed on breccia pipes--later event, gold possibly primary with the breccia pipe (hypothesis)

Thank You

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