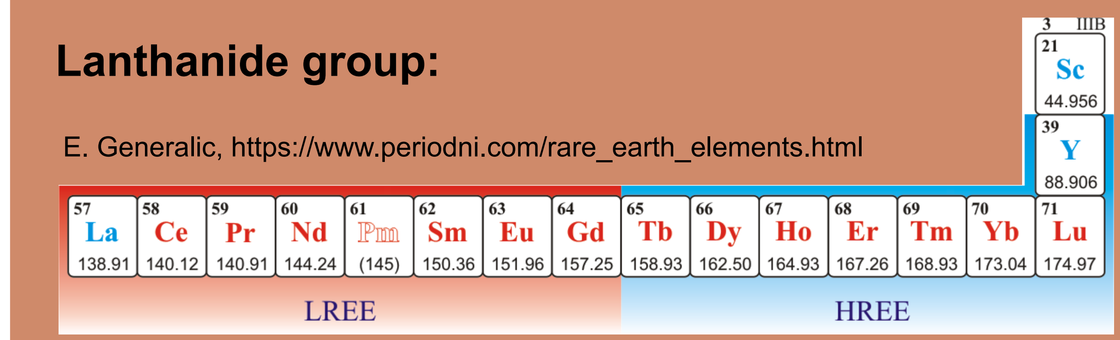
Tracking REE ore formation with fluid incluision from Gallinas Mountains, NM

Teagan Skinner (1)*, Nicole C. Hurtig (1), Alexander P. Gysi (1,2), Virginia Mclemore (2)
(1) Dept. Earth and Environmental Science, NMT, Socorro, NM 87801
(2) New Mexico Bureau of Geology and Mineral Resources, NMT, Socorro, NM 87801
*presenting author: teagan.skinner@student.nmt.edu

Introduction: Rare earth elements (REE)

Lanthanide group:

E. Generalic, https://www.periodni.com/rare_earth_elements.html



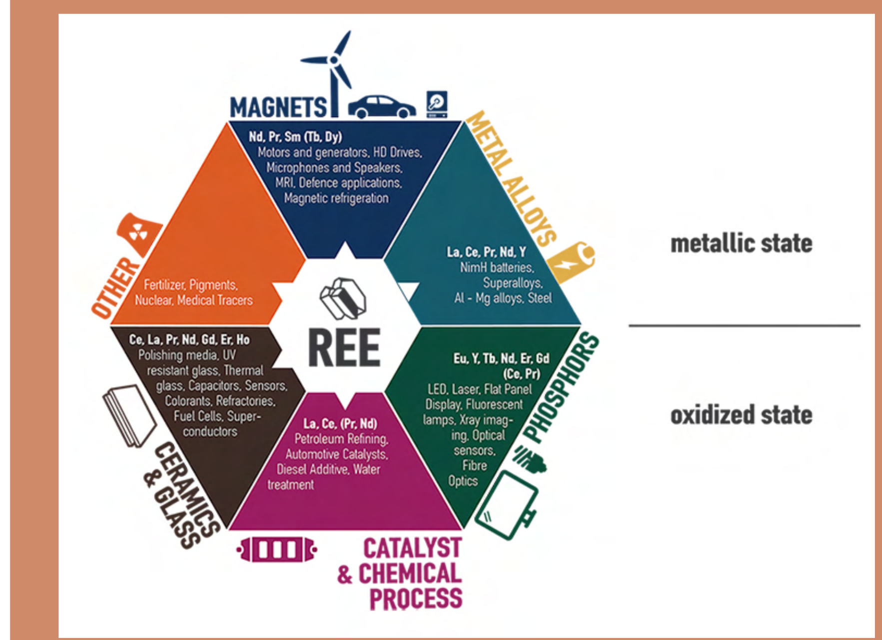
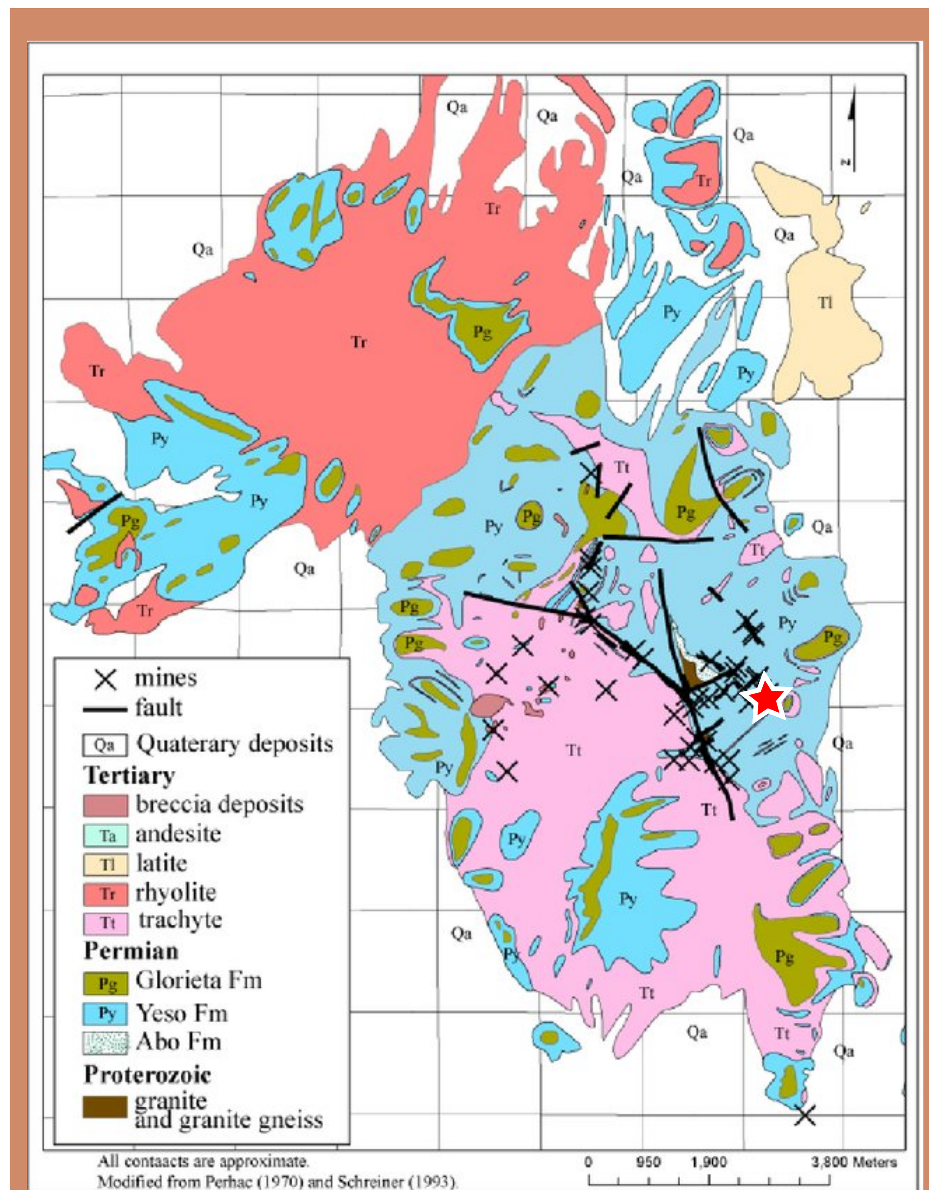


Figure 1: Uses of REE from https://www.eurare.org/

Rare earth elements (REE) are vital to society because they are on the forefront of current technological advancements. They are used in the development of **renewable technology** such as wind turbines, electric vehicles, and solar panels. The future demand for REE for use in technology makes **research on REE deposits critical to avoid a supply shortage**. We are researching fluorite-hosted fluid inclusions from the Gallinas Mountains in order to gain a better understanding of how REE deposits form.

Geological Setting



- The Gallinas Mountains are part of an alkaline-igneous mineral deposit belt, with the mountais dated at 29.9 million years old

- The hydrothermal REE-bearing fluorite veins are associated with syenite and trachyte, and are hosted in trachyte breccia pipes and Permian sedimentary formation

- This sample is a fenitized trachyte breccia, with cross-cutting fluorite and carbonate veins (Figure 2, 3) from Rough Mountain.

Figure 2: (McLemore, 2010) Geologic map of the Gallinas Mountains, Rough Mountain (red star)

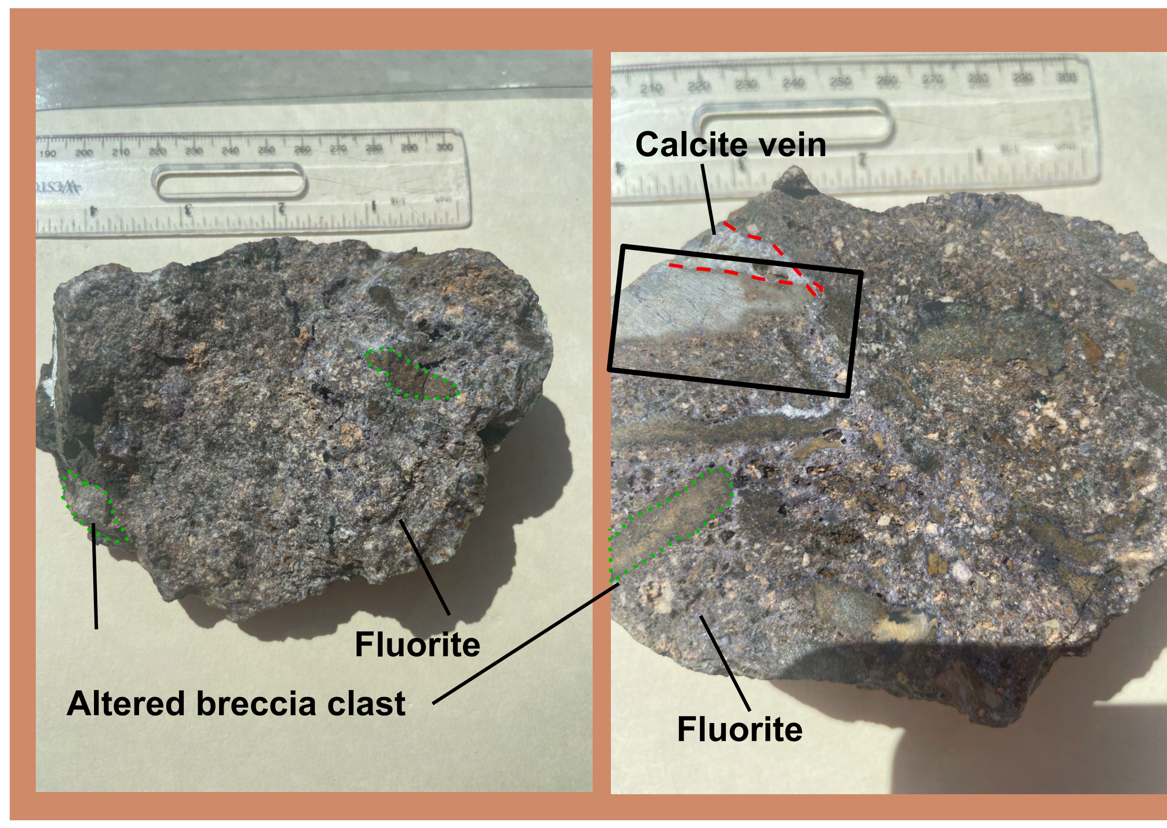
Methods

Microthermometry is performed using a USGS gas flow heating and cooling stage, which is mounted on an Olympus BX53 petrographic microscope. Salinity can be determined by freezing the fluid inclusion using liquid nitrogen and slowly heating it and recording final ice melting temperature (Tm, ice). Homogenization temperature is determined by heating the fluid inclusion and recording liquid-vapor homogenization (Th).

Cathodoluminescence (CL) is used for characterizing fluorite textures. The electron beam induces fluorescence which can be imaged using a digital camera mounted on the Olympus BX2 petrographic microscope.

Fluid and mineral inclusions are analyzed for their composition using a Horiba HR Evolution confocal Raman microscope. Raman spectroscopy uses the interaction of monochromatic light with a mineral, fluid, or gas to fingerprint its molecular structure and chemistry.

Hand sample



- Hydrothermal fluorite breccia with fenitized trachyte clasts

- Breccia crosscut by fluorite and calcite veins

Figure 3: Hand sample (GAL3018B) from Rough Mountain. Left: raw side Right: cut side. Black square is where the thick section (Fig. 4) is located.

Thick section

- Fenitized clasts are crosscut by several fluorite veins

- Fluorite veins have different orientations and crosscutting relationships

- Calcite vein crosscuts earlier fluorite veins

- Euhedral fluorite is in the larger central veins

- Later fine grained fluorite crosscuts ealier generations

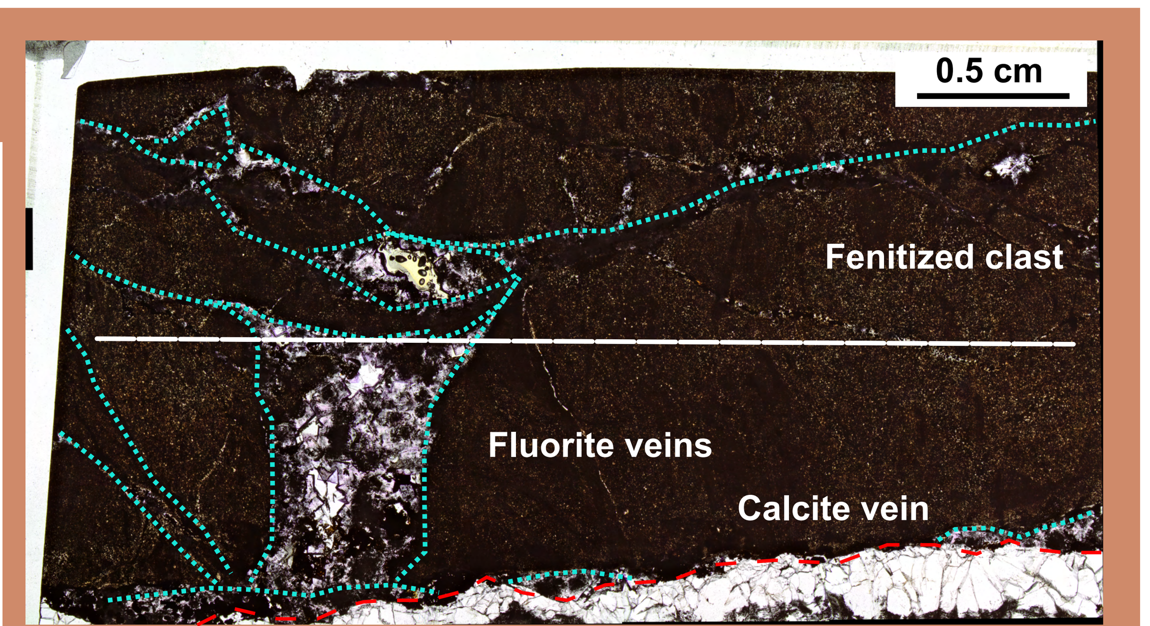


Figure 4: A scan of the entire thick section used in this study.

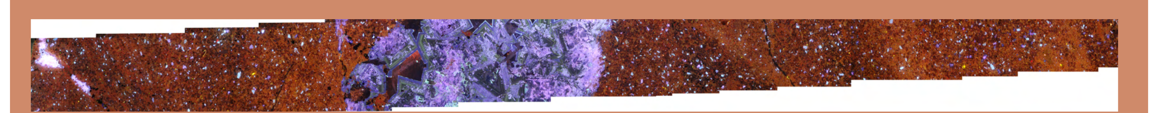


Figure 5: Panoramic cathodoluminescence image of the thick section showing fluorite veins and generations.

Fluorite textures and generations

- Early euhedral fluorite, shows green and blue fluorescence and oscillatory growth zoning

- Later/crosscutting fine grained fluorite, show bright purple fluorescence

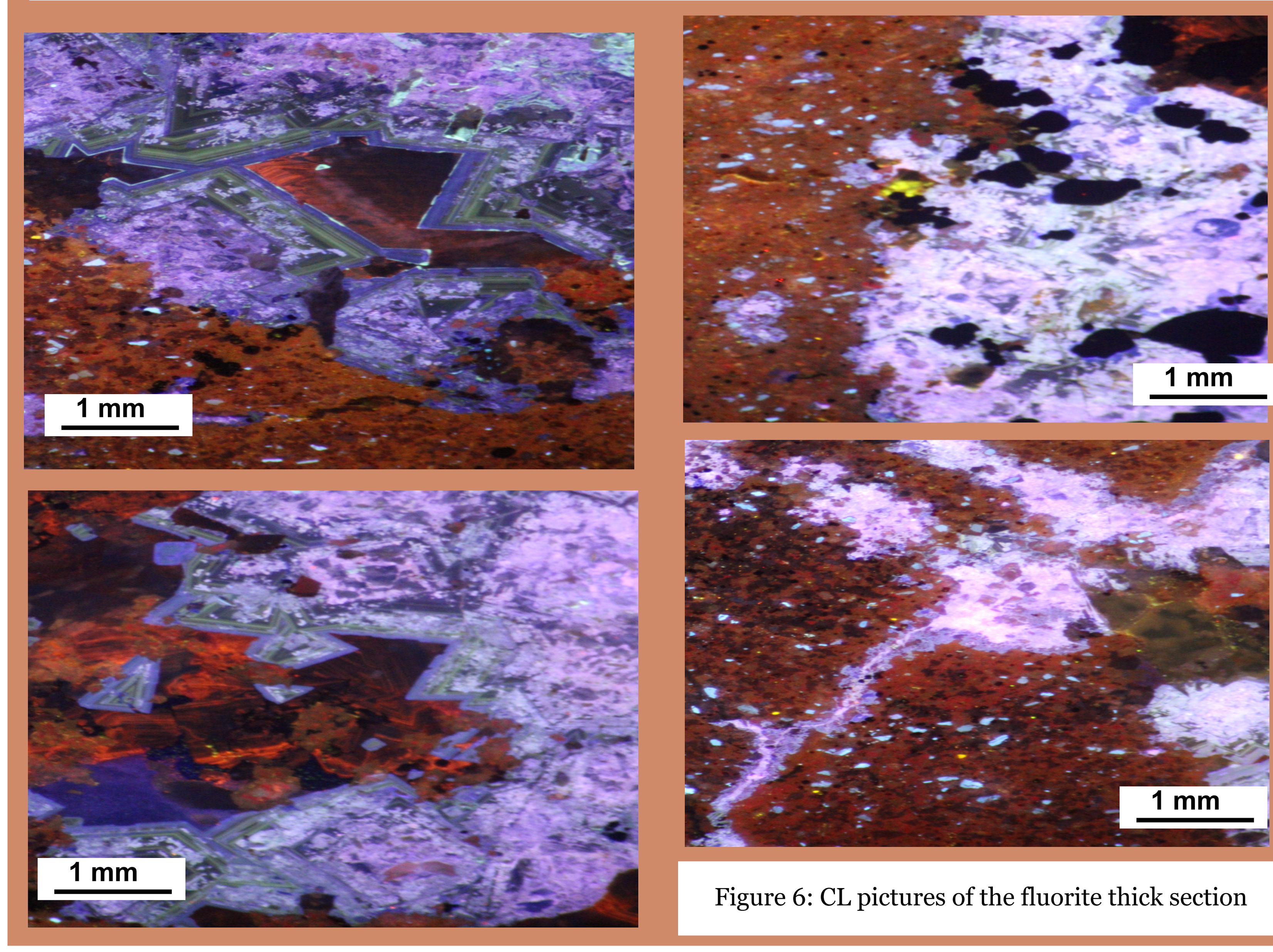
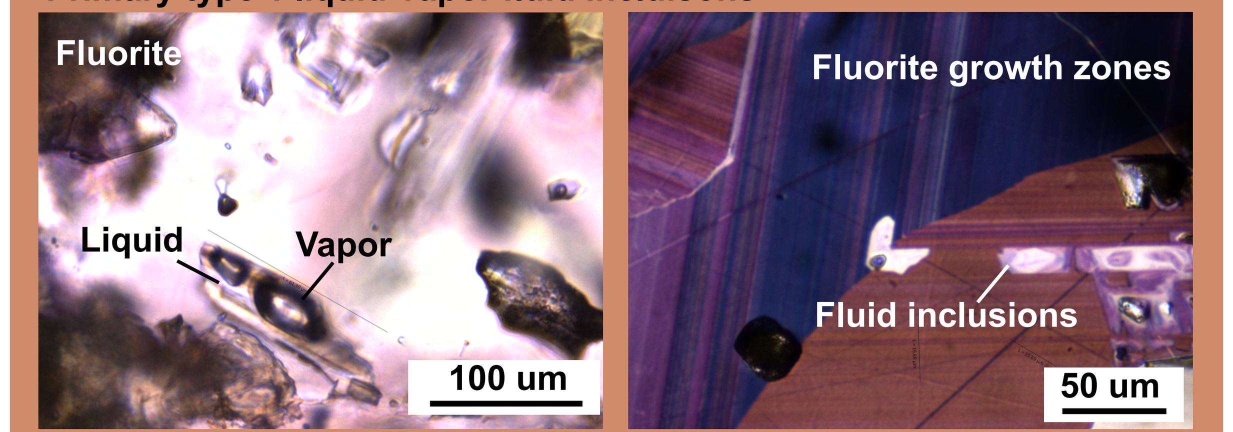


Figure 6: CL pictures of the fluorite thick section

Fluid Inclusions

Primary type 1 liquid-vapor fluid incluisons



Secondary type 2 liquid-vapor fluid incluisons

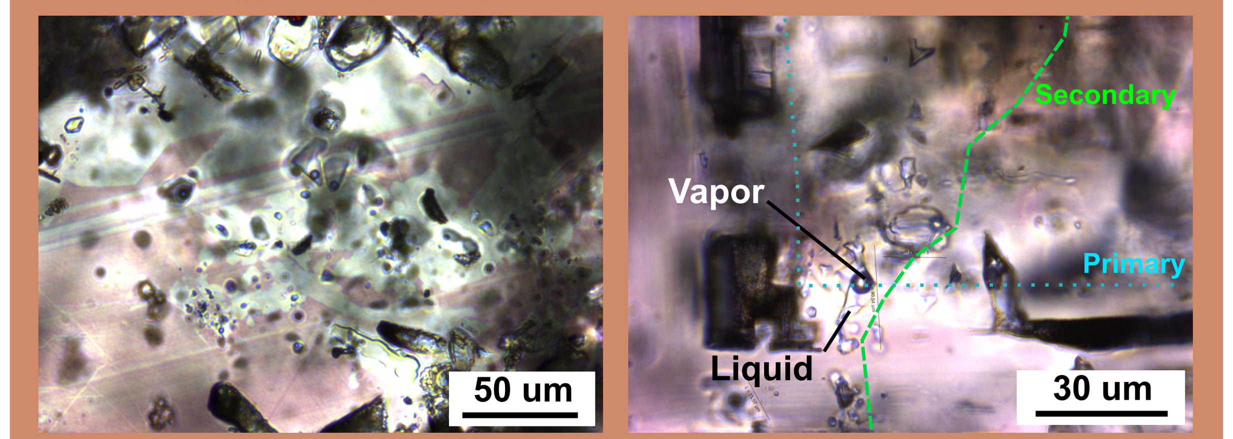


Figure 7: Photomicrographs of primary type-1 and secondary type-2 fluid incluions.

Fluid Inclusion Types

Fluorite generation	Description	Inclusion types	Phase	Shape	Vol% Vapor
FL-1a	Euhedral green fluorite growth rims, little to no inclusions	Small assemblages, majority primary	Liquid and vapor	Irregular, small (1-10 microns)	5-10%
FL-1b	Euhedral indigo fluorite, some inclusions	Mixed size assemblages, primary and pseudosecondary	Liquid and vapor	Round or irregular, usually large (>15 microns)	30-40%
FL-2	Purple fine-grained fluorite, abundant inclusions	Mixed size and shape, pseudosecondary	Liquid and vapor	Round or elongate, usually found in large assemblages of varying size. (5-10 microns, or >15 microns)	30-40% for larger inclusions, 5-10% for small.

Conclusions

-From the preliminary microthermometry data we've collected, the inclusions in the 1b generation have a melting temperature consistent with data from another study (recorded temperatures between -15°C and -10°C) written in 2000 about this same area (Williams-Jones et al., 2000).

-We expect the rest of the microthermometry data to look similar. Further salinity data will provide more information on how REE-rich minerals form from cooling and precipitation.

- Later in this study, we wish to do RAMAN spectroscopy to find the composition of the fluorite and find which fluorite generation contains REE.

References

McLemore, V., 2010, Geology and Mineral Deposits of the Gallinas Mountains, Lincoln and Torrance Counties, New Mexico; Preliminary Report : New Mexico Bureau of Geology and Mineral Resources, NMT Open-file report OF-532, 3 p.

Williams-Jones, A., Samson, I., and Olivo, G., 2000, The Genesis of Hydrothermal Fluorite-REE Deposits in the Gallinas Mountains, New Mexico: Economic Geology, v. 95, p. 327–342.

Acknowledgements: We would like to thank the Sophomore Research Program and its sponsors; the Air Force Research Laboratory, Sandia National Laboratory, Work Study and Academic Affairs of New Mexico Tech to Teagan Skinner, which made this research possible.
This project is also supported by NSF CAREER EAR-2039674 to AP, and NSF-MRI 2117061 to NH
We also thank Eric Ruggles for his help with microthermometry and cathodoluminescence, Madison Payne for the preliminary work on fluid inclusion petrography.