Using Pb isotopes to investigate Critical Metals in Northern California Gold Deposits

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Purpose

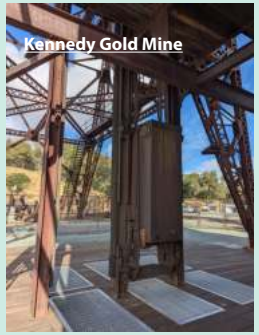
The global transition to green energy, driven by the fight against climate change, has significantly increased demand for metals used in technologies like solar panels, batteries, and electric vehicles. Balancing the need for increased mineral extraction with environmental concerns, while addressing supply chain vulnerabilities requires a deeper understanding of where economically viable metallic resources are concentrated, guiding more sustainable and strategic mining decisions. In this on-going study we are refining the use of Pb isotopes in examination of ore deposits by investigating the gold mineralization of the Sierra Nevada foothills region to better assess the timing and geological processes of mineralization. This new knowledge can then be used to help locating critical metals nationally, indeed globally.

The PI is a newly hired faculty member in the Geology Department. The time and funds provided by the Probationary Faculty Development Grant were utilized to accomplish several tasks towards establishing the PI's research program at Sac State.

1. Develop collaborative relationships with regional
2. Student Involvement and Mentorship
3. Laboratory Setup
4. Fieldwork and Sample Collection
5. Sample Characterization and Analysis

Student Involvement and Mentorship

The project offered substantial mentorship opportunities for two students. As described in the grant proposal, my experience has taught me that student involvement is a two-way street, offering the students great opportunities to engage in their learning, and as well benefits the program with the wealth and diversity of knowledge that they bring. Joey Scrivner, a graduate student, played an integral role in both field and lab activities. He accompanied me to several collection sites and has done work preparing polished epoxy mounts for microscopy. His work has allowed us to image rock samples in detail and prepare them for detailed analysis with a collaborator at UT-Austin. Additionally, undergraduate Aubrie Edmond, who has since graduated, contributed significantly by beginning the process of cataloging a historic ore rock collection within the department. She has created an initial detailed inventory and photo archive of some of these samples, many of which contain galena and could be relevant to Pb isotope comparison studies. Her work, funded through the grant, not only helped preserve departmental resources but also provided a foundation for future research directions.



Sample Collection - Sites accessed during the project

During the study time period we visited 4 sites to obtain sample materials for our investigations.

UC - Berkeley Earth & Planetary Science Research Collections Facility (Richmond, CA)
Working with John Grimsich we spent a day at the Regatta storage facility selecting historic rocks samples from XX mines. Sample selections were taken back to Sac State to make small cutoffs before returning the samples to the collections.

Kennedy Gold Mine (Jackson, CA)
Working with Doug Ketron I spent half a day touring the historic mine property and was able to select samples from multiple locations where waste and low-grade ore are currently on display.

Empire Mine State Park (Grass Valley, CA)
Working with Ryan Randar, Supervising Ranger, we gained access to a sea container loaded with historic drill core from the mine. We accessed several boxes and made mulitiple core selections.

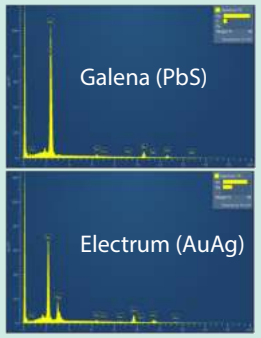
Northstar Mining Museum (Grass Valley, CA)
Working with Jeffrey Boylan, Director, we visited the impressive museum during the off season and were allowed to take 5 ore samples back to Sac State to cut off a selection for analysis prior to returning.

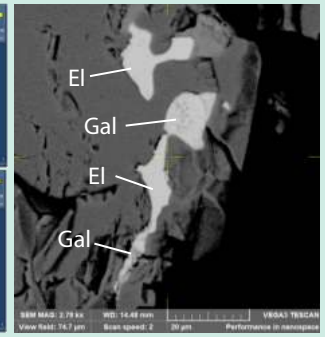
Laboratory Setup

During the project, one goal was to work on setting up the PI's primary lab facility in the Geology department Placer Hall room 1012. By setting up the in-house sample preparation and analysis tools, this enables future work to be carried out at partnering facilities with high end equipment supported by those universities. A major acquisition for this effort was a single wheel grinder/polisher using the PI's startup funds. Another important step was to work with a microscope effort to refurbish a 20+ year old reflective light microscope.

Sample Characterization and Analysis

Samples of gold bearing ore were cut into small pieces and encased in 1" round epoxy mounts so they can be polished and observed in reflective and scanning electron microscopes. Initial microscopy using the reflective microscope has provided valuable insights into sample textures and guided our selection of areas for detailed SEM analysis. Initial imaging on an SEM has taken place in the first part of the summer and we are ready to take samples for final analysis to UT-Austin.





In the above image master's student Joey Scrivner is working on the Sonoma State University Scanning Electron Microscope (SEM). He is imaging samples from the Sierra Nevada foothills to identify the intergrowth of mineral phases containing lead (Pb) with mineral phases containing gold (Au). In the example, the Electron Dispersive Spectroscopy (EDS) spectrums show that the cluster of inclusions in pyrite (the medium gray material) are made up of galena (lead sulfide) and electrum (a gold and silver alloy).

Conclusion and Future Directions

This project succeeded in establishing a framework for a sustainable and impactful research program in economic geology at Sacramento State. Through carefully planned fieldwork, meaningful student involvement, the construction of laboratory capacity, and the development of cross-institutional collaborations, the foundation is now in place for major externally funded efforts. The next steps include Pb isotope geochemistry at UT-Austin, and results dissemination at national meetings. We are actively building toward publication of early results and submission of a full NSF proposal to support continued student training, sample analysis, and geologic discovery in one of the most historically significant mining regions in the country.