Final Report – Probationary Faculty Development Grant

Project Title: Using Pb Isotopes to Investigate Critical Metals in Northern California Gold Deposits

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Introduction

This report summarizes the outcomes of a faculty development project designed to initiate a new line of research into the geologic and tectonic processes responsible for gold mineralization in the Sierra Nevada foothills. The project aimed to explore the use of lead (Pb) isotopes to determine the age and origin of mineralizing fluids and how these processes might correlate with the occurrence of critical metals in the region. Through an integrated approach combining fieldwork, lab development, student engagement, and external collaboration, this project laid the foundation for a long-term research program addressing both fundamental scientific questions and real-world resource challenges.

Fieldwork and Sample Collection

Field-based activities formed the foundation of this project. Four distinct sites across Northern California were accessed to gather representative samples for analysis. In Richmond, I worked with John Grimsich at UC Berkeley's Earth & Planetary Science Research Collections to select archival samples from historical mines. In Jackson, I collaborated with Doug Ketron at the Kennedy Gold Mine to collect ore and waste samples from multiple display areas. The Empire Mine State Park in Grass Valley, under the supervision of Ranger Ryan Randar, granted us access to historic drill core stored on-site, which provided excellent material for geochemical analysis. At the Northstar Mining Museum, Director Jeffrey Boylan allowed us to temporarily borrow ore specimens for cutting and characterization. These visits yielded a diverse suite of mineralized samples representative of key geologic settings in the region.

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.

Laboratory Setup

Much of the spring semester was dedicated to establishing the PI's on campus lab infrastructure. Startup funds and some departmental support funds were used to acquire a grinder/polisher, enabling us to produce high-quality mounts for optical and SEM work. I also collaborated with colleagues to refurbish a 20-year-old reflective light microscope, which has already been used to characterize several samples. By refurbishing the 20-year-old microscope this made available funds that would otherwise be used to purchase a new setup to instead purchase a heating and freezing microscope stage. This stage will enable the investigation of fluid inclusions in minerals from gold and other ore deposits. This in-house capacity, while modest, represents a significant leap forward in supporting undergraduate and graduate research in the Geology Department.

Sample Characterization and Analysis

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.

Collaborations and Partnerships

The project was also successful in cultivating collaborative relationships. I established a new partnership with Dr. Matty Mookerje at Sonoma State University, who is assisting with access to their SEM facility for high-resolution mineral imaging. This complements my ongoing collaboration with Dr. Aaron Satkoski at the University of Texas at Austin, who will conduct in-situ Pb isotope analyses on the prepared samples. I have also been working with Ben Parrish, a mineral resource geologist with the California State Geological Survey to utilize resources they have available, such as funding for student interns, as well to find access to historic mining areas. Field-based partnerships with state park rangers, museum curators, and university collection managers also helped establish a network of support for future field and sample access.

Dissemination and External Funding Development

While dissemination was not a central goal for this initial phase, we are planning to present preliminary results from Joey Scrivner's work at the Geological Society of America Annual Meeting in San Antonio in Fall 2025. We expect to include Pb isotope data from UT-Austin in the abstract submission due in August. More broadly, I received an Incentive for Developing External Awards (IDEA) Program grant to develop a full proposal to the National Science Foundation. This proposal builds directly on the work conducted here and includes co-PIs Dr. Satkoski from UT-Austin and Dr. Philip Gopon of the University of Leoben in Austria. With this broader network, I aim to build a multi-institutional program that integrates advanced analytical techniques and international collaboration. Due to on-going changes to the National Science Foundation ORIED has allowed me to extend my application deadline to later in the Fall 2025 semester.

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.