United States Department of the Interior

U. S. GEOLOGICAL SURVEY
Box 25046, MS 980
Denver Federal Center
Denver, Colorado 80225-0046
Geosciences and Environmental Change Science Center

Project: Fault geometry exploration module (FGEM)

CSM CSCI370 SU25
USGS 2

Organization Background

The U.S. Geological Survey provides science for a changing world, which reflects and responds to society's continuously evolving needs. As the science arm of the Department of the Interior and one of the world's leading scientific institutions, the USGS brings an array of earth, water, biological, and mapping data and expertise to bear in support of decision-making on environmental, resource, and public safety issues.

Project Description

Geologic maps are fundamental to advancing our Nation's economic prosperity and security, with applications ranging from finding economic deposits of critical minerals such as lithium to identifying faults that could host earthquakes. Although geologic maps are among the most data-rich products in the geosciences, most are vastly underutilized as quantitative analytical tools. Through the National Cooperative Geologic Mapping Program, the USGS seeks to accelerate detailed geologic mapping of the United States and expand the maps' utility, quality, and interoperability.

For this project, students will develop a software tool that identifies potentially prospective locations for mineral, water, and energy resources by identifying characteristic geometric patterns of faults and other features on digital geologic maps. The students will also develop a system to display visualizations of the results in existing web based USGS digital geologic map explorer pages.

The software tool should be flexible enough to operate as a module within larger mineral, energy, or water resource exploration workflows. When run on a specified area, the tool will generate polygons identifying pre-specified or custom geometries that are known to be associated with economic deposits, such as fault intersections, bends, relay ramps, horsetail terminations, or transtensional pull-apart zones. For each polygon, the tool will compute information relevant for exploration, such as fault intersection angles; size of the prospective area; characteristics of the geologic host units (e.g., to identify components of hydrothermal or magmatic systems); the mineral, petroleum, or flow system component that the identified structural zone could represent (e.g., the transport pathways); and the distance to other components of that resource system. Across the entire study area, the tool will compute statistics and generate map overlays of parameters such as fault length, orientation, density, intersection count, and complexity; types of geologic units cut by the faults; and the permissible age range for fault offset.

Desired Skillset

- *Required:* Proficiency with Python, R, or another relevant language.
- *Desired:* Basic knowledge of geology, reading geologic maps, and trigonometry.
- *Desired:* Familiarity with geographic information systems (GIS) software such as ESRI ArcGIS Pro or QGIS.
- *Desired:* Experience creating web-based data visualizations.
- *Optional:* Experience using geospatial packages such as ArcPy, GDAL, or the R package terra.
- *Optional:* Proficiency with PostgreSQL.

Student Benefit

- Opportunity to develop highly valued and versatile skills with:
    - Geographic information systems (GIS),
    - Digital cartography including geospatial data processing,
    - Natural resource exploration, and
    - Geology and geologic mapping.
- Opportunity to work with government professionals on a topic of key importance to national security and economic advancement.

Team Size

The preferred team size is 2–5 students.

Work Location

The preferred work location is remote. Meetings will be via Microsoft Teams.

Intellectual Property

Any Intellectual Property (IP) developed during the Project will be owned by the either USGS, Colorado School of Mines, and (or) its students as determined by U.S. law. Notwithstanding, for all IP and derivative data created during the Project, USGS will receive a Government Use license, allowing the Government to reproduce, publish, modify, or otherwise use the IP. Government use may include providing the IP and derivative data to the public via USGS websites or public software repositories.

Non-Disclosure Agreement

An NDA is not required.

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