F26.18 Testing for active deformation along the Needles fold with GIS based geomorphic stream analysis

Overview

The I2S student will perform GIS based analysis of stream profiles across the Needles fold in western Arizona, to test if the fold is actively deforming. The Needles fold and its associated fault system is thought to be able to host magnitude 6 earthquakes, and is considered by the US Geologic Survey and the Arizona Geologic Survey to be one of the top 5 hazardous faults of concern in the state of Arizona. However, little is known the rates of deformation along this fold, and if the fault at depth beneath this fold is still actively slipping today or not.

One way to address this question is to assess the geomorphic response of streams crossing the fold. If the fault at depth has been recently active, the fold would be actively growing, and actively deflecting the streams and causing them to increase their stream gradients across the fold axis.

In this project, the I2S student would use quantitative analyses in ArcGIS to extract stream longitudinal profiles from high resolution digital elevation models (DEMS), and calculate steam steepness indices for several streams crossing the fold. This project would be performed in collaboration with Dr. Regalla and NAU Geology MS Student Rebecca Bertel, who are working on mapping the fold structure and deformed sediments to determine the geometry of the fault beneath the fold, and the timing of deformation.

What the student will DO and LEARN

Tasks:

The I2S student will apply Digital Elevation Model (DEM) processing techniques using ArcGIS in order to test whether or not streams that cross the Needles fold have anomalous steepness indices indicating recent deformation of the system. Specifically, the student will:

1) Complete tutorials on DEM data manipulation in GIS, to learn research techniques 2) Create hillshade and slope derivatives from a 1m DEM, and map the axis of the Needles fold. 3) Perform hydrologic routing techniques to define streams and extract longitudinal profiles. 4) Calculate slope-length and/or slope area indices to quantify stream steepness as a function of downstream distance and position relative to the fold.

5) Analyze data to test the hypothesis that the Needles fold is actively deforming and causing streams to have anomalously high steepness indices.

6) Present results at the Undergraduate research symposium

I anticipate tasks 1-3 to be completed in fall 2025 and tasks 4-6 to be completed in spring 2026.

Learning outcomes:

As a result of this research internship, the student will learn how to:

- perform DEM analysis and manipulation in ArcGIS
- calculate hydrologic routing techniques on DEMs
- recognize and map active folds in elevation model data

- apply tools geologists use to determine slip histories on faults

Additional benefits

The student will gain skills in analysis of DEM data in ArcGIS and tectono-geomorphic analysis of the stream incisional response to actively growing folds. These types of GIS and data analysis skills are commonly sought by employers in the geosciences.

In addition to meeting regularly with Dr Regalla to discuss project progress, the awarded student will join a vibrant joint research lab group hosted by four NAU geology faculty. As part of weekly group meetings, the I2S student will be able to see other students present results of research and be able to give updates to their own research. Several students in the research group are experienced in the GIS skills the I2S students will be learning, and this the I2S students will therefore be part of a community of graduate students who can help them with issues that may arise.

Additional qualifications

Student should be pursuing a major, minor, or emphasis in Geoscience, or related fields who has an interest in map making, surface processes, and/or earthquakes. Student must be comfortable with computer based analysis (windows operating system) and be willing to trouble shoot technical issues with the help of supervisors and graduate students. Ideally the student has prior experience with ArcGIS.

The student must have taken an introductory Geology class (GLG 101 or GLG 112) and at least one 200 level or higher class in geoscience or related fields. Student preferably has taken a course in either Geomorphology, Field Geology, Physical Geography, or GIS/ Remote Sensing.

Time commitment

5 hrs/week for 30 weeks