A GIS Investigation of Regional Geologic Controls on Mercury Deposits in the Southwest Region of Arkansas

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Goals
The goal of this Master’s thesis project is to use Geographic Information Systems (GIS) to determine which mode of deposition (structural features or lithologic changes) better explains the linear depositional pattern of mercuric minerals within the Arkansas mercury district by examining which potential control mechanism is closer to the deposit locations. Presumably, the closer a controlling mechanism is to the site of deposition, the more influence it will have on the deposit location.

INTRODUCTION
The mercury district of southwest Arkansas is within Clark, Pike, and Howard counties, all in the southwest region of Arkansas. There are 75 mapped mercury deposits within the region (primarily in the form of cinnabar). Cinnabar deposits in the district have a distinct surface expression in map view. The geographic locations of the majority of the deposits tend to form an east-northeast alignment (figure 1).

Utilization of GIS tools provide insight to the regional controls on the spatial distribution of the mercury deposits by examining the proposed relationships between mercury deposits and regional thrust faults or changes in lithology, both of which have been suggested (Clardy and Bush, 1976) to explain the narrow band of permissive host rock for the deposits.

REGIONAL GEOLOGY
The rock types which host the mercury mineralization are Paleozoic. The Pennsylvanian Jackfork Formation hosts the majority of the deposits, while the Mississippian Stanley Formation hosts the remainder of the deposits (Clardy and Bush, 1976). These formations have been deformed by southward-dipping thrust fault zones resulting from what has been interpreted as part of a subduction complex (Viele, 1979). The region is comprised of a series of anticlines and synclines which trend east-west (Clardy and Bush, 1976). The deformation in the area occurred during the Alleghanian orogeny, creating the Appalachian-Ouachita fold-thrust belt (Hatcher et al., 1989). As a result of the deformation in the area, the Paleozoic host beds dip steeply to the south (Clardy and Bush, 1976).

METHODOLOGY
In order to accomplish the project goal, the regional thrust faults and changes in lithology must be mapped at an appropriate scale. A composite map of the changes in lithology, regional thrust faulting, and the deposits themselves will be used to determine which of the suggested relationships exerts more control on the placement of the deposits by being physically closer.

Regional thrust faulting and mercury deposits in the area were mapped from the 1:24,000 geologic map quadrangles published by the Arkansas Geological Commission (figure 1). To map the lithologic changes at the scale needed, a methodology developed by Belt and Paxton (2005) was utilized. According to their study, sandstone, being more resistant to weathering, yields a higher relief, while shale, being less resistant to weathering, yields a lower relief. A similar relationship exists with slope angles, where steeper slopes dominate sandstone areas while lower slope angles are found within shale zones. These relationships were used to build a model to classify the varying rock types within the region.

Using this methodology and ArcGIS Desktop, a 5-meter resolution Digital Elevation Model (DEM) was used to calculate slope (figure 2) and obtain elevation data (figure 3). Other topographic indices within the region, such as topographic wetness (figure 4), planform curvature, and stream power index were also computed from the DEM. User-defined sandstone, shale, and transitional (sandstone and shale both present) test areas, combined with the respective topographic indices previously discussed will be investigated through the use of machine learning algorithms to evolve a set of relationship rules. These relationship rules will then be used to build a model in order to classify rock types within the region. Mapping of the contacts between the lithologic changes will be based on this map.

CONCLUSION
In order to determine which relationship (regional thrust faulting or lithologic changes) better explains the position of the mercury deposition within the region, visual assessment and statistical analysis will be performed on three datasets. These three datasets will be composed of the distances...
found between each deposit and the nearest thrust fault and each deposit and the nearest lithologic change.

Figure 1: Mercury deposits and faults both mapped from 1:24,000 geologic maps of the region.

Figure 2: Sandstone ridges exhibit higher slope values (purples) while shale zones exhibit lower slope values (yellows).

Figure 3: Sandstone ridges exhibit higher elevation values (light shades) while shale zones exhibit lower elevation values (darker shades).

Figure 4: Sandstone ridges exhibit lower topographic wetness values relative to the adjacent shale zones.

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