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Modeling Copper Potential – Comparing a Web-GIS and Desktop-GIS Methods

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Summary

Mineral commodities are found by identifying high potential locations, increasing the chance for discovery through the integration of spatial associations of key exploration criteria from multiple data sources. Mineral potential is the likelihood that a particular mineral can be found in a given area when certain geological, geochemical, geophysical and remotely sensed features are present. The use of GIS technology to process geochemical data, integrate with geology-centered datasets and conduct multivariate data analysis to create mineral potential maps has been explored since 1994.

This study will evaluate two different approaches to guide stakeholders to identify sites with high copper potential in a knowledge-driven predictive mapping scenario using a Desktop-GIS, and a Web-GIS, Esri's Suitability Modeler widget in Web AppBuilder.

Theory / Method / Workflow

Recently, the components of GIS-based mineral potential mapping using the creation and integration of key predictor variables has aided in the generation of mineral targeting using predictive favorability maps. If a particular area has known mineral occurrences for the mineral-being-sought, then spatial associations between key geological features can be weighted according to relative importance and used as spatial evidence in predictive modeling. Tools to identify undiscovered mineral resources in a mature brown-field mine setting are common in the mineral exploration industry, however tools to identify resources in an under-explored greenfield setting are limited.

A geologically favorable study area was chosen, for its known copper potential in a porphyry copper setting and covers southeast Arizona, southwest New Mexico, and northern México. Desktop GIS-based tools have the ability to manage multiple spatial and non-spatial datasets with advanced targeting and modeling capabilities using both knowledge-driven and data-driven mapping techniques. The Suitability Modeler widget in Esri's Web AppBuilder provides a user-friendly Web-GIS environment that has built-in generalized global data, the ability to upload study data and reclassification functionality making the GIS task of modeling suitability (in this case copper prospectivity) a possibility.

This study compares the results of using spatial analysis for the remote-detection of copper across state borders using secondary data sources as inputs in a knowledge-driven predictive mapping scenario using two different GIS approaches. Both approaches use a Weighted Raster Overlay (WRO) for the analysis method, at the same scale, resulting in a single raster showing copper prospectivity that ranks tracts of land from High to Low using a prospectivity scale, where each cell is assigned a rank according to copper prospectivity in a porphyry copper setting. A series of evidential maps for each of the copper prospectivity criteria is presented with evidential map weights and rated evidential class scores that are integrated with other spatial datasets to produce a single, final raster map. This qualitative assessment is an expert-driven, knowledge-driven mapping approach.

Results, Observations, Conclusions

Several different techniques for knowledge-driven mineral prospectivity mapping using a GIS exist however, the subjectivity of the knowledge-driven input criteria should be questioned and would vary depending on the mineral-being-sought and the study area.

The preparation of input data before the execution of the Web-GIS was somewhat complex. Access to a cloud service, in this case, Amazon Web Services (AWS) with Image Server was required to host an ArcGIS Enterprise account where the Weighted Overlay Service is hosted. Access to the Weighted Overlay Service toolkit in ArcGIS Pro was required to resample the Web-GIS input data layers to the same cell size. Unlike the Desktop-GIS, a standard raster cell size was required. Once the raster data was standardized the Weighted Overlay Service was used in GeoPlanner for ArcGIS to identify Highly Prospective tracts of land based on the expert-guided input criteria. Several calibration datasets that cover the study area were used including the locations of known copper mines.

Several trial and error analysis attempts were required in order to derive an optimum best-case scenario. The analysis was calibrated by a) modification of the individual layer prospectivity ratings (same scale) prior-to the final Weighted Overlay Analysis; b) by modification of the weight or relative importance of each of the reclassified input layers; c) and by modification of the input raster cell size.

Both GIS approaches were successful in producing a single rated copper prospectivity map but is the single output map accurate enough to deploy significant exploration funds to these under-explored green-field settings. Both approaches could accommodate different types of data derived from different data sources, although data formats varied between approaches. The copper prospectivity criteria defined early-on in the analysis guiding the analysis would need to be changed depending on a chosen copper model in a particular study area. The Desktop-GIS offers a variety of Knowledge-driven and Data-driven Overlay Methods whereas the Web-GIS offered a single Weighted Raster Overlay method.

The Web-GIS provided a relatively fast and easy way of incorporating free and open source online data with secondary data inputs to produce copper prospective tracts of land that can quickly and easily be shared with the team or the public. The resulting interactive maps in the Web-GIS are made available to the public and therefore it is the responsibility of the developer to ensure a high-quality, and accurate product is presented at all times

To validate the analyses, a portion of the tracts classified as High for copper prospectivity should be field-checked for accuracy.

Novel/Additive Information

In order to truly achieve less subjectivity in creating copper prospectivity maps, data-driven modeling techniques could be applied to validate the knowledge-driven map as well as create more accurate mineral prospectivity maps in targeted areas. A second analytical approach could be experimented with using the Fuzzy Overlay method in a Desktop-GIS environment, a method commonly used in Mineral Potential Mapping.

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References

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