An Analysis of the Use of Predictive Modeling with Business Intelligence Systems for Exploration of Precious Metals Using Biogeochemical Data

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ABSTRACT

This study addresses the use of predictive modeling techniques; primarily feed-forward artificial neural networks as a tool for forecasting geological exploration targets for gold prospecting. It also provides evidence of effectiveness of using Business Intelligence systems to model pathfinder variables, anomaly detection, and forecasting to locate potential exploration sites for precious metals. The results indicate that the use of advanced Business Intelligence systems can be of extremely high value to the extractive minerals exploration industry.

Keywords: Anomaly Detection, Artificial Neural Networks, Biogeochemical Datasets, Gold Exploration, Pathfinder Variables

INTRODUCTION

The explosive increase in the amount of detailed, digitized exploration data that is available today from modern geological exploration programs is unprecedented in both opportunities and Business Intelligence management challenges. This is especially true for large capitalization precious metals exploration projects, which frequently make use of multiple data gathering systems in areas of the globe which have previously not been heavily explored. These various exploration observation gathering systems typically include rotary air-blast (RAB) drilling, diamond-core drilling, aero-magnetic and aero-radiometric observations. More recently developed advanced exploration techniques...
also include induced polarization (IP) observation, mobile metal ion (MMI) sampling, and biogeochemistry observations.

At the same time, the use of these various exploration methods, including the newer and relatively faster techniques mentioned above such as IP and biogeochemistry, still represent an inordinate direct cost to the exploration business. With precious metals exploration being extremely capital intensive and high risk; anything which can be done to successfully mitigate costs and speed up the exploration process is highly sought after. To underscore the capital and competitive risks associated with this industry, it should be understood that mineral exploration licenses must typically be bought in advance from host nations or other entities. Expensive specialized equipment and highly trained scientists must be brought to remote parts of the globe and logistically supported for potentially several years while exploration programs are undertaken. The prospecting licenses are generally granted for a finite period of time and specific element, after which they must be either returned or re-applied for and repurchased. Loss of a license would mean all exploration work and expense had been wasted, therefore it is imperative to complete exploration programs on time and on budget, and to wisely select prospective properties to explore before applying for an exploration license.

The focus of this paper is largely on the utilization of biogeochemical (BGC) datasets obtained from exploration prospecting license properties or PLs as a set of exploitable data sources. Because BGC data is comparatively inexpensive and quickly acquired, it can provide the large quantity of observations over a wide range of terrain types across multiple seasons which uniquely fit the needs of our multidimensional forecasting and analysis geological exploration model. The data is obtained from a rigorous botanical sampling methodology involving specific species of plants under controlled field conditions. Biogeochemical samples are then burned (ashed) in a controlled laboratory setting and analyzed by a laser spectrometer to determine which chemical elements were contained in the plant material; the plants themselves draw trace elements up from the soil via capillary action and serve as subsurface extraction tools. The ability of the plant to metabolize gold or other chemical elements is dependent upon the weather (seasonality), property license region, soil type, plant species and chemical elements.

This study examines feed-forward artificial neural networks and associated Business Intelligence tools’ capabilities. More specifically, the capabilities to be examined are modeling of pathfinder variables, anomaly detection, and forecasting and trend projection relating to mineral exploration.

Modeling of Pathfinder Variables is to determine which commonly and easily metabolized and dissolved chemical element has a relationship to gold (target variable). While gold itself can be metabolized by the plant and used as a predictor variable, its rarity (often in the low parts per billion) in observed samples often makes it unsuitable for statistical analysis. This is because it is often near the minimal detection capabilities of many laser spectrometers and of neutron activation equipment. Therefore, a suitable set of proxy chemical elements correlated with gold, called pathfinder elements can be established. These would be unique to each geographical region, plant species, season and soil type.

Anomaly Detection is to determine if an exploration prospecting license (PL) is a viable candidate for further detailed and more costly RAB and diamond drilling exploration work, OLAP database calculations will aid in this determination by detecting an anomaly pattern in the BGC dataset. Likewise, the use of Anomaly Detection can assist Senior Management in determining if a PL should be abandoned to save on license fee renewal and direct costs incurred from further exploration expenditures if no anomalies are detected at all.
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