MONGOLIA – Opportunities and challenges in the last frontier.

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SUMMARY

For decades, Mongolia remained largely underexplored because it is a landlocked nation sandwiched between Russia and China, and interest for their mineral deposits was minimal. As the center of global economic growth shifted to Asia in the last decade, many foreign investors became interested in Mongolia as the country has many known rich mineral deposits. What was then an isolated nation has become a positive strategic position as China could purchase many of the minerals Mongolia can produce to fuel its robust economic growth.

As a result, geological teams and geophysical surveying companies were quickly formed to explore and evaluate the country's mineral resource potential. Two recent world-class deposits were announced for development, i.e., Oyu Tolgoi (copper and gold) and Tavan Tolgoi (coal). Some geophysical case studies are presented to highlight the opportunities and challenges required to better understand the complex geologic and stratigraphic structures that gave Mongolia its diverse and rich mineral deposits.

Key words: Mongolia, mineral (gold, coal, & petroleum) exploration, diverse geophysics.

INTRODUCTION

Due to the rapid economic growth in Asia, Mongolia has now experienced a significant infusion of foreign investments in order to quickly evaluate its mineral resource potential. For decades, the country was largely underexplored and experienced little development as it is a landlocked nation. During this period, there was little interest to develop their mineral deposits.

However, the robust economic growth in Asia, largely driven by China, has resulted in major demands for essential minerals such as copper, iron, coal, gold, etc. As a result, Mongolia greatly expanded its domestic exploration program through forming joint ventures with international firms. In the last ten years, the country witnessed a rapid increase of geological teams, geophysical surveying and drilling companies. GeoSignals (GS) LLC was founded in 2006 to address the country's exploration challenges. In order to maintain high-quality results according to international standards, GS formed a strategic partnership with an American consultant who has extensive hands-on experience in employing diverse geophysical technologies to petroleum and minerals exploration and production. More importantly, GS needed valuable training and geotechnical support in the seismic methodology.

A geological map of Mongolia is presented in Figure 1. The South Gobi desert has extensive coal deposits while the central region of the country is composed of complex folded systems. Mineralized zones associated with copper, gold, iron ore, etc. are frequently encountered in the central region. Oil is produced from the eastern region.

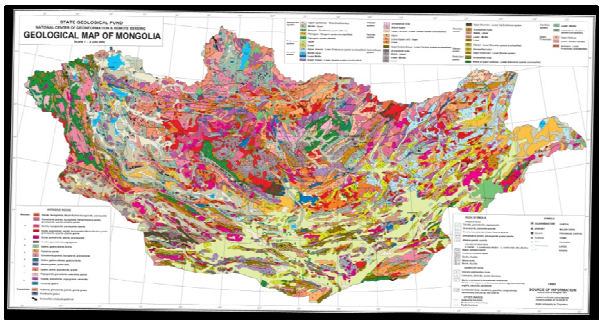

Figure 1. Geological map of Mongolia.

METHODS AND RESULTS

In order to address the country's varied and complex geologic and stratigraphic structures, innovative geophysical technologies need to be employed properly. Depending on the target objectives, imaging depths, and resolution, appropriate geophysical methodologies are conducted to maximize results. Some case studies are presented demonstrating the usefulness of geophysics to enhance the country's exploration program.

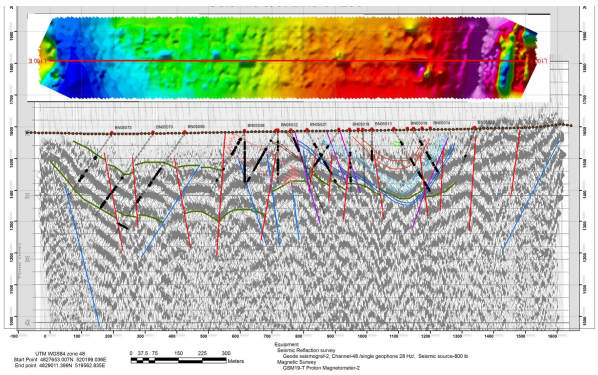

Figure 2. Correlation of magnetic and seismic data sets gathered in central Mongolia showing complex folding in a coal basin.

Non-seismic methods are initially conducted as a reconnaissance tool to study the subsurface because they are more cost-effective than the seismic method. In Central Mongolia, the region is known to have complex folded systems with numerous small basins. Figure 2 is an example in which the valley measured about 1.5 km wide. The magnetic data presented on top of Figure 2 shows high-frequency variations beneath the valley, indicating complex faulting in the coal basin. Thus, a high-resolution 2D surface seismic survey was later conducted and the results are shown in Figure 2 (bottom). It is evident from the coal seam reflections and interpreted faults that the area experienced past compression. There was a very good correlation between the two geophysical data sets and the results also supported the extensive drilling program which yielded complex geologic structures beneath the valley.

In coal exploration, drilling is still the primary exploration tool but the results can be limited especially when drillhole spacing are far apart. However, seismic can enhance any coal exploration programs by providing continuous subsurface profiles (Gochioco, 2005, 2000, 1992, 1991, and 1990). Figure 3 shows a high-resolution 2D coal seismic data collected in the South Gobi desert, indicating continuous coal seams with fairly uniform thickness coupled with minor interpreted faults. It is obvious that the surveyed area in Figure 3 will be easier to develop the coal deposit as compared to the complex folded area shown in Figure 2.

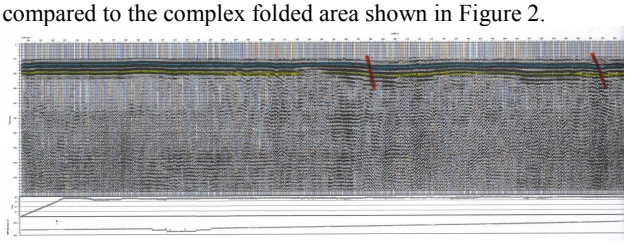

Figure 3. Coal seismic section indicates seam continuity with minor interpreted faults.

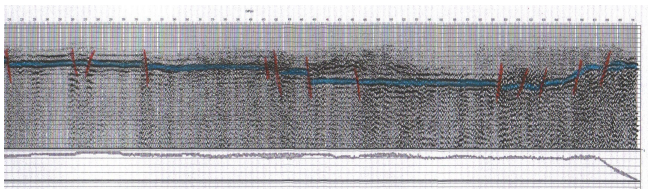

Figure 4. High-resolution seismic section of a detected collapsed volcanic caldera - source of epithermal gold.

Electrical resistivity and magnetotellurics methods are typically employed to detect and image mineralized zones associated with ferrous and non-ferrous metals. In one gold exploration study, a high-resolution seismic survey was added to better define the structure of a suspected collapsed volcanic caldera known to be a potential source of epithermal gold in the study area. Figure 4 shows one of the seismic lines that traversed over the collapsed caldera; thus, confirming the location and existence of such a structure.

Nearby the gold exploration study area, induced polarization and electrical resistivity surveys were also conducted to detect a mineralized zone associated with pyrite and gold. The map view image (Figure 5) shows some variable concentrations in mineral content. What is more interesting is the recording of very low readings beneath the mineralized zone. The vertical cross section clearly shows a plume-like structure (blue) coming from greater depths. A drilling program is being planned at this stage to determine what the anomaly is.

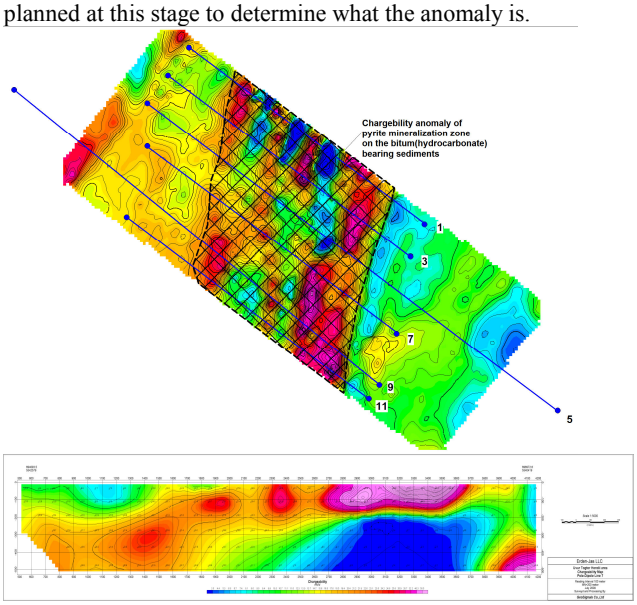

Figure 5. Induced polarization and chargeability images of a mineralized zone associated with pyrite and gold.

CONCLUSIONS

The case studies presented in this abstract demonstrated the high-quality of geophysical works local companies can perform in the country. By forming partnerships with international experts, Mongolia is able to shorten the learning curve in adopting leading edge geophysical technologies.

Mongolia is considered a late entry into the global exploration community. According to one government ministry, about 16% of the country had been surveyed. Given the vast potential of developing its rich mineral deposits, geophysical activities in the country will be robust for the next two decades and beyond.

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