Using 3D/4D modeling tools in exploration of gold-polymetallic potential areas in Greece

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ABSTRACT

Greece's geology favors a potent and dynamic use of mineral resources. Among the Non-Energy Metallic Minerals commodities, base and precious metals, in particular zinc, lead, copper gold, and silver are becoming an increasingly important and rapidly growing target of the mining industry. In NE Greece, where most of the potential resources and feasible deposits are hosted, gold-polymetallic mineralizations occur in a wide range of genetic types. The mineralization potential is consisted of magmatic porphyry copper type deposits, hypothermal / mesothermal manto-type polymetallic sulphides and epithermal gold systems. Local, semi-regional and regional scales of 3D/4D models were applied in most of the above mentioned deposit types achieving new metallogenic interpretations and exploration perspectives in relation to the geology, the structural setting, the stratigraphy, the tectonic evolution, the ore bodies geometry, the alteration zones, the ore grades distribution and the genetic links between the spatially related porphyry and manto systems, based on airborne geophysics, along with further interpretations for across border regional exploration potential.

Two areas have been studied in northern Greece: a) Eastern Chalkidiki peninsula with polymetallic replacement deposits (Olympias, Madem Lakkos, Mavres Petres) and porphyry copper deposit (Skouries) and b) Thrace region with epithermal gold deposits (Perama and Aghios Demetrios deposits).

Local/Deposit and semi-regional scales of 3D modelling were applied to understand better the deeper seated extensions of the ore bodies and further explore the regional metallogenetic aspects.

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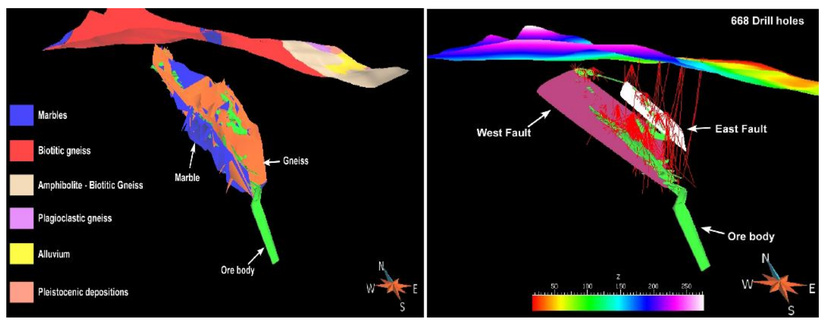
POLYMETALLIC REPLACEMENT AND PORPHYRY COPPER DEPOSITS IN NORTH-EASTERN CHALKIDIKI PENINSULA

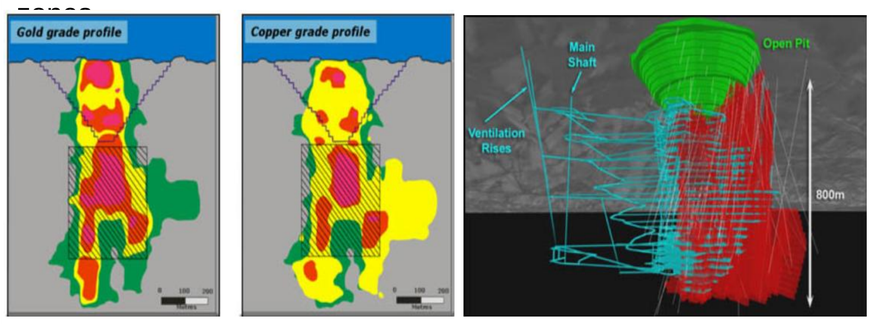
OLYMPIAS POLYMETALLIC REPLACEMENT DEPOSIT

It is a massive stratabound manto type ore body. The mineralization is controlled by a combination of marble horizons, and deep-seated faults developed as part of the crustal re-working of the area. Two ore bodies occur at the contact between marbles and overlying gneisses. The 3D model shows that the deeper extension of the ore body makes a potential exploration target.



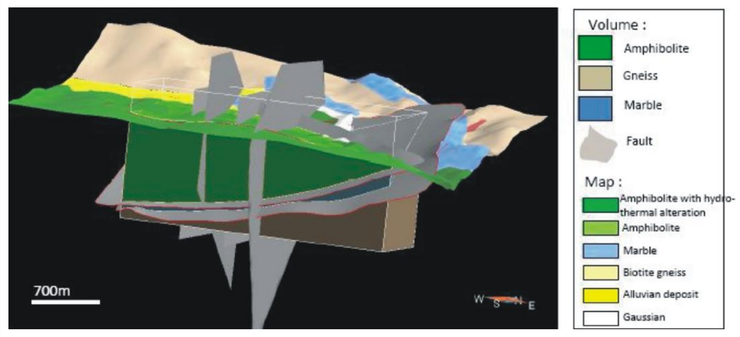
SKOURIES PORPHYRY COPPER DEPOSIT

The Skouries porphyry belongs to a series of dominantly dioritic to andesitic dikes and stocks forming a NE-SW trending intrusive belt and occurs as a pipe-like, mineralized subvolcanic body with surface dimensions of 180m N-S and 200m E-W with a vertical extent of at least 700m. The deposit is characterized by more or less concentric potassic, propylitic, phyllic and argillic alteration



MAVRES PETRES POLYMETALLIC REPLACEMENT DEPOSITS

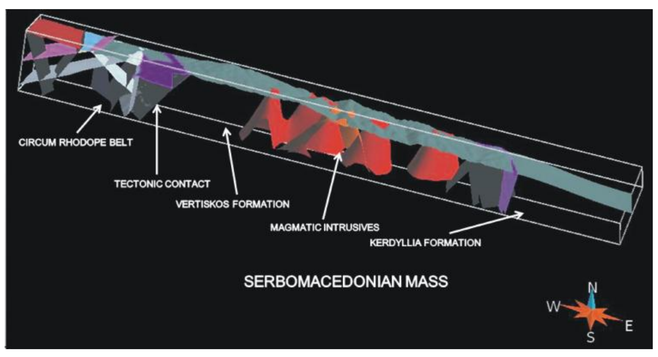
Mavres Petres, is a massive stratabound replacement deposits. The mineralization is controlled by a combination of marble horizons and deep seated faults, developed as part of the crustal re-working of the area and subsequent fluid movements.

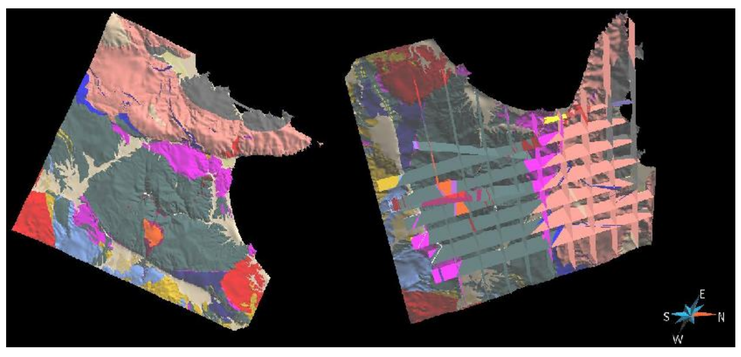


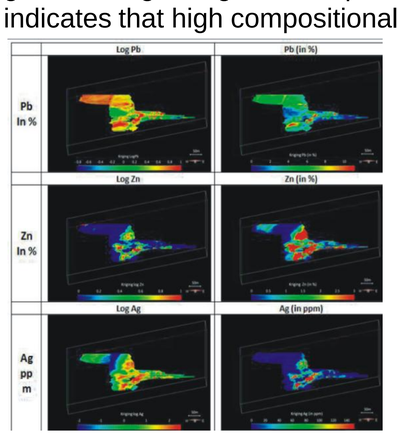
The geological setting shows biotite gneiss and amphibolitic footwall rocks. The Mavres Petres deposit is cross-cut by the major Stratoni-Varvara thrust fault and the sulphide ores extend westwards along the thrust into gold-bearing manganese deposits (e.g. Varvara, Piavitsa). Metal grades 3D modeling indicates that high compositional variations should be expected during production.

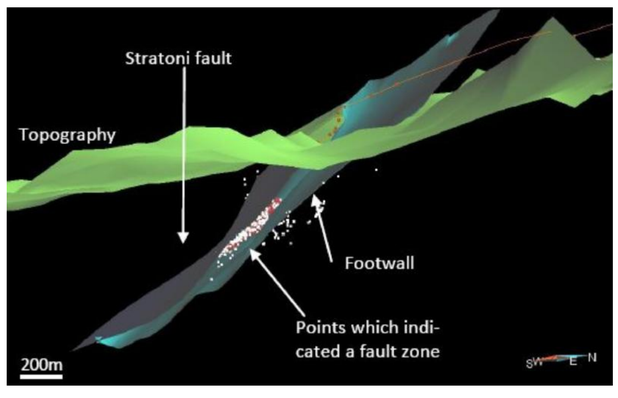
NORTH-EASTERN CHALKIDIKI SEMI-REGIONAL 3D MODEL

The geological setting, structural analysis and geophysical data based on fifteen (15) cross sections were 3D modeled to highlight the major metallogenetic players in the area.





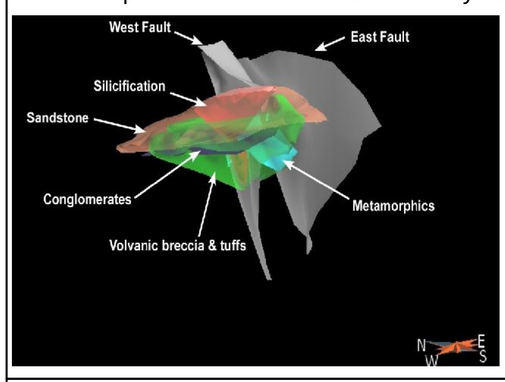


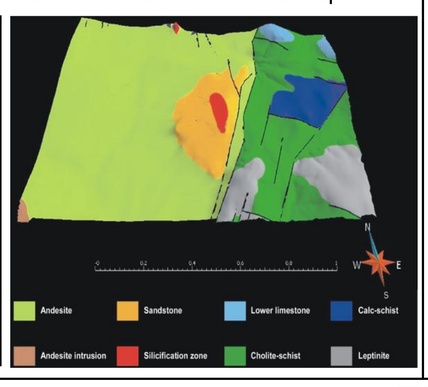


EPITHERMAL GOLD DEPOSITS IN WESTERN THRACE

PERAMA EPITHERMAL GOLD DEPOSIT

In the area of the deposit subaqueous pyroxene andesitic flows, debris-flows and hyaloclastite rest on the turbiditic series. The Perama sandstones which host the gold mineralization are coeval with subarial felsic eruption. Fractured silicified zones and hydrothermal fracturing is expressed at the contact of Mesozoic greenschists-calcschists and Perama sandstones. Silicification and advance argillic alteration (kaolinite-illite argillic alteration) are the main alteration assemblages in the deposit. From the 3D modeling applications it is obvious that: ♦ The mineralization is structurally controlled. ♦ The rift-fault between Mesozoic and Tertiary rocks was the channel way of the hydrothermal fluids. ♦ The sandstones are lithologically the favorite site of gold deposition. ♦ The deposit is characterized by vertical zonal pattern of the ore metals distribution. The main part of the base metals sulphide mineralization is hosted by volcanic breccias and tuffs at depth.

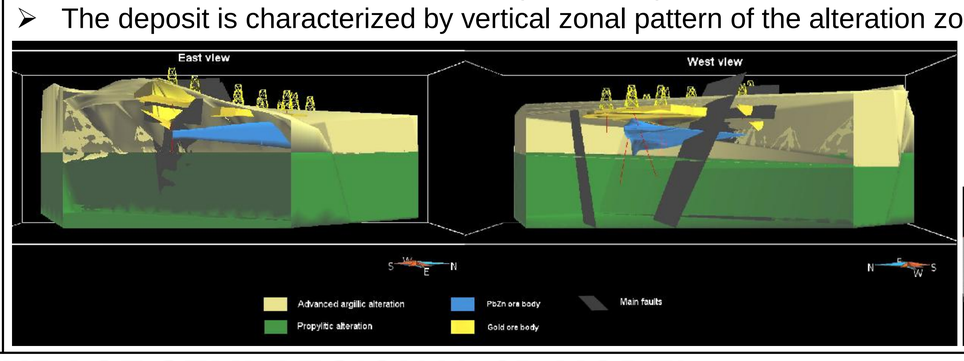


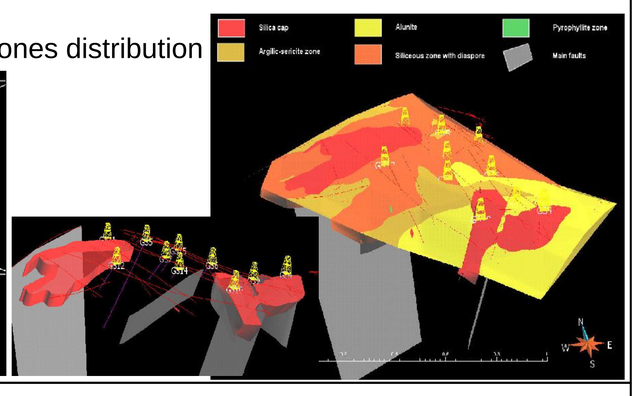


AGHIOS DEMETRIOS EPITHERMAL GOLD DEPOSIT

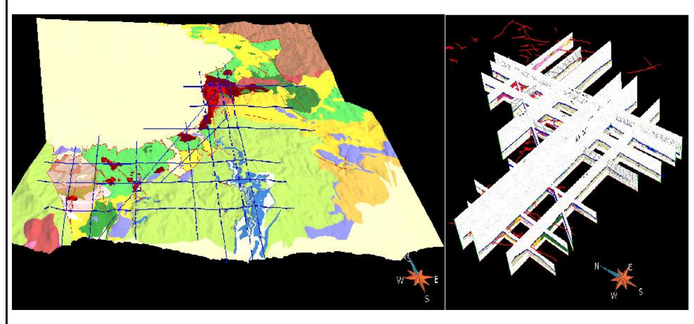
In the area of the deposit strongly altered agglomerate andesitic tuffs, lavas and volcanic breccias are observed, showing four main (Siliceous, Advanced argillic, Propylitic and Potassic) and two overlapping (Sericite and adularia) alteration zones. The hydrothermal eruption vent breccias are favorable structural setting for gold mineralization. Based on the 3D model the following can be concluded:

- The gold ore body occurs at surface, a flat lying form, trends to NW-SW and dips 5º-10º to NNE.
- The N-NE part of the area presents considerable potential for development of the ore body
- The dimension of the ore body is approximately 550 m. long and the width varies from 100-160m
- A N-E trending fault zone intersects and separates the ore body. This fault zone has also caused displacement of the wall rock alteration zones.
- Gold mineralization is mainly connected with hydrothermal eruption vent breccias
- Base metals mineralization is developed at deeper levels
- The deposit is characterized by vertical zonal pattern of the alteration zones distribution





THRACE SEMI-REGIONAL 3D MODEL



Thirteen (13) geological cross sections were used across the Petrota and Kirki Tertiary basins. The N-NE, N-S and E-W deep structures form regional scale rift-fault basins (Petrota and Kirki graben). The andesitic, rhyodacitic and rhyolitic stocks and dikes appear to have N-S structural control. An extensive N-S structure of about 7,5 Km long at the western part of the area is considered to mark a fissure vent system. A set of younger NE and NW faults have caused displacement of the structure. A geological reconstruction of the area of the Thrace epithermal deposits in semi-regional scale show N-NE and N-S structures to mark channel ways of hydrothermal fluids and fissure vent systems. In regional scale these deep structures control the formation of tertiary basins and the emplacement of intrusive rocks and correspond to the presence of alteration zones.