AEM2018 / 7th International Workshop on Airborne Electromagnetics

Airborne electromagnetic system EM4H as a part of a geophysical complex – efficiency on gold-rich sulphide deposits prospecting

Evgeny Karshakov
V.A. Trapeznikov Institute of Control Sciences, Russian Academy of Sciences; LLC Geotechnologies
65, Profsoyuznaya street, Moscow 117997, Russia
karsh@gtcomp.ru

Peter Melnikov
A.P. Karpinsky Russian Geological Research Institute Norilsk Branch
P.O.B. 1330, Norilsk, 663300, Russia
p.v.melnikov@yandex.ru

Tatiana Vovenko
LLC Geotechnologies
14, Burovaya str., Povarovka mcr, Solnechnogorsk distr., Moscow reg. 141540, Russia
info@geotechnologies-rus.com

SUMMARY

EM4H is a most widely used airborne electromagnetic system in the territory of the Russian Federation. It is a fixed wing and helicopter borne frequency domain system, which is used as a mapping tool. The paper describes how it can be used for gold-rich sulphide deposits prospecting. A forecast parameter is obtained through an image recognition procedure. A known deposit is used as a reference. The forecast parameter obtained shows distinctive association of conductive magnetized zones with the zones of higher sulphides content.

Key words: frequency domain electromagnetic survey, EM4H, gold-rich sulphide deposits.

INTRODUCTION

The paper demonstrates efficiency of frequency domain system EM4H (Vovenko et al., 2013) when applied as a part of airborne electromagnetic, magnetic and gamma-ray survey complex. The works in question were performed as a part of gold ore prospecting program. Surveyed area is located in Enisey Ridge region within the borders of a gold ore province known by its large and unique gold deposits.

METHOD AND RESULTS

The airborne survey was carried out to identify and rate available ore gold prospects. The deliverables have been complemented with recommendations on further analysis of the prospects identified. The airborne survey program included a combination of frequency-domain airborne electromagnetic (carried out with EM4H), magnetic and gamma-ray surveys. EM4H system was fixed on AN-3 aircraft fitted with a towed bird. Survey method implied flying over a series of parallel lines with 250 m spacing at an altitude of 120 m. Working frequencies of measurements performed with electromagnetic survey system EM4H are 130, 520, 2080 and 8320 Hz. A three-component EM receiver is placed in a towed bird on a 70 m long tow cable (Fig.1). System software provides for compensation of the impact of currents in the airframe. The survey complex deliver in-phase and quadrature filed components for all working frequencies mentioned above.

Figure 1. General view of the airborne complex fitted with EM4H electromagnetic survey system

Deliverables provided by results of survey and post-processing include high-quality maps of anomaly magnetic filed, natural radioactive elements concentration, apparent conductivity (130, 520, 2080 and 8320 Hz).

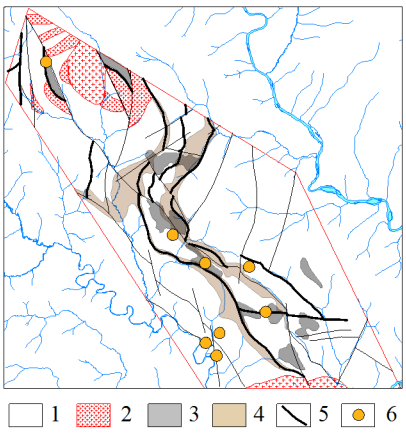
Application of combined survey methods is due to geological context of the territory where secondary ore formation processes are rather confidently identified in all three fields being measured. Besides, with geophysical methods combined it becomes possible to apply various multi-component data interpretation procedures which improves reliability of acquired forecasts significantly.

Geological section of the area is represented with rocks of Riphean (metamorphosed terrigenous), Paleogene (weathered crust) and Quarternary (alluvium) systems. Terrigenous Riphean rocks of the basement hosting the gold ore targets are dislocated compressive folds. Regional metamorphism of the rocks and metasomatic transformations are rather common. Syngenetic carbon occurs in some of the deposits and contributes to formation of geochemical barriers where accumulation of ore elements, primarily – gold, takes place. Gain of magnetic minerals (pyrrhotine, in the first place) and redistribution of natural radioactive elements are observed through these intervals. All ore processes and ore bodies locations are directly tied to tectonics. Gold ore in the territory is represented, mainly, with gold-rich sulphides, thus, the task consisted in mapping of carbon-bearing geological bodies. It was followed by analysis of uranium, thorium, potassium content and magnetic properties distribution.

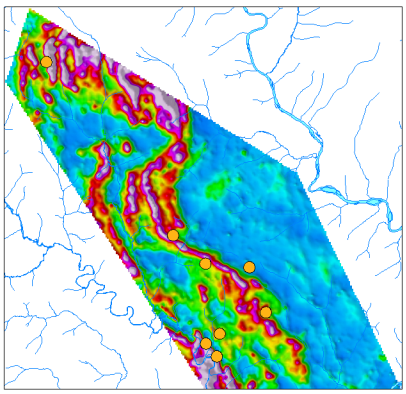
Analysis of all measured fields distribution patterns and further matching with known ore bodies of the territory were the most important. The analysis was performed through an image recognition procedure that consisted in comparison of statistical characteristics and transformations of the measured fields with characteristics of the fields over a reference body. Contrast linear high-conductivity zones mapped by results of survey and further EM data processing are confined to thrusts the crushed zones of which are the place of secondary sedimentation of a carbon-bearing matter, pyrite and pyrrhotine. Conformal magnetic zones appear locally within the linear zones mentioned above, with rock magnetization

being reverse at times which is caused by syn-ore pyrrhotine formation specifics.

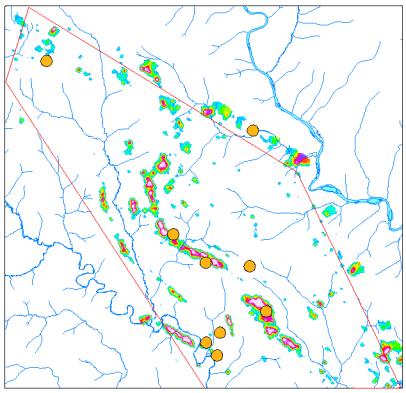
Radioactive properties of the linear zones vary but some areas of higher potassium and uranium content – a common sign of gold-rich sulphide deposits – still can be identified. Area prospects identification was completed with the use of image recognition procedure that implied using of all measured fields and their transformations as variables, the reference being a contour of one of the most representative major gold targets in the surveyed territory. A forecast parameter obtained through image recognition denotes similarity of a particular field group to the reference (Fig.2).



A



B



C

Figure 2. A – area geology scheme, 1 – Riphean metamorphosed terrigenous deposits, 2 – granites, 3 – zones of graphitizing, 4 – Paleogene weathered crusts, 5 – tectonic faults, 6 – gold mineralization; B – apparent conductivity map, 2080 Hz; C – gold-rich sulphide deposits, forecast parameter distribution.

CONCLUSIONS

The forecast parameter obtained shows distinctive association of conductive magnetized zones with the zones of higher sulphides and potassium-uranium content.

The map of forecast parameter distribution was used to identify gold-rich sulphides prospects. Recommendation on type and technique of further analysis of the prospects were provided along with conclusions made by results of the works.

REFERENCES

Pustozerov M.G., 1999, Application of geophysical methods in gold ore prospecting in black-shale strata of Enisey Ridge: Krasnoyarsk Research Institute of Geo1ogy and Minerals

Serdyuk S.S., Komorovsky Y.E., Zverev A.I. , Oyaber V.K., V.E. Babushkin, V.S. Vlasov, V.A. Kirilenko, S.A. Zemlyansky, 2010, Models of Siberian gold deposits in Enisey River area: Krasnoyarsk, Institute for Mining, Geology and Geological Technology, 169-207.

Vakhromeev G.S., 1978, Basic concepts of geophysical surveys combination method as applied in ore deposits prospecting: Moscow, Nedra, (in Russian).

Vovenko, T., Moilanen, E., Volkovitsky, A. and Karshakov, E., 2013, New abilities of quadrature EM systems: Papers of the 13th SAGA Biennial @ 6th International AEM Conference AEM-2013. Mpumalanga, South Africa, 1-4.