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Geology

Identification of Hydrothermally Altered Zones in the Area of Bertakari and Bneli Khevi Deposits (Bolnisi Ore District, South Georgia) with Remote Sensing Method

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In the study area ASTER images within the AST_L1B_00304092004080704_20180110171001_32359 sheet have been analyzed and the anomalies of hydrothermal, propylitic argillic and phyllic alteration have been identified. The images underwent atmospheric correction and were processed using Spectral index and Decorelation Stretching Algorithm. The interaction between hydrothermal alteration zones has been revealed using remote sensing methods, which was expressed by them overlapping each other. *© 2021 Bull. Georg. Natl. Acad. Sci.*

Bertakari and Bneli Khevi deposits, hydrothermal alteration, remote sensing

Gold and polymetallic deposits of Bertakari and Bneli Khevi are located in southern Georgia (Bolnisi municipality) and are part of Bolnisi ore field. The latter is within the eastern Pontides and the Lesser Caucasus Fold and Trust Belt, [1] and it is the only region in Georgia where the mining of gold-polymetallic deposits are intensively carried out.

Unlike other main deposits (Madneuli, Sakdrisi, Kvemo Bolnisi, David Gareji) in Bolnisi Ore Field, Gold-copper-polymetallic deposit of Bertakari is distinguished by its high content in gold, which gives the presented research more importance and relevance. The importance of research on the issues raised in the article is also enhanced by the fact that the study of the orogenic mineralizations within the phanerozoic orogenic belts is particularly relevant to the world [2] at the same time, the structural and stratigraphic control of such high contents of the gold of Bertakari and Bneli Khevi deposits remains unclear.

Geological Position

Within the study region, the oldest sediments are represented by the volcanic-sedimentary sequences of the andesite-basaltic composition of Tandzia suite **(K2tn)**. It is constructed with porous, at some places with andesite-basaltic lava of massive or

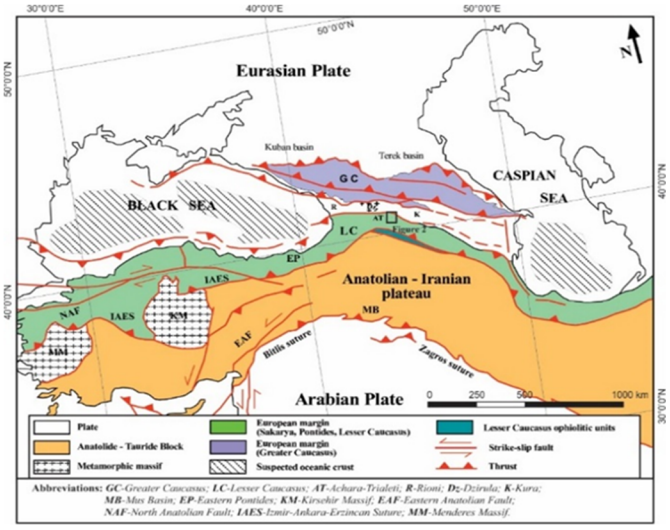

Fig. 1. Tectonic map of the Arabian-Eurasian Collision Zone of Sosson and others [1].

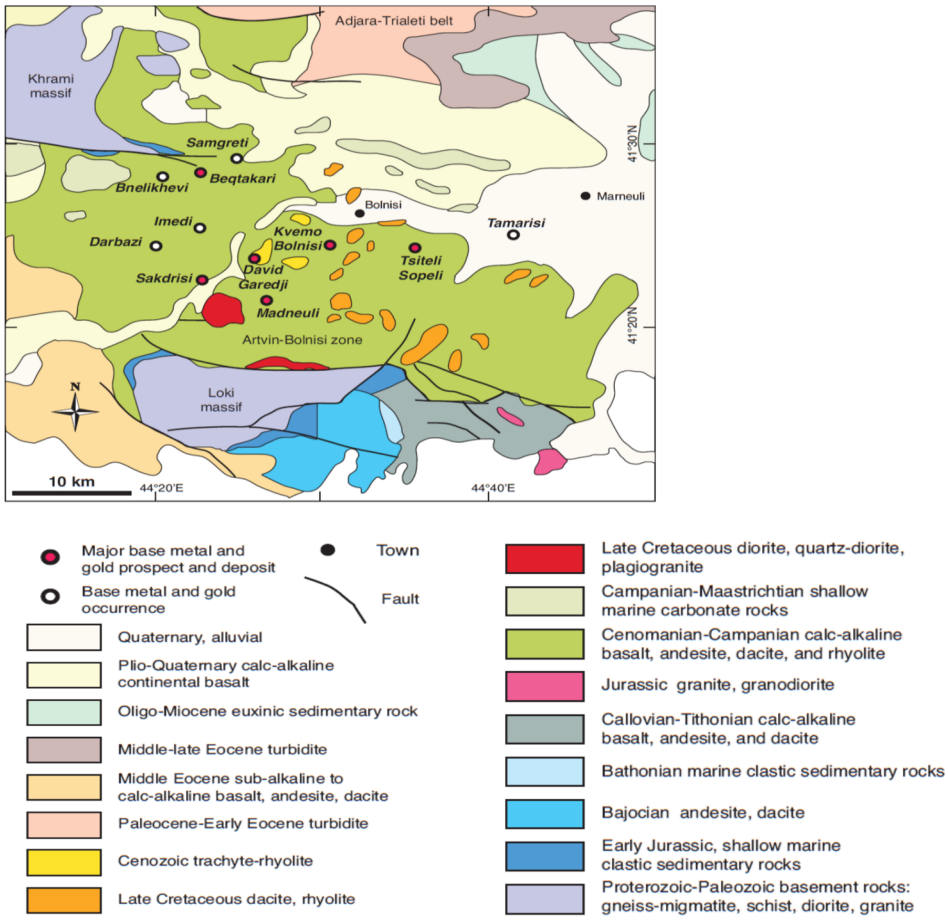

Fig. 2. Geological map of Bolnisi Ore Field [4].

column-like arrangement that changes in the ascending section with rough volcaniclastic intraformational polymictic breccia-conglomerates and tuff-breccia. In the stratigraphically ascending section, the sequence of Tandzia is accompanied by

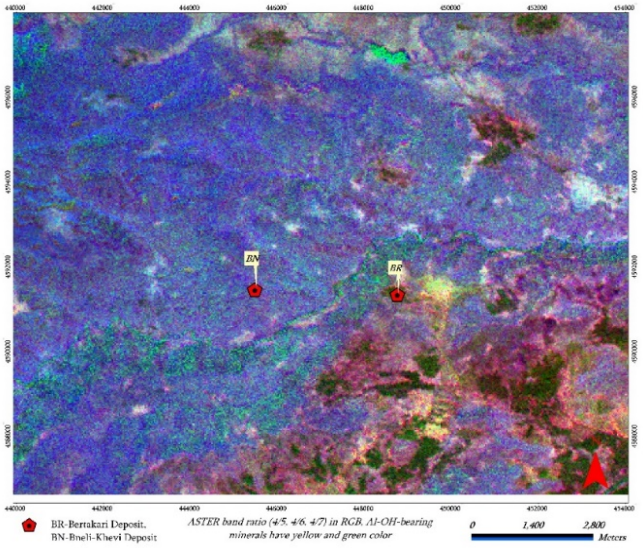

Fig. 3. AL-OH Bearing Minerals.

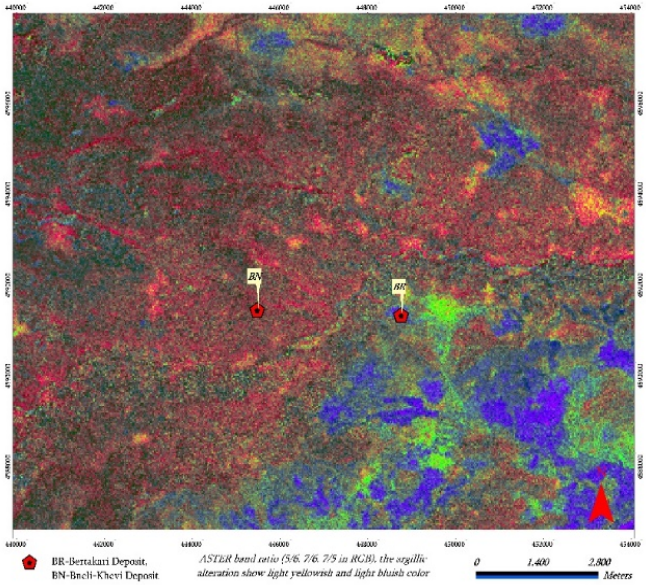

Fig. 4. Argillic Alteration.

the sequence of Gasandami, which is divided into lower and upper subsuites (Fig.2).

The lower subsuite of Gasandami suite (K2gn1) is constructed with mechanically, textually, chemically and mineralogically altered strata, which are predominantly derived on the expense of rhyolitic-dacitic lavas, volca-niclastolites and extrusions, and continues the Tandzia suite, outcropped in the heart of Bertakari anticline, stratigraphically upwards.

Hydrothermally altered strata (so-called hydrothermal breccia) and gold-silver-polymetallic mineralization of the Bertakari deposit are spatially connected to the gasandami lower subssuite, and the upper subssuite of Gasandami is a follow-up of these processes and does not contain the ore manifestations of production importance [3]. Following strata of the lower subssuite breccia conglomerates of Gasandami suite have undergone the quartz-sericite metasomatosis, adularization, argillization and propylitization.

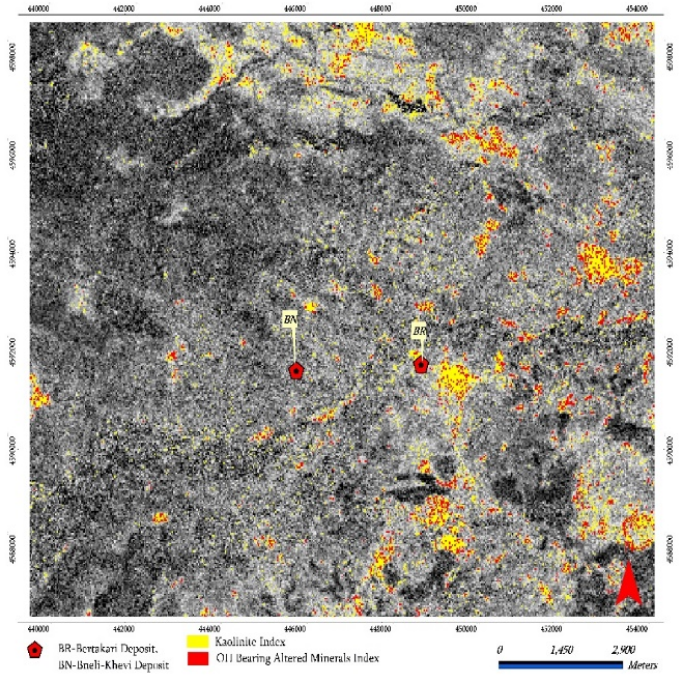

Fig. 5. Kaolinization and OH-Bearing Alteration.

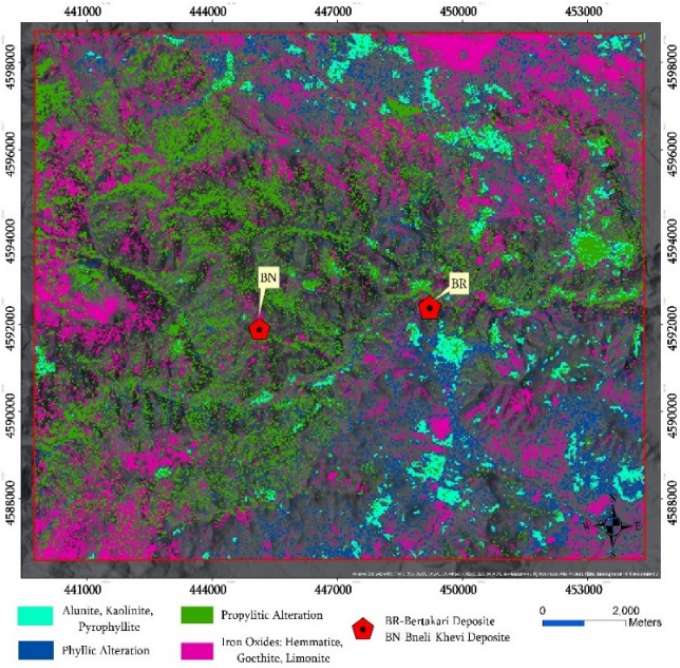

Fig. 6. Complete Alteration Map of Study Area.

Upper subsuite of Gasandami suite (K2gn2) follows lower subssuite. The base of the subssuite is represented by polymictic breccia conglomerates consisting of more or less processed pieces of different sizes (1-2 cm – 15 cm, 0.5 m). In the pieces, we mostly encounter the pieces of gold containing hydrothermal silicates of hydrothermally altered strata, as well as the pieces of unaltered volcanites.

Materials and Methods

The detection of hydrothermally modified zones within the study region by the remote sensing method was carried out for the first time. The use

of this method significantly reduces search costs and is highly reliable. At this stage of the study the following methods are used: two of the ASTER's (Advanced Spaceborne Thermal Emission and Reflection Radiometer) 3 spectral range, specifically: VNIR (15m, Visible Near Infrared) and SWIR (30 m, Short-Wave Infrared), as for thermal infrared range (TIR), it does not give us the desired result for hydrothermal alterations, because the minerals, that are related to the alteration processes, have low refracting and reflecting indicators in the thermal range, and will be observed better in visible and short-wave infrared range. [5]

The following algorithms of remote sensing have been used to detect hydrothermally altered zones: 1. Spectral Index (SI) and 2. Decorrelation stretching method (colour enhancement method). These algorithms allow us to map hydrothermally altered zones. [6]

Results

In the area of the Bertakari and Bneli Khevi deposits, we have analysed ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) data within the AST_L1B_00304092004080704_20180110171001_32359-sheet. The pictures underwent atmospheric correction. As a result of analysing the ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) data, the following has been identified: hydrothermally altered zones with propylitic, argillic and phyllitic alterations. Also we carried out the decorrelation stretching of the different spectral indexes in order to reveal the interference of altered zones with each other. The mentioned research technique of hydrothermally altered zones is important in terms of detecting the formation of environment of metallic minerals in the area of the research. There are minerals with AL-OH Bearing on the third picture with yellow and green colors (Fig. 3), argillic alteration is observed in the fourth picture with light yellow and light blue colours (Fig. 4), kaolinization and OH-bearing alteration products (kaolinite, montmorillonite, smectite) are represented with yellow and red colors (Fig. 5), hydrothermal alteration zones, specifically: argillic, propylitic, phyllic and minerals of the oxidization zone, specifically: hematite, goethite, limonite are presented on the last map, where the propylitization is seen in green colour, argillic alteration is blue, the phyllitic alteration is dark blue and the iron oxides are pink (Fig. 6).

Conclusion

As a result of the performed research on the Bertakari and Bneli Khevi deposits and the surrounding area, the hydrothermal alteration area is assigned and described. The interaction between hydrothermal alteration zones has been revealed using remote sensing methods, which was expressed by them overlapping each other (Fig.6). It is noteworthy that this method is distinguished by high accuracy and reliability and can be used in mineral exploration in both regional and local scales.

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გეოლოგია

ბერთაკარისა და ბნელი ხევის საბადოების (ბოლნისის მადნიანი რაიონი, სამხრეთ საქართველო) არეალში ჰიდროთერმულად შეცვლილი ზონების გამოვლენა დისტანციური ზონდირების მეთოდით

დ. მაქაძე

ივანე ჯავახიშვილის სახ. თბილისის სახელმწიფო უნივერსიტეტი, გეოლოგიის დეპარტამენტი, თბილისი, საქართველო

(წარმოდგენილია აკადემიის წევრის დ. შენგელიას მიერ)

ბერთაკარი-ბნელი ხევის ტერიტორიაზე პირველად ჩატარდა მადნიან მინერალიზაციასთან დაკავშირებული ჰიდროთერმული შეცვლის დისტანციური ზონდირების მეთოდით კვლევა. მოხდა ASTER-ის სურათების ანალიზი AST_L1B_00304092004080704_20180110171001_32359-ფურცლის ფარგლებში და გამოიყო ჰიდროთერმულად შეცვლილი ზონების, არგილიტიზაციის, პროპილიტიზაციის, ფილიტიზაციის არეალები. სურათების დამუშავება მოხდა სპექტრული ინდექსის და დეკორელაციური გაჭიმვის ალგორითმით. დისტანციური ზონდირების მეთოდის გამოყენებით გამოვლინდა ჰიდროთერმული შეცვლის ურთიერთკავშირი, რაც გამოიხატა მათი ერთმანეთზე ზედდებაში.

REFERENCES

1. Sosson, M., Stephenson, R., Sheremet, Y.. Rolland, Y. Adamia, Sh., Melkonian, R., Kangarli, T., Yegorova, T., Avagyan, A., Galoyan, Gh., et al. (2016). The Eastern Black Sea-Caucasus region during Cretaceous: new evidence to constrain its tectonic evolution. *Compte-Rendus Geosciences*. **348**, Issue 1: 23-32.
2. E, Stephen Kesler and H, Bruce Wilkinson. (2007) Tectonism and exhumation in convergent margin orogens: insights from ore deposits. *The Journal of Geology*, **115**, 6: 611-627
3. Adamia, Sh., Bukia, A., Zaqaraia, Z., Zaqariadze, G., Migineishvili, R., Gavtadze, T., Chkhotua, T., Beridze, T., Shavishvili, I., Chabukiani, A., Khmaladze, K. (2016) Bertakari-Bneli-Khevi: lithobiostratigraphy, structure and metalogeny. PP. 1-94. Report [in Georgian].
4. Adamia, Sh., Gujabidze, G., (2004) Geological map of Georgia 1: 500 000 (on the basis of 1:200000 and 1:50000 scale State Geological maps of Georgia), pp. 2-3. Department of Geology, Nodia Institute of Geophysics.
5. P. Ravi Gupta (2017) Remote sensing geology, third edition, pp. 291-355. Springer.
6. Beiranvand Pour Amin, Hashim Mazlan, (2012) The application of ASTER remote sensing data to porphyry copper and epithermal gold deposits. *Ore Geology Reviews*, pp. 1-8.

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