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Investigation of mineralization in copper-porphyry molybdenum using hydrothermal alternation in northwest region of Iran

Investigación de mineralización en molibdeno de pórfido de cobre mediante alternancia hidrotermal en la región noroeste de Irán

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ABSTRACT

Identification and determination of areas with mineral potential is one of the major and important applications of remote sensing in the field of mineral exploration. The aim of the present study was Identification of hydrothermal ultrason region using Landsat multispectral satellite imagery and hyperion hyperspectral imagery. To conduct this research, first the Advanced Space Borne thermal reflection radiometric data and the base metal mapping of the harvest were examined. Using principal component analysis using the key spectral change properties of key minerals, PC 2 enhanced the altered regions. Then we studied the MF spectral library and laboratory spectra of samples in the study area. In this study, two different methods, principal component analysis (PCA) and matched filter processing (MF), were compared and combined for mapping. In both methods, the key properties of changing the range of minerals in the study area were used. The results of the present study showed that from the top of the deposit to the bottom, the type of mineralization is gradually increasing. Chalcopyrite spraying gradually decreases from the depth of the deposit to the outer regions and vice versa, the amount of pyrite spraying increases. In Sungun, the main mineralization of copper in the second (main) stage of the activity of mineralized solutions has taken place, during which chalcopyrite has been extensively left in the form of vessels and sprays in rocks. Molybdenite is formed in a wide range of second stage mineralization processes in several successive phases. In the early processes, this mineral is sprayed and less in the form of veins and in later stages more in the form of veins. Thus, the copper-molybdenum porphyry deposit of Sungun Ahar, with a very high reserve of 7.1 billion tons and an average copper grade of 0.75 ٪ And molybdenite by-mineral in the early 80's will certainly be exploited among the largest copper mines in Iran.

Keywords: Mineralization, Copper, Molybdenum, Hydrothermal Treatment.

RESUMEN

La identificación e identificación de áreas con potencial mineral es una de las principales y más importantes aplicaciones de la teledetección en el campo de la exploración minera. El objetivo del presente estudio fue identificar la región ultrasónica hidrotermal utilizando imágenes satelitales multiespectrales Landsat e imágenes hiperespectrales de hiperiones. Para llevar a cabo esta investigación, primero se investigaron los datos radiométricos de reflexión térmica de First Space Borne y el mapeo de metales base del producto extraído. Utilizando el análisis de componentes principales utilizando propiedades de cambio espectral clave de minerales clave, PC 2 mejoró las regiones alteradas. Luego se estudiaron la biblioteca espectral de MF y los espectros de laboratorio de las muestras de la zona. En este estudio, se comparan y combinan dos métodos diferentes, el análisis de componentes principales (PCA) y el procesamiento de filtros adaptados (MF) para el mapeo. En ambos métodos se utilizaron las principales características de cambio de rango de minerales en el área de estudio. Los resultados del presente estudio mostraron que desde la parte superior del depósito hasta el fondo, el tipo de mineralización aumenta gradualmente. La pulverización de calcopirita disminuye gradualmente la profundidad del sedimento en las regiones exteriores y, a la inversa, aumenta la tasa de pulverización de pirita. En Sangun, la mayor mineralización de cobre ocurrió en la segunda etapa (principal) de la actividad mineralizada, durante la cual la calcopirita quedó en forma de vetas y rociados en las rocas. La molibdenita se forma en una amplia gama de procesos de mineralización de segunda etapa en varias etapas sucesivas. En las primeras etapas de este proceso, este mineral a menudo se rocía y en etapas posteriores se ve más como una racha. Por lo tanto, los depósitos ígneos de cobre-molibdeno en Sungun Ahar con una reserva de 7,1 mil millones de toneladas y un contenido promedio de cobre de 0,75 molibdenita se conocen sin duda como una de las minas de cobre más grandes de Irán.

Palabras clave: Mineralización, cobre, molibdeno, tratamiento térmico.

1. INTRODUCTION

Hydrothermal and magmatic solutions simultaneously with the formation of the deposit cause the alteration of rocks in the area and various alteration zones are formed. In an exploration área (Zubairi et al., 2003), before preparing geochemical and geophysical maps, which are costly, the alteration maps of the area should be prepared and the necessary interpretations should be made. On the other hand, the shape of alteration zones is a good guide for the shape of mineralization ; For example, vein deposits are linear alteration zones, and chemical and mineralogical changes are limited to the area around the vein (Amini et al., 2000).

Identification and determination of areas with mineral potential is one of the major and important applications of remote sensing in the field of mineral exploration. Are. Satellite imagery, due to its ability to cover a wide range of multispectral and multi-temporal areas, has a high potential for identifying alteration areas related to ore deposits and thus exploration of mineral reserves, especially in arid areas. The ASTER sensor has 14 bands in the spectral, visible, and near-infrared (0.25-0.86 μm), short-wave infrared (2.43-1.6 μm), and thermal infrared (11.65- 8.125 μm) ranges, respectively. They have a spatial resolution of 15, 30 and 90 meters (Alg et al., 2001).

Remote sensing is of special importance in geological studies today, so that this technology can provide valuable extensions in the study of geological structures, including the extraction of lines, identification of alteration zones, geomorphological phenomena, etc (Karimi et al., 2016). We put. Identification of alteration zones caused by hydrothermal solutions by satellite data has attracted the attention of many geologists in the search for deposits. Porphyry deposits are associated with hydrothermal alterations such as fillet, potash, propylitic and argillic, in which minerals containing hydroxyl base (clay minerals) are abundant. The use of ETM + sensor is limited to detecting areas with iron oxides and hydroxyl due to its low spectral resolution. But multispectral satellite imagery like ASTER makes it possible to identify more ultrasonic zones (Hafezi Moqaddas et al., 2019).

Ahar region is a semi-arid and mountainous low-lying mountainous region located in the north of Takab city in northwestern Iran. This region is of special importance due to its copper mines and hosts several famous copper deposits, including Zarshuran and Aghdareh. Copper mineralization is very extensive in this region and in fact copper, arsenic, antimony and base reserves are also common in Takab region. Ahar sedimentary sequence is characterized by stratigraphic interruptions and incompatibilities. The mining area is located in a basement of Precambrian metamorphism with late Carboniferous late carbonates and coils formed by the Cambero-Arduvich Formations (Ferreir et al., 2002).
The aim of this study was to identify hydrothermal alteration and mineralogy of mines using analysis data analysis. It is far away in the northwestern region of Iran and with emphasis on Ahar mines.

2. STUDY AREA

Sungun subvolcanic stock with granodiorite composition, during the Pyrenees phase during the Oligocene-Elicomyocene, 75 km northwest of Ahar (East Azerbaijan), inside limestone Cretaceous and Eocene igneous have been replaced. The product of this replacement is the formation of a large deposit of copper-molybdenum porphyry and in the vicinity of the limestones a small deposit of copper-lead-zinc and iron skarns, which we collectively call the Sungun skarno-porphyry deposit. Copper-molybdenum deposit of Sungun porphyry in the shape of an oval with east-west elongation and an area of 2.2 km2 with a large diameter of 2.2 And its small diameter is estimated at 1.1 km (Crosta et al., 2003). In Sungun deposit, three general stages of operation of alteration and mineralization processes have been identified. In the previous stage, hydrothermal fluids have affected the entire Sungun Mineral Area with an area of approximately 50 km 2. In the area of contact of Stoke Songun with Cretaceous limestones, skarn has been formed and in the roof of Stoke and the surrounding igneous rocks (Eocene) along with alteration, mineralization of spraying and vessels has taken place (Noorollahi et al., 2008); At this stage, pyrite mineralization with cataclastic texture. In the second stage (main stage), mineralization in skarn is completed and enriched, porphyry copper-molybdenum deposit formed during several successive phases, pervasive alteration zones (pervasive, potatic, propelic, phyllic and argillic) Copper and molybdenum have been formed and mineralized, and in the final stage, after the formation of the deposit, the performance of selective chlorination-calcite, epidote-calcite, chlorite, calcite and hematite alterations with intensity And various weaknesses of all types of igneous rocks and infertile dykes have infiltrated the deposit (Rown et al., 1997).The consequence of the formation of four alteration zones, the occurrence of pervasive siliceous alteration, caused the overprinting of the section A large part of the ore zone is concentrated in the phyllite zone and the rest in the potasic zone and the type of mineralization in the deposit is diffused (ore zonc). Disseminated) Stock work The most important minerals identified in the deposit are: chalcopyrite, molybdenite, pyrite, rutile, ilmenite, pure copper, copper, calcite, colin, Ideait, Arsenopi Rite, burnite and minerals of Fahlor group (tenantite, tetrahydrite) (Xu et al., 2019). The supergen enriched zone in the deposit is not well formed, it is mostly concentrated in the eastern slope of the deposit and its most important minerals are pure copper, chalcopyrite, caprite and burnite.

3.RESEARCH AIMS

3.1.Main aim

Identification of hydrothermal ultrason region using Landsat multispectral satellite imagery and hyperion hyperspectral imagery.

3.2.Secondary aims

Mineralogy of the region
Use remote sensing methods to assess the area and identify potential mine areas

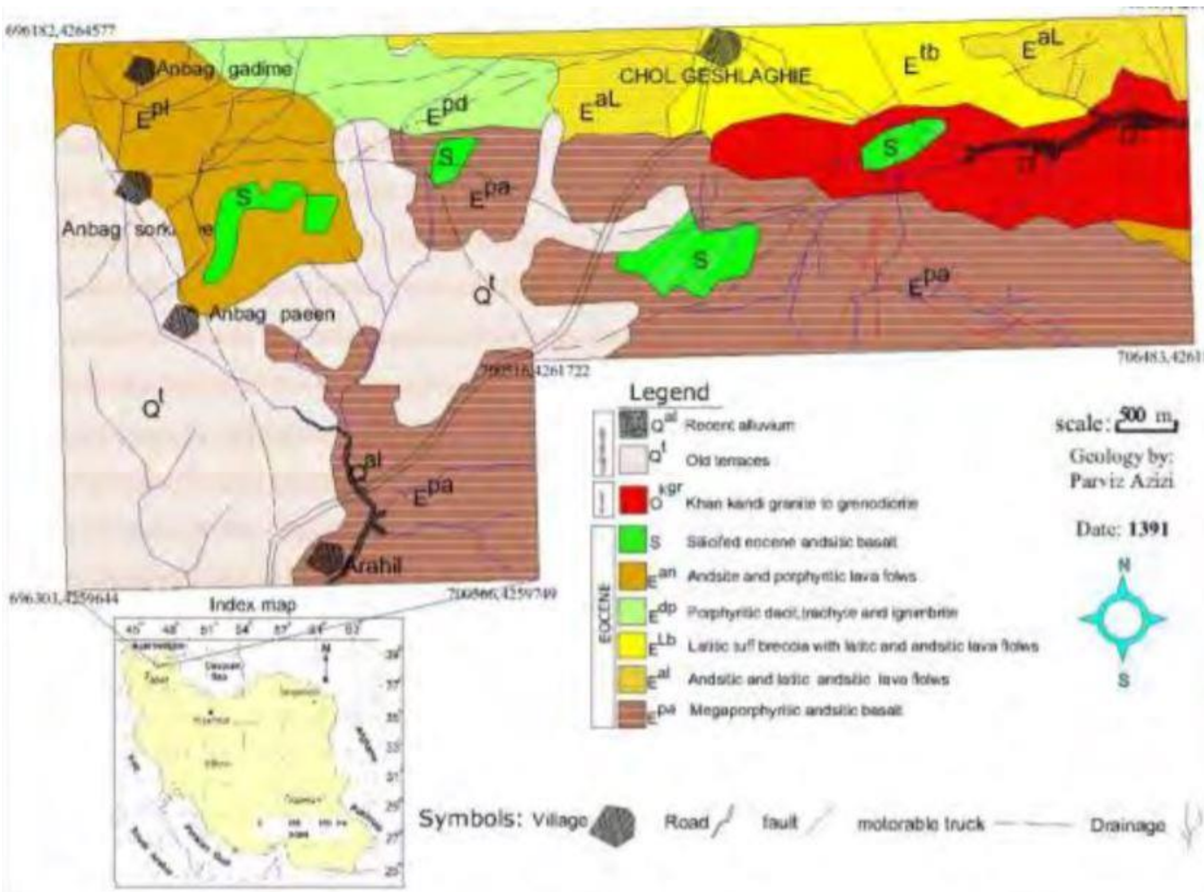

Figure 1. The regional geological map of the study area.

4. METHODSAND RESULTS

Remote sensing is defined as the science and art of obtaining physical and chemical amplitudes from terrestrial and atmospheric phenomena through the properties of electromagnetic waves reflected or emitted from them without direct contact with these phenomena. Identification and determination of areas with mineral potential is one of the major and important applications of remote sensing in the field of mineral exploration. Are. Satellite imagery has a high potential for identifying alteration zones related to ore masses and as a result for exploration of mineral reserves, especially in arid areas, due to its multi-spectral and multi-temporal coverage of a wide area. ASTER sensor has 14 bands in spectral, visible and near infrared (0.25 - 0.86 μm), shortwave (2.43-1.6 μm) and thermal infrared (11.65 - 8.125 micrometers) which have a spatial resolution of 15, 30 and 90 meters, respectively. The Advanced Reflection and Heat Emission Radiometer (ASTER) is a Japanese sensor and one of five remote sensing instruments installed on the Tera satellite that was launched into orbit by NASA in 1999. . The sensor has been collecting surface data from the ground since February 2000 (AB Pour et al., 2003).

The ester produces satellite images of the earth with high resolution in 14 different bands from the electromagnetic spectrum in the visible to infrared thermal spectrum. The resolution of the ester images is from 15 to 90 meters. Ester data is used to generate detailed maps of surface temperature, brightness, reflection, and altitude.

According to the past records, it is possible to receive studies of regional alteration, including field research, which is necessary and important for any country. The distinguishing feature of this research is in the study area. According to previous researches, it can be said that no comprehensive research has been done in the northwest of the country in this field. Therefore, we seized the opportunity to present our research in the form of a dissertation in this field.

Ahar region, located in northwestern Iran, is an important copper mining region with a long history of copper mining. This copper is associated with toxic metals / metalloids. To conduct this research, first the Advanced Space Borne thermal reflection radiometric data and the base metal mapping of the harvest will be examined. Using principal component analysis using the key spectral change properties of key minerals, PC 2 will enhance the altered regions. Then we study the MF spectral library and laboratory spectra of samples in the study area.

In this study, two different methods, principal component analysis (PCA) and matched filter processing (MF), are compared and combined for mapping. In both methods, the key properties of changing the range of minerals in the study area will be used.

Principal Component Analysis (PCA) is a common incremental technique used in various studies of lithological mapping and metallogenic change. This technique involves a mathematical change of the original data, which is rearranged according to the axes of maximum variability, creating new unconnected components. The length of the principal axes is determined by a set of values called eigenvalues, which measure the amount of data change in orthogonal directions. The direction of each axis is determined by another set of data called Eagen vectors, which defines the relationship between the main components (PC) and the main bands. The sign and magnitude of Eigen vector loads indicate which spectral properties of vegetation, rocks, and soil are responsible for the statistical variance plotted on each computer. The main components can be analyzed using standard or selective methods. In standard analysis, all available bands of an image are used as input to calculate the principal components, while in selective analysis only certain bands are selected.

As with all porphyry copper systems, there is a direct and close relationship between mineralization and hydrothermal alteration in the Songun porphyry copper-molybdenum deposit. In this research, while identifying and determining the characteristics of alteration zones, and identifying the types of metallic and non-metallic minerals related to each and mineralogical changes, multiple processes causing alteration and mineralization have been attempted. Separated and finally, while creating a correlation between the results of regional studies and the results of detailed studies, the deposit area is carefully identified and the keys and exploratory solutions are proposed. Copper deposit - Songun molybdenum porphyry is the first porphyry copper deposit in the northwest of Iran's porphyry copper belt. In this deposit, the alteration zones of potassium, propylitic, phyllic and argillic are well formed and the vertical vertical zoning of porphyry copper systems, ie leached zone, super gene and hypogene, is formed. Is. Potassic Alteration Zone: This zone is formed on the roof of Stoke Songun and the rocks above it, its border with the phyllite zone is gradual. Index minerals of this zone include secondary biotite (hydrothermal), secondary potassium feldspar, gypsum and muscovite.The hydrothermal biotites of this zone have a shreddy texture, a sagenitic texture, and a void-filling texture. Metal mineralization: In the potashic zone, mineralization is on two types of sprayers (often) and streaked. Veins containing chalcopyrite are mostly located above this zone and inside the phyllite zone. Rutile, ilmenite, chalcopyrite, pyrite, molybdenite, tenantite and burnite are the most important minerals of the potash zone, of which rutile and ilmenite are the most prominent high temperature minerals. . Propylitic Alteration Zone: This is the outermost and widest alteration zone in Songun. One of the prominent features of this zone is its micro and shear, along with the phenomenon of clay and carbonation. Chlorite, calcite, albite and epidote (clinozoite (pistachite) are the most abundant minerals in the proplitic zone. Metal mineralization in this zone is pyrite, which is mostly found in the form of shapes. Phyllic Alteration Zone The phyllic alteration zone is located between the central potashic zone and the propylitic zone and its boundary with the propylitic zone is gradual. Among the pervasive and selective alterations, siliceous and calcite alterations in many areas, respectively, have caused overprinting of the fillet zone. In the middle and lower parts of the filtrate zone and the upper part of the potasic zone of the Sungun deposit, the Qtz Stockwork zone (Qtz Stockwork zone) is beautifully formed, the outer surface of which is reflected in the form of a cup. Is. Other features of this zone are the presence of Korean fractures (7) with calcite filling (in the west of the deposit) and gypsum (in the east of the deposit) and pink quartz veins and veins. Calcite is abundant. The index minerals of the phyllite deposit zone are: secondary quartz, sericite, feldspar alkali and calcite. Metal mineralization: In the phyllite zone of the deposit, mineralization is mostly in the form of veins and stockwork (often) and spraying. Compared to potash zone, the ratio of pyrite to chalcopyrite increases in this zone. Pyrite, chalcopyrite, molybdenite, ilmenite, rutile cobanite, idaite, famatinite, arsenopyrite, tenantite and tetrahydrite are important minerals in this zone. Argillic alteration zone: This zone is located inside the phyllic zone and does not follow a certain zoning, so it does not have a clear boundary with the philic zone. In Sungun deposit, aryl and siliceous alterations are sometimes seen together and sometimes separately. The main minerals of the clay zone of Sungun deposit are: kaolinite, illite, sericite and quartz. Metal mineralization: including pyrite (dominant mineral), chalcopyrite, borneite, tenantite and tetrahedrite.

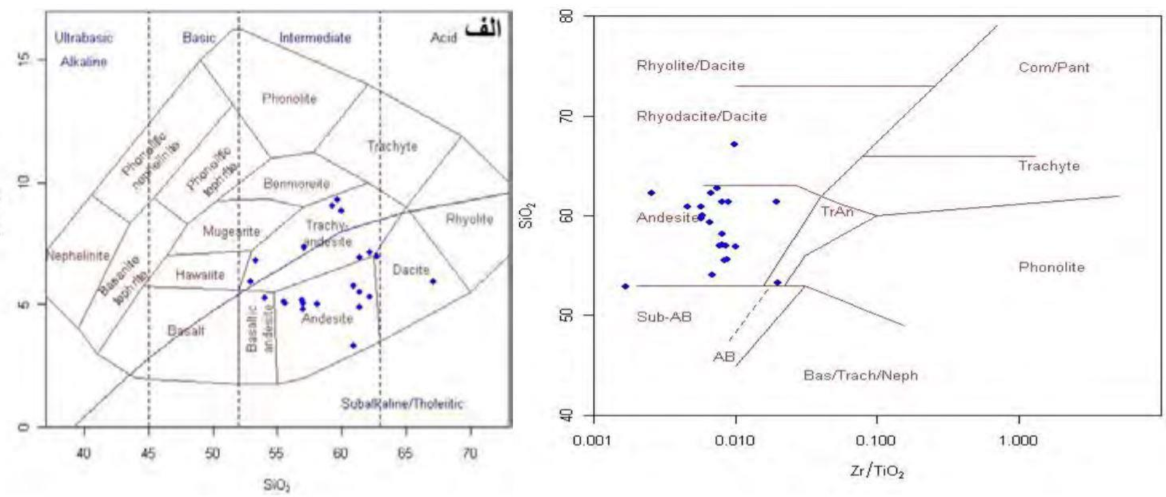

Figure 2. Location of the region's rocks

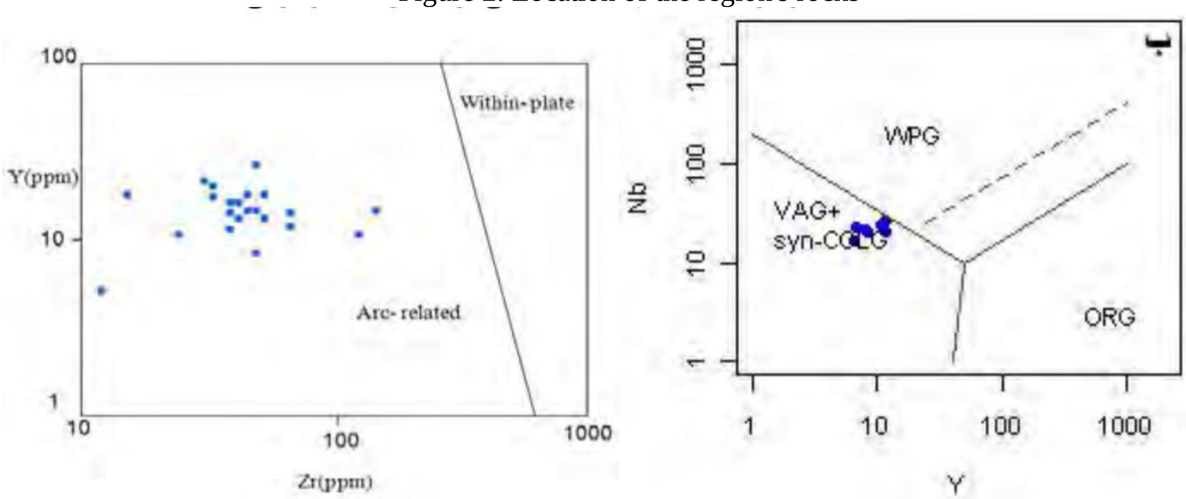

Figure 3. location of the region

5. CONCLUSION

In general, from the top of the deposit to the bottom, the type of mineralization is gradually increasing. Chalcopyrite spraying gradually decreases from the depth of the deposit to the outer regions and vice versa, the amount of pyrite spraying increases. In Sungun, the main mineralization of copper in the second (main) stage of the activity of mineralized solutions has taken place, during which chalcopyrite has been extensively left in the form of vessels and sprays in rocks. Molybdenite is formed in a wide range of second stage mineralization processes in several successive phases. In the early processes, this mineral is sprayed and less in the form of veins and in later stages more in the form of veins. Thus, the copper-molybdenum porphyry deposit of Sungun Ahar, with a very high reserve of 7.1 billion tons and an average copper grade of 0.75 ٪ And molybdenite by-mineral in the early 80's will certainly be exploited among the largest copper mines in Iran.

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