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Technical Note

Identification of Promising Areas with Remote Sensing Satellite Data in Karijgan, Khosf- Birjand

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Abstract: This study aims to use the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) remote sensing data to identify promising areas and design a targeted preliminary survey in the Karijgan area located in Khosuf-Birjand. Therefore, at first, necessary pre-processing, such as atmospheric and topographic corrections, was applied to the data. Then, from conventional processing methods on multispectral data, including band ratio, principal component analysis (PCA), and its improved type, the selective principal component analysis method (CROSTA), promising areas were identified. In this case, by using the band ratio method, index areas prone to iron oxides, silica, carbonate, chlorite and epidote, alunite, kaolinite and pyrophyllite, sericite, muscovite, illite, and smectite were identified. Also, with the Crosta method, various types of main alterations (propylitic, argillic, and phyllic) were determined. Finally, by combining the results, promising areas were identified for preliminary surveys. A check field and sampling of the identified areas were done to validate the processing results. The results of the sample analysis by ICP-OES and X-ray diffraction (XRD) showed good agreement and accuracy with the results obtained from the remote sensing processing of the Karijgan area.

Keywords: Karijgan, ASTER, Remote sensing, CROSTA, Alteration.

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INTRODUCTION

Remote sensing is the most important tool that reduces the cost of exploration and, at the same time, increases the speed of surveys for mineral exploration. This science, by identifying the alterations and studying the mineralogy of the area, provides beneficial information regarding guidance for field studies, sampling, and analyses that can help reject or accept an area as a deposit [1,2]. In the current research, the multispectral data of ASTER was used to process and identify the promising areas in the Karijgan area, located in the 100,000 sheets of South Khorasan province. Rajendran and Nasir presented a comprehensive review of the processing method types on ASTER satellite data in 2018 [3]. In 2022, a survey was conducted on the ASTER data to identify the metal potentials in the 100,000 Ahar sheet [4]. In addition, a study was also conducted in 2019 to identify alteration zones related to the porphyry system based on ASTER data in the Jebal-Barez region, southeast of Iran [5]. In 2019, Sheikh Rahimi et al. used ASTER data to map hydrothermal alteration minerals and better distinguish geological structural features related to gold mineralization in the Sanandaj-Sirjan zone [6]. In 2020, Rezaei also prepared a geological map of the Sangan region, located in the southeast of Razavi Khorasan, Iran, using remote sensing methods based on the output of the results of ASTER data processing [7]. A wide range of research using ASTER data to identify alterations and complications of the earth's surface in different places can be expressed in [8-12].

Geology of the case study

Structurally, this area is located west of the Sistan zone and east of the Lut zone. According to the geological map of 100,000 Khosuf, the rock units of this area include ignembrite, tuff, and tuff-breccia pyroclastic deposits along with volcanic phases with the combination of dacite, andesite, and andesite pyroxene with Eocene-Oligocene age. These units are cut by dyke-like structures called intermediate dykes. In general, the main trend of these dyke-like structures is northwest-southeast. In addition, there are silicified and jasperoid shear zones in the area [13].

Data

The ASTER satellite sensor is one of the five state-of-the-art instrument sensor systems onboard the Terra satellite, which was launched in 1999. Its short-wave infrared bands have six bands, which are very useful for geological applications. This study utilizes Level-1T (L1T) processed ASTER images, which have undergone geometric and radiometric corrections [14].

METHODS

Preprocessing

In this research, the Quick Atmospheric Correction, or QUAC, method was used, which is an atmospheric correction method in the VNIR-SWIR region for images. Unlike other atmospheric correction methods, it estimates the correction parameters directly from the observed spectra in a scene without the help of secondary information. In addition, in this study, the logarithmic residual (log-residual) correction technique was used to perform the correction. On the other hand, according to the rough topography of the studied area and the shadow effects caused by the topography, it is necessary to correct it [15].

Data processing

Determining the amount of vegetation in the studied area can help correct processing. Therefore, one of the vegetation spectral indices, called the normalized coverage index (NDVI=(2-3/3+2)), was used for this purpose. Then, to explore metal mineralization in the region, at first, band indicators related to iron oxides (band ratios of 2 to 1) and silica (band ratios of 14 to 12), prone areas, and index pixels were identified. According to the output of the results, most of the iron ferro-silicates are exposed in the northwest of the Karijgan area in the form of veins. In addition, parts of the north and south of the area are also concentrated in silica [3].

Other applied methods were also used to identify the types of alterations, namely principal component analysis (PCA) and its improved type, selective principal component analysis, or the Crosta technique. In this case, bands 7, 8, and 9 to identify propylitic alterations (Table 1), bands 1, 4, 5, and 7 to identify argillic alterations (Table 2), and bands 1, 5, 6, and 7 to identify areas of philic alteration (Table 3) were introduced as selected bands by the Crosta method. Therefore, according to the tables, the loading values that show the highest absorption and reflection in each band can be considered the band that determines the desired alteration [3].

FINDINGS AND ARGUMENT

Promising areas and field check

In this section, according to the results and processing done on ASTER data, the potential areas were designed for initial surveys and next exploration operations. Figure 1 shows the location of prone areas for preliminary surveys. After determining promising areas from remote sensing studies, a field check was made for the mentioned areas. With field investigations, it is possible to confirm the existence of metal mineralization, including copper, in accordance with the results obtained from remote sensing studies in the area. In addition, the positions of the identified alterations are also in acceptable agreement with the mentioned results.

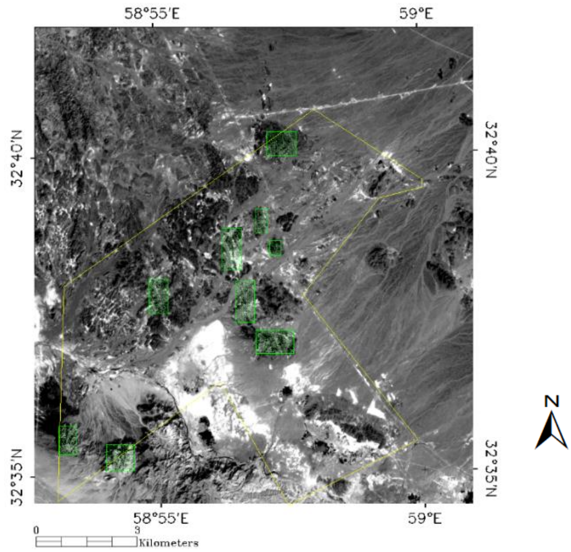

Figure 1. The position of the identified prone points for the initial survey in the Karijgan area

Finally, samples were taken from prominent outcrops in the region. In this regard, seven samples were selected for X-ray diffraction (XRD) and 34-element analysis (ICP-OES) and sent to Zarazamazengan Laboratory, Zanjan. According to the result extracted from the X-ray diffraction analysis, there was a high agreement between its output and the results of remote sensing studies, and the collected sample was in accordance with the position of argillic alteration identified with the ASTER images of the area. The results of elemental analyses also show the appropriate concentration of copper in some areas identified by remote sensing studies.

CONCLUSIONS

The studied area, located in the east of Iran, has a very high potential for mineralization, especially copper, due to many tectonic activities. Therefore, in this research, using principal component analysis (PCA) and its improved version (Crosta method), index alterations were identified. Then, by identifying the prone areas and checking the results, key areas were selected to continue the exploration process (survey and preliminary sampling) and process validation. In this case, an andesitic dyke and argillic alteration around it were considered the main targets of the survey. The results of the laboratory analysis showed acceptable compliance with the remote sensing processes, and the results of the studies led to the identification of altered zones, while the field control led to the identification of mineralized zones. As a general conclusion, remote sensing studies can be used as a successful exploratory method. Also, the studied area has the potential for additional exploratory studies.

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