Comparison of ASTER and Landsat-8 OLI data for detecting iron occurrences and alteration in Shahrak area, Kurdistan Province

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1-Introduction

In this study, the performance of different spectral processing techniques on ASTER and Landsat-8 OLI sensors data of the Shahrak mining area are compared. Shahrak is located 60 km north of Bijar city in Kurdistan province. It is located in the coordinates of 47°, 30΄, 30″ to 47°, 40΄, 34″ east longitude and 36°, 20΄, 20″ to 36°, 30΄, 25″ north latitude. It belongs to Takab structural zone. There are ten ore bodies in the Shahrak mining area, mainly composed of magnetite. The host rocks of mineralization are carbonate and volcanic rocks that have undergone argillic, epidote, and chlorite alteration. The purpose of this study was to compare the efficacy of ASTER and OLI images and PCA, ICA, and MNF processing methods in detecting iron ore mineralization and related alteration assemblages in the Shahrak mining area. Given the limited references available for remote sensing of skarn ores (Jeong et al., 2016), especially iron skarns, performing and comparing different algorithms in known skarn ores can help study unknown ore deposits. At pre-processing stage, FLAASH atmospheric correction was applied to both images to reduce noise. The processing techniques used in this study are band ratio (BR), band combination, principal component analysis (PCA), independent component analysis (ICA) and minimum noise fraction (MNF). The results validated by field observations and microscopic studies.

2-Methodology

The VNIR and SWIR bands of both images were used to detect iron oxides, carbonates, chlorite-epidote assemblage, and argillic alteration (Kalinowski and Oliver, 2004; Ducart et al., 2016). The spectral characteristics of minerals in the ore and host rock were investigated to select suitable bands. Various band ratios and false-color composites were prepared to determine which ones are best suited to detect iron mineralization, chlorite-epidote assemblage, and argillic alteration.

3- Results and discussion

The band ratio 4/3 in the ASTER image and 4/2 in the OLI image performed better in highlighting the magnetite orebodies (Fig. 4). The band ratio of (6 + 9) / (8 + 7) in the ASTER image could not characterize the endoskarn complex, but it performed better in color combination. The band ratio of 7/2 in the OLI image well-characterized the epidote-chlorite assemblage. The band ratio of 7/6 in the OLI image also detected argillic alteration (Fig. 5). In the ASTER image, RGB: 468 color combination and the false-color combination prepared using the band ratios RGB: (6 + 9) / (8 + 7), (7 + 9) / 8, (5/3) + (1/2), detected the chlorite-epidote assemblage, kaolinite and ferrous minerals. For OLI image, the false-color combinations RGB: 653, RGB: 345, and RGB: 4/2, 6/7, 5 were successful in detecting the mineralization and alteration. As the radiometric resolution in OLI images is higher than the ASTER images, the OLI image's mineralized areas are more evident. On the other hand, the highest reflection and absorption of ferric and ferrous iron are in the visible wavelength range, thus using OLI image results in better iron oxide detection due to having all three visible bands (Zhang et al., 2016).

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Principal Component Analysis (PCA), Independent Component Analysis (ICA), and Minimum Noise Fraction (MNF) spectral transforms were also applied to ASTER and OLI image bands. In the ASTER image, the best detection of iron oxides occurs in PC1 and PC2. The band PC3 is also useful for detecting argillic alteration. The OLI image PC4 shows the best detection of iron oxides. The obtained images show that in the PCA method, the OLI image detects iron mineralization and clay alteration better than the ASTER image.

In the ICA technique performed on the ASTER image of the Shahrak mining area, the best output was for the IC4 and IC5 components. In the OLI image, IC3, IC2, and IC1 have been successful in highlighting iron ores. Unlike the ASTER images, the ICA method act as well as the PCA method on the OLI image. In this technique, the OLI image reveals more details (Mahmoudishadi et al., 2017), so that the color combination of RGB: IC3, IC2, and IC1 can produce lithological maps in addition to highlighting the mineralization and alteration zones.
The MNF technique was used to reduce the noise and increase the resolution of the image. Then the resulting MNF bands were used to prepare different color combinations. The MNF5 band in the ASTER image highlights iron oxides (Gahlan and Ghrefat, 2018). In the OLI image, the MNF4 band detects iron oxides. The resulting images show that the OLI image performs better than the ASTER image in MNF transform. Of the three transforms used, ICA and then MNF performed better than PCA in the OLI image. Finally, it seems that due to the higher radiometric resolution of the OLI image, these images can detect the phenomena with more details.
Field observation was conducted to validate the results of the study. Sampling and microscopic studies were also performed. The presence of magnetite ores in the vicinity of marble, skarn zone consisting of the minerals epidote, chlorite, goethite, and crystalline calcite and kaolinite approved in several locations, were also detected on the satellite images.

4-Conclusion

Among the mentioned techniques, the ICA technique yields more precise results than other techniques such as PCA and MNF. The RGB image obtained from the OLI independent components IC3, IC2, IC1 could detect iron oxides, carbonates and the lithological units with comprehensive details, which can be useful for lithological mapping of the area.

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