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Research Paper

Comparing the Performance of ASTER and LANDSAT 8 Satellite Images in Identifying Iron Oxide and Porphyry Copper Alterations in Zafarghand Region of Isfahan Province

Esmaelzadeh Kalkhoran S.[1], Ghannadpour S.S.[2*], Moeini Rad A.[3], Jalili H.[3]

1- M.Sc Student, Dept. of Mining Engineering, Amirkabir University of Technology, Tehran, Iran

2- Assistant Professor, Dept. of Mining Engineering, Amirkabir University of Technology, Tehran, Iran

3- Assistant Professor, Iranian Space Research Center, Tehran, Iran

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Abstract: Separation and mapping of alteration zones is of special importance in the exploration of porphyry copper types. In order to highlight these alteration zones, remote sensing techniques have been applied. Zafarghand region is located in the southeast of Ardestan and northeast of Isfahan. Based on the division of geological structural zones, it is located in the Central Iran zone and also in the middle part of Urmia-Dokhtar magmatic volcanic arc. In this area, there are different alteration halos, including phyllic, potassic, propylitic, argillic, and slightly siliceous. In this study, argillic, phyllic, propylitic, and clay alterations have been identified using ASTER sensor images. Moreover, LANDSAT 8 images have been employed to identify clay and iron oxide alterations. In this regard, after performing the necessary pre-processing, methods of False Color Combination (FCC), Band Ratio (BR), Least Squares-Fit (LS-Fit), Matched Filtering (MF), and Principal Combination Analysis (PCA) were applied to reveal the zones containing these alterations. Among the applied methods, the LS-Fit and MF in Aster images, as well as the BR method in both images, and the PCA method in Landsat 8 have brought good results.

Keywords: Zafarghand, Remote sensing, Alteration, Iron oxide, ASTER and LANDSAT 8 sensor.

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*Corresponding Author Email: *s.ghannadpour@aut.ac.ir*

INTRODUCTION

Everything has a different and special reaction to radiant energy, which is determined by the way of different degrees of energy reflection. The ratio of reflected, absorbed, and transmitted energy in different phenomena for a wavelength is different and depends on the type of material and their conditions and status. These differences make it possible to identify different phenomena on the image. The ratio of energy in the three mentioned states for a given phenomenon also differs in different wavelengths [1]. The purpose of this article is to study and compare the efficiency of two sensors widely used in remote sensing (ASTER and OLI) in the prospecting area of Zafarghand (as an already known area) on which previous studies have been conducted and the existence of alterations has been confirmed by field studies.

CASE STUDY

The Zafarghand copper exploration area is located in southeastern Ardestan, in central Iran, about 110 kilometers northeast of Isfahan. The deposit is situated in the west of Zafarghand, as part of the 1:100,000 Ardestan geological sheet, ranging from 52°23’55’’E to 52°26’30’’E longitude and 33°10’30’’N to 33°11’52’’N latitude [2]. To access the area, one can use the Ardestan-Naeen Road in the eastern part, the Ardestan-Isfahan Road in the central section, the Zafarghand-Zefreh Road in the southern part, and the Ardestan-Natanz Road in the northern part of the region. The studied deposit is located at the western margin of the Central Iran structural zone and on the central part of the Urmia-Dokhtar Magmatic Arc (UDMA), which, similar to other porphyry copper deposits in Iran and worldwide, has a magmatic origin [2].

MATERIALS AND METHODS

In line with the main objective of this study and for highlighting various geological anomalies and important indicator minerals in the assessment of mineral potential in the study area and for comparing the performance of two different satellites in highlighting known alterations in the Zafarghand region, ASTER and Landsat 8 satellite images will be utilized. In this regard, after performing the necessary pre-processing, methods of False Color Combination (FCC), Band Ratio (BR), Least Squares-Fit (LS-Fit), Matched Filtering (MF), and Principal Combination Analysis (PCA) will be applied to reveal the zones containing these alterations. Figure 1 illustrates the steps of this study in the form of a flowchart.

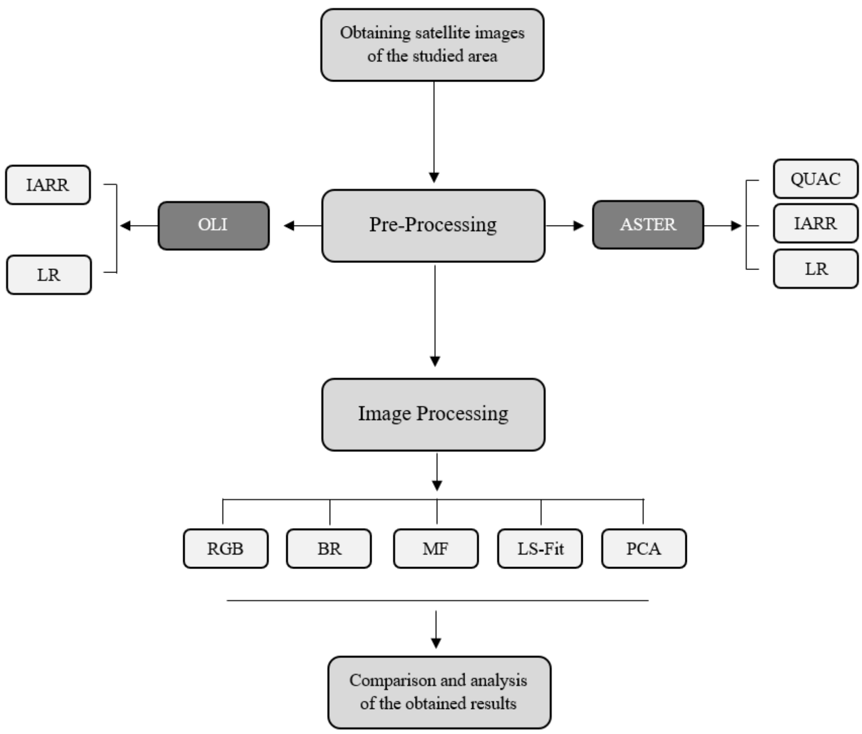

Figure 1. The flowchart of various stages and the process of the task execution

DISCUSSION AND CONCLUSION

Based on the results, it seems that due to the higher radiometric resolution in the OLI image, these images have a better use in highlighting the desired phenomena. Comparing the performance of ASTER and OLI sensors shows that ASTER has better spatial resolution and spectral resolution due to having 5 bands in the SWIR range compared to Landsat’s 2 bands. It has a better ability to identify alterations, including the separation of phyllic from argillic alterations. In this study, Landsat 8 was used to separate iron oxides and ASTER data to determine hydrothermal alterations. Among the processes performed on the image of ASTER sensor, BR, MF, and PCA methods have highlighted the alterations in the area well and with high accuracy. The LS-Fit method in the ASTER image was only suitable for highlighting argillic alteration and did not perform well for phyllic and propylitic alteration, but the Landsat 8 image provided acceptable results for iron oxide and argillic alterations. The results of the above methods are in an acceptable agreement with the alteration map of the area. The output obtained for potassic alteration with the matched filtering method was also acceptable based on the absence of potassic alteration in the alteration map of Zafarghand area and there were no bright spots indicating the presence of potassic alteration in Zafarghand area. Other methods have not provided an acceptable performance in the case of phyllic alteration, and the PCA method was more suitable for characterizing propylitic alteration than other methods. Most of the methods applied to the images of the studied area have identified argillic alteration well. Finally, it could be acknowledged that Landsat 8 has been more successful in characterizing clay alterations than ASTER.

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