Republic of Yemen

Sana'a University
Faculty of Petroleum and Natural Resources

الجمهورية اليمنية

جـامعة صنعـاء
كليـــة البترول والموارد الطبيعية

Master's Thesis discussion report for the student **Samah Ali Abdalmajeed Saeed Al-Sururi**

The committee convened on Sunday, 12/04/1443 AH, corresponding to 03/07/2022 AD, to review and adjudicate the Master's Thesis submitted by the student **Samah Ali Abdalmajeed Saeed Al-Sururi**. She is registered in the College of Petroleum and Natural Resources, Department of Earth Sciences. The discussion and judgment committee comprised the following:

The title of thesis is "**Geological Study of Volcanic Rocks by Using Remote Sensing and Geographic Information System Techniques in Sana'a Basin, Yemen** ". **Samah Ali Abdalmajeed Saeed Al-Sururi** presented the subject of thesis to the discussion and arbitration committee.

1. Associ. Dr. Khaled Muhammad Thabet Al-Selwi	**Sana'a University**	**Chairman**
2. Prof. Dr. Bassim Shaif Abdul Qader Al-Khirbash	**Sana'a University**	**Supervisor-member**
3. Assici. Dr. Arif Ali Abdullah Saghir	**Al-Hodiadah University**	**member**

This study focuses on the application of remote sensing and Geographic Information Systems (GIS) in classifying and mapping volcanic rocks of the Tertiary and Quaternary periods in the Sana'a Basin, Yemen. The complex overlap of different volcanic rock types in the region renders traditional mapping methods insufficient, necessitating the adoption of modern technologies for precise identification and classification. Utilizing Landsat 8 imagery, alongside ArcGIS and ENVI software, the study employs a range of techniques including supervised and unsupervised classification, ratio analysis, Principal Component Analysis (PCA), and false composite color (FCC). Preceded by spectral corrections through the FLAASH method to enhance image quality, these techniques demonstrated their effectiveness in distinguishing various volcanic rock units. Particularly, band ratios and PCA in RGB format were instrumental in identifying distinct volcanic rocks. While the maximum likelihood classification closely matched existing geological map. This confirms the obtained result. A majority-filter was applied for data smoothing, improving the classified map's precision. The study culminated in the creation of digital maps and spectral signatures for each volcanic rock unit, significantly aiding in the field's rock pattern identification.

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Through integrating modern remote sensing techniques, this research offers invaluable tools for geological exploration, contributing to a deeper understanding of the Sana'a Basin's volcanic rocks.

Abstract

Sana'a Basin is characterized by volcanic rocks of Tertiary and Quaternary ages. Due to the overlap of different types of volcanic rocks with each other in the study area, the detection and identification of these rock variations, using classical techniques and mapping methods, became difficult and laborious. In this study, remote sensing and geographic information systems techniques were used to identify and divide the different types of volcanic rocks, and then draw their digital maps. Thus, it has become necessary to use modern technologies in the field of identifying the invisible rocks in the field, classifying and mapping it. The use of modern technologies has become very effective and auxiliary tools in the detection of natural resources such as rocks and minerals. In this study, modern methods were used, such as Landsat 8 imagery data, to detect the rocky distribution and its diversity in the study area.

In order to achieve these basic objectives, ArcGIS and ENVI software were used in the current study integrated with Landsat imagery 8. Various technical methods were applied on the satellite images for the purpose of classifying and mapping volcanic rocks of the study area. Such methods applied in the study are, supervised, unsupervised classification, ratio, PCA, and composite colors. These methods were preceded by spectral corrections in order to improve the quality of the images and obtain the best desired results from the satellite image analysis, where the FLAASH method was used to improve the satellite images.

In this study, it was proved the effectiveness of using ratios and PCA methods in detecting different types of volcanic rocks in the study area. Thus, using Landsat 8 band ratios (7/6, 6/4, 5/3), (4/2, 6/5, 6/7) and (7/6, 6/4, 6/2) in RGB showed its ability and effectiveness to differentiate different types of volcanic rocks. On the other hand, principal components image (PC1, PC2, and PC4) and (PC5, PC2, PC4) in RGB distinguished different types of volcanic rocks in the area.

The classification method using maximum likelihood method was fairly accurate and matched the geologic map of the area. K-mean clustering was not given an accurate result due to the mixing of some pixels of the rock units. The classified image was passed through a majority-filter in the final step for smoothing of the data. This filtering effect was helpful in discriminating the pixels of volcanic rock units on the classified map. In the final step of the image processing and classification, spectral signatures were created for each volcanic rock unit in the Sana'a Basin, and it was preserved in the form of a digital map of the study area, which can be used directly to identify the various volcanic rock patterns in the study area.

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