GEOLOGICAL, MINERALOGICAL AND REMOTE SENSING STUDIES OF SOME BENTONITIC CLAYS, NORTH WESTERN DESERT, EGYPT

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ABSTRACT

The present study aims to identify the bentonitic clay quarries to the southwest of Al-Alamin City, north Western Desert, Egypt. To achieve the objective, multispectral satellite data were used to demonstrate the role of advanced remote sensing techniques in facilitating the differentiation of such clay quarries.

The studied rock succession belongs to the lower clastic-carbonate member of the Middle Miocene Marmarica Formation. The integration between the different remote sensing techniques; land surface temperature (LST), Band combination, Band Ratio and principal component analysis (PCA) with spectral reflectance measurements along with XRD and XRF analyses of some selected samples result in visual interpretation and creating of lithological and LST anomaly maps.

Thermal Infrared Bands (TIRS) of LANDSAT- 5, Thematic Mapper (TM) and LANDSAT- 8 Operational Land Imager (OLI) with acquisition dates (August, 1985, 2010 and 2020) used for LST estimation based on USGS algorithms. All of these images have the spatial reference (World Geodetic System – UTM 1984 - zone 35 N). The Landsat image of 1985 illustrates the study region before the two clay quarries existed, whereas the other images (2010 and 2020) show the existence of quarries, according to a visual examination of these images. 1) High LST values are found in areas covered by clay rocks (37°C in 1985, 43°C in 2010, and 44°C in 2020). 2) From 1985 to 2020, the area with the highest LST increases as more clay is exposed and quarried. 3) The highest value of LST is attributed to the dark-colored, fine-grained clay that contains a high amount of organic matter, iron oxides and moisture.

The spectral reflectance curves of the studied clay minerals show: 1) Doublet peaks at 2.17 and 2.21 and similar absorption peaks at 1.41 and 1.91μm. All of these peaks indicate that kaolinite, montmorillonite and illite are

the only recognized clay minerals. 2) all samples show a broad absorption peak near 0.9 μm, which reflects that the clays contain iron or ferrous minerals.

Based on the spectral reflectance measurements and XRF analysis, many band ratios were made to select the best one for clay minerals differentiation using Landsat 8. From spectral curves bands 6 and 7 represent the most reflectance and absorbance of clays (OH) in the SWIR region. Mineralogically, the qualitative XRD results of clay fraction and bulk samples show that there are three type of clay minerals in the examined area (kaolinite, montmorillonite and illite) in addition to, Quartz, calcite, dolomite, iron oxide, and gypsum, which is compatible with the results of the spectral curves. Consequently, the chosen band ratios were 7/6 to distinguish clay from other rocks and 5/6 and 5/7 to distinguish ferrous and iron oxide minerals.

The visual interpretation of PCs results is based on the sign and magnitude of Eigenvectors values. The most useful and contributed PCs are PC1, PC2 and PC4 for Deir El-Morair Quarry and PC1, PC4 and PC5 for Deir Abuel-Hagif Quarry.

Swelling index and sodium activation method for the three clay parts in the two quarries show that the upper fissile part is of sodium-type smectite, the middle massive part is of calcium-type smectite and the lower fissile part is of calcium-type smectite. Accordingly, we conclude that the remote sensing techniques, particularly LST are regarded as useful methods for detecting and discriminating the promising locations of clay quarries.