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Application of remote-sensing techniques in geological and structural mapping of Atalla Shear Zone and Environs, Central Eastern Desert, Egypt

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Abstract
The Atalla Shear Zone (ASZ) is one of the crucial megashears which are geometrically and kinematically akin to the Najd-Shear Corridor in the central Eastern Desert of Egypt. The Landsat-8 and ASTER-based mapping techniques integrated with extensive petrographic and structural-field investigations enhanced the geological and structural maps of the study area. The Neoproterozoic basement complex in the study area discriminated into ditinctive rock suites: Meatiq Group, ophiolitic melange, arc assemblage, syn- to late-tectonic granitoids, Dokhan Volcanics, Hammamat Sediments, post-Hammamat Felsites and post-tectonic granitoids. The true color composites (TCC) (4 3 2 for Landsat-8; 3 2 1 for ASTER), false color composites (FCC) (1 6 4, 1 6 7 and 7 5 1 for Landsat-8; 5 4 3 and 9 6 4 for ASTER), principal component analysis (PCA) (1 2 3, 3 2 1 and 6 4 2 for Landsat-8; 1 2 3 and 5 4 2 for ASTER), minimum noise fraction (MNF) (1 2 3 and 3 5 1 for Landsat-8; 1 2 4 and 3 2 1 for ASTER) and band ratios (BR) (6/2, 6/7, 6/5*4/3 and 7/6, 7/5, 5/3 for Landsat-8; 2/6, 7/5, 7/6 and 4/7, 3/4, 2/1 for ASTER besides the new created ratio 2/6, 7/5, 7/6) are the best combinations that demonstrate efficiency in discrimination of lithologic contacts and structural elements, using the spectral signature of different rock units. Moreover, the BR b7/b5, b5/b7 and b6/b4 of grey scale for Landsat-8 are used as a tool for mineral detection along with the spectral indices created to detect muscovite (b7/b6), ferrous silicates b5/b4 (biotite, chlorite and amphiboles) and ferrous iron b5/b3 (mafic minerals). The automatic lineament extraction utilizing the SRTM data advocated the role of NE- to NNE-trending lineaments in the tectonic framework of the study area. The structural fabric of the study area is evaluated in three main structural domains: Meatiq (MD), Atalla Shear Zone (ASZD) and Wadi Hammamat (WHD). The pronounced structural implication is the transposition of NE-oriented fabric in MD into NW-oriented penetrative shear-related fabric, fully in the ASZD and partly in WHD. The combination of transcurrent shearing with ENE-directed shortening along the ASZ that was resulted in noteworthy transpressive structures resemble in many respects those observed in the Ajjaj Shear Belt in Western Arabia. Among these structures are shear zone-related folds, imbricated thrust sheets, antiformal stacks and thrust duplexes. The deformation history of the investigated area proposed four phases of deformation (D_1–D_4). It depicts a long lasted deformational event covering the main accretion-collision phases concurrent with the E-W assembly of Gondwana, and the subsequent post-collision Najd-related transpressional phase which resulted in several major left-lateral transcurrent shear zones along with the exhumation of gneissic core complexes in the Arabian-Nubian Shield.

Keywords Atalla Shear Zone · Najd-related transpression · Pan-African belt of Egypt · Arabian-Nubian Shield

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Introduction

The Najd Shear System (NSS) in the Eastern Desert of Egypt still has problematic issues that need further investigation and discussion. The time, sense and scale of shearing are the most critical issues. The present contribution is an integrated study utilizing remote sensing/GIS and structural field-based mapping to investigate the shear criteria and decipher the deformation history and tectonic evolution of the major Najd-related ASZ and environs. Processing of remote-sensing data

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