Using remote sensing techniques and field-based structural analysis to explore new gold and associated mineral sites around Al-Hajar mine, Asir terrane, Arabian Shield

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ABSTRACT

Modern earth resource satellites provide huge amounts of digital imagery at different resolutions. These satellite imageries are considered one of the most significant sources of data for mineral exploration. Image processing techniques were applied to the exposed rocks around the Al-Aqiq area of the Asir terrane in the southern part of the Arabian Shield. The area under study has two sub-parallel N–S trending metamorphic belts of green-schist facies. The first belt is located southeast of Al-Aqiq, where the Al-Hajar Gold Mine is situated. It is essentially composed of metavolcanics and metasedimentary rocks, and it is intruded by different plutonic rocks of primarily diorite, syenite and porphyritic granite. The second belt is located northwest of Al-Aqiq, and it is composed of metavolcanics and metasedimentary rocks and is intruded by granite bodies. The current study aimed to distinguish the lithological units, detect and map the alteration zones, and extract the major fault lineaments around the Al-Hajar gold prospect. Digital satellite imageries, including Landsat 7 ETM + multispectral and panchromatic and SPOT-5 were used in addition to field verification. Areas with similar spectral signatures to the prospect were identified in the nearby metamorphic belt; it was considered as a target area and was inspected in the field. The relationships between the alteration zones, the mineral deposits and the structural elements were used to locate the ore-bearing zones in the subsurface. The metasedimentary units of the target area showed a dextral-ductile shearing top-to-the-north and the presence of dominant mineralized quartz vein-system. The area to the north of the Al-Hajar prospect showed also sub-parallel shear zones along which different types of alterations were detected. Field-based criteria such as hydrothermal breccia, jasper, iron gossans and porphyritic granite strongly indicate the presence of porphyry-type ore deposits in Al-Hajar metamorphic belt that may proof promising for subsurface mining.

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1. Introduction

The study area is a part of the Arabian Shield (AS) and is located between latitudes 19° 50′ and 20° 30′ N and longitudes 41° 25′ and 42° 25′ E (Fig. 1). It is located in the northwestern portion of the Asir terrane approximately 80 km southeast of Al-Aqiq City. The study area is composed essentially of metasediments and metavolcanics. Numerous intrusive igneous bodies of Precambrian age also dominate the study area. The AS comprises five major tectonic terranes: Asir, Al Hijaz, Madyan, Afif, and Ar Rayn. The first three terranes are formed of intraoceanic island arcs, and are located at the western part of the Shield. The other two are of continental origin and are located on the eastern part of the Shield. These tectonic terranes are separated by four suture zones that are decorated by ophiolite belts. The sutures include: Bir Umq, Yanbu, Nabitah, and Al-Amar (Al-Shanti, 2009).

Generally, the area under study has not been previously subjected to detailed geological studies. Reconnaissance geological mapping of the study area was conducted within the regional map of the Al-Aqiq Quadrangle on the scale of 1:100,000 by Greenwood
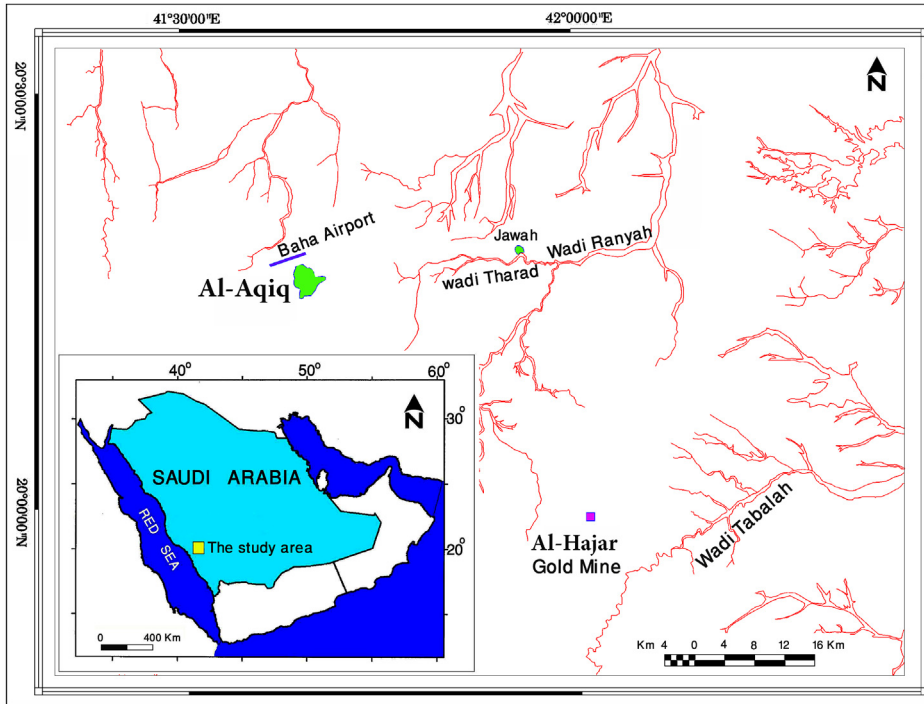
Fig. 1. Location and physiographic maps of the study area.
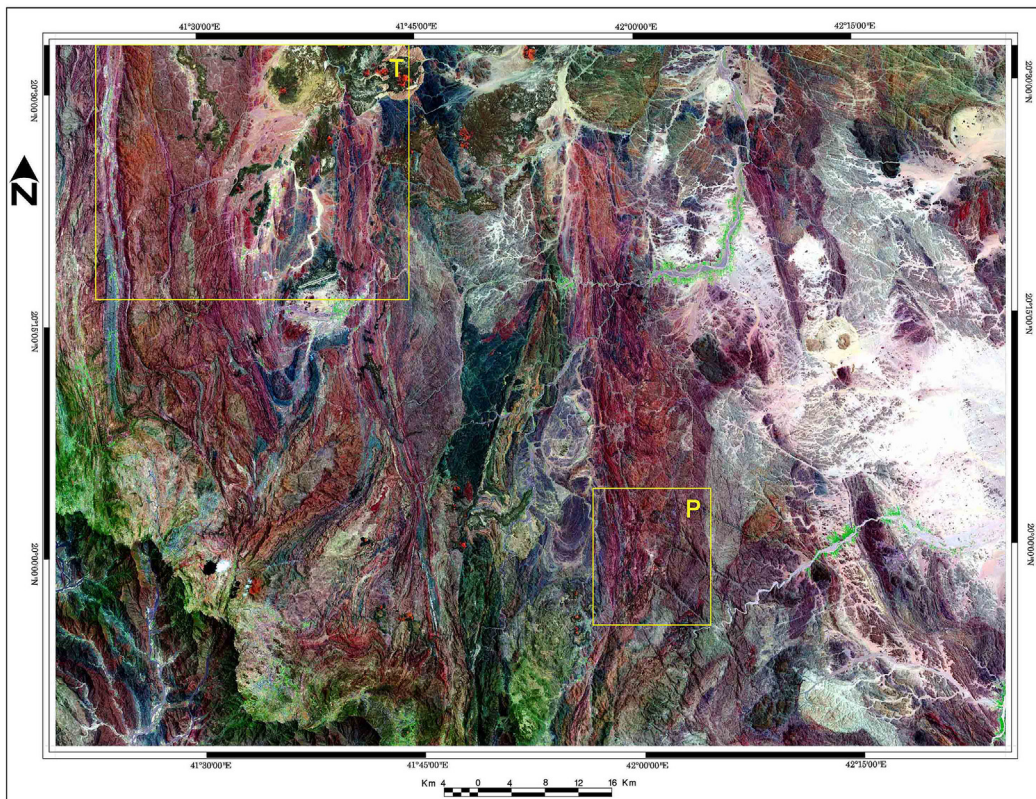

Fig. 2. False color composite Landsat image of the study area, ETM + bands 7, 4, 2 in RGB, showing the prospect area (P; Al-Hajar mine) and the target area (T; newly distinguished area).