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LANDSAT INVESTIGATION OF MINERALIZED GRANITES IN THE AREA BETWEEN GABALS EL-URF AND EL-EREDIA DUE WEST OF SAFAGA, EGYPT

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ABSTRACT

Assuming a genetic relationship between structure, mineralization and igneous activities, the Precambrian basement exposed in the area between Gabals EL-Urf and EL-Eredia due west of safaga, Egypt, was found promising to seek hydrothermal mineralizations. Digital processing of landsat MSS data including ratios of MSS bands and color enhancement techniques were used. Four ratios were employed each of which was followed by color enhancement in order to clarify any subtle tonal contrast. The band ratios comprised AT(7/5)x2 , 7/5x50, 5/6x25 and AT 4/5. The first two were found to be the best ratios in detecting numerous bright signatures in three main localities, namely EL-Urf, EL-Gidami and EL-Eredia areas. The fourth ratio was the least of all where the bright signatures were rendered dark, hardly recognizable, and many of them were missed. The bright signatures appear in the ratio images as parallel halos measuring up to 4 km. Ground truth investigations revealed that these signatures reflect numerous hydrothermal alteration halos and mineralized quartz veins. These were primarily controlled by rejuvenated tension fractures associated originally with major strike slip faults. The hydrothermal alteration halos are confined to the granitic terrain and might be genetically connected with mesothermal deposits in depth. The mineralized quartz veins are restricted to the mafic metavolcanics and could have possibly derived from sulfide deposits occurring at deeper levels.

1. INTRODUCTION

The present work aims at the use of digital processing of landsat MSS data in an attempt to detect hydrothermal alteration zones in the Precambrian basement exposed in the area between Gabals EL-Urf and EL-Eredia due nest of Safaga, Egypt (Figure1). Because of the arid climate vegetation in this area, as is the usual case throughout the Egyptian Precambrian, is nil and weathered surface does not exceed in many cases

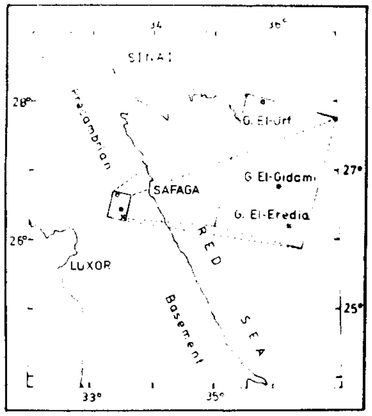


Figure1. Index Map Showing Study Area

a few centimetres in thickness. The choice of this particular area was premised upon five primary considerations. First, it is characterized by the presence of several mountainous masses of postkinematic granites which are generally considered to be genetically related to tin-tungsten and copper mineralization (see EL-Shatoury et al.,1975).[7] Second, many of these postkinematic granites proved to be structurally controlled, i.e. their emplacement took place along well-defined NNW, NW and NNE megalineaments (Kisvarsanyi and Habib,1980 1980).[15] Third, these lineaments in addition to WNW ones were also found to represent lineament metallotects for late precambrian hydrothermal mineralizations, i.e. gold, tin, tungsten and molybdenum (Habib, 1981).[11] Fourth, from the lithologic and tectonic viewpoints the study area occupies a special situation in the Egyptian basement. It lies at the boundary between the geanticlinal swell (EL-Ramly and Salloum,1974)[6] to the north, where the sialic material is predominating, and the eugeosynclinal basin to the south, where the simatic material is remarkably overwhelming (EL-Gaby and Habib).[3] Fifth, the geology and main tectonic features of the study area are known to the author.

11. GEOLOGY OF THE STUDY AREA

The study area (1200 km^2) includes the following rock varieties beginning with the oldest : gneisses and granodiorite - gneisses, metasediments, ophiolitic fragments (i.e. metavolcanics, serpentinites and metagabbros), syntectonic granitoids, gabbros and postkinematic granites, together with a series of quartz veins and dykes (Figure 2). More than two-thirds of the study area are occupied by the granodiorite-gneisses, syntectonic granitoids and postkinematic granites.

The gneisses are of limited occurrence and represented by two minor outcrops in the northeastern corner of the study area. They are formed of biotite-and hornblende gneisses, amphibolites and calc-quartzites. They are considered to represent the ancestor of the granodiorite-gneisses into which they gradually merge(Habib, 1972).[10]

The granodiorite-gneisses compose a part of an infrastructure produced by granitization processes of older gneisses and amphibolites that persisted as discontinuous lentoidal relics (Akaad et al., 1973).[1] They build up low-lying terrair composing the northern part of the study area.

The metasediments are formed of slates,phyllites and low grade schists representing originally turbidite sequences of shaly flysch subfacies (Habib and EL-Nadi, 1978).[12]They occur as minor outcrops forming low ground in the central and southeastern parts of the study area. The metavolcanics are composed of pillowed metabasalts and massive, locally sheeted, metadiabases. They are commonly intercalated with discontinuous lenses of metadacite tuffs. These metavolcanics are exposed in the southern part of the study area forming moderately elevated terrain. Both the metasediments and the metavolcanics are intruded by the syntectonic granitoids and postkinematic granites. The invaded rocks are thermally metamorphosed up to the hornblende hornfels facies (Habib, 1972).[10]

The serpentinites are represented only by a single outcrop in the southern part of the study area. It is encircled by the mafic metavolcanics and displays a vague relation against them.

The metagabbros are represented by two elongate bodies; one is located at the northwestern corner of the study area, and the other occurs at its central eastern margin. The former is completely encircled and invaded by the postkinematic granites, whereas the latter is intruded by the syntectonic granitoids.

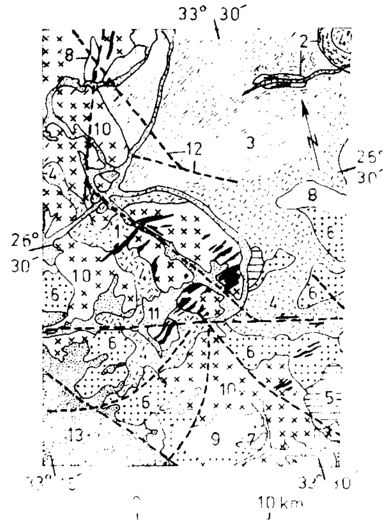


Figure 2. Geological Map Of Study Area (Modified After EL-Ramly, 1977).[4]1. Hydrothermal Alteration Halos, 2. Gneisses, 3. Granodiorite-gneisses, 4. Syntectonic granitoids, 5. Metasediments, 6. metavolcanics, 7. Serpentinites, 8. Metagabbros, 9. Gabbros, 10. Postkinematic grnites, 11. Wadi alluvium, 12. Faults, 13. Nubia Sandstone.

The syntectonic granitoids form ovoidal masses and diapiric bodies (EL-Gaby and Habib, 1978)[2] representing the rheomorphosed equivalents of the granodiorite-gneisses (Akaad et al., 1973).[1] They moved from the infrastructure and intruded into the metasediments, metavolcanics and metagabbros at the transition tectonic level. Assimilation of the mafic rocks by the granodioritic material led to the development of hybrid diorites.

The gabbros are thought to be late tectonic bodies emplaced into the meta volvanics due west of Gabal EL-Fredia. They caused thermal metamorphism in the invaded rocks up to the hornblende hornfels facies.

The postkinematic granites form stock-like bodies and thick sheets which build up discontinuous mountain ranges stretching, in a NNW direction, from the north-western to the southeastern parts of the study area. They comprise, from north to south, EL-Urf, Abu shihat, kafari, EL-Gidami, EL-Markh and EL-Eredia granite plutons. Their composition ranges between alkali granite and quartz monzonite, and textures vary from coarse-grained granitic to porphyritic. Such granites terminated the Pan-African plutonism, i.e. within the 540-480 Ma range (Hashad, 1980).[13]

A series of quartz veins and a group of silicic, intermediate and mafic dykes, belonging to the post-granite dykes of EL-Ramly and Akaad (1960)[5], were found to cut across the postkinematic granites as well as the older rocks. According to Schurmann (1966)[17] the dyke formation extended from the late recambrian to early aleozoic.

111. HYDROTHERMAL MINERALIZATIONS

The late Precambrian hydrothermal mineralizations of Egypt are genetically classified into true hydrothermal fissure veins and deposits formed by hydrothermal processes in shears and fractures (EL-shazly, 1957).[8] The first category is genetically related to the postkinematic granites and includes gold, tin, tungsten, molybdenum and barite. These deposites belong to different hydrothermal classes, the most important of which is the mesothermal class. The second category is later than the first one and is represented by steatite and talc, zinc and copper, and kaolin deposits. The temperature of formation of such deposits was generally moderate.

In the study area mineralizations belonging to the first category include gold, tin, tungsten and molybdenum;those related to the second one are represented only by copper, less commonly iron, mineralizations.

A. GOLD VEINS

Gold veins are considered to be deep to shallow mesothermal deposits (EL-Shazly, 1957).[8] They occur in quartz veins (averaging 1 m thick) either traversing syntectonic granitoids, or in metasediments (mainly schists) not far removed from syntectonic granitoids (Hume, 1937).[14] The ore body is limited as to length on the surface and is similarly restricted as to depth. Besides, all the auriferous veins have shown diminution of richness of gold-content in depth where the gold is commonly associated with sulfides of lead, iron and even zinc too. The lead age of the galena is 550 Ma (Schurmann, 1966).[17]

B. TIN, TUNGSTEN AND MOLYBDENUM VEINS

Tin, lungsten and molybdenum veins are typically hypothermal and occur in quartz veins (up to 45 cm thick) cutting various rock units, e.g. granodiorite-gneisses, metasediments, metavolcanics, metagabbros or postkinematic granites.

C. COPPER AND IRON MINERALIZATIONS

Cpper and iron mineralizations are formed by hydrothermal alteration and replacement in shear zones, commonly of mafic metavolcanics, or filling fractures in various rock units, e.g. schists, postkinematic granites or quartz veins. For example, in the Um EL-Atawi area (outside the study area) the ore body is malachite and hematite with traces of pyrite. According to EL-Shazly and Sabet(1955)[9] the hypogene sulfides might exist in depth. Schurmann (1966)[17] believes that the primary ore might be chalcopyrite, pyrite and

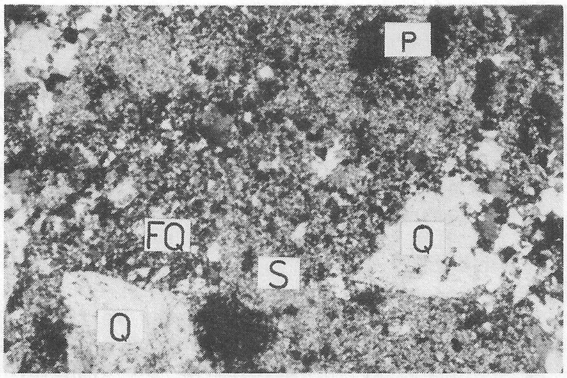


Figure 3. Photomicrograph Showing Intensive Hydrothermal Alteration In Quartz Vein. Q = quartz relic, S = sericite, FQ = fine-grained silica, P = pyrite. C.N.X60.

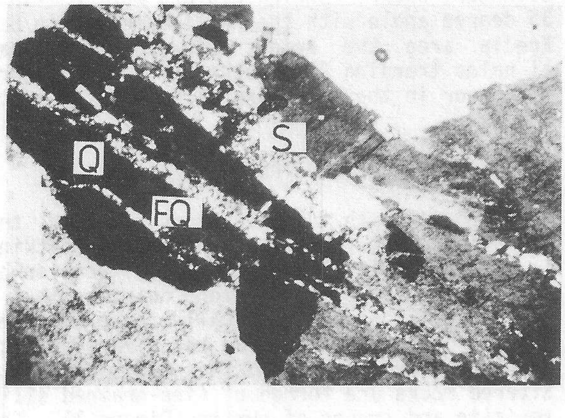


Figure 4. Photomicrograph Showing Limited Hydrothermal Alteration Along Parallel Microfractures In Quartz Vein. Q = quartz, S = sericite, FQ = fine-grained silica. C.N.X60.

galena.

1V. METHODS AND TECHNQUES

Digital processing of landsat MSS data of the study area was carried out through the Comtal Image Processing System (CIPS) at the University of Missouri-Rolla. Ratios of MSS bands and color enhancement were the main techniques employed in this study using the RR program. Due to the band ratio process the influence of topography and overall albedo was minimized in an attempt to detect lithological or mineralogical variations. Four ratios were employed, each of which was followed by color enhancement in order to clarify any subtle tonal contrast. The band ratios comprised: AT(7/5)x2, 7/5x50, 5/6x25 and AT 4/5. The first two were found to be the best ratios in detecting numerous bright signatures in three main localities, namely EL-Urf, EL-Gidami and

EL-Eredia areas (Figure 2). The fourth ratio was the least of all where the bright signatures were rendered dark, hardly recognizable, and many of them were missed.

The ratio images were displayed on the comtal screen and photographed directly with a suitable 35-mm camera using High Speed Kodacolor (ASA 400) films. The color prints were helpful during the field check.

The bright signatures appear in the ratio images as elongate halos measuring up to 4 km long by 300 m wide. In EL-Urf area the signatures are represented only by a thin discontinuous halo extending in a NNE direction along the major axis of both the Abu Shihat and EL-Urf granite plutons. In EL-Gidami granitic terrain, they appear as a series of parallel halos trending generally ENE and making a 35 degree angle with the WNW trending lineament (Habib, 1981).[11] Along the northern periphery of EL-Gidami granite, however ,a bright signature occurs running E-W and making also a 35 degree angle with the NW lineament. In EL-Eredia area the bright signatures form parallel halos trending ENE whether in EL-Eredia granite pluton or in the adjoining mafic metavolcanics.

V. GROUND TRUTH INVESTIGATIONS

Ground truth investigations revealed that the bright signatures observed in the postkinematic granites reflect hydrothermal alteration halos running parallel to and along quartz veins, 20 cm-1 thick, that cut vertically these granites. The hydrothermal alteration has clearly affected both the quartz veins and the granite host. The attered rocks are formed of fine-grained silica, sericite and traces of pyrite (Figure 3). The hydrothermal alteration is intensive along the quartz veins and decreases gradually away from them (Figure 4). Width of the alteration halos varies from one place into another, ranging between 2 m and a few hundreds of metres. Generally the alteration halos of EL-Gidami area are extensive if compared with those of the other districts. The quartz veins and alteration halos strike at 35 degrees to the NW and WNW lineaments which proved to be left-lateral strike slip faults (Figure 5). The emplacement of the quartz veins as well as the ascent of the hydrothermal solutions appear, therefore, to have taken place along tension fractures genetically associated with these faults. Such tension fractures are considered to be much better hosts for ore solutions than large faults (Park and McDiarmid, 1975).[16]

The bright signatures observed in the mafic metavolcanics indicate the presence of swarms of quartz veins, averaging 1 m thick, cutting these metavolcanics (Figur 6). Some of these veins are mineralized, carrying hematite and traces of malachite (Figure 7). The quartz veins occur in two sets trending ENE and NW, and dipping at 40°S

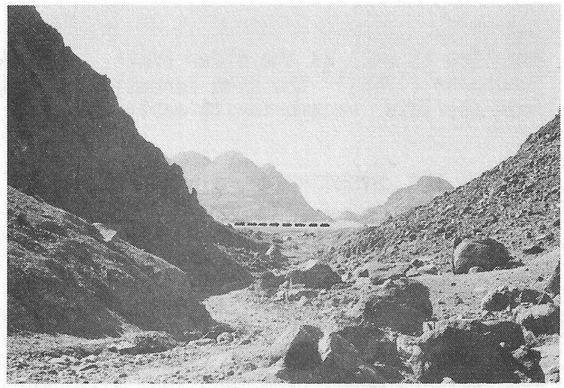
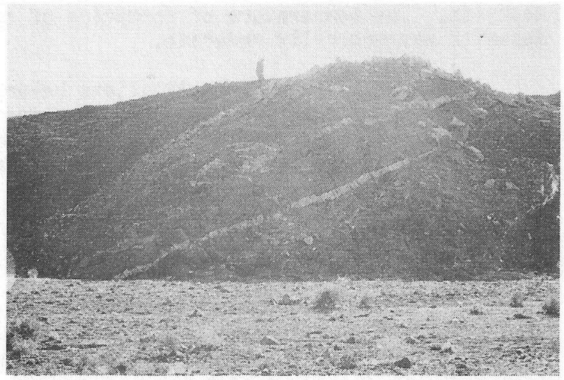


Figure 5. NW Lineament Crossing EL-Gidami Granite.



Figur 6. ENE Quartz Veins Cutting Mafic Metavolcanics Due East Of EL-Eredia Granite.

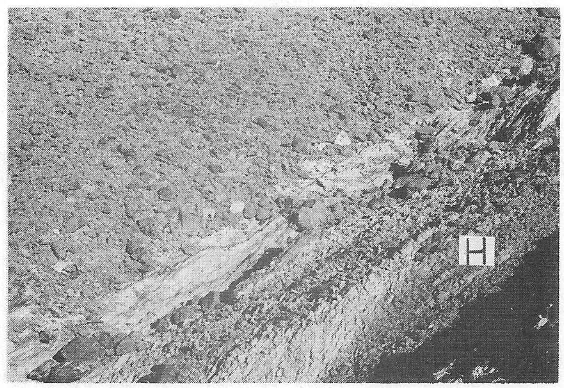


Figure 7. Mineralized Quatz Vein Cutting Mafic Metavolcanics. Q = sheared quartz, H=hematite.

and 60°NE, respectively. The ENE trend is the master one and appears to represent tension fractures genetically related to the WNW left-lateral strike slip fault. The quartz veins were crushed and severely cataclased pointing out that rejuvenation along the earlier fractures had taken place (Figure 7). Ferruginous, less commonly copper, solutions were passed through these rejuvenated fractures and deposited their materials therein. Such mineralizations could have possibly derived from sulfide deposits occurring in depth.

VI. CONCLUSION

The Precambrian basement exposed in the area between Gabals EL-Urf and EL-Eredia due west of Safaga, Egypt, possesses features relevant for ore formation. Digital processing of landsat MSS data of tnis area has revealed significant results. Ratios of MSS bands and color enhancement were the main techniques employed. The ratios AT(7/5)x2 and 7/5x50 proved to be the best ones in detecting numerous bright signatures in the postkinematic gra ites and the metavolcanics. The bright signatures observed in the granites reflect hydrothermal alteration halos formed of fine-grained silica, sericite and traces of pyrite. The entire absence of chlorite in these halos suggests that they might be genetically connected with mesothermal deposits in depth. Geochemical prospecting is, therefore, needed to confirm or deny the existence of such deposits. The original hydrothermal solutions appear to have ascended through fractures developed along pre-existing quartz veins that cut the post-kinematic granites. Such fractures represent rejuvenated tension fractures associated originally with major strike slip faults.

The bright signatures observed in the metavolcanics reflect swarms of quatz veins, some of which are mineralized, i.e. carrying hematite and traces of malachite. These could have possibly derived from sulfide deposits occurring at depth.

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