Shear zone microfabrics and multiple source of gold at the Hangaliya mine, Eastern Desert, Egypt.

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**Abstract**
Gold mineralization at the Hangaliya mine is confined to a NW shear zone in the northern part of the NW trending Nugrus granite pluton. The latter comprises monzo- to syenogranites cut by 0.5 - 3 m auriferous milky and smoky quartz- veins. Some of these veins extend into the surrounding country rocks that are made up of an ophiolitic melange and island-arc metavolcanics.

Microfabrics of the shear zone show evidence of brittle deformation such as conjugate fracturing and microfaulting in the least deformed and altered granite. Shear zone anatomy suggests that wall-rock alteration is dominated by sericitization resulting in frequent quartz-sericite rock varieties. Maximum gold content (3.3 ppm) in the quartz-sericite rock is positively correlated with abundant arsenopyrite and galena. Abundance of gold in the milky and smoky quartz-veins is 1.4 to 32 ppm and up to 10.2 ppm, respectively.

Fine secondary gold specks in covellite are produced from invisible gold in the internal structure of primary chalcopyrite due to supergene alteration.

It is suggested that the source of gold is multiple; being leached from serpentinites, metavolcanics and dolerite dykes. These rocks contain Au ranging from 0.46 to 6.6 ppm, whereas it only amounts 0.34 - 0.74 in the hosting granite. Cr and Co (up to 127 and 104 ppm, respectively) are recorded in the sheared granite.

Abundance of gold in the milky and smoky quartz veins is 1.4 to 32 ppm and up to 10.2 ppm, respectively. Fine secondary gold specks in covellite are produced from invisible gold in the internal structure of primary chalcopyrite due to supergene alteration.

It is evident that the auriferous shear zone enriches U from 20 ppm in fresh granite to 34 ppm. Accordingly, the present article deals with an uraniferous-auriferous shear zone at Hangaliya.

**Keywords:** Hangaliya-gold-shear zone-brITTLE deformation-multiple source-uranium.

1-INTRODUCTION
Gold mineralization at the Hangaliya old gold mine (Fig.1) is a typical example of deposits formed at the vicinity of granites. Hume (1937) mentioned that gold-bearing quartz veins at Hangaliya mine are associated with sericitization and silicification at the vein contacts with Nugrus granite at the vein contacts. This was also observed by Soliman (1986) who also added that the relative enrichment of the Nugrus granite in Sn at the Hangaliya mine area is ascribed to its derivation from stanniferous granitic magmas formed by partial melting of metasediments, i.e. S-type granite.

Production of gold at Hangaliya mine during this century was confined to the period between 1938 and 1952 (Mineral Map of Egypt, 1979). Mode of occurrence and genesis of gold at Hangaliya mine area were the subjects of study by some workers. Osman and Dardir (1986&1989) showed that gold mineralization at Hangaliya occurs in simple fissure filling quartz-veins in the sheared Nugrus granite trending WNW-ESE. They (op.cit.) recorded pronounced greisenization, chloritization, sericitization in addition to kaolinitization and ferrugination as wall-rock alterations. Auriferous pyrite and gold (primary and secondary) are common in the quartz veins of Hangaliya (Osman,1989) who also added that altered pink granite in direct contact with the gold-bearing quartz veins is barren of gold. Dardir and Gad (1988) restricted the gold mineralization at Hangaliya mine to the hydrothermally altered granites and quartz-veins. Recently, Murr and Klemm (1998) and Khalil and Helba (1998) related the gold mineralization at Hangaliya to the interaction of the granites with the ultramafic and metagabbro-diortite rock association. Their models seem to follow the models of Takla et al. (1990&1995). Gold in Egypt has also a genetic linkage with the Dokhan volcanics (Ivanov and Hussein, 1972; Botros,1993), rhyolite (Shalaby et al., 1994), Atalla felsites (Wetait, 1994) and fossilized placers (Hussein, 1990; Eldougdoug, 1991).

One of the main goals of the present paper is the study of detailed microfabrics of the auriferous shear zones and quartz-veins at Hangaliya mine area including the style of deformation and its imprints on the distribution of gold. Also, the source of gold in the veins and adjacent country rocks is discussed. Behavior of trace elements in the shear zone is treated in order to get a reasonable conclusion for the ore genesis.

In most of the literature covering gold mineralizations at the Eastern Desert of Egypt, it is stated that they are controlled by shear zones in the younger granites or along their contact with other rock types (e.g. Kochin and Bassiuni, 1968; Hussein, 1990). Enough information on the sense of shearing and
mechanism of deformation are not presented and consequently the timing of shearing is not well determined and whether shearing is brittle or ductile. So, the present paper tries to discuss the major tectonics of Hangaliya area in the sense of shear zone geometry, both on the field and microscopic scales.

2-MODE OF OCCURRENCE

The Precambrian basement rocks of Hangaliya area are represented mostly by an ophiolitic melange and island-arc metavolcanics intruded by pink younger granites. Two granitic masses of this type are identified, namely Nugrus and Magal El-Harami granites (Fig. 1). Both masses occur as NW-SE elongated bodies. This trend suggests that they were intruded into the ophiolitic melange parallel to the major Nugrus thrust further to the west at the contact with the NNW-SSW Hafafit culmination. Field, aerial photographs and Landsat data show sharp contacts of the younger granites against both the ophiolitic melange and island arc metavolcanics. Along contacts, the granites are not foliated but show some mineral lineation and enclose some metavolcanic xenoliths (3cmx4.5cm). Abundant joints striking mostly N60-70°E with dip amounting 70-82° SE are recorded. Less abundant N-S and NNE joints are recognized parallel to some master strike-slip faults striking nearly N-S and dips 40-65° SE. North-east and northeast-east faults are also present and occur perpendicular to the NW-SE major Nugrus thrust.

Along NW-SE faults (Fig. 2a), brittle shear zones are developed in the Nugrus granite at the site of Hangaliya gold mine. Brittle deformation is manifested by severe mylonitization of the granite and formation of a mega-conjugate fracture system (Fig.2b). Granite in this case becomes friable even in the absence of any quartz injections (Fig. 2c). Width of the alteration zone ranges from few centimeters up to 70 cm. The main types of alteration are kaolinitization, sericitization and silicification. Deep in the inclined mine shafts parallel to the main quartz lode, chloritization is also observed. Megascopic sulphide crystals (up 4mm across) and dendritic Mn-oxides are common in the altered granite within the shear zone. This granite sometimes exhibits sheet-like appearance due to intensive brittle shear zones. Along shear planes, thin quartz veinlets are injected in the granite (Fig. 2d&e), especially along the conjugate fractures. Angle of fracturing in the conjugate system is obtuse (105-125°) which is typical of brittle shear zones of cohesive rocks like granites (Ramsay, 1980; McClay,1994).

Mineralized quartz-veins (mostly milky and less common smoky) range in thickness from 0.5 to 3 m and along which the shafts of the mine were dug (Fig. 2f). Some shafts are present at the contact between the dolerite dykes in the melange and Nugrus granite (Fig. 2g). In this case, chloritization is more pronounced than sericitation as wall-rock alteration. Milky quartz shows shades of blue, green and red coloration due to the supergene alteration of Cu- and Fe-sulphides resulting in the formation of azurite, malachite and goethite-“limonite”. In the front of the shafts, there are dumps of quartz from the exploited auriferous quartz-veins (Fig.2h). Also, there are some well preserved grinding mills (Fig.2i) found near Bir Hangaliya and made up of either quartz-diorite or gabbro. Ruins of early mining activities are represented by labour houses, railway tracks, firing and extraction unit. Styles of housing are ancient and modern which may suggest that extraction of gold at Hangaliya was not only confined to the present century but might date back to the old Pharaonic and Roman times. Shafts at the wadi level are mostly horizontal whereas they are inclined (about 60° NW) at the deeper levels, approximately 35m below the mean wadi level.

3-MINERALOGY AND MICROFABRICS OF THE SHEAR ZONE

Based on the shear zone(s) anatomy on the scale of handspecimens and microscopic fabrics, four distinct sub-zones of granitic alteration along the contact between the Nugrus granite and the auriferous quartz-veins are distinguished. These sub-zones are petrographically described as follows, arranged from the granite toward the quartz-veins:-

3.1. Zone I (least deformed granite):

This zone represents the least deformed part of Nugrus granite along the shear zone occurring in the form of remnant lensoidal bodies within the sheared varieties. The rock still preserves some of its proper igneous fabrics such as the interlocking of crystals. It is dominated by quartzofeldspathic minerals (plagioclase, quartz and perthites) that are here termed “porphyroclasts” in the sense of shear effects. These minerals are brecciated and exhibit some characteristic textures of shear zones, e.g. mortar and augen textures. Coarse quartz crystals exhibit minor conjugate shear planes along which fine intracrystalline quartz is formed (Fig. 3a). The latter most probably resulted from the dissolution and recrystallization of quartz due to shearing and heat effect (Passchier and Trouw, 1996). Quartz porphyroclasts are commonly strained and corrode plagioclase, especially the early fine generation of the latter. The presumably coarse porphyritic plagioclase shows shear curvature and dislocation of the twin lamellae along microfaults (Fig. 3b). Alteration of feldspars into kaolinite is uneven.
Biotite is intensively altered to sericite, chlorite and iron oxides which are located between the coarse feldspathic porphyroclasts. Sericite resulting from the alteration of plagioclase is injected within other minerals or forms continuous streaks oriented along the major shear plane of the rock.

3.2. Zone II (pyrite-quartz-sericite rock): Deformation in this variety is more remarkable than in the previous one. The major differences between the two varieties are represented by the extensive alteration of plagioclase to sericite and its alignment in bands along the major shear plane. Also, perthite is more fractured, dislocated and its exsolved plagioclase lamellae are totally obliterated. In contrast to the mortar texture characterizing the pervious variety, this variety is characterized by ribbon-structured quartz. No traces of biotite are recorded as the mineral is completely hydrated and transformed into iron oxides and amorphous materials. This variety is characterized by the presence of appreciable amount of pyrite. Alignment of pyrite along the minor shear planes suggests that mineralization post-dates the main events of shearing. Formation of pyrite showing extensive hydration to goethite (Fig. 3c) is contemporaneous to the injection of the main milky quartz lode.

3.3. Zone III (pyrite-arsenopyrite-quartz-sericite rock): This variety is similar in mineralogy and fabrics to the previous variety, but the following differences are recorded:

i. sericite flakes become distinctly coarse and some quartz porphyroclasts are still present (Fig. 3d).

ii. increase in the amount of aligned pyrite and arsenopyrite. The latter is more abundant than the former.

iii. appearance of euhedral carbonate rhombs (ankerite).

iv. ferrugination along the micro-shear planes.

3.4. Zone IV (arsenopyrite-sericite rock): The main differences between this variety and the aforementioned varieties are summarized as follows:

i. Sulphides are confined to coarse carbonates which may suggest contemporaneous crystallization from the hydrothermal fluid (Fig. 3e). Some lensoidal fractures are filled by later annealed quartz (Fig. 3f) which is related to the introduction of the main quartz lode and that accompanied small quartz veins.

ii. amount of arsenopyrite is greater than that of pyrite.

iii. Sericite becomes the most abundant mineral ranging in abundance from 70 to 90% (Fig. 3g). Ribbon-structured quartz (Fig. 3h) ranks second in abundance after sericite in this variety.

4-ORE MINERALOGY OF THE SHEAR ZONE AND QUARTZ VEINS

Detailed ore-microscopic study was carried out for the fresh granite, alteration products within the shear zone and the quartz veins themselves. Alteration products include mylonitic granite (least deformed, altered granite) and the four sub-zones of sericitization represented by the four varieties of quartz-sericite rocks. As shown in the previous section, type of opaque minerals, particularly pyrite and arsenopyrite, in addition to their abundances and degree of sericitization can clearly distinguish these four sub-zones. All previous works in Hangaliya area were concentrated on the opaque mineralogy of the quartz veins only (c.f. Osman, 1989).

4.1. Fresh granite: Two varieties of Nugrus biotite granite are distinguished, namely rose syenogranite and brownish pink monzogranite. Most of the mineralized quartz veins are present in the vicinity of shear zones within or at the contacts with the monzogranite. No sulphides or native gold are recorded within the two fresh varieties of the granite. Opaque minerals (1-1.5%) in the monzogranite are represented only by ilmenite showing deformational twinning lamellae and extensive replacement by anatase due to low-temperature oxidation. On the other hand, the monzogranite is magnetite-rich, but some scarce skeletal ilmenite is recorded, both amounting about 3% of the rock mineralogy and are usually confined to the mafics (mainly biotite). Magnetite in this case exhibits heat martitization. It is worth to mention here that the nearby Magal El-Harami younger granite deoid any sulphides but also bear magnetite and ilmenite.

4.2. Shear zone rock varieties:

4.2.A. Least deformed granite: Magnetite of the fresh granite does not exist in this variety anymore. Only sulphides are recorded (about 1%) represented by pyrite and arsenopyrite (Fig. 4a). Anhedral specks of native gold do also exist.

4.2.B. Pyrite-quartz-sericite rock: This variety contains sulphides (~2%) comprising common coalesced pyrite (Fig. 4b) as well as subhedral crystals juxtaposing arsenopyrite (Fig. 4c) and abundant euhedral arsenopyrite rhomic crystals (Fig. 4d). Pyrite is readily oxidized to goethite leading to the transformation of invisible gold into a visible one.

4.2.C. Pyrite-arsenopyrite-quartz-sericite rock:
Arsenopyrite in this variety is more common than pyrite. The latter becomes deformed due to the continuation of shearing. Sulphides (~2%) show variable degrees of oxidation; arsenopyrite is entirely fresh but whereas pyrite is sometimes altered to goethite. Native gold is also a common opaque phase (Fig. 4e).

4.2. D. Arsenopyrite-sercite rock;
Sulphide minerals in this zone close to the quartz veins are abundant occasionally. They amount from 4 to 8%, but some random samples contain up to 11-12% sulphides and native gold. This variety contains euhedral rhombic and prismatic arsenopyrite. Some small euhedral pyrite cubes are hydrated at their rims (Fig. 4f). In some other rare instances, they are slightly flattened. Specks of native gold are also common.

4.2. E. Auriferous quartz veins;
Although sulphides and gold represent low modal percentage of the veins (1-2%), they exhibit wide variation in mineralogy and textures. The sulphides include hypogene phases (pyrrhotite, pyrite, arsenopyrite, sphalerite, chalcopyrite and galena), in addition to secondary supergene sulphides (covellite, chalcocite and digenite). In all cases, the sulphides are more concentrated along microfractures in coarse quartz crystals. Mineralogically, the sulphides of the quartz veins can be separated into the following categories:

i. High-temperature assemblage is represented by early specks of native gold, pyrrhotite and chalcopyrite-sphalerite intergrowth. Figure 4g shows the paragenetic sequence of native gold and pyrrhotite followed by unmixing of chalcopyrite from sphalerite to form emulsion exsolution texture on cooling. The hypogene sulfidization fluid might have formed at temperature of 450-500° C which form the so-called “chalcopyrite disease” in sphalerite (Barton and Bethke, 1987). The intergrown crystals enclosed by coarse younger generation of chalcopyrite at lower temperature. Native gold is either isolated or adjacent to the sulphides.

ii. Moderate-temperature assemblage includes coarse cubes of pyrite, and the second generation of chalcopyrite. Both are hypogene and the latter is commonly replaced by supergene minerals. Galena (Fig. 4h) belongs to this assemblage and occurs juxtaposing chalcopyrite.

iii. Low-temperature assemblage usually includes supergene or secondary sulphides, mostly Cu-phases. Such supergene event leads to the liberation of secondary gold in microfractures of both sulphides and quartz. Rim replacement of hypogene chalcopyrite (generation II), by digenite, chalcocite and covellite is common forming prominent atoll structure (Fig. 4i). Native gold in the quartz veins is commonly present along microfractures (Fig.4j).

5-GEOCHEMISTRY AND EDAX DATA
Trace elements in the Nugrus granite, their alteration products within the shear zone and the auriferous quartz veins were determined by XRF technique at the Nuclear Material Authority (NMA) of Egypt using a Philips X’Unique machine model PW 1510 with automatic sample changer. U, Th and Ra (eU) were measured in the NMA by the means of Gamma-Ray Spectrometry in the Department of Geochemical Exploration. Gold content was determined by the fire-assay technique at the central laboratories of the Geological Survey of Egypt as well as by atomic absorption at the NMA. The obtained data are given in Table 1.

In comparison with the fresh Nugrus granite, it is clear that both Cr (up to 127ppm) and Co (up to 136ppm) attain abnormal values in the sheared granite rocks (Table 1). These elements never exceed 10 ppm and 12 ppm, respectively in fresh granites just at a distance of 2m from the sericitized shear zone. This gives clues that both elements are leached from the melange ultramafics upon the emplacement of Nugrus granite and consequent hydrothermal veining. Similar data in other old gold mines in the Eastern Desert were documented by Takla et al. (1995). Surprising high values of Pb (up to 13608 ppm) in the shear zone is attributed to the presence of galena in fine injected quartz veinlets in the analyzed quartz-sercite rock. It is obvious that Zn in the shear zone (up to 144 ppm) is greater than its content in the fresh granite (39-79 ppm) which is a function of the element mobility within the shear zone and abundance of sphalerite.

With respect to As, Cd and Sb, there are no differences in their abundances in both fresh granites and the shear zone rock varieties. Table 1 also shows values of these elements in the quartz veins. It is here concluded that the budget of these elements comes from the granite, similar to what was documented by Takla et al., 1998 at the gold mine of Atud. Data of Table 1 also shows that Au in the fresh granite never exceeds 0.74 ppm whereas it amounts up to 6.5 ppm in the country rocks (metavolcanics, serpentinite and dolerite dykes, Table 2). So, it is suggested that leaching of gold to be concentrated in the shear zone is of multiple source. Nevertheless, shearing of granite in the Au budget is not neglected. No clear trend of Ag (0.1-0.2 ppm) enrichment in the examined rock types, especially in the shear zone(s) is evident. Enrichment of Ba (759-861 ppm) in the quartz veins is attributed to
crystallization of few barite during supergene oxidation of hypogene sulphides.

As to radioactive elements, it is noticeable that U is more enriched in the auriferous shear zone. U increases from 13-16 ppm in the fresh granite to 34 ppm when the rock is altered within the shear zone(s). This is also expressed by abundant equivalent uranium (eU), up to 17 ppm in the shear zone (Table 1). Accordingly, it is believed that the auriferous shear zones in the Nugrus granite and the Hangaliya area are uraniferous to some extent. Gamma-ray spectrometry of the quartz-veins revealed that the smoky ones are more enriched in both U and Th (8-10ppm and 22-30ppm, respectively) than the milky ones (2-3ppm and 8-12ppm, respectively). Zircon, monazite, fluorite and other common minerals that can bear both U and Th in the smoky quartz-veins are almost absent. This suggests that the different grey shades of the smoky quartz-veins are attributed to their relatively high radioactivity. Both U and Th are induced being derived from the felsic system during the episode of shearing that led to the development of the shear zone. Most workers on gold deposits in the Eastern Desert of Egypt ascribed the grey colouration of the auriferous quartz-veins to the thermal dissociation of carbon dioxide from carbonates along shear zones which follows the aspects of Boyle (1979).

Semi-quantitative microanalyses of some sulphides in the shear zone and quartz-veins were obtained using the EDAX-SEM technique (Philips XL30 with accelerating voltage of 30 kV) at the central laboratories of the Geological Survey of Egypt. Generally, supergene Cu- sulphides, e.g. covellite and chalcocite are barren in Au which is attributed to mobilization of the element to form secondary gold specks during supergene alteration as mentioned before. Involvement of Cr in the shear zone (derived from subsurface ophiolitic ultramafics) is evidenced by 0.30 wt% of the element at the structure of chalcopyrite (Fig. 5a). The microanalytical data also show that sphalerite is Fe-bearing, containing 5.14 wt% Fe (Fig. 5b). As to galena, it always shows considerable content of chlorine, about 2.17 wt% which may suggest that gold might have been carried in the fluid as chloride complexes.

6-CONCLUSIONS
a. The auriferous quartz-veins at the Hangaliya gold mine area occur along a NW-SE shear zone within the Nugrus granite pluton or at its contact with the Precambrian ophiolitic melange. Mega- and microfabrics show evidence of brittle deformation such as conjugate fracturing, flexuring and microfaulting.

b. Wall-rock alteration of the Nugrus granite at the contact with the quartz-veins is represented by various degrees of sericitization, and much less common kaolinitization, chloritization, ferrugination, silification and carbonatization, all in quartz-sericite rock varieties. Four textural types of quartz in the shear zone are identified, namely intracrystalline, augen, ribbon-structured and annealed.

c. Four sub-zones of sericitized shear granite are distinguished, being enriched in arsenopyrite >> pyrite toward the vein contact. This is equivalent to the argillic alteration at a temperature of 100-280 °C (White and Hedenquist, 1990).

d. Three sulphide paragenesis in milky quartz-veins are identified as follows: pyrrhotite-chalcopyritel-spalerite (high-T assemblage) pyrite-arsenopyrite-chalcopyrite-galenite (moderate-T assemblage) and supergene digenite-chalcocite-covellite in the oxidation zone (low-T assemblage). Primary and secondary native gold associate high and low-T assemblages, respectively. The former is sometimes accompanied by hydrothermal carbonates (specifically ankerite).

e. Alignment of most sulphides (specifically pyrite) along the minor shear planes suggests that mineralization took place after the main event of shearing. Random orientation of the relatively younger arsenopyrite also supports such conclusion.

f. Primary hypogene gold is followed by the precipitation of gold in the supergene zone via oxidation of primary Cu-sulphide (Seward, 1991), i.e. secondary gold that might be formerly invisible. Secondary gold usually associates barite in quartz-veins resulting from the oxidation of pyrite to goethite and chalcopryte to secondary sulphides.

g. Rock varieties in the auriferous shear zone of the granite are enriched in Cr and Co which suggests circulation of both metals from serpentinites due to the felsic intrusion (i.e. Nugrus granite). Enrichment of this zone in U is also detected. Radioactivity of the smoky quartz veins suggests that their grey colour is attributed to their U and Th contents.

h. Source of gold is multiple, being derived partly from Nugrus granite itself and to much greater extent from serpentinites, arc metavolcanics and dolerite dykes.

i. Abundant gold (up to 3.3 ppm) in the shear zone is evidenced by the presence of microscopic native gold. Hence, it is recommended that rock varieties in the shear
zone are a promising target for gold exploration in the future, either at Hangaliya or other localities. The present work contributes to the delineation of an auriferous-aufuriferous shear zone at the Hangaliya gold mine area.

7-REFERENCES

**Figure Captions:**

**Fig.1:** Geological map of the Hangaliya gold mine area.

**Fig.2:** Field observation and megafabrics:
- a) Local NW-SE shear zone in the Nugrus granite. b) Conjugate fracturing within the shear zone in the vicinity of one of the main shafts. c) Mylonitized granite without silica injection. d) Thin quartz veinlets (Qz) in “sliced” granite (Gr). e) More or less conjugated thick quartz (Qz) in the granite (Gr).
- f) A 35cm thick quartz-vein (Qz) within the Nugrus granite (Gr).
- g) A gold shaft dug along dolerite dyke (dol) - granite (Gr) contact.
- h) A dump of crushed auriferous milky quartz left after the old mining activities. i) A grinding mill made up of gabbro.

**Fig.3:** Microfabrics of the shear zone:
- a) Intracrystalline quartz along the conjugate microfractures in a coarse quartz crystal, C.N.
- b) Plagioclase showing microfaulting and flexure microfolding, C.N.
- c) Small goethitized pyrite cubes aligned along minor shear planes, P.P.L.
- d) Appearance of arsenopyrite associating quartz porphyroclasts, P.P.L. e) Intimate association of carbonates (carb) and sulphides (sulph), C.N.
- f) Annealed quartz showing mosaic fabrics in a highly sericitized rock, C.N.
- g) Foliated sericite rock with fine quartz, C.N.
- h) Ribbon-structured quartz in the highly silicified portion of the mylonitized granite, C.N.

**Fig.4:** Opaque mineralogy (all photos are in reflected light):
- a) Euhedral arsenopyrite in the least sheared granite. b) Coalesced pyrite cubes arsenopyrite (asp).
- c) Composite grain of pyrite (py) and arsenopyrite (asp).
- d) Euhedral rhombic arsenopyrite crystals with some silicate inclusions e) Fine gold speck in a quartz-sericite (cp-sph) altering to covellite (cov) rock.
- f) Partly hydrated pyrite at its rim in a quartz-vein. g) Chalcopyrite (cp) - sphalerite (sph) exsolution showing alteration to covellite (cov) and chalcocite (cc).
- h) Chalcopyrite-sphalerite juxtaposing galena, quartz-vein.
- i) Chalcopyrite (cp) altering to digenite (dig) and covellite (cov) in a quartz-vein.
- j) A native gold speck along microfractures, quartz-vein.

**Fig.5:** EDAX microanalyses of some sulphides.
الأنسجة الدقيقة لمنطقة القص والمصدر المتعدد للذهب بمجم حنجلية، الصحراء الشرقية، مصر

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تعدم الذهب بمجم حنجلية محمي بمصفحة قص ذات أنواع حجر غرب - جنوب شرق بجزء شمالي من كتلة حنجلية مكشوفة، وتمتد في الإتجاه الشمالي الغربي. وتزداد الكثافة بالقرب من المروجات، كما تعتبر المروجات بعواف نفوذ (لد ذو ومستعد) الحاوية للذهب و التي تراوح عمقها من 0 إلى 3 متر، وبعض هذه العروق يمكن أيضاً في صخور والملاج الأوفيولي، وصخور الجرانيت الجوعية المتحملة.

وتوضح الأنسجة الدقيقة لمنطقة القص دلائل التتشو من هيئة مقص و التصدع الدقيق خاصة في الجرانيت، و الأقل هششم. وتفاصيل منطقه القص تدل على أن تغري الصخر الحاوي على الذهب في الجيولوجيا نفسها من نوع من صخور الجرانيت - بيرسيت، وأكبر تركيز للذهب هذه النوعية من الصخور (3,3 جزء من المليون) مرتبط با تتواجد معدات الأزنجيريتيت والترايل. وتزداد تركيز الذهب في عروق لمو الجليد من 1,4 إلى 23 جزء من المليون في حين أن هذا التركيز يفوق ال 10 حزام من المليون في عروق لمو الجليد. وتثبت البحث العالمي أيضاً أن عملية التحلل الناصح لعواف كبريتيدات الحديد على النسج (مثل تحت الكالاكريتوتيت كورانيت ) تنجب حبات ذهب ثانية من الذهب الغير مبكر في هذه الكيريتيدات.

تختتم البحث أن مصادر الذهب في منطقة منجم حنجلية متحدة و يعتمد العصر من صخور السيرينتنت و صخور الريكيتيت المتحملة، حيث تزداد تركيز الذهب في هذه الصخور من 46, إلى 60 حزام من المليون في حين أن تركز العصر بالجرانيت الحاوي لعروق المرو يبلغ 34, 74, 127, 104 حزام من المليون على التوالي. بالجرانيت المورش. ويبقى نتائج هذا البحث أيضاً أن تمعدن الذهب بمنطقة القص حنجلية مصحوبة أيضاً بالككتازات كروموتستو فيلاب فيلاب في عرض المرو من 34 حزام من المليون في حين أنه لا يتجاوز 13-16 حزام من المليون في الجرانيت العاجي.