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HOGGAR SHIELD GOLD MINERALIZATION (ALGERIA)

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ABSTRACT

The Hoggar Shield is one of the most ancient geological objects of Algeria. It is made up of the Archean, Lower Proterozoic and Riphean-Vendiangranitoids, and metamorphosed volcanogenesedimentary rocks.

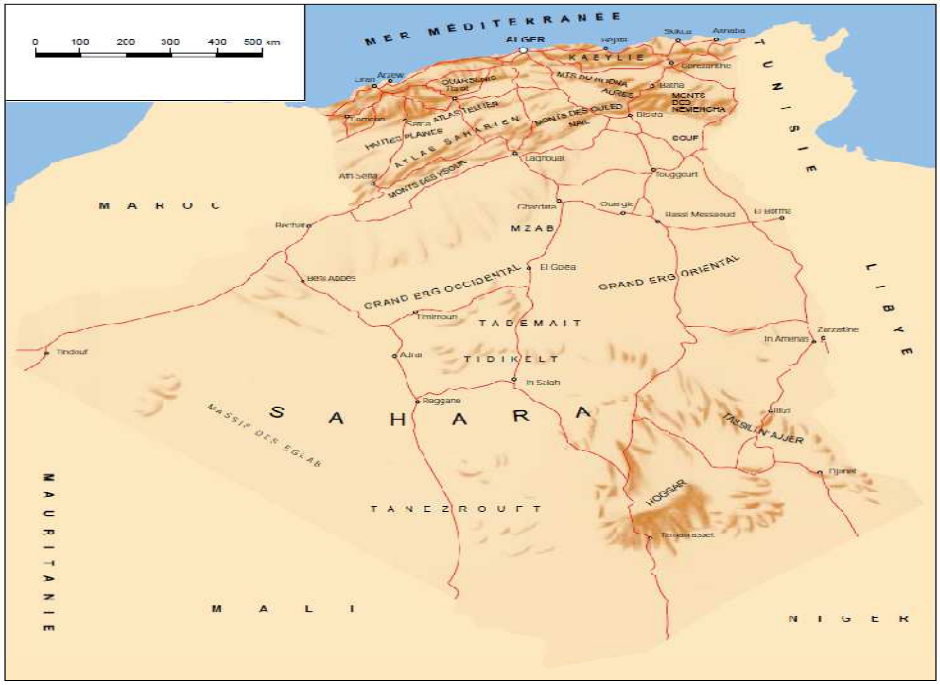
The main tectonic elements of the Shield are horst-anticlinoria and dividing them graben-sinclinoria.The age of their formation is about 760-600 millions years.

Gold ore mineralization is connected with hydrothermal veins of different age, origin and mineral composition. Five types of auriferous veins have been defined according to these criteria.

KEYWORDS: Hoggar Shield, Horst-Anticlinorium, Graben-Sinclinoria, Gold Mineralization, Geological Formations

INTRODUCTION

From the standpoint of its area (2,381,741 Km^2), Algeria is the largest country in Africa and the Arab world. Distances are great, some 2000 Km from the Mediterranean coastline to the Hoggar range and 1800 Km from In Amenas in the east to Tindouf in the west.

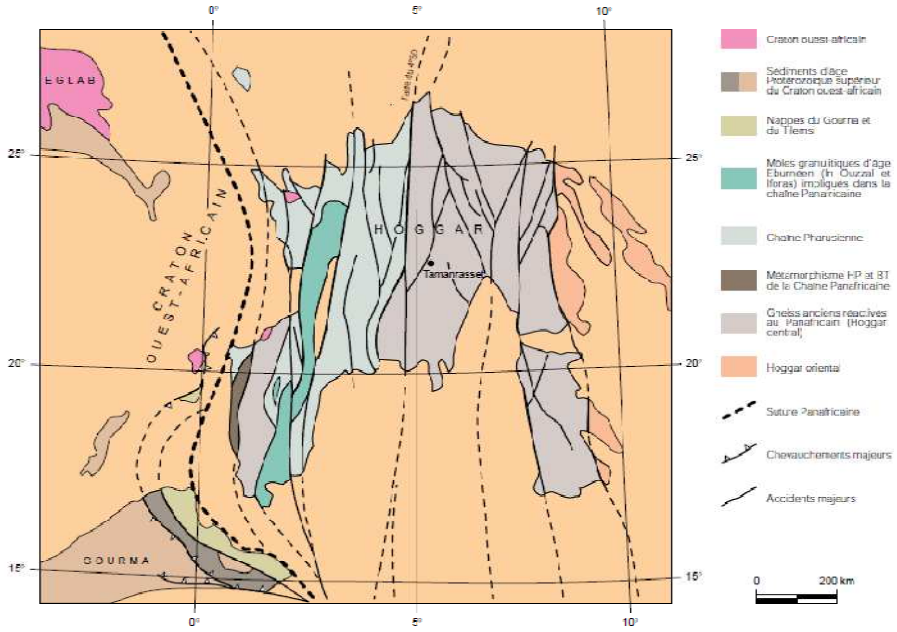


Map Creation LR/GEOGRAPH, 1994

Figure 1: Geography of Algeria

Hoggar crystalline platform mass is one of the oldest geological constructions of Algeria. It is a blocky-folded

area of about 550 thousand km^2 situated in the central part of the Sahara desert (Figure 2).



According R.CABY 1987, Simplified

Figure 2: Simplified Geology of the Hoggar Shield

Geological Setting

The Shield is composed of Archaean crystalline rocks, Lower Proterozoic and Riphean- Vendian metamorphosed and volcanogenic-sedimentary, and carbonaceous rocks. Such structure allows considering the Hoggar crystalline platform mass as a typical shield at the territory of the ancient African platform.

Geomorphologically the Shield territory corresponds to the Hoggar mountain region. The mountain region itself represents a Mesozoic bending fold complicated by deep faults. They stipulated winding outlines of South and North borders of the Shield at the contact with basalt formations of the Ordovician sedimentary cover (Figure 3). In the Central and the North-East parts the fold is complicated by big uplift of younger volcanic origin range of mountains and basalt table land. The central part of the region corresponds to the most upstanding block.

At the current denudation section abyssal, significantly granitized parts of the ancient African platform basement are exposed. Relative distribution of co folded granotoids, especially in the central, the most uplifted part of the massive together with outcrops of post folded granites works out about 30-40% of the Shield area. Its remaining part consists of plutonic- metamorphic and regionally metamorphized volcanic, volcano-sedimentary and sedimentary formations, their quantitative proportions being equal or so.

The Hoggar Shield area fully belongs to the northern Riphean area that is composed of upper part of Katanga-Damarean structural stage formations. Its characteristic feature is development of middle massifs that represent granitized complex of Riphean geosynclines. The complex known in literature as “Suggarian series” (Figure 5) is composed of granitized and gneissized volcanic-sedimentary formations. Among them there are formations belonging both to the group of eugeosyncline and miogeosyncline[9, 11,13,14].

The Shield has also more ancient Riphean formations, consisting of ophiolitic ones of Kibar structural stage as

well as relicts of Eburnean basement and original basite-granulite crust, underlying Riphean geosynclines. The oldest Eburnean Archean middle massifs having relics of granulites and charnokites are exposed at In-Uzzal block (Figure 4) as well as in the north of the Central Hoggar. Kibar formations are widely developed within the massifs that are represented by granitized rocks building up peculiar Suggarian age middle massifs within the structure of the Shield. They are represented by horst-anticlinoriua, limited by long-laid and development submeridional strike faults. Renewal of their movements during the period of Alpine orogenic processes, accompanied by platform type active volcanism is one of peculiarities of these faults. The horst-anticlinoria blocks are divided by graben –synclinoria having a characteristic folded-blocky structure. They remind volcanic-sedimentary troughs made up of Proterozoic flysch, porphyritic and molasse formations. This complex is known as “Pharusian series” [3, 7, 11, 14].

The Hoggar Shield [14] is characterized by a single major folding corresponding to the Katanga-Damarean epoque maximum age of which belongs to the age range of 680-550 million years according to numerous determinations of massif rocks absolute age. Middle massifs of Suggarian block-anticlinoria and lower parts of Suggarian blocks sections have earlier age (760-600 mln. years). These structures’ selvedges and middle massifs in Pharusian volcanic graben-syclinoria have later age Pharusian-Damarean one.

Roof block uplift of the Shield is surrounded by Ordovician-Devonian sedimentary cover deposits unionized under the title “Tassili complex” [3, 11].

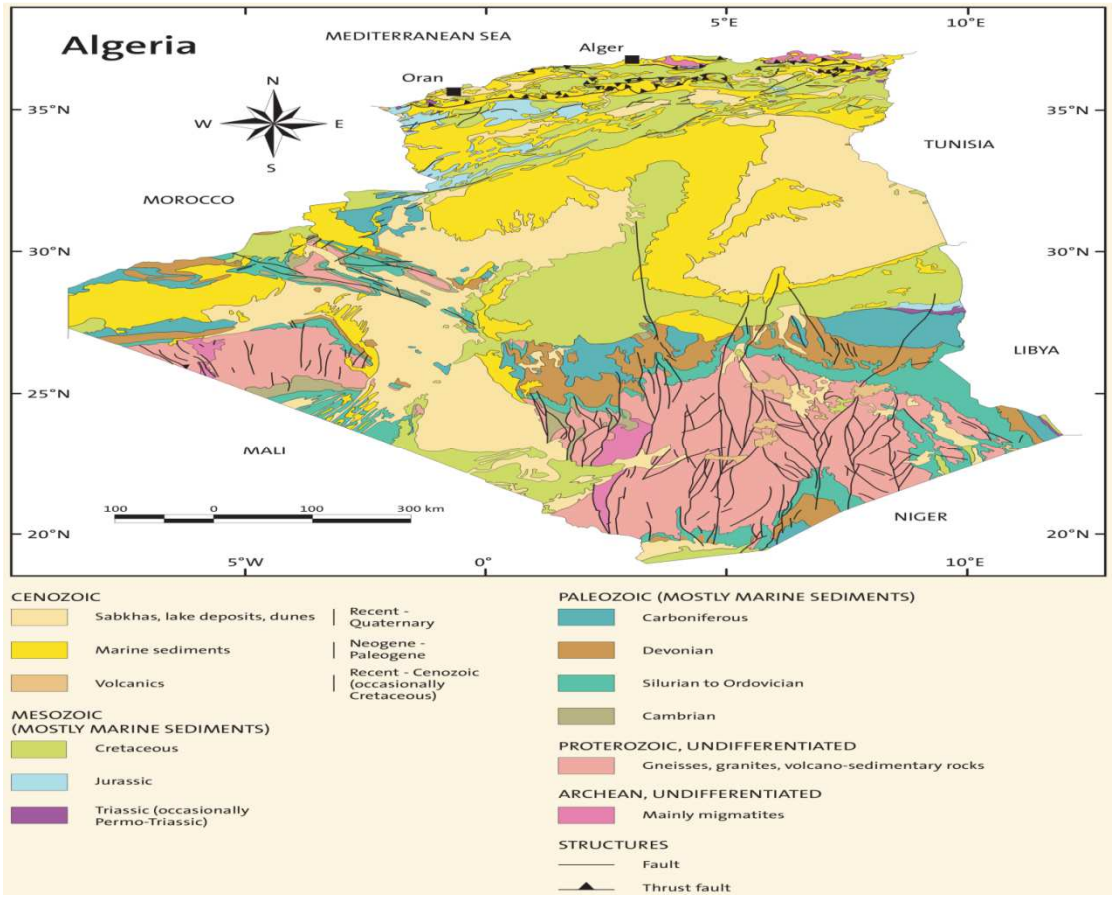


Figure 3: Geological Map of Algeria (After Fabre and Others, 1978, Corrected by the Author)

Therefore, structural zones delineation as horst-anticlinoria and dividing them volcanic-sedimentary

graben –synclinoria is the base for tectonic demarcation of the Shield. Besides, Tassili sedimentary cover and superimposed riftogene volcanic structures of Alpine Age are the main structural elements for tectonic zoning of the Shield [13, 14].

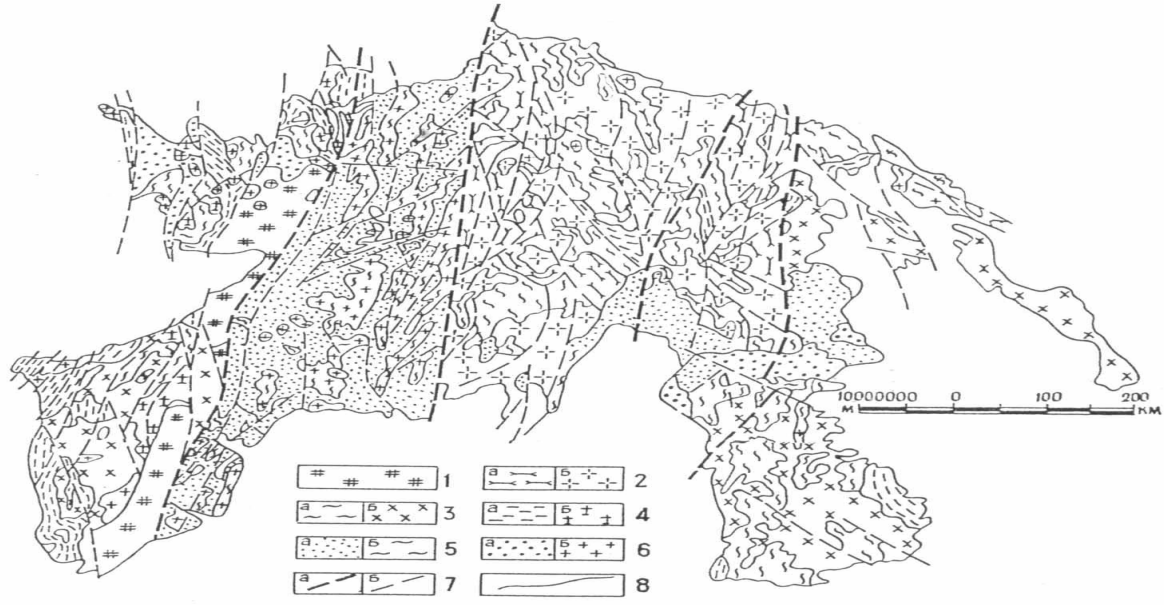


Figure 4: The Hoggar Shield Geological Map (After Grigoriev V.N. and Others, 1984)

Arhean: 1 – complex In-Uzzal; 2 – Suggarian complex: a – metamorphosed volcano-sedimentary formations, b – granitoides.

Lower Proterozoic: 3 – complex Tassendjanel : a – metamorphosed volcano-sedimentary formations, b – pre-orogenic and later orogenic granitoids.

Middle Proterozoic: 4a –stromatolithic series; b – Wallen granitoids.

Upper Proterozoic: 5 – Pharusian complex: a metamorphosed volcano-sedimentary formations, b – orogenic and later orogenic granitoids and granites of Touarirt.

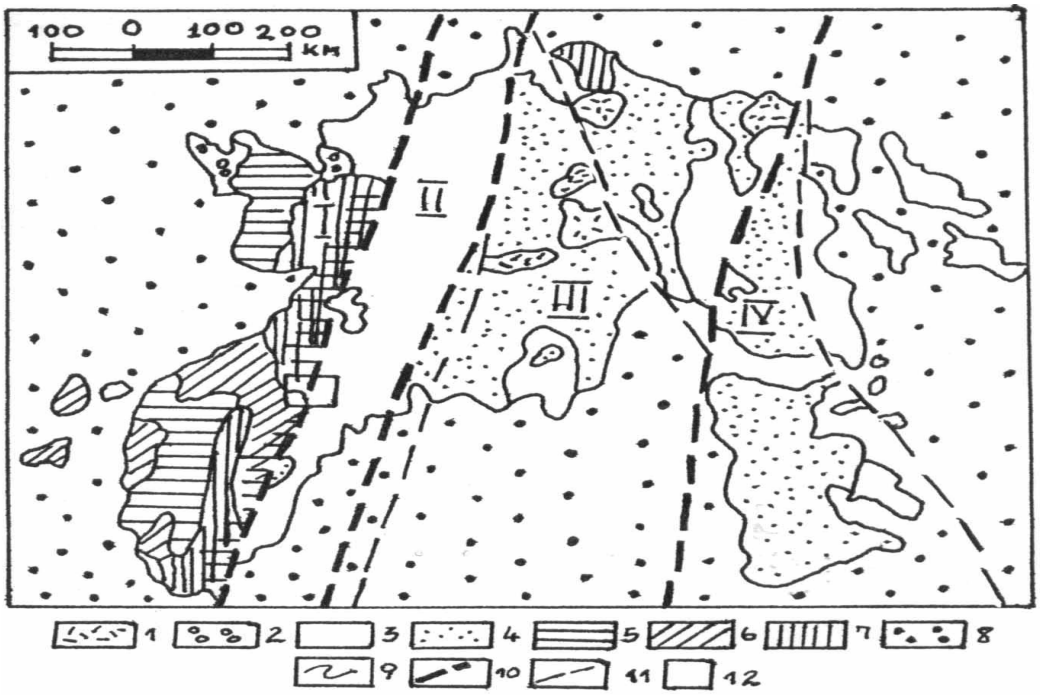
Paleozoic (Cambrian): 6a – Anet purple series; 6b – In-Uzzal granites.

Other conventional formations: 7 –faults: a – abyssal, b – crustal; 8 – contact lines.

Main structural and formational zones of the Shield, divided by areal faults of submeridional strike are the following ones (Figure.5)

- West-Hoggar horst-anticlinorium having Archean block (middle massif) In-Uzzal within its limits;
- West-Hoggar graben –synclinorium made up with Pharusian sedimentary-volcanic formations of Upper Proterozoic age representing Riphean residual geosynclines structure;
- Central Hoggar horst-anticlinorium whose structure includes Riphean granitized formations;
- Eastern Hoggar made up with both Archean granitized anticline structures and Pharusian series of Proterozoic formations synclines.

- It is found nowadays that gold mineralization within the Hoggar Shield is represented by three types:
- Quartz meso- and epithermal low-sulfidation ore veins ;
- Pyrite – tourmaline-quartz veins;
- Kies-polymetallic ores containing silver and gold.



I – IV – Structural and Formational Zones: I – West-Hoggar Horst-Anticlinorium, II – West-Hoggar Graben –Synclinorium, III – Central Hoggar Horst- Synclinorium, IV – Eastern Hoggar Structural Zone; 1 –Young Volcanic Complexes; 2 – Anet Purple Series; 3 – Pharusian Series ; 4 – Tassendjanel Series; 5 – Lower Riphean Formations; 6 – Old Plagiogneiss Complex ; 7 – In-Uzzal Granulite –Charnokite Complex ; 8 – Lower Paleozoic Sedimentary Cover; 9 –Complexes and Series Contacts ; 10 –First Rank Faults; 11 –Second Rank Faults.

Figure 5: Tectonic Scheme of the Hoggar Shield (After Schubert U. and *Faure-Muret* M., 1973)

Besides, Chayka V.M. [6] points at the possibility of gold-bearing conglomerates occurrence as well as buried alluvial Quarternary placers within Ordovician formations.

The biggest part of the Hoggar Shield gold deposits is confined to the following quartz veins:

- Veins related to Pharusian granitized diorites;
- Veins in the rocks of Tiririne series;
- Veins feathering fault in granilite rocks of In-Uzzal block.

First type veins are best studied within West-Hoggar graben –synclinorium where they form zones represented by the series of superimposed bodies, stretching along all synclinorium. The veins have various morphology and sizes. Veins having the size of several meters along the strike and thickness up to 0,3 m predominate. This type veins investigations verified their high mineralization, but only 20-30% of them are gold bearing. It was found [12] that gold only localizes at the fields of greenstone rocks development, especially diorites, that appeared at granitizing volcanic and intrusive rock of

basalt and andesite composition.

Gold distribution at productive veins is highly irregular. Its high content is common for perisalband parts of big veins or for small partings.

The following peculiarities of gold-bearing veins were defined when studying developed deposits [10, 12]:

- Productive veins proximate connection with granitization zones along the wings of anticline structures;
- Veins localization at the fields of autochthonous diorites development;
- Copper mineralization evidences;
- Presence in vein content of later generation quartz segregations;
- Hydrothermal – metasomatic alterations of salband parts of veins.

The second types veins are connected with sedimentary rocks of Tiririne series. According to the results of gold bearing field Tiririne studies [3, 4, 5], this type veins consist of several generations of quartz. Gold only occurs in “young” quartz that has pink color and creates exfoliation joints and “gas chambers” in it. Low sulphide mineralzation represented by pyrite, chalcopyrite, galenite, fahlites, sphalerite is a characteristic feature for this type of veins. Besides, these veins are subjected to propylitization and ankeritization processes. Gold distribution within the veins is very irregular.

Most of investigators of Tiririne deposit have made the conclusion that this gold mineralization is very young[6]. The main reason for that is the fact that gold-quartz veins penetrate into the faults dissecting Taurirt alkaline granites massifs, as well as the fact that gold mineralization evidences can be observed at Ordovician and Devonian sandstones located not far from Tiririne deposit.

The third type of gold bearing veins is confined to shear faults at In-Uzzal granulite block (South-West part of the Hoggar Shield). This type veins are confined to granitoids of Wallen complex and older Archean and Lower Proterozoic granulites. They are small vein bodies having extent of up to 200 m at the thickness of up to 3 m. Gold associates with chalcopyrite and its oxidizing products as well as with galenite, fahlites, bismuthine[6]. Gold distribution is extremely irregular, its content is non-commercial.

Besides the described types of gold mineralization, another two ones were defined when investigating the Hoggar Shield.

- High temperature pyrite-tourmaline-quartz mineralization confined to Pharusian gabbro massifs noticed at border grabens of the South- East wall of the Central-Hoggar horst- anticlinorium[6]. This type is characterized by commercial concentrations of gold. After the studies [12], gold bearing pyrite-tourmaline-quartz veins and partings dissect altered acid rhiolite dykes and are marked in hydrothermally altered gabbroides. These facts allowed the conclusion about close links of this gold mineralization type and granitizing processes of Pharusian plutonic rocks.
- South-West Hoggar veins consisting of dark and black quartz have visible gold inclusions at exfoliation joints of veins along their salbands. Veins thickness does not exceed 1 m and, after investigators[10, 12], they are extended along the strike and stretch at the distances of more than several km. When studying the content of veins microelements it was defined [12] that the substance filling them was supplied from enclosing formations during

later phase of Pharusian granitization.

CONCLUSIONS

The Study we Performed Allowed us to Show

- The presence of geological formations, promising for the detection of industrial gold mineralization. These include: a) supreme order synclinal like structures in the rock mass of spilite-keratophire and andesite-rhyolite formations; b) abissal fault zones bounding West-Ahaggar graben-sinclinorium on the areas of Pharuziy rock series distribution; c) areas of small intrusions formation and Taurirt granitoides formation distribution.
- The Hoggar has been separated into two major stratigraphic units. The Suggarian whose metamorphism and structure are due to the Eburnean phases and the Pharusian resulting from major Panafrican events some 600 MY ago.
- The general structure of the Hoggar, roughly interpreted be alternating horst and graben by north-south faults and with lateral block ejections and that these large fractures play an important role in sedimentation and structural edification in the Paleozoic and Mesozoic times.
- The Precambrian tectonic events are responsible for the creation of anextensive fracture network comprising major vertical faults, that is to say the horst-anticlinorium and graben –synclinorium (volcano-sedimentary) is the base for tectonic of the Shield And the latter is composed of crystalline, metamorphosed and volcanogenic-sedimentary, and carbonaceousrocks.
- Finally, based the peculiarities of the structure, composition and metamorphisme of gold –bearing rock complexes, is made assumption of polygenic metamorphogenic-hydrothermal nature of auriferous mineralization on Hoggar Shield and the Gold ore mineralization is connected with hydrothermal veins of different age, origin and composition. And the types of gold mineralization are: Quartz, Pyrite –Tourmaline-Quartz, and Kies-Polymetallic ores -Silver and the gold distribution at productive veins is highly irregular.

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