

Mineral exploration in Algeria: current state and perspectives

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Algeria territory is still underprospected. On the basis of the geodynamic evolution, we can define three metallogenic domains from South to North of Algeria : Eglab and Hoggar shields, Saharan Platform and Alpine chain. In this work we will expose for each domain, the existing mineralization and then by means of the predictive metallogeny and our field work, we attempt to predict the promising areas that deserve exploration

1. Eglab and Tuareg shields

1a. Mineralizations of the Eglab shield (West African Craton): The main mineralizations which are formed during the Eburnean Orogeny and prospected by the ORGM (National Bureau of Mining and Geology of Algeria) in this shield are:

- Orogenic gold veins hosted in greenstones formations and linked with shear zones
- Cu-Mo-Au veins and disseminations hosted in monzonite–syenite structures
- Ni-Cu sulfides ± PGE showings linked with ultramafic rocks
- Cu-Zn-Pb-Au-Ag of VMS type.
- Placers and paleoplacers of gold, diamond, rutile, ilmenite, zircon

Perspective: the junction zone that separates the Yetti from the Eglab domain is highly promising for the anorogenic-alkali granites (Nb, Ta, Zr, U, P), carbonatite-syenite complexes (REE) and REE pegmatites.

1b. Mineralizations of the Hoggar shield; The Hoggar is composed of reworked Archean-Paleoproterozoic terranes and juvenile Pan-African terranes (750-550 Ma). The ORGM has discovered the following deposits:

- Gold: orogenic gold deposits linked to the trans-lithospheric faults
- Rare Metals mineralizations (W–Sn–Ta–Nb–Li–Be) spatially associated with evolved Li–F granites (latest stage of Pan-African felsic magmatism)
- REE bearing carbonatites and metacarbonatites
- Cr, Ni, Cu (± PGE) mineralizations within the mafic-ultramafic rocks seeming without economic importance.
- Cu-Zn of VMS type.

Perspective: the Hoggar shield is part of several metallogenic panafrikan belts. Our Works allowed us to reveal the existence of a Tantalum sub-province in the Iskel terranne. Besides, more detailed prospecting should be achieved for the following promising targets: (i) REE bearing panafrikan pegmatites, (ii) F-Nb-Ta-REE bearing alkali granites, (iii) Cu-Mo-Ag-Mn-Au porphyry linked to the hypo-volcanic granites, (iv) Rare metals skarns and Paleoskarns, (v) Rare metals and Au-Ag-Sb linked to the rhyolite–ignimbrite calderas, (vi) REE-Nb-Zr linked to the Cenozoic-Quaternary alkali volcanism (syenites phonolites) and the residual REE resulting from the alteration of these rocks.

2. Mineralizations of the Saharan platform

This domain constituted by a series of sedimentary Paleozoic to Cenozoic basins represent a huge hydrocarbon reservoir and contain other metalliferous mineralizations.

2a. Mineralizations of the Ougarta range: The Ougarta range is constituted by a Proterozoic volcanic basement crowned by a Paleozoic sedimentary detrital formation. Exploration work carried out by ORGM has revealed:

- Cu mineralization of VMS type linked to the Neoproterozoic andesite-basalt formation

- Mn veins, layers and lenses linked to the Neoproterozoic Rhyolitic formation
- Cu (Ag, V) mineralization of red beds type and U-V silcrete
- Baryte veins hosted in Cambro-Ordovician sandstones

Perspective: when replacing the existing mineralization in the Mitchel & Garson model, it flow from that it would be wise to explore the following mineralization (i) syenites - carbonatites (Nb, P, REE, U, Th), (ii) anorogenic granites Sn, Nb, REE, U, (iii) U-V silcrete, (iv) Zr, Nb, Ta, Ti placers, (v) Li, B, K bearing sebkhas.

2b. Mineralization of the Bechar and Tindouf basins: the Bechar Basin, constituted by Proterozoic to Quaternary sedimentary formations, contains various mineralizations: coal layers, manganese lenses, Cu-Ag VMS mineralizations. The Tindouf Basin contains large layers of oolitic iron hosted in Devonian sandstones (reserves > 4.10⁹ tons).

Perspective for the Saharan Platform: several placers resulting from the weathering of crystalline basements (Eglab, Hoggar, Ougarta) must be prospected. Some occurrences of Zr, Nb, and Ta are found by the ORGM in the Cambrian-Ordovician boundary; predicting the possibility to discover important reserves. Silurian black shales formations (Co, Cu, Ga, Ge, Ni, PGE, Tl, Th, U, V) are spread out throughout the Saharan platform. Moreover, the numerous sebkhas are promising for important Li, K, B, Rb resources

3. Alpine Chain

The Algeria Alpine chain (Maghrebides) is formed during an oblique collision between Africa and Europe. We can define three metallogenic districts from North to South of Algeria : (i) crystalline massifs (Kabyldes) domain, (ii) Tell domain, (iii) High plateau and Saharan Atlas domain

3a. Crystalline massifs domain: Greater Kabylia, Lesser Kabylia and Edough

3a1. Mineralizations strongly linked with the crystalline basement (Hercynian to eo-Alpine phases)

- Fe (magnetite)-Ba, Pb, Sb, Au : as layers hosted in amphibolites, gneiss, marbles
- Gold mineralization (stockwerk) hosted in metagabbros and amphibolites
- Pb-Zn-Ba-Ag hosted in micaschist-marble formations
- Cr (\pm PGE) lenses hosted in metaperidotites and serpentinites

3a2. Mineralisations linked with the basement cover:

- Hg, Sb, As, Au, Ag hosted in the cover and partially in the basement
- Ba, Pb, F especially hosted in the “dorsale calcaire”

Perspective: (i) Nb-Ta-Sn-W linked with the Hercynian granites, pegmatites and metagresens ; (ii) Au, Zr, Ti, Ta ... placers.

3b. Tell Domain: The mineralizations occurring in this domain remain understudied. In the Mouzaïa-Guerrouma district exist Cu-Pb-Zn and Fe -Cu-Ni occurrences hosted in Cretaceous marls. In the Babors-Berrouaghia district stay a non economic mineralization: Cu, Pb, Zn, As, F, Fe veinlets and Fe-Cu-Pb-Ba of MVT type. The Bibans district holds the Beni Mansour strontianite deposit linked with an evaporitic diapir emplacement.

3c. High Plateau and Saharan Atlas

3c1. Mesozoic-Cenozoic cover

- Meseta and Hodna domains: Pb-Zn-Ba-F of MVT type
- Constantine Neritic and parautochthonous domains : Sb-Zn-Pb-As-Hg-Au deposits (MVT, and Hot springs types)
- Eastern Part of the Saharan Atlas: Fe-Cu-Pb-Zn linked with Triassic evaporitic diapir and huge reserves of Phosphates at Djebel Onk
- Western part of the Saharan Atlas: Cu-Pb-Zn-Ba and Mn occurrences hosted in clastic sediments.

Perspective: gold deposits of Carlin type and Au-Ag-Sb of Hot spring type must be prospected in the neritic and parautochthonous domains.

3c2. *Palaeozoic Inliers (uplifts)*: by uplifts, the Hercynian basement outcrops as Palaeozoic inliers through the Atlas and high plateau domain. Late Hercynian magmatic events were accompanied by Sn-W-Ta-Nb -Au and Cu-Pb-Zn-W occurrences. Later, Eocene and Miocene events have favored Cu-Pb-Zn-Ba veins

4. Magmatic and hydrothermal events

During the Alpine orogenesis, Miocene, Pliocene and Quaternary distension phases are responsible of magmatic and linked to mineralization emplacements.

- W-Fe (Au, Bi, Te) of skarn type
- Cu- Pb-Zn-(Au, Ag, Nb, Ta) veins and Sn-W-Nb-Ta linked with Miocene granites
- Au-Ag-As-Sb deposits (HS and LS types) and Cu-Pb ±Ni-Co (stockwerks) linked with late volcanic events
- Cu, Zn, Pb, F, Ba, Au, Ag of VMS type
- Kaolinite and bentonite deposits resulted from hydrothermal alteration of magmatic and volcanic rocks

Conclusion

Algeria hold a very big potentialities in various conventional mineral resources (Au, Ag, Cu, Pb, Zn, Sb, Sn, W Fe, Mn, P, etc.), but the strategic elements (Ga, Ge, In, Se, Te, Tl, etc.) who exist at the diffuse state in the minerals are unnoticed or unknown. Moreover the hydrocarbons, oil field brines, coals and black shales constitute also an important source for the following elements: He, Se, Te, Ge, Ga, In, V, Tl, U.