Placer Gold Deposits in Madari Gold Mine, Southern Eastern Desert, Egypt: Orientation, Source and Distribution

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***Abstract*—**Madari gold mine is delineated by latitudes 22° 30' 29" and 22° 32' 33" N and longitudes 36° 24' 03" and 35°11' 44" E. Geologically, Madari rock units are classified into dismembered ophiolites, arc volcanic assemblage, syntectonic metagabbro-diorites and Mineralized quartz diorite and granodiorite**.** Deposition of gold in area occurred as a direct result of weathering of nearby gold-bearing veins. Main concentrations of gold are supposed to ensue close to the bed rock. Nevertheless, the several shallow channel-fill features covering lag deposits, arising throughout the alluvial fan sequence would definitely contain a percentage of the finer gold due to the limited washing and sorting capacity of the uncommon flood events. Gold deposits arise as disseminated and separate gold with limited pyrite, arsenopyrite and chalcopyrite everywhere veins in the wall rocks and lode gold deposits in quartz veins. In places, the wall rocks, in near district of the quartz vein, are grieved strong silicification, chloritization and pyritization as a result of a metasomatic alteration due to purification of external hydrothermal fluids. Quartz veins are mostly steeply dipping and display banding features and frequently sheared and brecciated.

***Keywords*—**Madari gold mine, placer deposits, southern eastern desert, gold mineralization, quartz veins.

I. Introduction

MADARI gold mine area is delineated by latitudes 22° 30' 29" and 22° 32' 33" N and longitudes 36° 24' 03" and 35°11' 44" E, can be reached by "Shalatin-Gabal Maladob" asphaltic road, then 15 km south east of Gabal Korab Kansi (Fig. 1). The rock units showing in the area are categorized into dismembered ophiolites, arc volcanic assemblage, syn-tectonic metagabbro-diorites and mineralized quartz diorite and granodiorite (Fig. 2).

Gold placers follow in a varied number of kinds situated in a diversity of geomorphological environs. Reference [1] made a simplified classification that included Residual placers, Eluvial placers, Stream placers, Bench placers, Flood gold deposits, Desert placers, Tertiary gravels, Miscellaneous types (Beach placers- Glacial deposits- Eolian deposits- Marine placers), Fig. 3.

II. Geological Setting

A. Dismembered Ophiolites

These rocks form rugged mountainous belt and delimits the study area from the east and south then their foliations turn left along the northwest direction due to the effect by NW-SE sinistral strike-slip fault against the metavolcanics and metatuffs further west. Elsewhere, the movement by this fault is associated with thrust component and some slices of the highly sheared ultramafic rocks are thrusted over these arc volcanics in style of transpression contact. To the east and south, the foliatons are mainly striking ENE-WSW as they controlled by the ENE-WSW dextral strike-slip fault. In this part, the dip of foliations is generally moderate (50°-60°) and orients SE but, in places, it attains NW direction revealing NE-F1 minor plunging folds.

The ultramafic rocks form the higher peaks and are separated tectonically from the ophiolite metagabbro and amphibolites by highly sheared derivatives of talc schist, tremolite talc schist, talc graphite schist and talc carbonates (Figs. 4 (a)-(c)). The ophiolite metagabbros are highly deformed and dominantly transformed, especially along the contact with the ultramafic rocks into amphibolite. They form elongated masses with relatively moderate outcrops but with unmapped scale.

B. Arc Volcanic Assemblage

This assemblage covers the easternmost part with some exposures farther west of the study area. It is mainly recognized as metabasalts to metabasaltic andesites and metatuffs. In the field, the rocks are characterized by dark green colour and rusty brown weathered surfaces. Their foliations are mainly striking WNW-ESE to NW-SE and dip generally NE and, elsewhere SW indicating development of NW-F2 minor plunging folds. Against the ophiolitic components, they are extensively transformed into epidote chlorite, chlorite and, occasionally, hornblende schists.

C. Syntectonic Metagabbro-Diorites

These rocks are intruding the northern parts of the dismembered ophiolites and form highly eroded moderate and low-lying exposures (Fig. 4 (d)). They are less deformed and enclose relics of dismembered ophiolitic components. Generally, the rocks are dark in color, but occasionally display leuco- and melano-cratic bands away from the ophiolitic contact.

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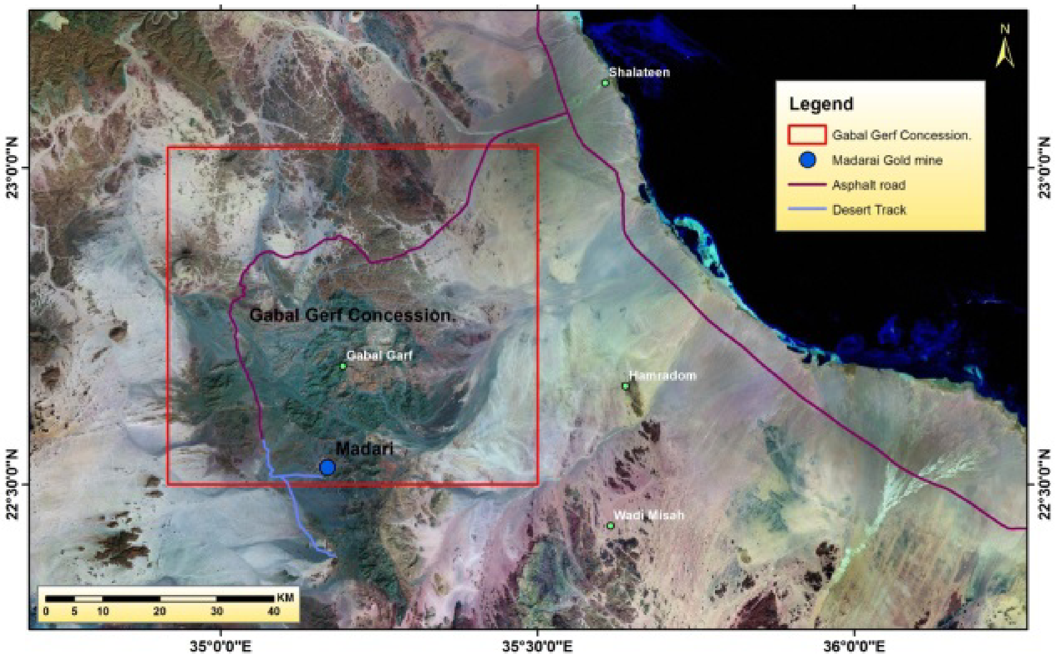

Fig. 1 Location map of Madarai gold mine and accessibility

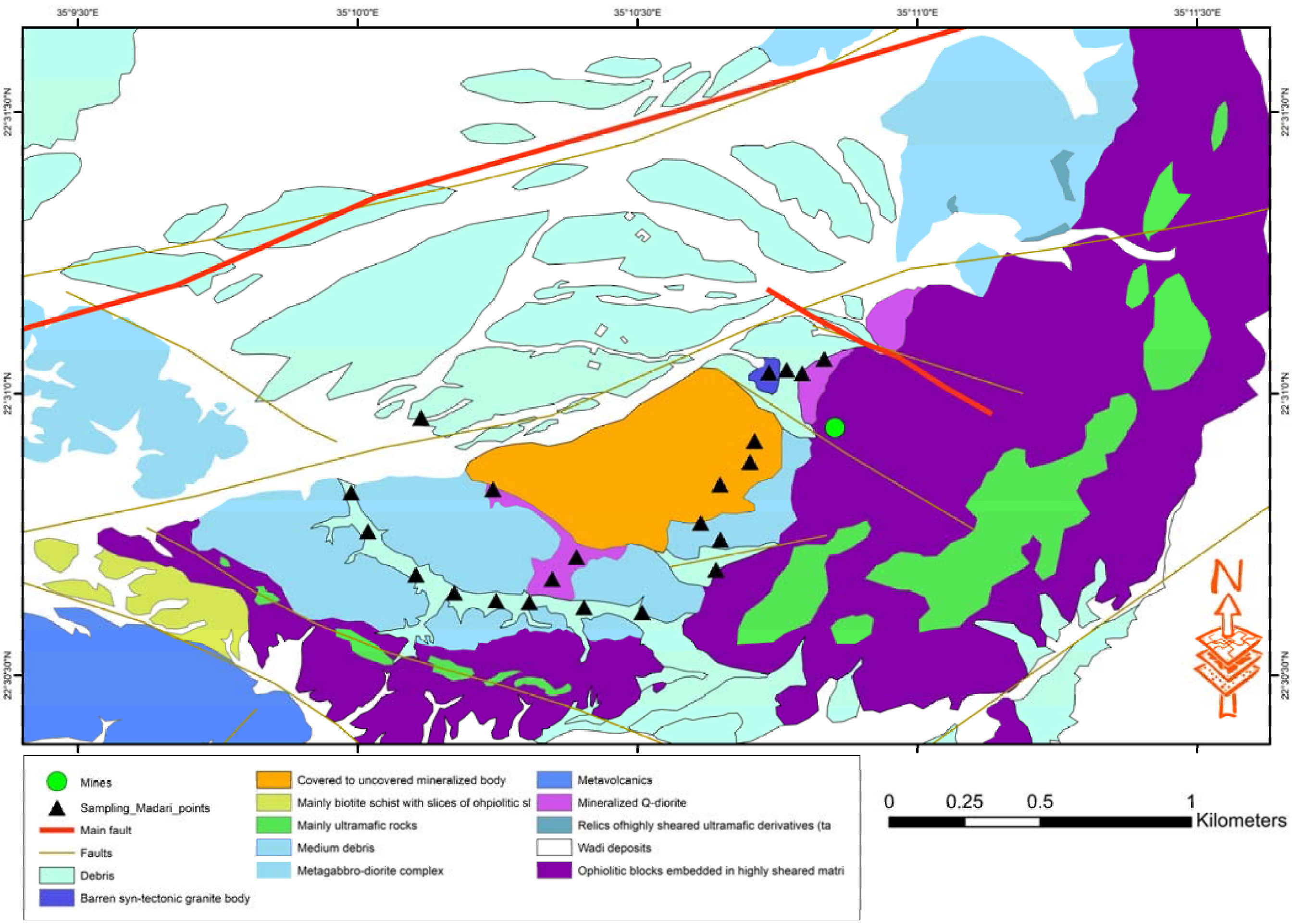

Fig. 2 Geologic map of Madari area

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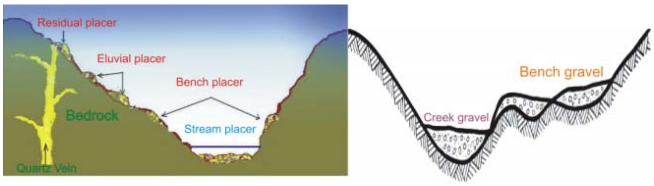

Fig. 3 Placer types

D.Mineralized Quartz Diorite and Granodiorite

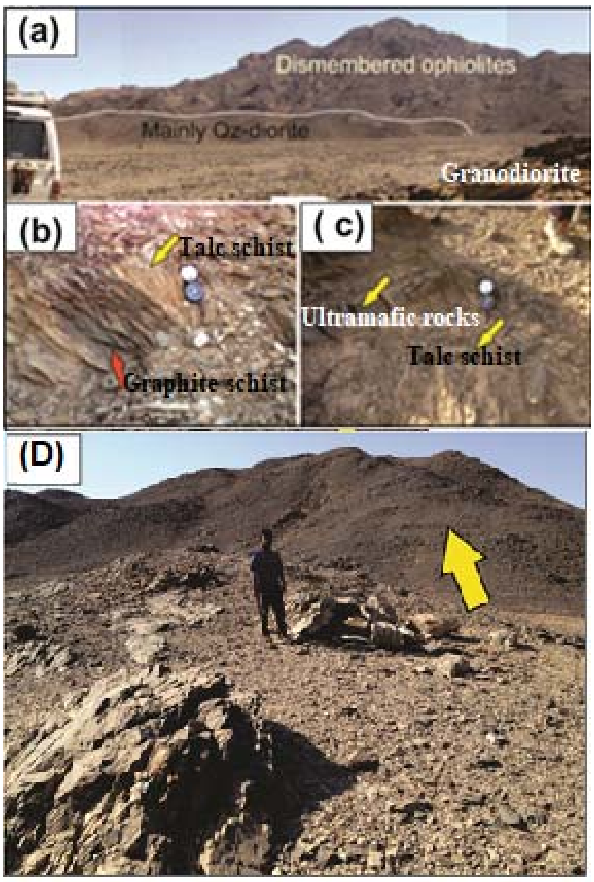

Fig. 4 (a) White line separating the contact of mineralized quartz diorite against the high relief dismembered ophiolites, (b) Outcrops of talc schist and graphite schist of highly sheared ultramafic rocks, (c) Relics of ultramafics within talc schist, (d) Yellow arrow refers to moderate relief of syntectonic metagabbro against low-lying outcrop of mineralized granodiorite

Quartz diorite is highly deformed mainly exposed in the center forming low-lying outcrops (about 350 by 850 m) Other masses are exposed in the east and west penetrating and, sometimes, extending underlying the foliations of metagabbro-diorite and rarely dismembered ophiolites. To the north, field work showed appearance and extension of the quartz diorite at many unmapable outcrops beneath the wadi deposits. A lot of auriferous smoky quartz veins to veinlets attaining linear and sigmoidal pattern and enriched in gold mineralization are injected the quartz diorite and dominated along ENE-WSW and occasionally NW-SE trends (Figs. 5 (a), (b)). Granodiorites form low relief in the center and are represented by coarse-grained and fine-grained types intruding the quartz diorite. The first type is relatively very rare and unmineralized, while the second type is mostly enriched auriferous quartz veins and delimits the margin of quartz diorite against the metagabbro-diorite (Figs. 4 (d), 5 (c)). Elsewhere, the mineralized granodiorite involves relics of highly altered or digested quartz diorite masses.

Fig. 5 (a) Auriferous smoky quartz veins and sigmoidal vein striking ENE-WSW in quartz diorite (shown by small yellow arrows in (a), (b)) and granodiorite (yellow arrow in (c))

III. Gold Trap Sites Determination and Sampling Process

The orientation stream sediment survey is carried on Madari area to help in identifying the best parameters in the sampling process.

Stream classifications are used to choice the best (Grade A) area to take the placer sample (gold trap), if the channel pattern is straight, meandering or braided (Fig. 6) [2]. Prospection of gold mineralization of stream sediments program is accompanied by digging of pits in the stream sediments shed of the investigated area. Collected samples of stream sediments were panned into heavy concentrate fraction which endangered to mineralogical studies and atomic absorption analyses to identify their gold and silver contents. Applied prospecting program includes also the atomic absorption analyses of stream sediments (-3 mm fraction) samples to identify their gold contents, Fig. 7.

IV. Gold Deposition and Distribution

Deposition of gold in Madari gold mine occurred as a direct result of weathering of nearby gold-bearing veins, Fig. 8, and was deposited as a result of the alluviation of the pedimont surface along the base of the uplifted fault block. A series of shallow braided channels starting at the head of the deposit merge down slope to form a broad area of more or less continuous placer diggings.

Highest concentrations of gold are believed to occur close to the bed rock interface in topographically low areas delineated by channels and scoured depressions. However, the numerous shallow channel-fill features containing lag deposits, occurring throughout the alluvial fan sequence would undoubtedly contain a portion of the finer gold due to the limited washing and sorting capacity of the infrequent flood events.

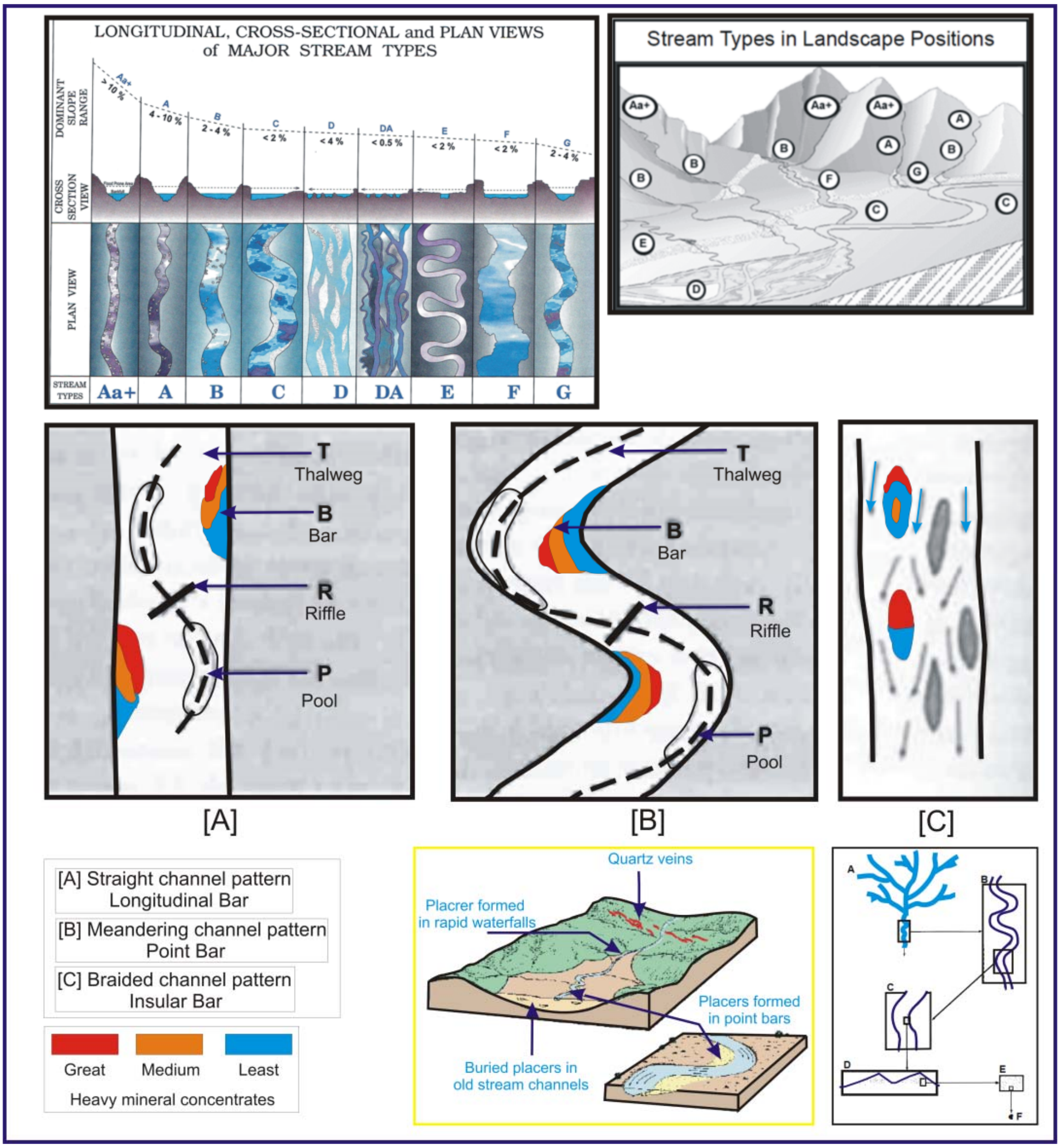

Fig. 6 Stream types, gold trap sites in 2D and 3D,

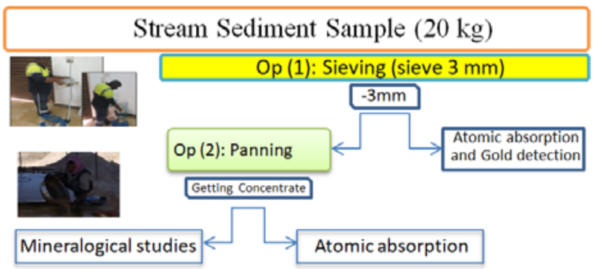

Fig. 7 Sampling preparation for analysis (sieving and panning) [Op; operation abbreviation]

V. Nature and Source of Gold Mineralization

Gold mineralization in Madari prospect is highly complex, due to different trends of the smoky and white quartz veins and not all of them mineralized as well as the felsic porphyry dikes which sometimes have a low grade and sometimes barren. The smoky quartz veins, in general have two main trends 120/25 SW and 350/50 E. The first trend is the mineralized one with thickness from a few centimeters to half a meter and found as sheeted veins and always host in the gabbro-diorite. While the second trend is related to the post mineralization N-S shear zones and not mineralized. The felsic porphyry dikes invaded throw the gabbro-diorite intrusive and always neighbor to the smoky veins. This porphyry has high silica, biotite and sericite alterations. The white sheeted veins with trend 280/70 N host in gabbro diorite and located to the SW of the main old work area and appears to be post mineralization veins.

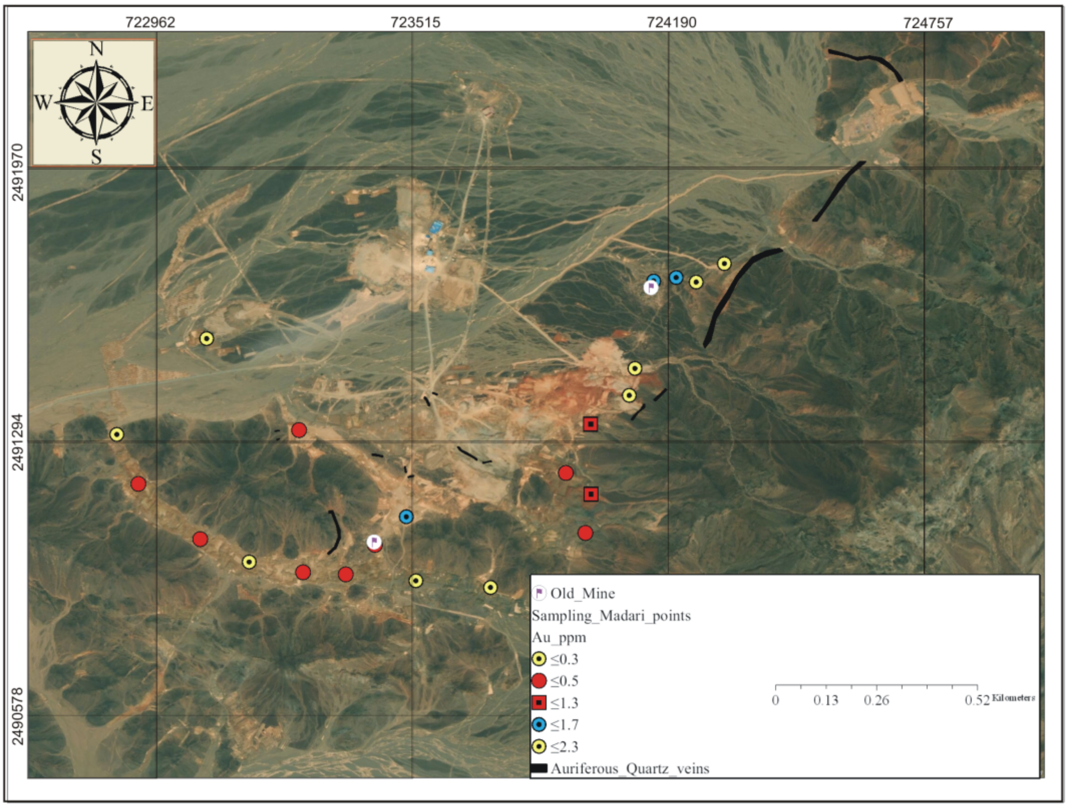

Fig. 8 Landsat map show the distribution of the placer gold sample near the bed rocks and auriferous quartz veins

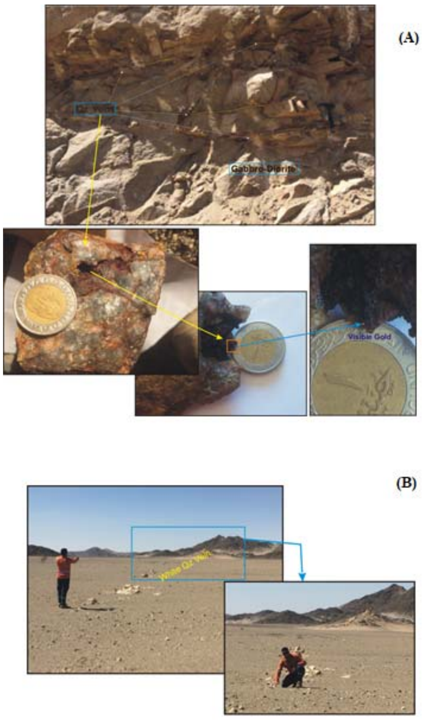

Fig. 9 (A) Smoky quartz vein with visible gold, (B) White Qz vein intruded within gabbro-diorite

Gold deposits occur as disseminated and discrete gold with limited pyrite, arsenopyrite and chalcopyrite around veins in the wall rocks and lode gold deposits in quartz veins. In places, the wall rocks, in close vicinity of the quartz vein, are suffered intense silicification, chloritization and pyritization suggestive a metasomatic alteration due to percolation of external hydrothermal fluids. Quartz veins are mostly steeply dipping and exhibit banding features and mostly sheared and brecciated.

Originally, the gold mineralization depends on three factors; source rocks, source of hydrothermal fluids and engine that transport and concentrate the gold deposits in mineable gold localities. In the Eastern Desert of Egypt, despite there is a general agreement that the source rocks are mainly ophiolites and island arc volcanics and, sometimes, granitoids intruded inside or nearby the contact of these rocks, however source of the two other factors have been a matter of controversy among many authors. Some authors consider that the intrusion of granitic rocks is accompanied by a convection flow system at the contact with the pre-existing metamorphic rocks and represent as heat engine and thus leads to the mobilization, leaching and re-deposition of gold into quartz veins close to this contact [3]. Others favor either a metamorphic origin [4] combined metamorphic-magmatic origin [5] or brittle-ductile shear zones for the source of hydrothermal solutions and spatial distribution of gold deposits [6]. The results of surface (Avg. = 0 to 3.08 ppm) and subsurface (Avg. = 2.1 to 21.01 ppm) samples reflect more concentration of gold deposits at depth. Green and black circles in the structural map represent distribution of surface and subsurface locations of rock samples, Fig. 10.

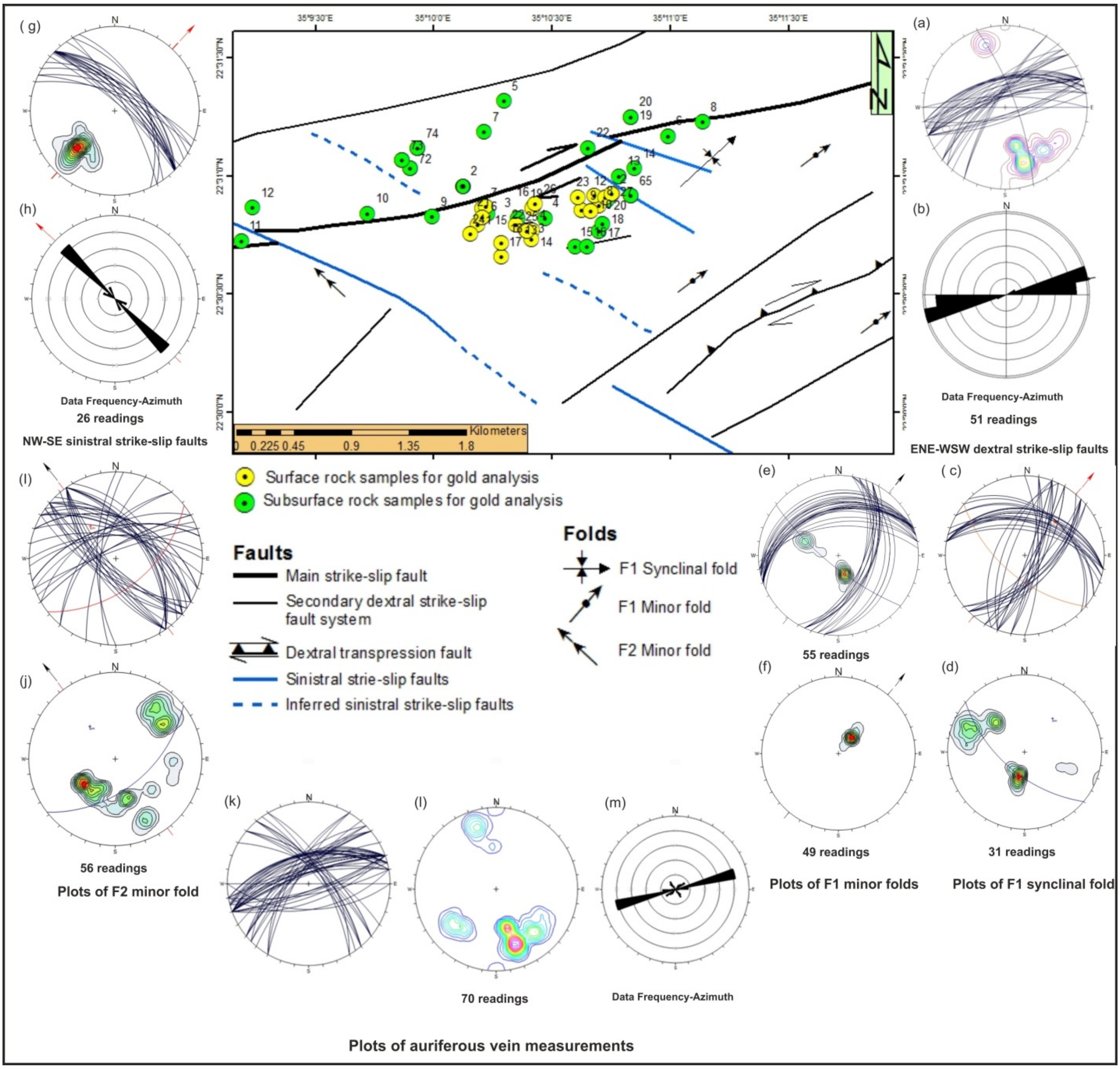

Fig. 9 Structural map showing the distribution of surface and sub-surface bed rock and quartz vein samples

VI. Conclusion

Madari area contains geologically dismembered ophiolites, arc volcanic assemblage, syn-tectonic metagabbro-diorites and mineralized quartz diorite and granodiorite. Gold in Madari gold mine transpired as outcome of weathering of adjacent gold-bearing veins. Gold deposits ensue as disseminated and discrete gold with pyrite, arsenopyrite and chalcopyrite everywhere veins in the wall rocks and gold deposits in quartz veins. Formerly, the gold mineralization is firm by three factors; source rocks, source of hydrothermal fluids and machine that conveyance and distillate the gold deposits in mineable gold localities.

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