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GEOLOGIC AND STRUCTURAL CHARATERSITICS OF THE URANIUM, COPPER, IRON-MANGANESE AND GOLD MINERALIZATION BELT AT SOUTHWESTERN SINAI, EGYPT

ABDALLA S. ALSHAMI
Nuclear Materials Authority, Cairo, Egypt

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Name:
ABDALLA S. ALSHAMI

E-mail:

Tel:

ABSTRACT

The environs are located at the eastern side of the Gulf of Suez and covered by rocks ranging from Precambrian to Quaternary. The Paleozoic sediments at southwestern Sinai comprise seven stratigraphic formations, from bottom: Sarabit El Khadim, Abu Hamata, Adedia, Um Bogma, El Hashash, Magharet El Maiah and Abu Zarab formations.

The uranium bearing sediments are mainly confined and associated with Um Bogma and upper most part of Adedia Formations. The uranium deposits are concentrated near the center of the area at Allouga, Abu Thor, El Sahu, Talet Selim and Abu Hamata localities.

The copper in Sinai was known mined and exploited since the Ancient Egyptian Times. The organic matter, clays and Fe-Mn oxides and hydroxides in Um Bogma Formation play an important role in the formation of the Cu and U epigenetic deposits.

There are two main models reported for the origin of the Fe-Mn ores hydrothermal and sedimentary.

Abnormal content of gold are recorded at the study area with abrupt and sharp decrease from 49 to 0.3 ppm.

Introduction

The study area are located on the east coast of the Gulf of Suez at southwestern Sinai, particularly between lat. 28° 55` - 29 05` N and long. 33° 20` - 33 25E.(Fig.1)

Geologically, it is covered by Precambrian basement rocks comprising gneisses and schists intruded by diorites, granodiorites and granitic bodies. These are non-conformably by Paleozoic sediments.

The Paleozoic sediments were classified into: Lower Sandstone Series, Middle Carbonate Series and Upper Carbonate Series (Barron, 1907). Soliman and Fetouh (1969) classified the Lower Sandstone Series into: Sarabit El-Khadim Formation, Abu Hamata Formation and Adedia Formation. Weissbrod (1969) applied the term Um Bogma Formation for the Middle Carbonate Series. However, Omara and Conil (1965) classified the Um Bogma Formation into: Lower Dolomitic Member, Middle Dolomitic Limestone Member and Upper Dolomitic Member, which were adopted by most authors with some differences.

Also, Soliman and Fetouh (1969) classified the Upper Sandstone Series into: El-Hashash, Magharet El-Maiah and Abu Zarab formations.

Since, Abdel Monem (1958), El-Sokkary (1963), El-Aassy et al. (1986), Alshami (2003), uranium and copper anomalies were discovered at several localities of the study area. The Uranium and copper mineralization at these localities will be investigated in relation to the sedimentary facies hosting it. These facies include gibbsite bearing sediments, ferruginous siltstone, shale, dolostone, claystone, marl and iron-manganese ore.

On the other hand, Fe-Mn ores was discovered by Bauerman (1869), while the gold occurrences was discovered by Alshami (2018b, in press) in conglomerate of Taba Formation, sandstone of Sarabit El Khadim Formation and dolostone of Um Bogma Formation.

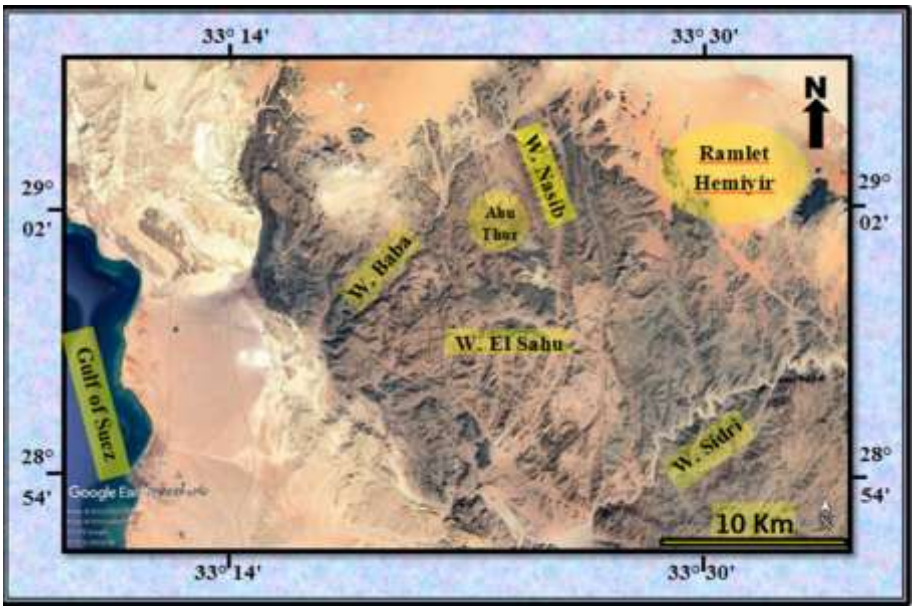

Fig.(1): Google earth of SW, Sinai.

Fig.(2): Basal conglomerate hosting gold of Taba Fm. at Khaboba locality , looking W .

Geologic setting

The Um Bogma Formation exposed in the study area is characterized by the presence of uranium, copper, Fe-Mn ores and some gold especially with dolostone. This formation reached its maximum thickness (67) m at khaboba locality (Alshami, 2003), Talet Selim (28) m and Abu Thor (27) m. The Um Bogma Formation is well represented in the central parts of the study area (Allouga and Abu Thor). In the following paragraphs, the structure, U, Cu, Fe-Mn ores and some occurrences of gold) Fig.2).These ores will be described in details with some correlation in between the various investigated localities. The facies and the horizons hosting the U, Cu, Fe-Mn and Au mineralization will be pointed out.

Structure

The main tectonic trends in Egypt are the N-S Precambrian trend, the EW Paleozoic-Jurassic trend, WNW Early Cretaceous drag trend, the ENE Syrian Arc trend of Late Cretaceous to Early Tertiary and the NW Red Sea trend for Late Tertiary (Meshref, 1990).

The Gulf of Suez represents on a symmetric half graben (Moustafa, 1976). Chanet et al. (1984) concluded that the evolution of Suez rift began in the Oligacene times. The start of major faulting took place during Early Miocene. The tectonic structure in the study area is represented by the planar and linear structural elements. The planar structures include bedding, faults and joints while the linear ones include fold axes and quartz rods.

The major faults cutting the basement and sedimentary rocks show a complicated structural history, which are mostly rejuvenated more than one time since their formation. Field observations confirm rejuvenation movements as indicted by different types of striation along the fault planes having the same trend.

The present study found that the Fe-Mn , Cu and U are located within the belt extended NE-SW. This belt acts as a barrier and controls this ores.

Uranium deposits

In the study area the uranium deposits are concentrated at the center at Allouga, Abu Thor, El Sahu, Talet Selim and Abu Hamata areas (Figs.3,4) . It is found as visible spots on the surface of rocks, along joints and disseminated in the beds (Figs.5,6,7). The siltstone, shale and claystone are considered the main facies hosting the uranium deposits especially at the lower member of Um Bogma Formation. The uranium minerals found within these facies comprises oxides, oxyhydroxides carbonates, silicates, phosphates, arsenates, vanadates, molybdates and sulphates (Alshami, 2018a). The following paragraphs summarize the recorded U-mineral species observed in the study area, and show the distribution of U-minerals within different facies, as well as the various member of Um Bogma Formation.

Allouga

The siltstone of lower member of Un Bogma Formation comprise liebigite, both woodite, autunite, meta-autunite, hydrogen out unite, meta-torbernite, metauranocircite meta-zenurite, carnotite, Rb-carnotite, meto-tyuyamunite, K-zippeite and zippeite. Some of these minerals are occur as visible spots of

the surface of rocks along joints and disseminated in the others. While at the shale of lower member of Um Bogma Formation comprise uranophane and bassetite.

b) The dolostone of middle member of Um Bogma Formation comprise uraninite, coffinite, brannerite, meta-calciouranonite and strelkinite. While at marl of middle member of Um Bogma Formation comprise meta-autunite.

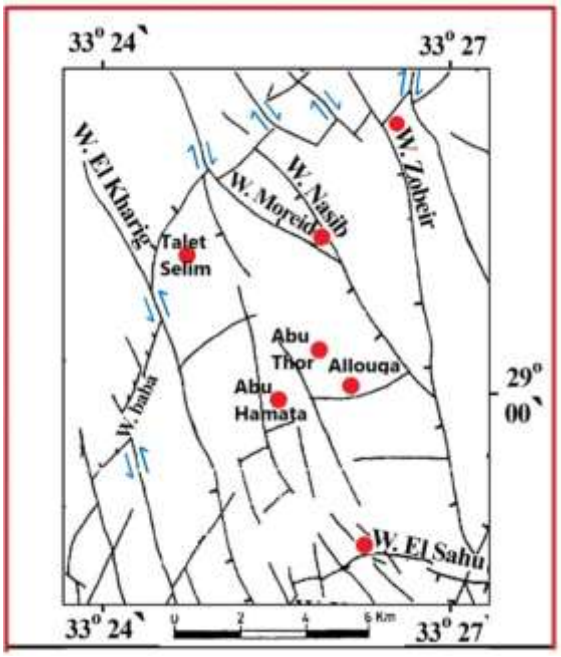

Fig. (3) The westem side of belt (Baba-El Seih) act as a barrier to U-mineralization (after Alshami, 2018a) with some modification

Fig.(4): Google earth of promising localities at SW, Sinai. (after Alshami, 2018a)

Fig.(5): Uraniferous sandy dolostone at Allouga locality, SW, Sinai.

Fig.(6): Visible U-mineralization of sandy siltstone of Adadia Fm. at Ramlet Hemiyir looking S.

Fig.(7): Visible U-mineralization of sandy claystone of Um Bogma Fm. at Abu Hamata looking E .

Shale of upper member of Um Bogma Formation comprises kasolite, sklowdowskite, uranophite meta-uranocircite, meta-zeunerite and carnotite. It is occurs as disseminated spots in the rocks.

Abu Thor

a) The carbonaceous shale of lower member of Um Bogma Formation comprises moluranite sedovite and umohoite. While at gibbsite bearing sediments of lower member of Um Bogma Formation comprise Zn-zippeite.

b) Dolostone of middle member of Um Bogma Formation comprise soddyite. While the gibbsite bearing sediments contains uraropilite.

Gravels contain clakeite, uranophane Beta-uranophane, kasolite, skloudowskite Bottwoodite, carnotite, K-zippeite phosphuranylite.

El Sahu

Claystone of lower member of Um Bogma Formation contains, metatorbornite, phurcalite carnotite. It is occurs as both disseminated and at the surface of joints.

Abu Hamata

The claystone of middle member of Um Bogma Formation contains phurcalite and renardite, while at the dolostone of the middle member of Um Bogma Formation It contains soddyite.

Talet Selim

Carbonaceous shale of lower member of Um Bogma Formation contains umbohotie.

Copper deposits

Since the Ancient Egyptian Time, the study area has been considered as an important target for some economic ores of copper. In the following paragraphs, the Cu mineralization (Figs.8,9,10),the mode of occurrences and description of the copper deposits at some localities are given below.

Ramsi

It is located within the normal fault that extends from Wadi Kharig to Abu Zarab. It is found along Wadi Baba and near Wadi Abu Thor as it seems to be a separate mountain. The copper deposit extends for 3m inside old mine and the thickness about 2m. They are associated with ferruginous siltstone of the lower member of Um Bogma Formation, Atacamite is observed on the walls of the mine.

Zobeir-Lehian locality

This locality appears as V-shaped or long hill. The topography is moderately low. It is affected by normal faults and located nearly at the north of the study area. South Gabal Um Rinna. Malachite deposits are associated with marl of the middle member of Um Bogma Formation.

Talet El Zarqa

It is located along the low topography of Wadi Um Hamd. It is extends about 45m with thickness about 3m. Turquois deposits are found in ferruginous siltstone of lower member of Um Bogma Formation.The mode of occurrence of copper minerals are found as fine disseminations in sandstones, thin films and encrustations along the fissile laminae surface of shale or small thin veinlet's in marls as well as their association with (Fe-Mn) ores. (Ramsi, Zobeir-lehian and Talet El Zarqa from Alshami, 2003).

Fig.(8): Marl hosting Cu-mineralization of Um Bogma Fm. at Allouga locality looking W .

Fig.(9): Carbonaceous shale hosting Cu-mineralization of Um Bogma Fm. at Allouga mine looking W .

Fig.(10): Dolostone within Cu-mineralization of Um Bogma Fm. at Allouga locality looking W .

On the other hand, such materials adsorb metal ions from circulating fluids on their surface causing high concentration of the metal ions in the pore fluids which facilitate the reactions with the available ions.

Iron-mangarese deposits:

The Fe-Mn deposits (Figs.11,12,13) are found as lenticular bodies within the lower member of Um Bogma Formation. The mode of occurrence of Fe-Mn deposits is differing from locality to other. It found at the base of Um Bogma Formation, or intercalated with dolostone, overlying the part of lower member of Um Bogma Formation, sometimes occupies the lower member of Um Bogma Formation; finally, it is rarely found at both the middle and upper member of Um Bogma Formation. The field investigation indicate that the stratiform Fe-Mn are within the Um Bagma Formation were formed during marine encroachments (Kora, et al., 1994). Shale siltstone found within Fe-Mn ores, these may be related to terrigenous source. Also, the Fe-Mn ores were derived by the supply of manganese through the continental erosion during marine transgression, Roy (1981). Mineralogically of Fe-Mn deposits, Attia et al. (2012) found at the study area woodruffite, chalcophanite, cryptomelane, danalite and wolfranite. Bishr and Gabr (2012) found krettenichite, chalcophanite and hetaerolite in Fe-Mn ores at Talet Selim.

There are two main models reported for the origin of Fe-Mn ores: (1) hydrothermal origin, based on the relation between the thickness of the or body near the faults and the presence of hausmanite and manganite as indicators for hydrothermal activity; (2) sedimentary origin based on the presence of Fe-Mn ore in fixed stratigraphic horizon, lower member of Um Bogma Formation.

Fig.(11): Fe-Mn ore of Um Bogma Fm. at Abu Thor locality looking N .

Fig.(12): Lenses of Fe-Mn ore of Um Bogma Fm. near the unconformity surface at Abu Hamata locality looking E .

Fig.(13): Lens of Fe-Mn ore of Um Bogma Fm. at Allouga locality looking E .

Relations between U, Cu and Fe-Mn deposits.

I) The enrichment of uranium mineralization is concerned with the oxidation degree of Fe in the Fe-Mn ore lenses at Allouga and El Sahu localities.

II) Uranium was enriched during the main karst laterization processes concrurrently with Fe-Mn remobilization during the weathering active processes (Shata and El- Balakssy, 2012).

III) Adsorbed U-minerals, hydrogen autunite and carnotite disseminated in the interspace of pyrolusite radial and a circular grains.

IV)The present study reported that, the presence of organic matter, clays and Fe-Mn oxides and hydroxides in the Um Bogma Formation plays an important role in the Formation of the Cu and U epigenetic deposits.

Placer gold:

The gold content recorded at Infra-Cambrian of conglomerate of Taba Formation 49 ppm, then it abrupt and decrease at Cambro- Ordavician sediments in three formations:

a- Sandstone of Sarabit El Khadim Formation (4.5 ppm).

b- Shale of Abu Hamata Formation 0.4 ppm.
c- Sandstone of Adedia Formation 0.3 ppm.
On the other hand, it is found in dolostone of Um Bagma Formation of Lower Carboniferrous which reaches up to 9.7 (Alshami, 2018b, in press). From field investigation the gold content and associated elements found high values where the Taba Formation overlain the basement rocks comprise mica-schist than those of granitic rocks.

Conclusions

To summarize the U, Cu and Fe-Mn deposits of southwestern Sinai are represents as a belt which extended NE-SW. The west side of this belt is located along Baba-El Seih, while the east side extended from El-Sheikh Soliman – Hemeiyir. These ores and association elements are concentrated within Um Bogma Formation (Lower Carboniferous). In addition, the uranium deposits are found at uppermost part of Adedia Formation and the Cu deposits are found at both Adedia and Abu Hamata formations.
This belt controlled by the structural trend of Wadi Baba-Wadi El Seih, from the map (Figs.14, 15) this NE trend had been cut and displaced (lift lateral) in the SW part of Wadi Baba. However such displacements (right lateral) by NW younger faults, this resulted in the curved shaped of Wadi Baba-Wadi El Seih province.
The present study found that, most of the occurrences of U, Cu, and Fe-Mn are located within the belt which extended NE-SW. On the other hand, the present study found from the detailed field observation that:
1- The mineralization of U and Cu are confirm with epigenetic origin
2- Fe-Mn ores has a fixed stratigraphic horizon within lower member of Um Bogma Formation of Lower Carboniferous, therefore, the present study assign to sedimentary origin to most of the Fe-Mn ores.
3- The explorations of gold are consider at beginner stage and need farther studies. The gold is found within conglomerate of Taba Formation of Infra-Cambrian, sandstone of Sarabit El Khadim Fomation of Cambro-ordovician and sandy dolostone of Um Bogma Formation of Lower Carboniferous. The present study focused on the conglomerate of Taba Formation which spread at most south Sinai as a very promising paleo-placer sediments of gold.

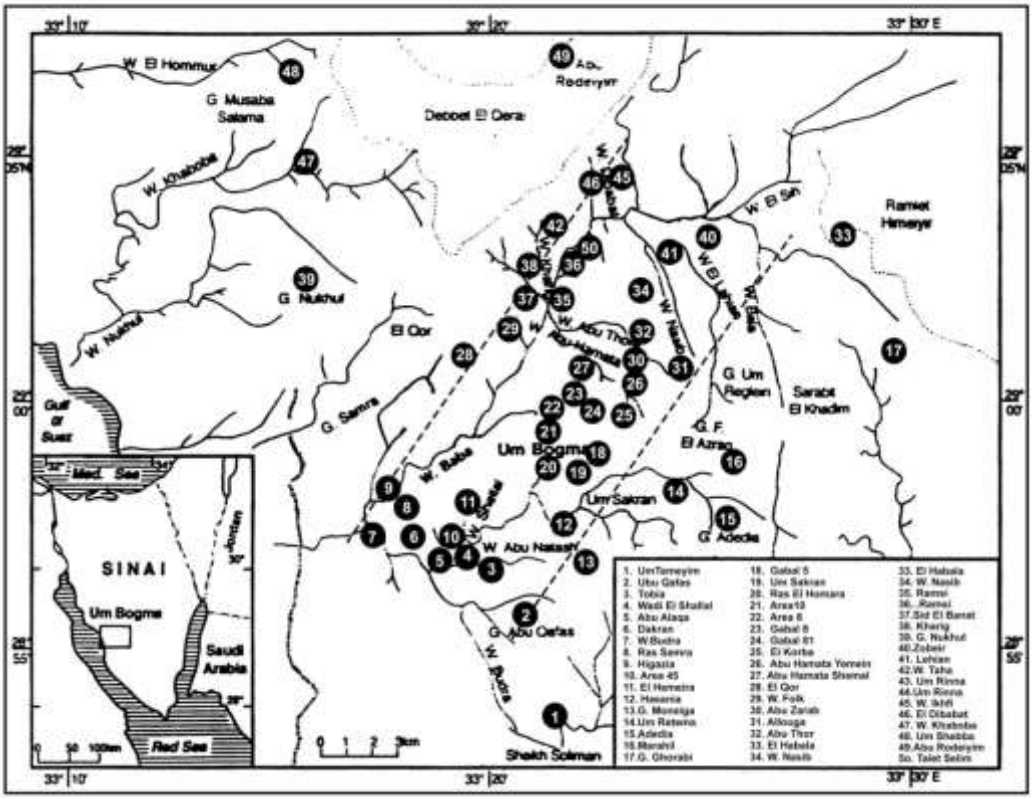

Fig. (14) The belt comprises Fe-Mn ores at SW, Sinai, after kora et al.,1994 with some

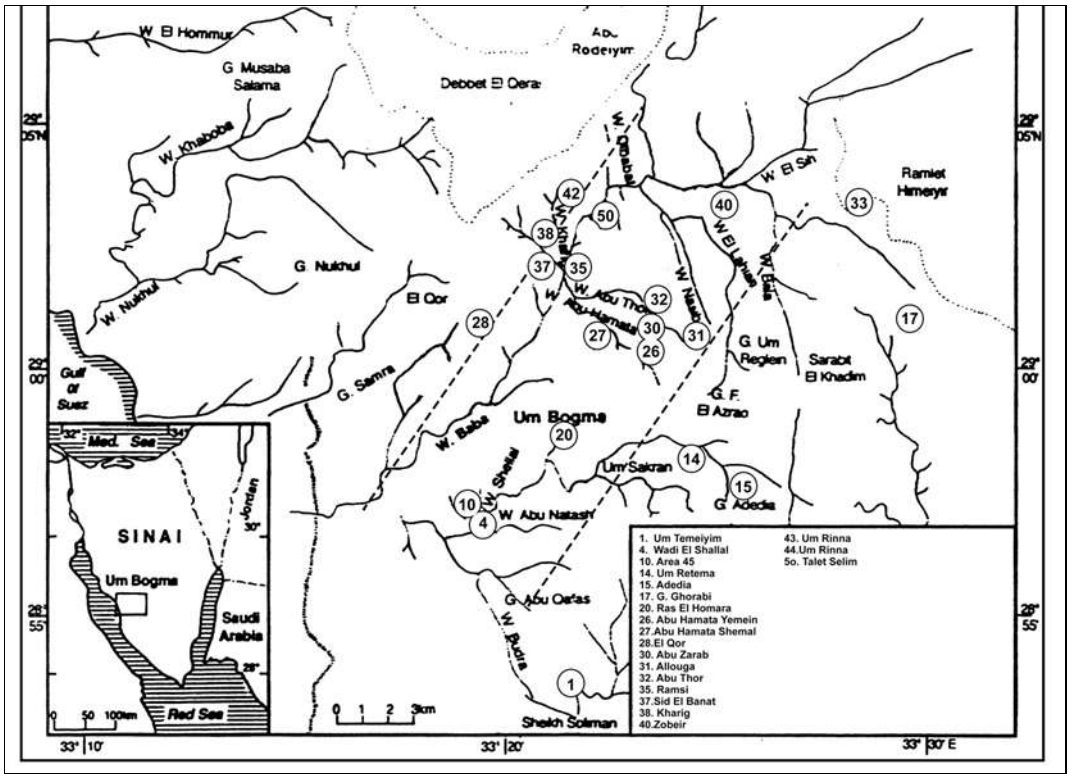

Fig. (15) The belt comprises U and Cu occurrences at SW, Sinai, after kora et al.,1994 with modification.

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الملخص

– تقع منطقة الدراسة على الساحل الشرقي لخليج السويس وتعد هذه المنطقة من المناطق الواعدة حيث تحتوي على خامات المنجنيز والحديد والنحاس و اليورانيوم وحديثا بعض تواجدات الذهب و هذه الخامات جميعها هي موضوع الدراسة.

– وضحت هذه الدراسة أن هذه الخامات محكومة بتركيبية و طوبوغرافية المنطقة حيث يحدها من الغرب صخور مابعد الباليوزوي ومن الجنوب صخور القاعدة و التي يصل ارتفاعها إلى 1000 متر فوق سطح البحر و من الشمال تختفي صخور متكون أم بجمة الحاوي لهذه الخامات حيث أن الميل في المنطقة ناحية الشمال. و بهذا تختصر تواجدات الخامات في اتجاه (شمال شرق – جنوب غرب) والذي حددته هذه الدراسة.

– هذا و قد أثر وادي بعبع– وادي السيح من ناحية الغرب تأثيرا واضحا في التحكم في هذه الخامات فنادرا ما نجد تمعدنات خلفه مقارنةً بالتمعدنات أسفل هذا الحزام التعديني.

– وكذلك فإن الناحية الشرقية للحزام التمعدني هذا يبدأ من منطقة الشيخ سليمان حتى جبل حمير، و هذا أيضا محكوم بصخور القاعدة من الجنوب و جزئيا من الشرق.

– هذا و أن وسط هذا الحزام (منطقة العلوجة وأبو ثور وأبو حماطة و تلعة سليم و الصحو) تعد المناطق التي تحتوي على كميات كبيرة من الخامات بالإضافة إلى أنها ذات درجة عالية لنقاوة الخام بالمقارنة للتواجدات الأخرى.

– تأمل هذه الدراسة أن يزداد الاستكشاف في هذا الاتجاه (شمال شرق –جنوب غرب) والذي حددته هذه الدراسة للحصول علي تواجدات جديدة تضاف إلي ما قد تم استكشافه سابقاً.

– أما بالنسبة للذهب فقد تم اكتشافه في صخور الكونجلوميرات فى متكون طابا و الحجر الرملي فى متكون سرابيط الخادم والدولوستون فى متكون أم بجمة وتعتبر مبشرات أولية تحتاج إلي دراسة أوسع.

من ناحية أخرى ومن خلال الدراسات الحقلية التفصيلية تتفق هذه الدراسة على أن رواسب اليورانيوم والنحاس تكونت بعد نشأة صخور الباليوزوي وتتركز في وسط الحزام المشار إليه فى هذه الدراسة و الذي يمتد شمال شرق– جنوب غرب. وكذلك تتفق هذه الدراسة على أن رواسب الحديد والمنجنيز معظمها رسوبية التكوين حيث أنها تقع فى نطاق استراتيجرافى ثابت وهو العضو السفلي من متكون أم بجمة.