# Geochemical Investigation Of Gold Mineralization in Sodari Locality- North Kordofan State- Sudan (January2024 To August 2024AD)

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**Abstract:**

This study was conducted in Sodari Locality- North Kordofan State - Sudan. January , 2024 .The study was intended to the geochemical investigation of gold mineralization and associated minerals in the study area.The objectives of this study is to investigate the relationship between the geological structures of the gold bearing rocks and the mineralization and other associated minerals in Sodri area , this objectives in the study area has been achieved the quantities and descriptive approaches were used in this study as needed ,the importance of this study lies in the fact that it provides us with valuable insight into the volume of gold and other minerals ores found in the study area which may contribute to the development of traditional mining and corporate mining and identifying the locations where the mineral is highly concentrated ,this study also sheds light to modern mining in the study area , The secondary data was collected from reports, researches and studies related to the study area . The primary data included field visits and sampling from Jebel El Zaraf . 35 of the collected rock samples were chemically analyzed using the Inductively Coupled Plasma (ICP) and Atomic Absorption Spectrometry (AAS) . While the other 17 rock samples were cut in thin sections and studied using petro graphic microscope . The results obtained from the petro graphic study showed that the gold bearing rocks are characterized by shear zone (Sodri Ombadir shear zone) structures in deferent depth . The gold mineralization in the area

is linked to quartz veins, which differ in trends and dimensions-Results which were obtained for Au and accompanying elements ( Au ; Cu ; Zn ; Ni Pb) were subjected to statistical analysis to reveal parameters (background value Cb ; coefficient correlation ' coefficient of variation , geochemical factors , productivities , and coefficient Sampling of residual soil was found to be effective in prospecting in combination with primary and anomalous contrast in the study area The morphology of secondary dispersion halos of ore elements reflects more or less the morphology of the hidden ore bodies The revealed geochemical parameters can be used as prospecting and exploration criteria Geochemical reserve can be used to indicate priorities for further expensive exploration studies Coefficient of mobility can be used to adopt sampling intervals and grid system Coefficient correlation when they are reliable can be used to define path finder's to prospect for the difficult gold Geochemical factors can indicate horizon of mineralization and level of weathering And analysis revealed that gold concentration varies in values between 0.031 ppm in sample S10 in medium 28.666 ppm in S3 59.193 ppm in sample S3. On the other hand, the other elements such as Zn, Co, Pb, Ni, show Variable concentrations with regard to that of Au. On the other hand, the other elements such as Zn, Co, Pb, Ni, show Variable concentrations with regard to that of Au The study suggested some recommendations that detailed investigations and exploration are needed for better understanding of the type of gold mineralization in Abu Zaima area and in the other part of North Kordofan State where the artisanal gold mining activity is practiced by local miners and some mining companies and making comparison between the study area and others areas in Sudan.

**Keywords:** Gold Mineralization, in Sodari Locality**,** geochemical investigation, quartz veins, North Kordofan.

# استخدام طرق البحث (التحريات) الجيوكيميائية للتنقيب عن الذهب في منطقة سودري بولاية شمال كردفان - السودان (يناير 2024 – أغسطس 2024م)

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المستخلص:

تمت هذه الدراسة بمنطقة سودري في ولاية شمال كردفان بالسودان في الفترة من يناير إلي أغسطس 2024م, بغرض دراسة تمعدنات الذهب والمعادن المصاحبة له و التراكيب الجيولوجية والتمعدن في الصخور الحاوية لمعدن الذهب في منطقة الدراسة تم جمع المعلومات الثانوية لهذه الدراسة من التقارير والبحوث والدراسات المتعلقة بمنطقة الدراسة تضمنت المعلومات الأولية لهذه الدراسة تلك التي تم جمعها في الزيارة الميدانية عن طريق جمع العينات الصخرية من منجم جبل الموجود في المنطقة اتبعت هذه الدراسة في منهجيتها الأسلوب الكمي والأسلوب الوصفي معا وذلك حسب الحاجة الأهمية الأساسية لهذه الدراسة هي الكشف والوصف التغريبي لخامات الذهب الموجودة في منطقة الدراسة تم التحليل الكيميائي لعدد 53 عينة باستخدام طريقة البلازما بالحث وجهاز الامتصاص الذر وتم قطع وعمل الشرائح لعدد 71 عينة زجاجية ودراستها بالمجهر وأظهرت نتائج الدراسة المجهرية أن الصخور الحاوية للذهب هي أحزمة قص (نطاق قص سودري أم بادر )ويمتاز معدن الذهب بارتباطه بعروق الكوارتز التي تختلف في شكلها وابعادها وأعماقها النتائج المتحصل عليها أخضعت لعمليات إحصائية وحسابية لقياس المحتوي الأصلي في الطبيعة ومعامل المقارنة ومعامل التغير, والإنتاجية , ومعامل الانتشار عند تحليل النواتج باستخدام القيم الحسابية وجدت أنها ذات جدوى ومكملة لبعضها البعض ,حيث إن معامل الارتباط بين الذهب والعناصر الأخرى الموجودة في منطقة الدراسة والمصاحبة لعينات الصخور تظهر نتائج يعتمد عليها في البحث والاستكشاف التفصيلي لمنطقة الدراسة كذلك أظهرت الدراسة الاختلاف والتمايز في قيم العوامل الجيوكيميائية لنسب العناصر المتكونة في درجات حرارة مرتفعة إلى تلك التي تكونت في درجات حرارة منخفضة والتي توضح مستويات عميقة من التمعدن والتجوية وعند تحليل النواتج باستخدام القيم الحسابية وجدت أنها ذات جدوى ومكملة لبعضها البعض، حيث أن معامل الارتباط بين الذهب والعناصر الأخرى الموجودة في منطقة الدراسة والمصاحبة لعينات الصخور تظهر نتائج يعتمد عليها في البحث والاستكشاف التفصيلي أوضحت نتائج التحليل الكيميائي بأن تركيز الذهب يختلف في قيمته والتي تتباين وتنحصر بين. حيث من المليون كحد ادني في العينة S10 وإلى 28.666 جزء من المليون كقيمة متوسطة في العينة مورفولوجيا هالات الانتشار الثانوي لعناصر الخامات تعكس بصورة واضحة أو تغريبيه مورفولوجيا أجسام الخامات التي تكون في أعماق بعيدة وغير مرئية أو مدسوس التحريات الجيوكيميائية التي أثبتتها هذه الدراسة يمكن أن تستخدم كطريقة مثلي للبحث واستكشاف الخامات المعدنية في المستقبل ومن جهة أخرى فأن تراكيز العناصر الأخرى مثل الزنك والكروم والنحاس والنيكل والحديد أظهرت تغيراً واضحاً مقارنه بتركيز عنصر الذهب العوامل الجيوكيميائية أوضحت أفق التمعدن ومستوي والتجوية توصى هذه الدراسة إلى أجراء استكشاف وبحث تفصيلي دقيق لمعرفة جيولوجية منطقة أبو زعيمة وأجزاء أخرى بولاية شمال كردفان ودراسة العلاقة بين تمعدن الذهب في المناطق التي

يتـم فيهـا التعديـن التقليـدي للذهـب والـذي تتـم ممارسـته بواسـطة التعديـن التقليـدي بالمنطقـة وبعض شركات تعديـن الذهـب ومقارنتـه بالتمعدنـات الأخـرى في السـودان.
**الكلمات المفتاحية:** تعدين الذهب، في عروق الكوارتز، شمال كردفان

## 1. *Introduction :*

Historically, gold mining is its exact one of the oldest activities practiced by humans. It is impossible to know date, but some of the oldest known gold artifacts were found in some graves which were built between 4700 and 4200 BC. Sudan is famous for gold mining, since this mineral was mined in Nubian (North of Sudan) and that could be at least 7000 years age.

During the 19th century, numerous gold rushes in remote regions around the globe caused large migrations of miners in USA and other regions around the world.

The discovery of gold in the With water sand led to the Second World War and ultimately the founding of South Africa, which is the primary gold production country in the world.

In Sudan these gold rushes started in the last decade and hundreds of thousands of gold miners were spreading throughout the regions of Sudan.

In the northern desert parts of North Kordofan State, many sites were discovered and thousands of small miners are working in gold mining.

Geologically gold was associated with different geological environments.

It can be extracted from extensive alluvial deposits, from quartz veins, sulphide ore deposits of hydrothermal origin or from metamorphic rocks.

The study on geology of the area and gold mineralization are of great importance, since they aim to investigate the relationship between its origin, the geology of the gold bearing rocks and the structural setting of the area.

acidic to intermediate volcanic origin .

Zones of talc schist are common probably representing more basic facies of the volcanic protolith.

In Abu Zaima area in Northern Kordofan State at least two distinctly different Precambrian basement sequences are exposed.

The two sequences have been intruded by late to syn-tectonic granites and are uncomfortably overlain by phases of deformation are discernable.

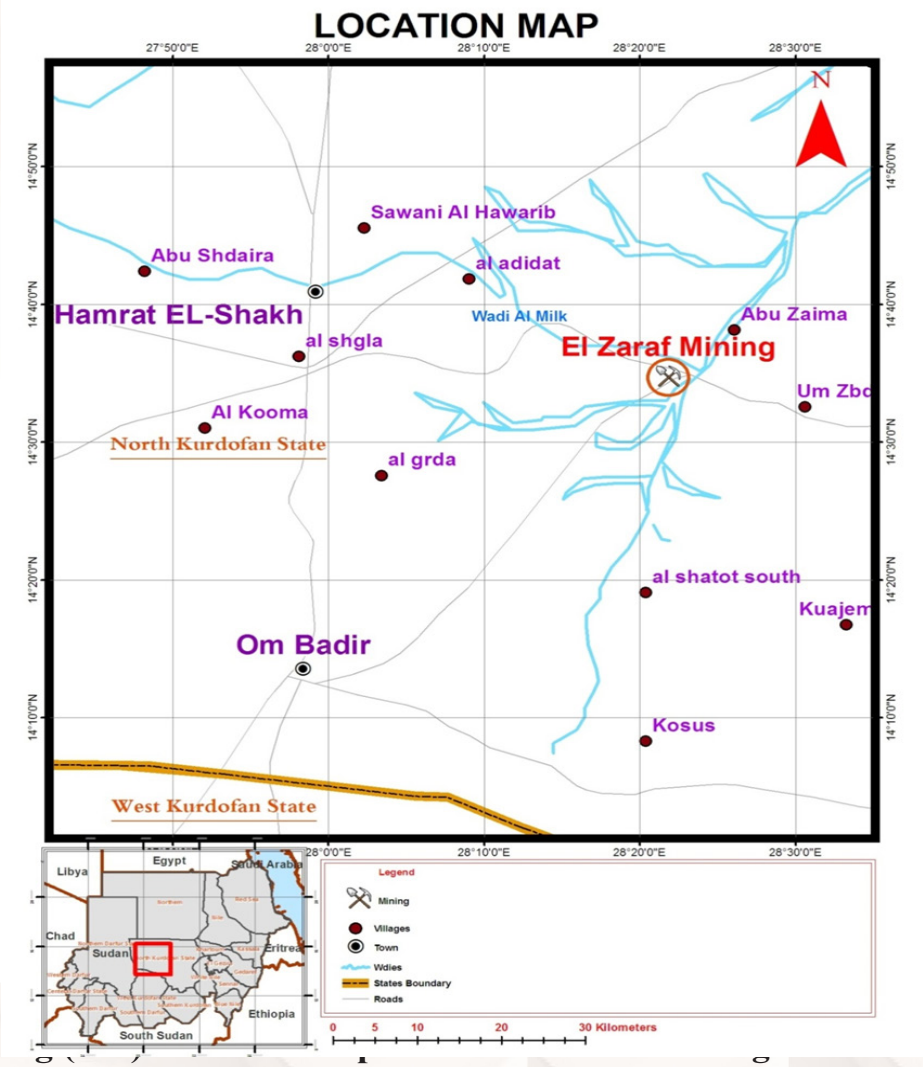


Fig ( 1 ) Location Map Of Elzaraf Gold Mining ( This map was drawn by geologist Mustafa Ahmed Elfaki October 2024 ) .

2. Objectives Of The Study :

Already known area of gold mineralization were selected for this experimental study the main objective is reveal quintile Geochemical investigation criteria which can applied for study area of similar climatic , geochemical and geotectonic environments

The main objectives of the study are:

1. To investigate rocks of basement complex exposed in the study area using different techniques of remote sensing , geological mapping , geochemical investigations , in order to classify , nominate , and discriminate the basement rock units to a chive a better understanding of all subdivisions and characteristics of rocks of basement complex and their related structures and metallogensis .
2. To evaluate the economic potential of the study area by prospecting for gold and associated minerals in order to locate potential areas and layers of gold mineralization .
3. To contribute to elaboration of the tectonic setting and evolution of basement complex .
4. Determination focus in grams per ton concentrate of other minerals in the study area and its relationship between gold and other minerals .
5. To deduce the genesis processes and the factors controlling the occurrence and distribution, of the different mineralization in the area. and applied methods of investigation during the present work are enrolled three main subdivisions (Office work, Field work, and Laboratory work).

*type and origin of gold in the study area.*

***3. Methods of Investigation :***

During the above mentioned field trips the materials have been collected from field for laboratorial studies are .

**Table No ( 1 ): Summarized Of Field works ( by geologist Mustafa Ahmed Elfaki March 2024 ) .**

| Area | Rock Samples | Soil Samples | Purposes |
|---|---|---|---|
| El Zaraf | 35 rock samples | 15 soil samples | Petrographical studies and ore microscopy Chemical analysis for trace elements |
| El Zaraf | 20 rock samples | 28 soil samples | Petrographical studies and ore microscopy Chemical analysis for trace elements |
| | | | |

### 3.1 Field Works:

Field works performed through three main trips, which involved regional geology, geological mapping (rock sampling), and prospecting for mineralization's.

Programs were performed, including regional and detailed geological mapping, structural interpretation, geochemical sampling .

Samples have been collected in a way to represent the rock units and the mineralized zones, carefully taken, wrapped, numbered and packed.

geochemical samples have been collected from streams sediment, and soil, Chip samples from different auriferous quartz veins. The Spacing between the profiles is about 300 meter in average the interval of sampling within the profile is about 1.2 kilometer.

The collected samples have been prepared to chemical analysis by converting the samples material into a form that is suitable for the relevant chemical analysis.

### 3. 2 ROCKS SAMPLING :

Sampling included massive rocks specimens, chips rocks samples, and unconsolidated soil mater .

specimens were collected along geotraverses from different litliological units. Samples were fresh and representative specimens were collected for petro graphic mineralogical studies and chemical analysis.

### 3.3 SOIL SAMPLING:

43 samples of clayey fraction samples were taken along the streams which drain the mineralized area. The samples were sieved in the field. only clay Fraction was collected in plastic envelop for chemical analysis.

### 3.4 Chip quartz Samples :

The auriferous quartz veins for areas out crops on the surface. On the quartz Veins the selves profile have-not developed, samples were collected from in between quartz fragments and couples according to a grid system

100x 300 the base lines were drawn parallel to the strike of the quartz veins and the sampling lines were constructed perpendicular to the has line across the strike of toe ore bodies.

### 3.5 LABORATORY METHODS:

The laboratory work can be subdivided into three major phases according to the technical mean that is involved in the procedure and their outputs.

These phases are: preparation of thin sections, preparation of polish sections (at GRAS, and ElNeelin University rock preparation laboratories and Red Rock Company) and chemical analysis for elements in the samples in the study area .

### 3.6 Chemical analysis:

The collected samples have been prepared to chemical analysis by converting the samples material into a form that is suitable for the relevant chemical analysis.

Samples of rocks have been converted into fine powder following the standard procedures. The Atomic Absorption Spectroscopy (AAS)technique is used to analyze suspected auriferous samples.

geochemical samples have been prepared and assayed at Red Rock laboratory.

Gold, and associated elements, were analyzed for using AAS methods of detection at GRAS laboratories.

### 3.7 Atomic Absorption Spectrochemcal Technique (AAS):

AAS technique has been used for the determination of the elements: Au,Ni, Cu, Pb, and Zn. The analysis was carried out in two laboratory the Geological Research Authority of the Sudan (GRAS) using Perkin Elmer Machine mode In the former laboratories the powdered samples were digested acid; and in the later laboratories digestion was achieved using cyanide (procedure in appendix A). Measurements are carried out with mono or multi hallow Cathode lamps using an air—acetylene flame. Calibration Curves were prepared by using a number of covering the range of expected element concentration in sample solution. These standards were prepared from rocks and minerals standards.

### 3.8 Methods Of Interpretation Of The Results :

Interpretation of results of chemical and mineralogical analysis of samples was expected to reveal secondary drainage is person patterns of gold mineralization in the catchrnent area of sampled drainage system.

In this study an attempt has been made to quant geochemical criteria expected to be revealed as a result of orientation studies outlined above. These criteria arc to be used to prospect for and to explore gold mineralized ore bodies which are either outcropping on surface but with unseen mineralization, buried by unconsolidated and consolidated younger deposits or blind ore bodies.

The following geochemcal parameters and geostatisical factors are Considered. This is a ratio between element contents. Such as ratio summarizes the geochemical landscape of a mineralized zone. It can also help in determination of weathering level and mineralization horizon of hydrotlcnnally mineralized ore body.

Such ratios should reflect a geochemical meaning i.e content of element of epithermal zone (low temperature) to those of hypothermal Zone (high temperature.

### 1.9 Data Interpretation :

*The obtained data from chemical analysis is going to be interpreted using computer program s such as Safer, in order to determine the correlation between the gold mineralization and the coherent elements. This correlation will identify the presence of the gold in the study area and specify its origin.*

*In This study geochemical methods are used, the following results are expected to be obtained:*

- *Geochemical analysis results of the gold bearing rocks in the study area.*
- *Geochemical correlation between gold and coherent elements.*
- *The possibility of using computer programs in interpreting geochemical data for identifying the presence of gold and its origin.*

## 4. Discussion of Gold Mineralization :

- Simi*larly, the meta-volcano-sedimentary sequences that are exposed at the intersection region where SSZ offset OBSZ are interpreted as part of the newly formed oceanic crust in Ombadir -Sodari Shear Zone.*
- *The deformation regime and the metamorphic evolution of the study area resembles, to a great extent, those regimes described in the juvenile Pan-African rocks in the Arabian Nubian Shield the initial compressive ductile regime resulted in successive ductile strains of folding and refolding which is fulfilled by ductile shearing phases. These are typical Dl, D2, and D3 deformational phases. There are three phases of igneous activity in the area:*

5. **Sulfides and associated Gold Mineralization :**

*Auriferous quartz veins represent the common mineralization style in the study area. In addition, small grains of sulfide minerals like pyrite, galena, chalcopyrite, sphalerite, with malachite in addition to iron oxides are common mineral species in the mineralized quartz veins.*

*The area witnesses the presence of active Artisanal gold miners. They extract about 3 to 14 g (Au)! 50 kg. They usually practice primitive and crushing the mineralized quartz and milling them y grinding machine and wash and finally they use mercury amalgamation to extract gold.*

6. **Au assay correlation :**

*Mineralization Zone were selected for base metal analysis. These are: Ni, Pb, Cu, Zn, and Au respectively.*

*The results have been correlated to the Au assay of the sample in order to investigate the relations of gold mineralization to the sulfide minerals and native pb mineralization. above correlations indicate posi tive proposition is found between Ni, Cu sulfide and gold mineralization, and a weak relation between Zn, Pb sulfide and gold mineralization*

*It can be concluded that the economic importance of the area takes its impetusfrom the presence of hydrothermal sulfides mineralization of Cu, Zn, Ni (polishsection) sulfides, and Ni positively associated to Au mineralization . in addition to the presence of kaolinite, building materials and decorative stones.However, if we consider in addition to that, the artisanal mining activities in the area, in particular along the shear zones.*

7. **Background Value:**

Univariate analysis for gold range from 1.38 to 59.193 ppm. FormulaNo.1 has been used to calculate background values (Cb),

and anomalous Value .

The high standard deviation for gold reflects the erratic distribution of this clement. This necessitates that in prospecting for gold chips sampling should follow detailed scale. The other elements subjected to chemical and statistical treatments are Au, Cu, Pb, and Zn.

Petrographicaly the graphite display fine grained making strong foliation plain with the following mineral assemblage: [Graphite + Quartz + muscovite]. The Graphite is the dominant mineral (50-60%) dark gray color fine to medium grain with long thin lepidoblastic crystals.Quartz is subdominant (40-30%) fine grain xenoblastic, affected by shearing and making sigmoidal shape. The muscovite constitutes (10%) of the rock, fine grained and lepidoblastic crystals. This mineral assemblage indicates low-grade metamorphism of green Schist facies.

Coefficient of correlation of the trace elements Zn, Cu, Ni, Pb, and, with Au of the residual soil samples show negative or week values, since most of these elements are more mobile than Au itself and they are dispersed during digenetic process. Coefficient of correlation calculated for gold and mobile trace elements are more reliable if they are based on results of ship composite rock samples rather than on unconsolidated residual soil samples.

. Gold geochemical reserves of area is calculated to be 43.56000 Tons, that of Abu Zaima area. This is not to the actual geological reserve of gold, but only geochemical reserve which is the result of geochemical dispersion of primary areas.

concentrate maps of the ore element (Au) and those of accompanying e1ements are elongated concordantly along the auriferous quartz veins. Hence the morphology of Secondary dispersion halos of both the ore element and accompanying elements reflect more or less the morphology of the hidden Primary ore bodies.

The conclusions which have been drawn as the result of this

experimental work are given as shown below in systematic order based on the actual Stages usually adopted lo conduct geological investigations leadingtowaeds finding gold deposits defining geological criteria which encourage prospecting, to define potential targets (in this study geochemical anomalies and finally dissection or detailed prospection-preliminary exploration of revealed secondary dispersion geochemical patterns.

**Table No.( 2 ) : Coefficient Of Correlation of elements all with all (by geologist Mustafa Ahmed Elfaki June 2024 ) .**

Coefficient of correlation of elements of quartz veins chip samples in profile (1) table No .(1)

| | Au | Zn | Cu | Ni | Pb |
|---|---|---|---|---|---|
| Au | 1 | 0.011 | 0.08 | 0.03 | -0.05 |
| Zn | | 1 | 0.83 | 0.55 | 0.15 |
| Cu | | | 1 | 0.41 | 0.01 |
| Ni | | | | 1 | 0.031 |
| pb | | | | | 1 |

shows reliable correlation relative to the residual soil samples , because the former example is not digness Gold shows weak positive correlation with Zn and Pb ( r = 0.011 , r= - 0.05 ) and negative correlation with both Ni and Pb (r =-0.03 r= -0.05 ). satisfactory with Zn ( r ) . Au and Cu show positive correlation and negative correlation with Au .

This indicate that Au is either of different phases of mineralization with both Au and Cu or mobile elements have been leached since staring age of digness .

Coefficient of correlation of Cu with the elements Au , Pb is weak ( r = -0.08 ) respectively . and positive with elements Zn and Ni

in the same profile .
coefficient of correlation of Pb is ( r =- 0.05 , 0. 11 ) weak negative with Au .

Weak correlation with Cu, and negative with Au .

8. **Coefficient of Dispersion of Trace Elements:**

The general factors that control the geochemical dispersion of ore elements in the semi-arid environment are: Eh-Ph conditions, complexion agents, biological reaction, absorption and Base Exchange reactions, diffusion and solubility.

The dispersion of Au, Zn, Cu,Ni , pb in the study area is constructed in the form of Isoconcentrate map. The morphology of haloes of these maps indicates that:

- The ore zone is elongated in N-S direction.

The contents of the element gold increase towards the outer zones of the anomalous area towards the content of the outer zones of the anomalous area towards the contact of in the talc-carbonate. Nickel content increase towards the inner zone of reaching in the upper part of the hill. In crystals and talc- carbonate towards the outer contact and grades upwards into calc-silicates and silicate in the form of quartz stock work. Tectonic structures (faults, shear zones ...etc.), which are believed to be related to the final stages of Pan African thermo tectonic events prevailing in NE African terrains, seem to be the controlling factors for localization of our bodies associated with Precipitation of gold takes place by a number of mechanisms; the following mechanism is assumed to be the most effective in the mineralization type of Abu Zaima area.

9. **Coefficient of variation (v):**

The analysis of variance of trace elements in Abu Zaima area

of gold , zinc , copper , Nickel and lead based 50 m internal sampling as defined by the above form, have large component of variation 9.5653 % , 29.4754 % , 13.66 % , 31.0095 % , 14.49699 % respectively in the study area .

Jebel El Zaraf consists of siliceous developed hematite, and pyrite. has shown the existences of gold mineralization in anomalous content ranging from 0.031 to 59.193 ppm. and the carbonated facies are located along a shear zone .small quartz stock works veins and pockets of amorphous silica with pyrite. Isoconcentrate map is controlled by the morphology of the ore body . Gold in the study area values tend to form irregular high grade zones or shoots , which are separated by areas of lower grade mineralization . This is clearly seen in several steeply pitching or shaft ore shoots anomalous gold values ( 59.193 gram per ton) .of the secondary dispersion haloes that occur through the vein system .

Investigation of the geological anomalous shows that many of the anomalous gold samples could be related to the known gold – bearing outcrops and reflect the direct down transport gold by gravity . Traversal gold values decreases to be background about 100 m towards the base of the slope .

- The process of wea*thering is broken down into its constituents, which are dissolved by water.*
- *Then the metals contained in these serpentine are leached out and precipitated in different depths.*
- *The dispersion of Zn differs from gold where the fist display hydro morphed distribution pattern . The Isoconcentrate map has been rusted . Zn from a halo surrounding the high grade zone around shaft (3) ,* where concentration is reaching 440 ppm with mean 55 ppm and low grade in the south direction in the study area value 20 ppm .

Copper shows enrichment zone around the deposit . on the slopes of quartz veins profiles No 1 and 2 and I think found high relationship between Gold and copper from the same hydrothermal solution may be ,and from same the primary source .

10.**Au :**

In the study area , analysis of residual soil samples have revealed significant dispersion of the ore elements and accompanying elements . The standard deviation , and coefficient of variation is typical of erratic mineralization this have been reflected in probability .

11.**Zn :**

The dispersion of Zn in the area shows atypical hydro orphic distribution pattern , with the highest values near the base of the hill slops and the aureole follows controlled by the drainage system i.e open haloes along valleys towards the north direction . The elements has been partially depleted due to its high coefficient of mobility .

12.**Cu :**

The dispersion of Cu in the area shows maximum concentration on the quartz – bearing veins , and anomalous concentration down the slopes . This is the result of both clastics and hydro orphic dispersion on the slope .

These are rocks and nonmetallic mine al occur

rences that have economic importance and ca be used directly without major processing as industrial material like carbonate rocks and kaolinite residual soils that are used as raw , materials in many industries in addition to some unique quartz Alumina dike. Marbles and mans are frequently exposed at many localities in the study area mainly at the no eastern and south eastern region. In addition, distinctive white soil horizons characterize the study area .

## 13.Discussion of the Results:

*This study discusses the geochemical interpretation of the results of the revealed trace elements contents in study area distribution, patterns of dispersion and geochemical correlation. The trace elements considered are: Au, Zn, Cu, Ni, and pb of Jebel El Zaraf have been sampled according to 100x300 grid. Analytical results have revealed anomalous values for some of the trace elements as will be discussed later.*

## 14.Geochemical Results:

*Characteristics of the distribution and abundance of the elements of economic importance is as follow:*

*Gold component in ranges between 0.31to 59.193 ppm, with the mean value is 14,351 ppm. Nickel has consistent high concentration in a range of 90ppm and 40 ppm. The vast majority of the analyzed samples contain Nickel in excess of 39.375 ppm. pb is present in anomalous concentration with lowest level being 20 ppm and highest level of 1560 ppm.*

*Copper is present in very high concentration at a range of 640 and 40 ppm. Zn occurs in high anomalous values ranging 440 ppm and 20 ppm.*

## 15.Geochemical Reserve (QH):

*QHisanestimationoftheoreticalamountofametalexpectedfrom an ore body and is calculated according to the following equation.*

*QH =q . H. 1/ k (C.F) Ton*

*Where the depth or vertical continuity of the primary ore.*

*K=Proportionality factor.*

*(C .F) correction factor = 2.5*

*Proportionality factor (k) is the ratio of linear productivity (m) of a profile Cutting through C max. To linear productivity of the same profile cutting through the max. Content of element of the ore body. Sometimes k can be computed by dividing the Aerial productivity of the secondary hale by the*

*amount of metal on the surface of the ore body average content of haphazardly collected composite chip samples multiplied by the area of the body outcropping on surface.*

Reserve to Au for all the study area to 36 kilometer =
The preliminary gold reserve from a layer/meter thick, an area of36,000 m2, and average element (Cav) equal 22 ppm is calculated by following the formula: QH=S.H.(S.G) = 36,000 ×2.5 ×22 ×22 can be estimated as 43.560.000 ton

16.**16. Conclusion :**

The geology of the Basement Complex in area is formed up of high grade Migmatitic -gneisses associated with bodies of tholeiitic ultra basic rocks that are interpreted as Wondering slaps of an oceanic crust. The former rock unit is overlain by low grade metamorphosed Volcano sedimentary sequence occurring as roof pendants on top of the Syntectonic granitic complexes They are formed of bimodal volcanic rocks that show alcalkaline to tholeiitic chemical affinity. This metamorphic event seems to have been accompanied by the first phase of deformation (Dl) that is manifested in isoclinal folding in the high grade Migmatitic gneissic basement units and the met sedimentary belt of Ombadir.

During this regional tectonometamorphic episode the emplacement of the foliated and deformed Syntectonic granitic complexes took place which, intern, have raise the country rocks temperature that resulted in a superimposed contact metamorphic aureoles (M2). This was followed by another phase of deformation (D2) that caused refolding in the earlier structures of (Dl) especially the meta sediments of the Ombadir belt, and to numerous shear zones. These formations show clear evidence of a retrogressive phase of metamorphism (M3), due to crustal uplifting and shearing of the whole area.

A post tectonic igneous activity resulted in- emplacement of the post tectonic intrusion of granites, syenites gabbros and fel-

sites and trachyte dykes of calcalkaline (Shoshonite?) chemical affinity These rocks are young, and show no clear evidence of metamorphism.

Sulfides and .associated gold mineralization in the area is related to the acid igneous activity (volcanism) of the upper volcano -sedimentary assemblage, in addition to contact metamorphism (M3), via metamorphism during post tectonic acidic plutonic emplacement.

The conclusions which have been drawn as the result of this-Experimental work are given as shown below in systematic order based on the actual Stages usually adopted lo conduct geological investigations leadingtowaeds finding gold deposits i.e. defining geological criteria which encourag prospecting, to define potential targets (in this study geochemical anomalies and finally dissection or detailed prospection-preliminary exploration of revealed secondary dispersion geochemical patterns.

These investigations should reveal quantitative parameters which can be adopted to prospect and ex plore for gold elsewhere in virgin areas of similar geotectonic setting and geochemical environment; these conclusions are:

- the -study area fall within the arid-semi arid (desert semi-desert) climatic zones, where the physical-mechanical weathering and denudation processes dominate.
- The revealed secondary dispersion patterns of gold (the main ore element) and the affiliated accompanying elements indicate prowl one and variable) Conditions of secondary enrichment and impoverishment of these elements.

Both forms of secondary gold enrichments placer concentration chemical enrichment should not be excluded as targets for pros-

pecting In this desert-semi desert geochemical landscape. Therefore prospecting For gold deposits in such terrains should not he focused only on spaced primary ore bodies hut also on those secondary enrichment Zones , ided by other prospecting criteria such as paleo-burried channels, old rocks,, geomorphologic features and unconformities.

From the studied locatives has been found that both primary and secondary mineralized zones are confined to areas where the bed rocks of met volcanic-meta sedimentary litho logical assemblages of the low green schist facies (locally amphibolites). Shear zones and other planes weaknesses along structural features and silicification in form of quartz vein lets within -contact zones of granitoidal batholiths are encouraginging prospecting criteria.

Theabove-mentionedlithologicalmilesandthegeotectonicarearacteristicofarc-backarcevironmentwithintheArabian-NubianShield constitutes the northern part of the Prolorozoic Pan-A African.

in two phases. the first phase resulted in the motion of the large gold-hearing quartz veins. The second phase of silica circumvent gave the dray cross—cutting quartz lenses of milky whitish are supposed to be post mineralization, and appear to be of gold.

The gold bearing hearing quartz veins are always bluish-gray in color. When other minerals are encountered accompanying gold in oxidation Zone the veins are smoky with yellowish brown color due to Fe-hydroxides Free (liar vie) grains have also been reported captured in porcs and the revealed geochemical parameters for the three studied areas, when minified can be used as prospecting criteria. these parameters have been splayed in tables in the text.

Abu Zaaima gold background value is 2.5 ppm, anomalous value is 13ppm Only 8 % of the analyzed samples show anomalous content.

Zaraf gold background value is 0.3ppm and anomalous value is 0.5. Coefficient of correlation of the trace elements Ag, Co, Cu, Pb,

and, with Au of the residual soil samples show negative or week values, since most of these elements are more mobile than Au itself and they are dispersed during digenetic process. Coefficient of correlation calculated for gold and mobile trace elements are more reliable if they are based on results of ship composite rock samples rather than on unconsolidated residual soil samples.

The variation in the distribution of gold increases with depth. Deep weathering had mobilized and concentrated the gold in the zone of secondary enrichment at the water table.

Gold dispersion shows erratic distribution. The other mobile e1ements are dispersed around the mineralized quartz veins. Never the less the is concentrate maps of the ore element (Au) and those of accompanying e1ements are elongated concordantly along the auriferous quartz veins. Hence the morphology of Secondary dispersion halos of both the ore element and accompanying elements reflect more or less the morphology of the hidden Primary ore bodies.

The geology of the Basement Complex in area is formed up of high grade Migmatitic -gneisses associated with bodies of tholeiitic ultra basic rocks that are interpreted as Wondering slaps of an oceanic crust. The former rock unit is overlain by low grade metamorphosed Volcano sedimentary sequence occurring as roof pendants on top of the Syntectonic granitic complexes They are formed of bimodal volcanic rocks that show alcalkaline to tholeiitic chemical affinity. This metamorphic event seems to have been accompanied by the first phase of deformation (Dl) that is manifested in isoclinal folding in the high grade Migmatitic gneissic basement units and the met sedimentary belt of Ombadir.

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Sulfides and .associated gold mineralization in the area is related to the acid igneous activity (volcanism) of the upper volcano -sedimentary assemblage, in addition to contact metamorphism (M3), via metamorphism during post tectonic acidic plutonic emplacement.

In the study area , analysis of residual soil samples have revealed sigificant dispersion of the ore elements and accompanying elements . The standard deviation , and coefficient of variation is tipical of erratic mineralization this have been reflected in probability The morphology of secondary halo as shown in the Isoconcentrate maps are controlled by morphology of the ore bodies .The down slope of outcropping quartz vein towards the NE direction . The erratic results of gold suggest that dispersion is clastics with in scree developed on the slopes .

In the study area gold values tend to form irregular high grade zones or shots , which are separated by areas of lower grade mineralization or harden quartz This is clearly seen in several steeply pitching or chaff ore shots I.e anomalous gold .

Investigation of the geological anomalies show that many of the anomalous gold samples could bee related to the known gold – bearing outcrops , and reflect the direct down hill trasport of de-

ferral gold by gravity. Concentration of gold reaches its maximum on the notthern part of the study area from 20 – 50 gram per ton .

17. **Recommendation** :

- Gold explor*ation should be ceased in what has been designated as central mineralization zone.*
- *Exploration should proceed in the other designated mineralization zones similar to what is done in the central mineralization zone.*
- In Northern mineralization zones are located where SSZ offset OBSZ and the meta volcano sedimentary sequence is exposed (meta andesite, marble, and marl), which seem to be part of turbidities are very interesting for future prospecting for sulfides and gold mineralization's.
- Geological and exploration works should be carried on to discover new potential areas for gold mineralization.
- The geological and geochemical investigation in the study area .

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