

## Ore Evaluation

The total ore reserve amounts to 2.5 million tons, 1.75 Mt of which is indicated and the rest as the rest inferred, with a grade of 0.11%.

## 4- Kuturn Lead-Zinc Mineralization

The Pb-Zn mineralization is about 4 miles NE of Kutum town in Northern Darfur State [Lat. 14°14'N, Long. 24°39'30"E]. kutum [Loc. 5] is about 65 miles away from El Fasher, the State capital.

## Geology

The area is occupied mainly by regionally metamorphosed achists and gneiss flanked with granitic rocks from the south and basaltic dome-shaped hills from the north and east. The granites, their associated dykes, pegamatites, quartz and mineral veins are the youngest of the basement rocks.

## Mineralization

The ore was mined and smelted intermittently by the native as from the turn of the 9<sup>th</sup> century until 1917. The mineralization and the geology of the area, was surveyed during three successive seasons [1959-1961]. Twenty trenches have been dug and sixteen boreholes were drilled totaling 2,668 ft in depth. The sulphide ore is formed from the association of galena, sphalerite and pyrite, with minor amounts of chalcopryrite and silver. The ore minerals occur in veins ranging from few to 20 inch in thickness and extend down to more than 200 ft. their general trend is north westerly with a steep south westerly dip. The main deposit area measures 100m x 1,700m which may, after further studies, be extended taking in consideration that an ancient open cast mine, is found less than 700rn to the north east of the area. The mineralization is believed to have formed after hydro-thermal solutions of granitic origin that found easy passage through older shear planes. Chemical analysis performed on some non-oxidized samples from few veins gave the fbi- lowing range of values: Pb [up to 65.6%], Zn [up to 26.2%]. Fe [14 to 22.9%], Sn 4.1 to 12.2%], Cu [0.03 to 0.1%]. The results reflect the effect of the rations of the three main mineral components galena, sphalrite and pyrite on the analyzed samples. Thus further exploration work is needed for a proper, evaluation of the deposit.

## 5. Other Promising Areas

### I- Ariab Area

Ariab Area Mineralization similar to that of Abu Samar Areas has been discovered in the very similar geological environment of the Araib area. About 16 gossans were encountered in the upper Proterozic volcano-sedimentary belt of Ariab-Arbaat [Loc. 1]. The area is leased for gold, however, in the course of drilling up to 60m thick pyrite-rich-massive sulphides were traversed averaging 1-2% Cu, 1-3.8% Zn, 0.1% Pb, 0.3 ppm Auad 10 ppm Ag. No effort has yet been made to fully evaluate the massive sulphide deposits. Three of these (Hassai, Hadal Awatib and Oderuk) deposits are indicated to contain a total of 62mt with an average equivalent Cu grade of 4%. The potential for the discovery of further deposits must be good, especially if an aerial EM survey is undertaken

### II- Tagoteb, Loc. 4

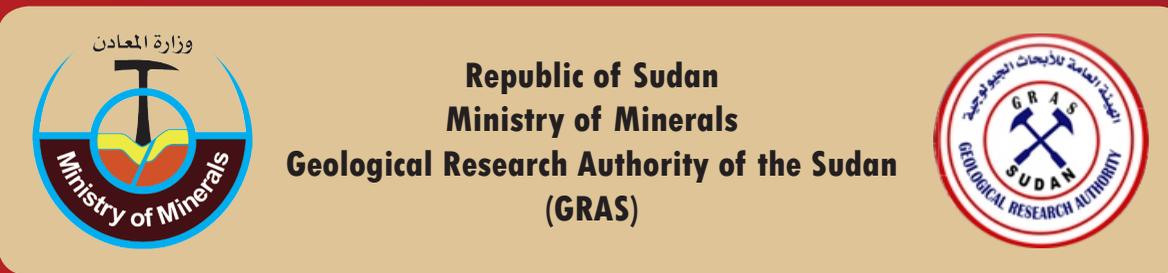
An extensive gossans zone along a NNW trending zone at leat 1700m long, caps three hills made up of brecciated silicified material containing abundant dissimilated limonite along fractures and boxworks. The northly hill called Jebel Tagoteb (Lat. 17o33' Long. 36o14') measures about 600m by 500m and thus has a large tonnage possibilities. Limited drilling in the area, intersected abundant pyrite and chalcopryrite.

### III- North-eastern Nuba Mountains

In the NE Nuba Mountains [Loc. 6] about 450km SW of Khartoum, there is a number of gossans anomalous with respect to Cu, Cu-Zn, or Cu-Ni-Zn and Ag, were reported by the Bundesanstalt fir Geowissenschaften undRohstoffe (BGR) of Germany, in the early 80s. Further additional investigation is required particularly by drilling. The region is built up predominantly of a N. Etrending Proterozic volcano-sedimentary sequence which is affected by an important NNE-SSW shear zone. The gossans are concentrated mainly in the south western part of the area. They are regarded as being derived from a volcano-sedimentary rock sequence as Araib and Abu Samar areas of the Red Sea region where sulphide ores, closely related to oxidic iron formations were found.

### IV- Red Sea Hot Brines

Chemical analysis of samples from cores recovered from the Red Sea Hot Brines [Loc. 1] by Atlantis Deep 11 published in 1969, show a high content of base metals [copper and Zinc] and silver. The area is roughly 6.12 x 10 square feet. About 2 billion tons of ore are indicated with an average grade of Cu-0.2%, Zn-0.7%, Ag-0.3 oz per ton, and associated Au-0.05 oz per ton.



# Base Metals in the Sudan

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## Forward

Base metal mineralization to Sudan was known since ancient times, as evidenced by archaeological discoveries of base metal furnace slags. In the 18<sup>th</sup> century natives from Darfur region used to smelt copper from Hofrat en Nahas area, in clay furnaces. Russegger in 1838 stated that the locals obtained the ore, which was found in a pure native state from a vein 2 feet beneath surface.

Base metals have been reported from nearly 70 places in Sudan. A great number of these occurrences are closely related to the greens tone belts. A brief account is given hereafter for a few of those occurrences that had received more attention.

### 1- Hofrat en Nahas Copper Deposit

The old mine of Hofrat en Nahas is located in southern Darfur State 09°45' N and 24°18' E. It is slightly over 200 miles from Ed Da'em nearest point on the railway line, Loc 7.

### Geology

The area is underlain by precambrian metamorphic complex intruded by precambrian to palaeozoic mafic and acid intrusive. The metamorphic complex includes biotite and hornblende gneisses, migmatitic acid gneisses, biotite chlorite schists.

### Origin and Mode of Occurrence

The ore is a vein type forming lodes and mineralized zones related in origin to the residual solutions of the granite and pegmatite intrusions. The mineralizing hydrothermal solutions may have concentrated along open spaces in sheares, faults and there seems to be a bedding control giving rise to the said mode of occurrence.

### Ore evaluation

Exploration and evaluation of Hofrat en Nahas deposits have been carried intermittently as from 1922 up to 1981. The results are shown on the following table. Nevertheless, it is worth mentioning that copper mineralization is associated with a linear structural feature over 100km long. Excluding Hofrat en Nahas area still some large coincidental geochemical—IP anomalies along the mineralized belt have not been investigated by drilling. One anomalous area (in Jebel Waranja) is 4km long and up to 1.2km wide.



The presence of steep faults, favorable for the emplacement of granite old rocks, and the complex tectonic conditions of the region, support the possible presence of still undiscovered potential deposits.

Company	Period or Study	No. of total bore depth holes (Z)	Ore—reserve estimate
Nile Congo Divide Syndicate	1925 – 1922	10 1028m	20.000 tons or ore per foot of depth
Geological Survey Dept. (GSD)	1959 – 1957	15 786m	10.183.300 tons 2.778% cu
Nippon Mining Co.	1966 – 1965	9 1400m	Sulphide ore 766.000 tons oxide ore 291.000 tons
UNDP	1971 – 1968	23 3400m	8,741,000 tons 4% cu
UNDP & Geo. Survey Dept. (GSD)	1973 – 1971	18 2200m	6,109,445 tons 2.01% cu 1.6 ppm Au 165 ppm 1 150 ppm Mo
Chevron Resources Co.	1981 – 1979	27 rotary holes & 2 off—set coreholes	

The Nippon Company works was concentrated mainly on the Hofrat en Nona old mine area only and they had omitted any veins containing less than 2% Cu, or those of less than 1 inch in width.

The mineralized zone occupies an area of 350m x 725m SE of an adjacent to the airstrip. A hole (27\*80) drilled about 1 km southwest of this mineralized zone showed ore grade mineralization. Therefore, the potential for the area may be in excess of ten million metric tons (Chevron, 1980).

### 2-Abu Samar Mineralized Area

Abu Samar area (Loc. 1), which lies 250km SW of Port Sudan, became known in the 1950s for small scale manganese ore mining. In between 1977–1983, the Geological and Mineral Resources Department (GMRD), now (GRAS), in collaboration with Bureau de Recherches Geologiques et Minirers (BGRM) executed a joint exploration program in that area. They reported the discovery and evaluation of a substantial ore of massive sulphides and barite.

### Geological Setting

Abu Samar massive sulphides deposit are hosted by paragneisses of Late Protozoic volcano—

sedimentary rocks known as Tolik Series. The rocks had been subjected to intense deformation, migmatization and regionally metamorphosed to grant amphiblite facies with local grade into granulite facies. Thermal metamorphism following the emplacement of granitoids intrusions affected parts of the area.

### Abu Samar Massive Sulphides

Detailed gravimetric survey diamond drilling and petrographic studies, proved the existence of volcanogenic massive sulphide ore bodies. The minerals pyrite, pyrrhotite, sphalerite, chalcop yrite and galena constitute the major component, with minor molybdenite, realgar, bismuthinite, silver, jacobsonite and cubarite. The ore minerals are mostly coarse—grained occurring as bedded aggregates or disseminated crystals in the host rocks. They have been encountered up to a depth of 265 inch, their aggregate thickness ranges between 20 to 25m and of 200m length.

### Ore Evaluation Massive Sulphides

Ore reserves calculation, estimated the ore tonnage in the range of 2.13 to 3.64 million. However, Abu Samar and some other minor occurrences seem to be related to a lengthly volcano—sedimentary, granite contact and additional larger sand—covered ore “blind” occurrences may be present. Chemical analysis performed on ore: samples, gave the following average values: Zn (5.1%), Cu (0.6%), Pb (0.59%) and Ag (72–81). In addition, the ore contains gold of a grade decreasing with depth from (0.84 g/t in 30 to 70m) section: (0.58 g/t in 70 to 150m) section: (0.13 g/t in 1.50 to 300m).

### Barite

The barite calculated reserves are confined to the upper oxidation zone (down to 40m) with an estimated total reserve of 420,000 tons with BaSO<sub>4</sub> averaging 35%.

### 3- Jebel Ayub Wolfram Deposit

J. Ayub mineralization is hosted by leucocratic granite intruding the volcano—sedimentary rocks of the Tolik Series. Hydrothermal alteration resulted in a wide spread griesnization effect on Jebel Ayub. The area was mapped in detail and sampled via trenching, pitting, percussion and diamond drilling. Field and laboratory studies [GRAS and BRGM, 1983] proved the presence of the ore minerals scheelite, molframite and huebnerite within the quartz veins and the greisens.