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DEVELOPMENT AND ASSESSMENT
OF THE MAIN MINERAL RESOURCES
IN THE SUDAN

(Document submitted by the Government of Sudan)

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NOTE: This document has been prepared by Mr. Mohd Safie Eldin.

DEVELOPMENT AND ASSESSMENT OF THE MAIN MINERAL RESOURCES IN THE SUDAN

A. Introduction

The Democratic Republic of the Sudan, the largest country in Africa with some 2.5 million square kilometres, is a very favourable geological environment for minerals of commercial value. Efforts are now being made to develop mineral resources to satisfy local needs, reduce imports of minerals and fuels, generate foreign exchange by developing export markets, diversify the primarily agriculturally-based economy, provide employment opportunities in the developing regions and increase the value of current mineral production through local processing.

The Geological and Mineral Resources Department (GMRD), which is directly responsible to the Minister of Energy and Mining, is presently responsible for conducting geological surveys and mineral explorations, making detailed assessments of mineral occurrences and formulating and implementing mining and oil exploration legislation.

Mineral development activities in the Sudan are conducted in four areas, namely, the Red Sea Hills in the east, the northern and southern parts of the Nile Province, south-west Darfur in the west and the Ingessana Hills, Ouala on Nahl and Ottash areas in eastern and south-eastern Sudan. (see the attached map for mineral deposits and occurrences).

B. Mineral activities in the Red Sea Hills

Detailed studies on the evaluation of the following minerals were carried out:

1. Iron ores(a) Sofaya iron ore deposits

Investigations of iron ore deposits in the northern Red Sea Hills were completed at Sofaya. Total reserves of the deposits were estimated at 14 million tons of iron grading between 41 and 56 per cent Fe with an average iron content of 43.5 per cent.

(b) Karrora iron ore deposits

Investigations for iron ore deposits at Karrora in the southern Red Sea Hills were carried out at Karrora. Seventeen boreholes totalling 1,490m in depth were drilled to check for magnetic anomalies. Magnetite was discovered with total reserves estimated at 14 million tons containing 40 per cent Fe.

(c) Fodikwan deposits

The Fodikwan group consists of iron ores occurring at Fodikwan 13 km west of Marsa Oseif on the Red Sea shore 317 km from Port Sudan (Haliab Road).

Previous work was carried out by GMRD and the deposit was mined by the Joint Sudanese Yugoslav Company. Production was suspended by the closure of the Suez Canal in 1967. The reserves of the deposit are estimated at 2-3 million tons with an iron content of 50 per cent.

The geographical location of these reserves and the recent discovery of natural gas in the Red Sea favour the establishment of a pelletization plant and/or a steel mill at this site.

2. Tin and tungsten

(a) Shankuk tin occurrence

This occurrence lies between longitude $36^{\circ}38'$ and latitude $18^{\circ}51'$.

Tin was reported in the cleavage of quartz boulders at Knor Shankuk. The boulders were said to be derived from pegmatite and quartz veins in granite. No details were given.

(b) Khor Abeit tungsten occurrence

This occurrence lies between longitude $36^{\circ}53'$ and $37^{\circ}00'$ and latitude $19^{\circ}00'$ and $19^{\circ}02'$.

Wolframite and scheelite were reported to occur in pegmatites intruding granites at Khor Abeit. No details were given.

(c) Jebel Gash Amir tungsten occurrence

This occurrence is located between longitude $36^{\circ}07'$ and latitude $22^{\circ}15'$.

Jebel Gash Amir, 30 km north-west of Halaib village, contains tungsten-bearing quartz veins intruding the hill where alpidolite, dolerite, pegmatite and barren quartz veins are also found. The mineralized veins vary in length from 25-50m and in thickness from 10-25cm and mainly occupy a horizontal set of joints. Tungsten in the richest veins ranges in content from 23.1-33.03 per cent and in the adjacent country rock from 0.09-0.8 per cent.

The mineral is mainly hübnerite with a measured specific gravity of $6.9569/\text{cm}^3$ and a chemical composition of 48.2 per cent Mn, 3 per cent Fe and 43.7 per cent W.

(d) Jebel Gash Amir tungsten mineralization

This occurrence, lying between longitude $36^{\circ}14'$ and latitude $17^{\circ}51'$ is a recently located occurrence of wolframite and scheelite located about 20 km east of the Imbasa railway station. The two minerals are present in stockworks of quartz veins criss-crossing a gneissed rock zone measuring 1 sq km, which is also mineralized on a whole mass of granitic hill. Remnants of the old meta-sediments can be seen at different places around the hill. The mineralization, thought to have a large potential, is currently under extensive investigation by BRGM of France and GMRD of the Sudan.

3. Gold

Gold has been mined from the Nubian Desert along the Nile and in the northern parts of the Red-Sea Hills since pharaonic times. Mining was resumed at the beginning of this century and has continued intermittently up to the present.

More than 50 gold sites were recorded in the area that extends from longitude 36.5°W to the Nile and from latitude 19°N into Egypt. Some of the old mines were

extensively exploited during the period from 1900-1903 during which a few tons of gold were said to be mined. Currently only two mines are under very limited production by local companies. Prospection of the promising areas has been conducted since 1974. The following table indicates the location of some gold sites.

<u>Name</u>	<u>Latitude</u>	<u>Longitude</u>
Gebeit mines	21°3'30''	36°19'00''
Oyo mine	21 55 00	36 7 00
Abirkateib	20 34 20	34 55 40
Serakoit	20 10 00	35 50 00

(a) Gebeit mine

Extraction of gold from the Gebeit mine began a long time ago. The upper 20-30 metres of the auriferous quartz veins were partly exploited by the ancient Egyptians but extensive mining to a depth of at least 200 ft was begun in 1903 by English companies. The mine is currently leased to a private Sudanese company which produces only a few ounces of gold at intermittent periods because of a lack of experience, finances and equipment.

The auriferous veins intrude along the foliation planes of the greywackes that belong to the Naferdeib series. They extend to up to 100 m along the strike. Their thickness varies from a few cm to 2m. The gold content ranges from a few grams to 16 grams per ton. The mine was exploited down to depth of 200 m and four tons of gold were mined with maximum production occurring between 1924 and 1934. The mill formerly used by the present company date back to 1927, but since no spare parts are available, the mine has now been abandoned.

During the regional mapping of the area in 1973 more auriferous veins around the old mines were located. Prospection began in 1975 but no definite information has been obtained.

(b) Oyo mine

The Oyo gold deposit was one of the major mines exploited during the period 1920-1944. The average gold content of the veins was 23-26 g/ton in 1923; 26 g/ton in 1931, 10 g/ton in 1934 and 7 g/ton in 1944. The mineralized veins which occur in the rocks of the Naferdeib series have different strikes. The north-east striking group of veins was the most exploited. Gold is associated mainly with pyrite and arsenopyrite and rarely with chalcopyrite. The length of the veins varies from 120-180 m and the thickness from 6-15 cm.

Mineralization of gold, pyrite and arsenopyrite was reported in a stock of young granite lying near the Oyo mine. Veinlets of arsenopyrite 7-15 cms thick were said to occur at the contact of the granite with the sublatitudinal dykes dissecting the stock. The significance of this mineralization has not been checked.

(c) Abeir Kateib mine

Abeir-Kateib is an old mine, which has been leased since 1935 to a private Sudanese company. The old workings can be traced for more than one kilometre along the strike. The average gold content calculated from the 1956 production was 16.6 g/ton. The auriferous quartz veins occur on the foliation planes of the Nafardeib rocks.

The company intends to use foreign aid first to recover gold from the piled dumps resulting from the amalgamation process by cyanidation. The average gold content in the old dumps is said to be 1.555 g/ton. Crushed ores will then be extracted from the veins.

(d) Sarakoit mine

The auriferous veins in Sarakoit lies within an area 5 km by 2 km as indicated by former workings. During the last three years, 1974-1977, detailed geological investigations were carried out together with contour mapping, trenching, drilling and surface sampling. Rich gold zones were located especially in the southern extension of the area. In this particularly rich zone the old workings are deeper than elsewhere. Hence, gold was extracted to a depth of about 30 metres along a 160 metre strike. The total subsurface extraction carried out by GMRD amounted to 177 metres as follows:

Adit	48 metres
North striking drift	65 metres
South striking drift	28 metres
Crosscuts	19 metres
Raise	17 metres

Three rich gold quartz lenses were crossed along the north striking drift. The content of gold varies from 10 to 20 g/ton in rich localized zones. Pyrite, chalcocyanite, malachite and iron oxide should be investigated further, especially by subsurface drilling to follow and check the behaviour of the quartz lenses at greater depth.

An agreement was concluded with an American company to carry out more investigations in order to evaluate and possibly exploit the gold.

C. Mineral activities in the northern and southern parts of the Nile Province1. Prospection and mining of mica (muscovite) in the Rubatab area

The mica-bearing pegmatites which concentrated in the Rubatab area, are intrusive bodies that occur in different forms, either as lenticular dykes or veins, and are found in knolls or in shapeless outcrops. They are conformable with the foliation of the meta-sediments and have sharp contact with them. These pegmatites are composed primarily of feldspars and also of muscovite mica.

Mining activities started in 1974 in three areas at El Shereik in the Nile Province. These areas were known to contain large reserves of mica of good quality. The reserve was not yet established but mining operations and prospection were carried out simultaneously to determine the mica reserves.

The monthly production rate of trimmed mica is about 800 kg.

Muscovite in workable pegmatites is of good quality and classified as well stained to densely stained. Scrap mica will be beneficiated into ground mica. The preparation of mica consists in sorting, splitting, trimming, grading and quality separation.

Earlier sizing tests showed that some bulk samples taken from the pegmatites contained approximately 50 per cent of grade six, 25 per cent of grade five, 10 per cent of grade four and 15 per cent of less than grade four mica. The test sheets produced had variable staining and hence were of variable value. However the 1972 United Nations figures indicated that the average mica content of the Shereik pegmatites was about 17 per cent with scrap mica constituting more than 70 per cent of the films.

Some 40 mica-bearing pegmatites have been recorded in a zone 30 km wide situated on the west bank of the Nile between Abu-hamad and Herbe.

Two main grades of muscovite mica can be exploited. One is a dimension sheet mica which is split by hand and the other is small fragmentary material, "scrap mica", which is crushed before use. The former product, which is in great demand, is commercially more important and has a higher value in international markets.

The exploitation and processing of mica are currently being carried out by the Sudanese Mining Corporation.

2. Exploration of the Kyanite deposit at Jebel Gerein

The Jebel Gerein Kyanite deposit was discovered 60 km north-west of Atabra during a regional survey of the Bayuda Desert in 1972 by the Sudanese-German exploration project.

The surrounding rocks consist of biotite gneiss, muscovite gneiss, garnet hornblende gneiss and amphibolite as well as quartzite sericite, quartzite and mica-schist intercalations that contain kyanite and staurolite.

The Jebel Gerein kyanite mineralization has a strike N 60°E and is associated with a fault zone. There are several smaller kyanite bodies south-west of Jebel Gerein with a maximum outcrop of 20 sq. m.

Petrographic investigations, chemical analysis and initial tests for technical applicability on 11 kyanite samples and three bulk samples collected from different parts of the deposit gave positive results, justifying further investigations.

The reserves were classified as:

Indicated	76,000 tons of crude ore
Inferred	81,000 tons of crude ore
Possible	296,000 tons of crude ore

A drilling programme was proposed for further development and to establish the actual reserves. Further petrographic, chemical and technical investigations on the unweathered kyanite ore obtained by drilling will be carried out to provide information on its quality and industrial applicability.

The average chemical composition of the samples is (in percentages):

SiO ₂	TiO ₂	Al ₂ O ₃	FeO	MnO	MgO	CaO	Na ₂ O
31.15	1.807	64.38	0.75	0.002	0.12	0.10	0.005
K ₂ O	P ₂ O ₅	SO ₃	LiO ₂				
0.19	0.15	0.09	0.94				

D. Mineral exploration at south-west Darfur

Copper at Hofrat En-Nahas and associated minerals

Exploration work carried out includes:

(a) A topographic survey covering the Hofrat En-Nahas mine area 1 by 2 km (scale 1:1,000) and the Hofrat En-Nahas region, an area of 20 square km (scale 1:20,000).

(b) A detailed geochemical survey of an area 8 km south of Hofrat En-Nahas and the preparation of a map on the scale 1:5,000 was prepared.

(c) The drilling of 21 boreholes in the old mine area totalling 3,344 metres in depth. Ten boreholes were found to be rich in minerals. According to the evaluation of the reserves in the old mine area, proved copper ore reserves amount to 5,145, 800 tons with an average grade of 4.11 per cent Cu and probable copper ore reserves, 4,170,630 tons with an average grade of 3.98 per cent Cu. Therefore reserves of the previously worked area total 9,318,430 tons grading 4.05 per cent Cu.

A joint venture agreement was concluded between the Government and a foreign partner for the evaluation and development of copper deposits and their associated minerals, gold and uranium.

E. Mineral activities in the Ingessana Hills, Gualaen Nahl and Ottash areas in eastern and south-eastern Sudan

Investigations have been conducted to evaluate and develop the following minerals:

1. Chromite

Economic deposits of chromite were discovered in the Ingessana Hills in the south-eastern Blue Nile Province. The area lies between the following co-ordinates:

<u>Latitude</u>	<u>Longitude</u>
11°16'	33°34'
11°31'	34°11'

The area lies some 80 km to the south-west of Roseires and Damazin on the west bank of the Blue Nile.

The deposits are found in the form of particular bodies or irregular veins having different sizes ranging from less than a metre to several metres. The fact that chromite is very often associated with carbonate rocks can be used as a prospecting criterion in searching for chromite.

The Ingessana Hills are characterized by the presence of a very large mass of serpentines and related rocks that represent one of the largest ultramafic outcrops. They mainly consist of basement complex rocks comprising both metamorphic and intrusives. The basement complex rocks are of the Precambrian age and comprise a series of metamorphosed sediments, serpentines and related rocks, pyroxenites, epidiorites, gabbros, granites, past granites, dykes and quartz veins.

(a) Exploration of chromite deposits

Exploration work started in 1973 in accordance with the provisions of the agreement of economic and technical co-operation between the Government of the People's Republic of China and the Government of the Democratic Republic of the Sudan.

The main work completed and results achieved are as follows:

- (i) completion of a geological map on the scale of 1:50,000 covering an area of 1,064 sq. km and indicating all the occurrences discovered 147 chromite occurrences,
- (ii) completion of 93 sheets of topographic and geological sketches and plans of chromite occurrences on the scales of 1:500 and 1:1,000,
- (iii) completion of one sheet of a topographic and geological map of the Gam mining area on the scale of 1:1,000 covering an area of 1.2 sq. km.,
- (iv) completion of detailed gravity surveys covering 6.5 sq. km. and magnetic surveys covering 4.2 sq. km.,
- (v) Completion of:

(a)	11,573	cu m	of trenching
(b)	1,753	m	of pitting
(c)	9,375	m	of cross-cutting
(d)	31,965	m	of drilling, of which

15,329 metres were drilled in the Gam mining area, 13,678 metres for checking chromite occurrences and 2,907 metres for checking for geophysical anomalies.
- (vi) Estimation of 700,000 tons of chromite ore reserves including 400,000 tons from the Gam mining area grading 50-52 per cent Cr_2O_3 .

(b) Mining activities in the Ingessana Hills

There are two mining area in the Ingessana Hills, the first belonging to the Ingessana Hills Mines Corporation and the second to the Nile Chromium Corporation.

(i) Ingessana Hills Mine Corporation:

This Corporation owns four mines: Jebel Jam, Jebel Kurba, Jebel Abu-Dom and Chicky.

(a) Jebel Jam mine

The Jebel Jam mine is the oldest and the largest mine in the Ingessana Hills. Mining work has been underway in the mine since 1962. Chromite is mined by open-cast and underground methods. Almost all the chrome ore in this area is hard, massive and of good quality.

(b) Jebel Kurba mine

This mine is located about 5 km south-west of Jebel Gam. There are over 10 outcrops scattered in the area. Mining work is carried out on a small scale and some exploration work is underway.

(c) Jebel Abu Dom

No mining work has yet been carried out.

(d) Chicky deposit

This deposit is located in the southern part of the Ingessana serpentine massif, 500 m east of the Gam Hills group. There are four chromite ore bodies outcropping at the upper part of the hill.

The average amount of chrome ore produced from the Ingessana Hills mines since it was put into operation in 1962 is 20,000 tons per year.

(ii) Nile Chromium Corporation Mine

The Nile Chromium Corporation possesses only one mine about 59.8 km from Seddans. The area is located about 7 km north of the Village of Cabinet. Chromite is being extracted from an outcrop on the surface by open-cast mining.

The average production of the mine since it was put into operation in 1969 is 8,000 tons per year.

(c) Quality of the chrome ore

The chrome ore in the Ingessana Hills is hard, lumpy and of good quality. A chemical analysis of the ore gave good results. It generally contains 50.58 per cent Cr_2O_3 and with an average chrome to iron ratio of 3:1.

Two Japanese companies entered into an agreement with the Sudanese Government to carry out a feasibility study on the ferrochrome industry and the extraction of low-grade ore chromite from the new occurrences.

2. Asbestos

The exploration and evaluation of chrysotile asbestos in the Ingessana Hills and en Nahl have been increased under a UNDP project and through laboratory studies

conducted in Yugoslavia and Canada. Asbestos reserves in the Ingessana Hills have been estimated at 16 million tons of crude asbestos with 3 to 4 per cent fibre content.

A joint venture agreement on the evaluation and exploitation of asbestos fibres was concluded between the Government and its two partners in February 1978 for asbestos deposits in the Ingessana Hills, Qala en Nahl and the Ottash area.

A pilot plant was set up in the Ottash Hills for the production of asbestos fibre. The capacity of the commercial plant is 100,000 tons of asbestos fibres per year.

F. Government policy in the field of mineral investment

The Government has made serious efforts to promote the discovery and the development of the country's mineral resources and has formulated a basic policy which can be summarized as follows:

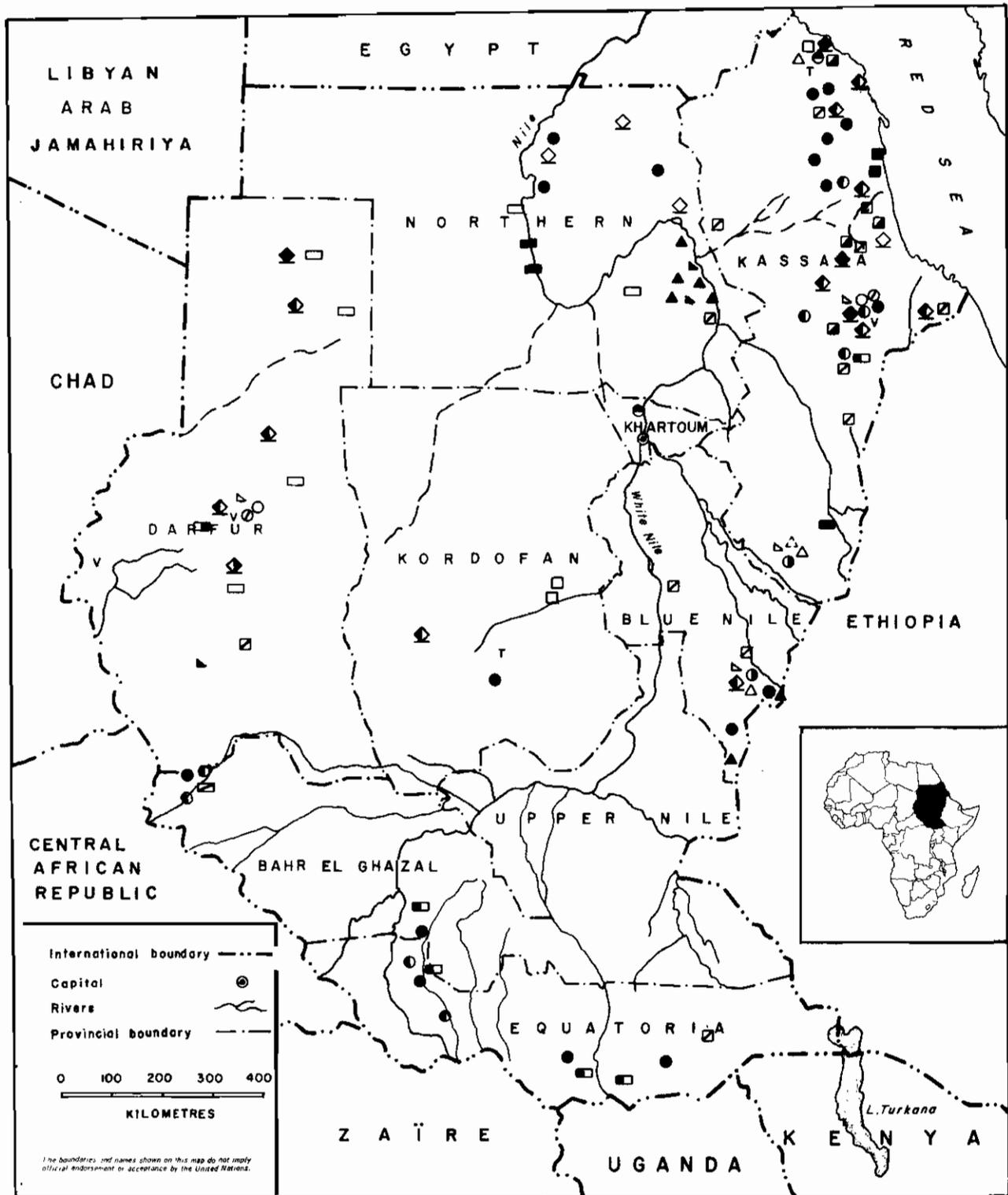
(a) The Government has shown a strong interest in mineral prospection and geological and geophysical work since 1920. Its work in this area has been accelerated as a result of the technical assistance provided by friendly countries,

(b) Joint ventures with technical partners and foreign investors will constitute likely means of future government participation in major exploration, mining and processing,

(c) Private investment in mineral resources is strongly encouraged by the Investment Encouragement Act of 1980,

(d) The recently established Sudanese Mining Corporation may broaden the scope of mining activities and participate actively or financially in any mining venture.

SUDAN MINERAL DEPOSITS AND OCCURRENCES



CART-M-80-18

UBO-0644

GOLD	..... ●	MAGNESITE	..... ◻	OCHER ◻
COPPER	..... ⊙	MARBLE	..... ◻	COAL ◻
CASSITERITE	..... ⊖	FLUORSPAR	..... ◻	DIATOMACEOUS EARTH ◻
LEAD	..... ⊕	MICA	..... ▲	KAOLION ◻
ZINK	..... ○	ASBESTOS	..... △	URANIUM ◻
WOLLASTONITE	..... ⊙	CHROMITE	..... △	NATRON ◻
GYPSUM	..... ◻	MANGANESE	..... ◻	KYANITE ▲
WOLTRAMITE	..... ◻	IRON	..... ◻	GRAPHITE ◻
SULPHUR	..... ◻	VERMICULITE	..... v	TALC	..... T