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# SPECIAL SIERRA LEONE GEOLOGICAL POTENTIAL REPORT

## Part 1. A BRIEF OVERVIEW OF THE POTENTIAL OF SIERRA LEONE GOLD DEPOSITS

for Mr. Bader Al Monawer


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Freetown, November 2018

On the territory of Sierra Leone is a fragment of the Leon-Liberian shield of the Precambrian age. Various types of minerals and, above all, diamonds and gold are associated with crystalline rocks and overlying rocks of the sedimentary cover. This Review focuses on gold deposits.

Sierra Leone gold exports for 2017 totaled 142.06 kg, down 24.31% on the 2016 level. Gold exports last year were worth US$5.2 million. "In all, 16 exporters participated in 2017," the NMA said. "Only 67 certificates were issued to expedite the exports."

An averaged of US$1,140/oz was received for the 4,567.81oz of gold exported in 2017.

Unfortunately, official statistics do not take into account the volume of gold production by local residents. True, one must admit that the source of this unaccounted amount of gold is the alluvial sediments of modern rivers and some not deeply located gravel levels of buried ancient river valleys that are technically available to local diggers.

In Sierra Leone Gold deposits are divided into the following geological and industrial types (Fig. 1).

Each of these types of deposits is characterized by various parameters (this is what distinguishes them from each other):

- *morphology of ore bodies;*
- *depth and compactness of their occurrence;*
- *size (thickness) of productive ore bodies;*
- *gold extraction technology;*
- *presence of concomitant industrial minerals;*
- *average Au content;*
- *cut-off grade;*
- *content of sulfide minerals and type of these minerals (affecting to the product quality)*

General Prognostic technical-economic parameters, which determine the economic attractiveness of an industrial field within a Licensed areas (are as follows):

- *The presence of territories containing direct signs of the presence of one of the geological and industrial types of deposits.*
- *Gold resources / reserves;*
- *Average metal grade;*
- *Mine capacity by ore;*
- *Annual gold output;*
- *Total capital investments;*
- *Exploration expenditures;*
- *Annual exploitation expenditures;*
- *Full operating cost per 1 gold c.u.;*
- *Annual income;*
- *Profitability to capital investments;*
- *Capital investment recovery term;*
- *The cost of conducted geological exploration and many others*

The economic efficiency of gold extraction from different geological targets are depends on from these economic parameters.

Therefore, a potential Investor (before making a decision on investment in subsoil use) should pay attention to the possibility of obtaining a qualified conclusion about how likely it is to find certain industrial fields within the Licensed Area.

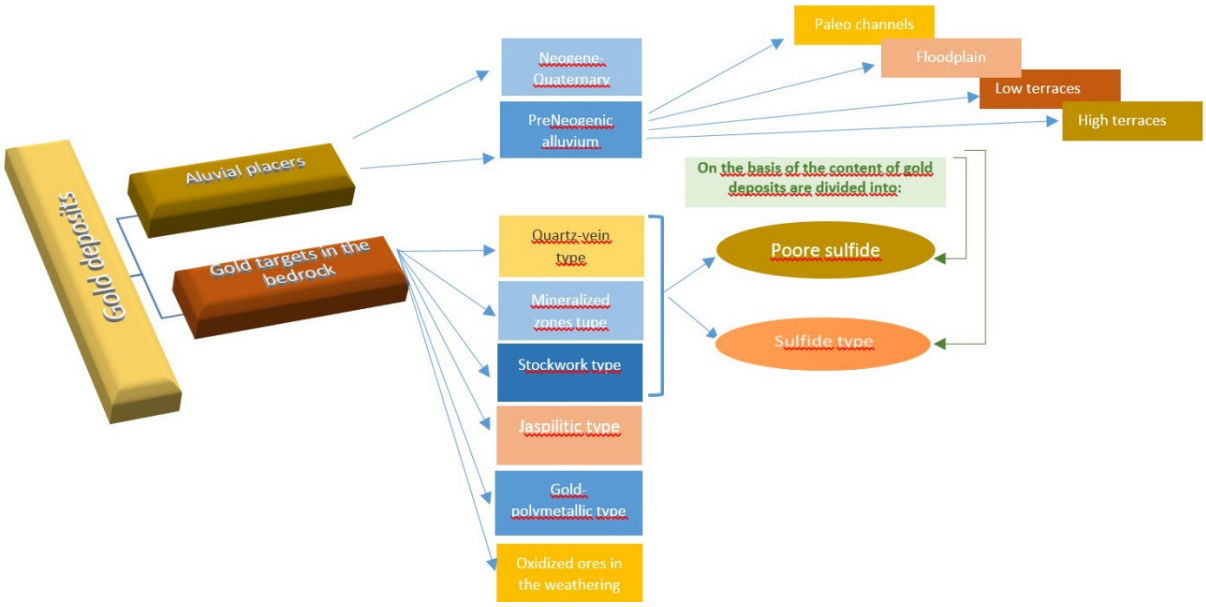



*Fig. 1. Different types of the gold economic deposits in Sierra Leone*

As in generally known, gold occurrence is widespread in Sierra Leone and both alluvial and lode gold deposits are confined to rocks of the Kambui Super Group, mainly those of the Sula Group Supra-crustals. Rocks of the Sula Group constitute the greenstone belts of Sierra Leone and they consist of meta-volcanic and meta-sediments metamorphosed to various sub-grades of ore greenstones facies during the Liberian Episode.

As a rule, gold mineralization associated with these rocks is present in the form of several geological-industrial types (Bobrov, 1986):

1. *quartz-veined (sulphide) type*
2. *mineralized zones*
3. *stockwork zones*
4. *gold-jaspilite type (type Vubachikve / Foster, 1984; Bobrov, Maluk, 1985)*
5. *gold-polymetallic type in association with ferruginous quartzites*
6. *skarn type (this type of mineralization and gold is extremely rare and not typical for the geological structures of Sierra Leone.)*

# 1. QUARTZ-VEINED (SULPHIDE) TYPE

The quartz-vein type of gold mineralization is manifested in various types of rocks of the Precambrian migmatite complex and is controlled by a system of faults of different direction. The apparent connection with plagio granitic intrusive massif (including those not eroded by erosion on a modern surface) makes it easily identifiable and exploitable in order to establish industrial deposits.

The presence of a large number of veins and stems, as well as small (5-10 km2) diorite-tonalite massiffs does not exclude the existence of a spatial and paragenetic connection with this mineralization.

We studied this type of mineralization in different geological structures of the Precambrian basement. One of the brightlly example - a knee-like fragment Sewa River, altered by a combination of the

fault system with the NW-NE direction.

This type of gold mineralization must continue to be tested and prospected within different Areas.

# 2.MINERALIZED ZONES / 3.STOCKWORK

Linear stockworks in spatial connection with ore-producing rhyolites - this completely new type of gold mineralization for Sierra Leone been discover by Trinity Geomining Services (SL) Ltd in 2017 in Sewafe Area and combines types 2 and 3 mentioned above.

In Sierra Leone (Sewafe area) for the first time have been established the presence of a system of bodies with rocks of acid composition, which represented by rhyolites and rhyodacites of various facial types: lava, pyroclastic and subvolcanic / hypabyssal.

This type of ore deposit studied in detail for the Ukrainian Shield (Bobrov, 1986). This type is predominantly distributed within granite-greenstone and granulite-greenstone areas. Here it is ore-producing for the main type of gold mineralization in greenstone belts, namely, mineralized zones and various ore stockworks with gold-polymetallic and gold-rare metal mineralization (Bobrov 1986; Bobrov, 1990; Bobrov, Levitan, 1990; Bobrov 1994; Bobrov et al., 2002; Beliawskiy Bobrov et al, 2004; Bobrov et al, 2004; Laz'ko, Bobrov et al, 2005; Metal and non-metal minerals…, Edit. by Bobrov, Shcherbak, 2005; Malyik, Bobrov et al, 2007).

Rhyolites and rhyodacites form a closely spaced and genetically related group of rocks like volcanical-plutonic rocks association. The predominant species are rhyolites.

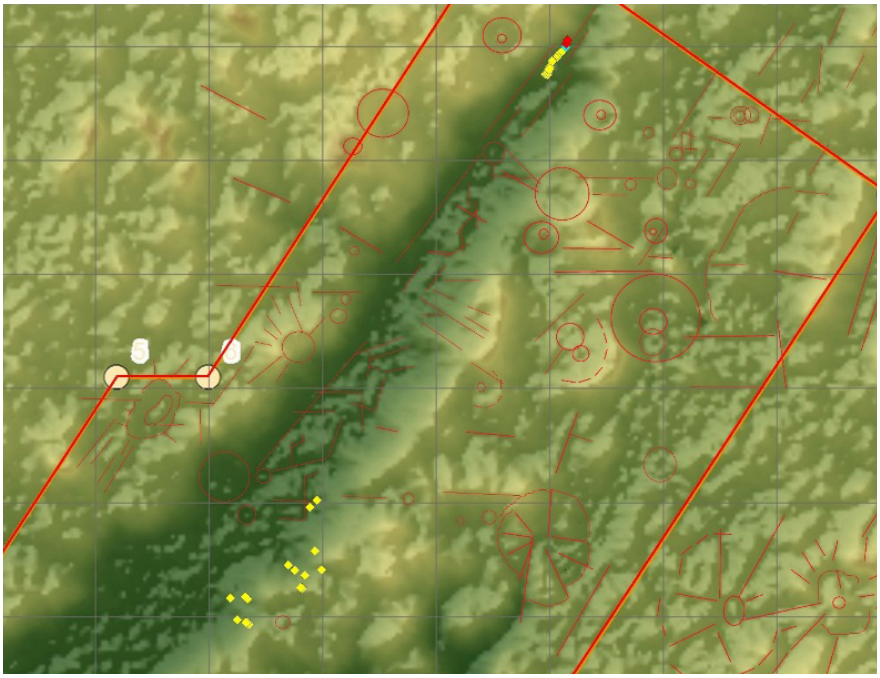


*Fig. 2. Gold productive rocks location in Sewafe Area (different type of riolites) are located (yellow points) along fault zone (Az. 30-350).*

A detailed study of this rocks made establish signs of sulphide mineralization and the presence of native gold. The testing of individual varieties of rocks of this association confirmed the data on the possible industrial mineralization of gold in individual areas of distribution of rhyolites . Gold content (1-7.4 g/t) was determined by assay and ICP analysis (State Enterprise «Ukrainian Geological Company» Address: 02088, Kyiv, Ukraine, Geophysics Street, 10); "ALS Liberia Ltd", (Liberia, New Georgia Estate Road, Monrovia).

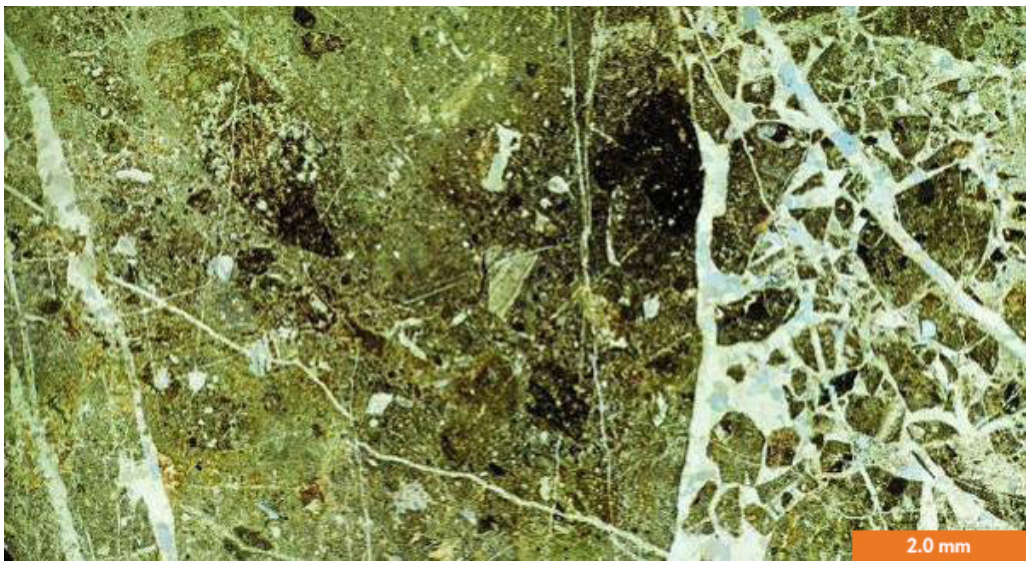
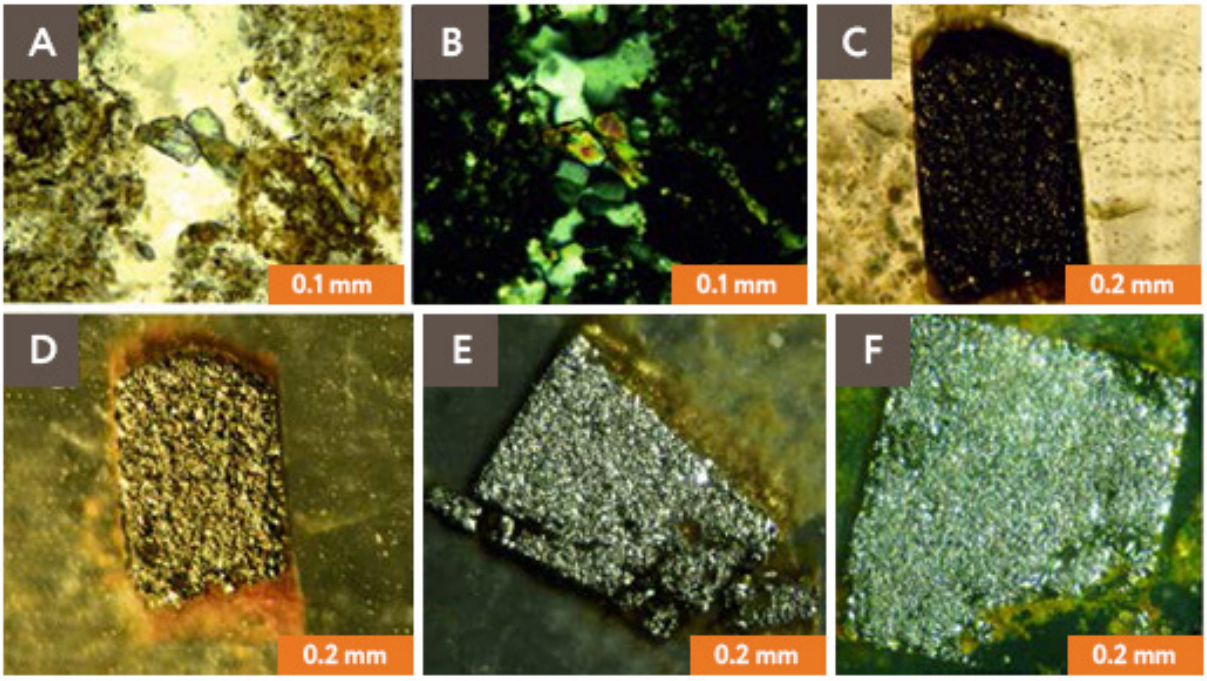



*Fig. 3. Stockwork in riolites (thin section, under the microscope)*



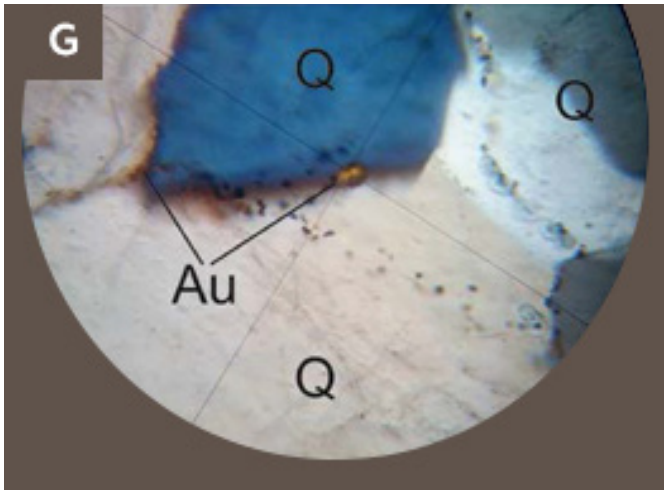




*Fig. 4. Gold and associated minerals in riolites*

**A,B** - *Small crystals of topaz in quartz vein. To the left is Nicole II, right is Nicole X;*

**C,D** - *Sphalerite in quartz. On the right is Nicholas II, on the left is Nicholas X;*

**E,F** - *Aggregate pseudomorphosis of galenite, the light is reflected;*

**G**-*native gold grain under the microscope*

In several areas of Sierra Leone already installed an ore stockworks. Some of them, which is traced by a system of GPR profiles in the southern part of the License Area. We do not yet know with what type of rocks it is connected, but it is now obvious that this is also a system of intersecting quartz veins and veins. They may refer to a different genetic type of stockwork zones than the one described above (see below).

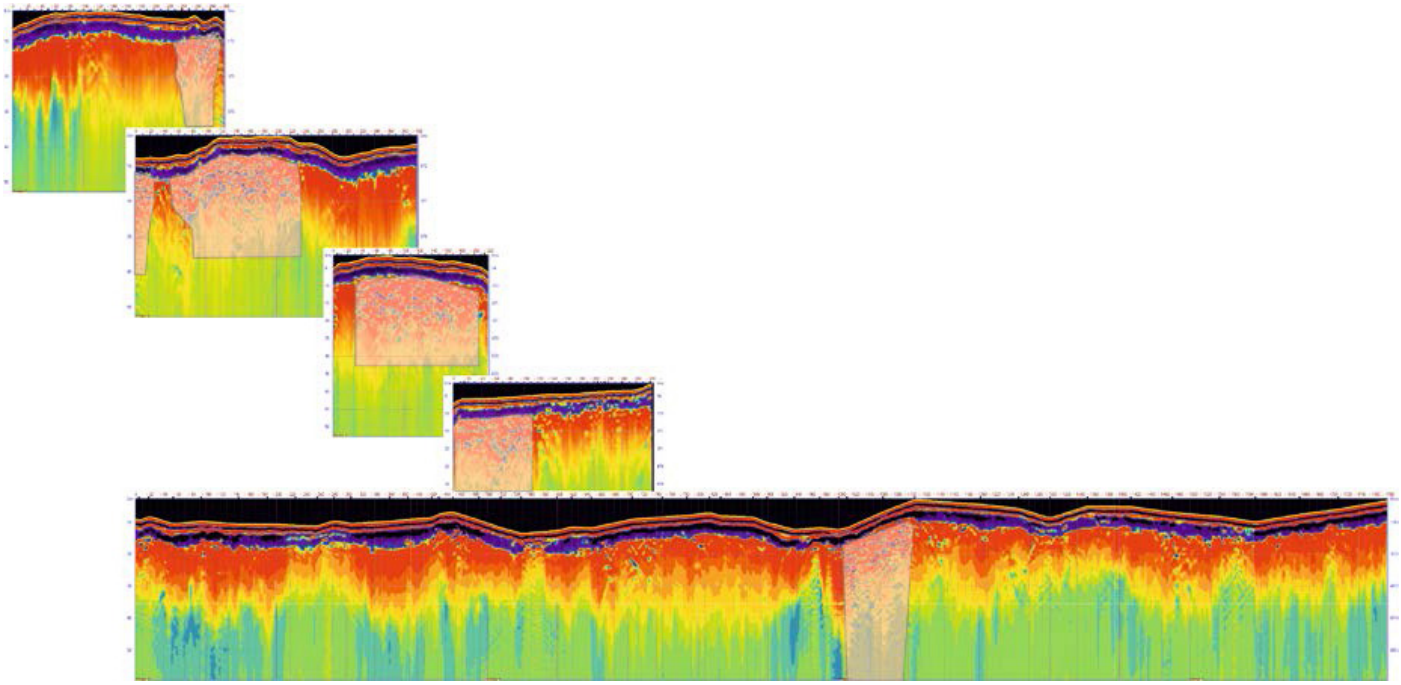


*Fig. 5. Ore stockwork in GPR profile system Sewafe Area ((© Trinity Geomining Services Ltd)*

# 4. GOLD-JESPILITE TYPE

## (TYPE VUBACHIKVE) (FOSTER, 1984; BOBROV, MALUK, 1985)

This type of gold mineralization is easily confused with deposits and ore occurrences in ferruginous quartzites on contact with tonalite massifs and rhyolite stocks / dikes. At the same time, they significantly differ not only geologically and genetically, but also a whole set of estimated parameters of ore bodies (such as gold content, mineral composition, ore body morphology, and resource potential).

Gold-Jespilite type of mineralization almost never forms large deposits, while the stockwork type (or gold-polymetallic type) of deposits forms large industrial deposits. So for this reason, the presence of jespilites in the studied geological sections always requires careful study of the genetic nature of gold mineralization.

# 5.GOLD-POLYMETALLIC TYPE

## IN ASSOCIATION WITH FERRUGINOUS QUARTZITES

This type of mineralization is remarkable in that, in addition to the industrial grade of gold, industrial contents of silver, zinc, lead, and copper et al are present in the ore zones and bodies of this type.

So far, it has been poorly studied, but in the case of additional in-depth study in the process of geological exploration in areas where there are fragments of greenstone orders, it promises to give significant discoveries of deposits of this type.

Signs of its existence are known in the areas of distribution of ferruginous quartzites in relics of greenstone belts.

# SHORT DESCRIPTION OF MAIN AREAS

Below is a brief description of the main sites of gold mineralization, which are publicly available, are available in Reports and archives and, to a large extent, are historical. In addition, the description briefly describes the previously unknown data from our studies, which are currently not even published in the open press.

Some of these data can be viewed as factual, complementing the picture of the distribution and quality of gold ore facilities, and some - as unique information about fundamentally new types of gold mineralization, not previously known.

All these types of gold mineralization that we briefly described are found in different regions of Sierra Leone. To date, there is a lack of sufficient evidence to accurately identify them and be able to separate from each other. This must be done in the process of exploration for each of the Licensed Aeas under study. In this case, all new information about each of the studied types of mineralization is extremely important to report in the annual Reports of companies conducting geological exploration.

In this case, in the near future, we can, through joint efforts, be able to more accurately typify industrial gold ore facilities in each of the well-known gold regions of Sierra Leone.

Below we will try in a very brief form to give a general description of each of the known gold mining and exploration areas.

## MOKAYE AREA (BANTA AND BUMPE CHIEFDOM)

There was continuous gold mining up to 1956 with a total production of 342,784 troy ounces. Production ceased in 1957 with the advent of the Alluvial Diamond Mining Scheme. Since then a few troy ounces have been produced. A peak in production was in 1936 with 40,794 troy ounces. This was followed by a very slowly declining till 1942 and ended in a rapid drop to only 199 troy ounces in 1946. Production started to rise again due to the activities on the Pampana River, and to the Yemen Company Limited, who were working small underground mine at Baomahun and the Valunia Chiefdoms. The increase of production from 199 troy ounces to 2,512 in 1947 was mainly due to the resumption of activities by the dredge, on the Pampana River. In 1950 been mined 2,490 troy ounces.

Operations were always difficult t because of rock bars which had to be blasted to make a passage for the dredge. The annual production from 1947 to 1953 varied between 1,609 and 3,945 troy ounces. As the known rich and shallow deposits became exhausted, the Holders of titles changed over to working by means of tributers - In the mean time illicit mining had become widespread and difficult to control.

No good reasons have been given why gold mining ceased in 1956. It is obvious that all alluvial gold mining operations were carried out in the recent river gravel, by hand operations. Only in the Pampana River mining was mechanized by the use of a dredge. It is not known to what extent the gravel of the low and high terraces along those gold-bearing rivers have been investigated. It is therefore highly recommended to investigate the following areas for potential gold bearing gravels in the flood plains along the rivers as indicated on the several maps within Laminaia Area, Around Bumbuna-Rokel-Seli River, around Lake Sonfon, Tonkolili, Pampana and Tebenkow River, Wongo River in the Nimini Hills, Area around Njaiama-Sewafe, Gori Hills (also Wungi River near Baomahun).

Bank drilling would be the easiest and best prospecting method, to check the presence of gold-bearing horizons. There is also a good potential for lode gold and base-metals in the vicinity. The Sula Mountains/Kangari Hills are the best investigated and the results are given in Chapter6.11.2. It is conclusive that there is a mineralization with gold molybdenum, zinc, copper and arsenic; but the relationship between gold and the base-metals is unknown and also the type of mineralization. Considering this old Precambrian rock association (volcanic and sedimentary geosyncline rocks) and the mineral association (gold and base-metals like galena, sphalerite, chalcopyrite, arsenopyrite, molybdenite and others) and comparing it with similar mineralized Precambrian areas in Canada, South Africa/Rhodesia, where these deposits are worked with profit. It is obvious that with those indications, further prospecting ought to be undertaken. In the first instance emphasis should be laid on detailed geological work to become

familiar with the lithostratigraphy which is necessary for correlations of potential mineralized zones. Geophysical (magnetometer and electromagnetic) and geochemical soil surveys will be necessary additions to the geological work.

## SEWAFE AREA

During 2017-2018 Seawright Mining Company performed a limited amount of mining to test ore stockwork associated with rhyolite intrusions, which gave positive results of laboratory tests. More information about this area is given above when describing a new geological and industrial type of gold mineralization in section 2.Mineralized zones /3.Stockwork zones/

## KONDE AREA

According to factual date by Northern Province Prospecting Venture, N.P.P.V., a joint venture between DELCO and HUNTING the area is approximately two miles north-west of the village of Foria. The area is near the southern edge of, and within a boss of late-kinematic granite which extends for about 6 miles in a north-south direction and 4 miles in an east west direction.

Recent geological exploration has discovered outcrops of pink coarse grained granite, and amphibolite. Traces of molybdenite were found in a boulder of gneiss and a boulder of pink granite. The geophysical surveys, induced polarization and electromagnetic, were made along 4 traverses over the chemical anomaly to locate mineralization. Two pits were subsequently dug by N.P.P.V. on the basis of the geophysical result.

## BONGONE AREA

Regionally the area consists of metamorphosed basic igneous, ultrabasic and sedimentary rocks of the Sula Mountains Schist belt. The Schist belt is enclosed by granitic rocks and boulders of late-kinematic granite have been found in the northwestern corner of the Bongone area. The regional strike of the Schist belt is north-east; this also is the inferred direction of major fold axes. The Bongone area lies just to the west of the axis of a syncline. Faulting has been inferred in north-south and north-east directions but has not been positively identified in the vicinity of the Bongone area. A photo geological study of the Lake Sonfon block shows many linear features with dominant directions of north-north-east, north-east and west-north-west.

Two diamond drill holes were sunk .to investigate the zone beneath the, highest part of the geochemical anomaly (in the Bongone area) and outlined a zone of sulphide mineralization which; was approximately 280 feet wide. Traces of molybdenite were found in part of this zone. Values ranged from 4-8 ppm.

Within Area carried out the following work:

1. *Check stream sediment and bank soil around the Lake Sonfon area.*
2. *Detailed duricrust Survey resulting in proving of a well defined anomaly than 200 ppm over 2,000feet strike length, followed by auger drilling.*
3. *Diamond drilling (3 drill holes) .*
4. *Geophysical survey using IPM, EM, GPR.*

According to Dr. Freitag data the bore logs show intersection of sulphide- mineralization. As the Lake Sonfon area was one of the most productive alluvial gold mining areas, it is highly recommended to look for both alluvial and lode gold as well as base metal mineralization.

## MAKALANKALA AREA

The area is centred on a rounded hill about one mile southwest of the southern most part of Lake Sonfon. The nearest mineralized outcrop is to the south-east near the confluence of the Tongoboten and Sende River; it is a steeply dipping gold-bearing-quartz-tourmaline-pyrite vein. About the same

distance to the west-south-west quartz-tourmaline veins containing traces of gold occur in the valley of the Kawkaw River near its confluence with Kawkawba.

Pieces of late-kinematic granites have been found in gravels in the southern part of the Kawkaw. Regional geochemical sampling of the duricrust show anomalously high values in the Makalankala area. The geochemical anomalies was further investigated by detailed sampling and revealed a low order molybdenum anomaly. The geophysical surveys, induced polarization and electromagnetic were carried out to locate the source of the geochemical anomaly. The induced polarization results indicate widespread occurrence of polarisable material at shallow depth. The anomalies are not specifically related to the geochemical anomalies and the polarisable material is thought to be pyretic amphibolite. It is suggested that a granite boss occurs at shallow depth and may be the source of the geochemical anomaly.

## DALAKURU AREA

The area lies to the west of the Sende River and immediately to the north of the Fundiburu River and may be reached by footpath from the village of Dalakuru. The Topography is hilly on the western side of the Sende River the ground rises to The axis of a major syncline passes through the area. Amphibolite and late-kinematic granite crop out in the Sende River, banded ironstone occurs to the west of this area.

In 2015, profiling was carried out and significant prospects were confirmed for gold mining not only in placers (in the buried canals of ancient rivers), but also gold in crystalline rocks. It is associated with numerous zones of sulphide mineralization and silicification.

The following examples of geophysical studies fully illustrate the positive results obtained.

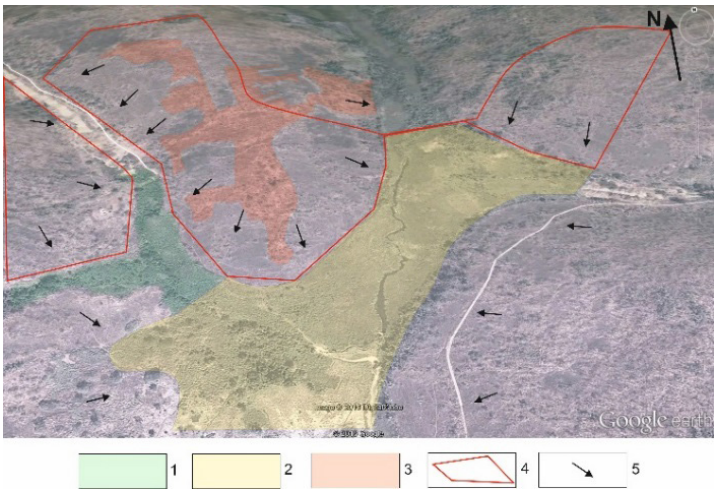



*Fig. 6. Localization valleys within Darakuru and Sofon sites and indigenous sources of gold placers*

*1 - valley and distribution of potential placers on Darakuru site;*
*2 - valley and distribution of potential placers on Sofon site;*
*3 - countor of the predicted localization of primary gold source;*
*4-direction of the demolition.*

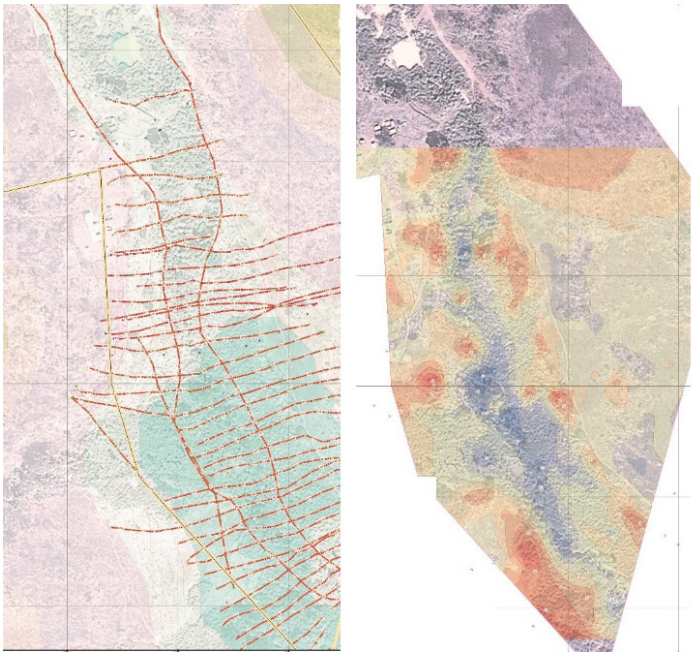


*Fig. 7. Some examples of the GPR profiles on the site (left) and the map of the equal thickness of gravel (right)*

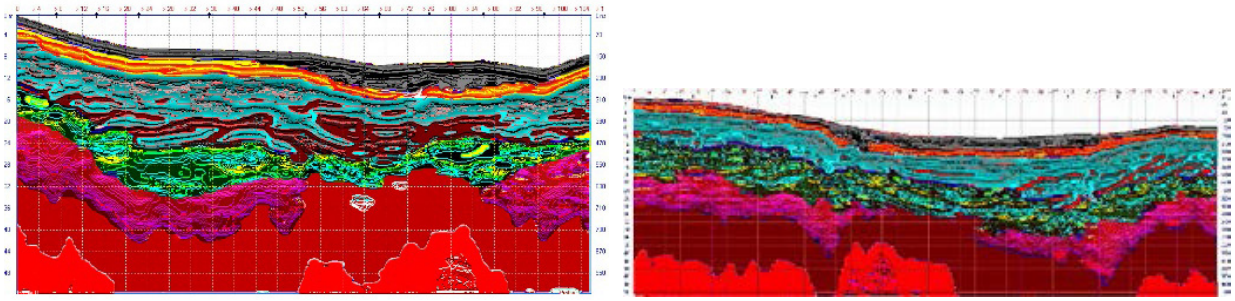


*Fig. 8. Gravel (green color) on the geophysical cross-section*

The electromagnetic anomalies are widespread and largely due to conductive zones within the overburden. Two conductors in the southwestern part of the area appear to be located within bedrock and may be due to sulphide mineralization.

We strongly recommend potential investors to conduct active geological exploration, which promise to give a positive result on the discovery of economic gold deposits both in the alluvial type and in crystalline rocks.

## LAKE SONFON AREA

Outcrops of unweathered rock are exceptional round Lake Sonfon and loaming is unsatisfactory on duricrusted surfaces, which are impenetrable without drilling and are in many places soil free.

Prospecting has to be confined 'therefore mainly to the rivers. Loaming is fairly reliable on their banks if they have broken through the duricrust, but the main guides to mineralization are boulders of lateritised gozzan and laterite which evidently baffled earlier prospectors, for gossanous boulders are not uncommon.

About 1935 the Geological Department reported floats of wulfenite and a bismuth mineral from the steep-sided valley of the upper Sende a mile or so below Dalakuru; in 1951 a departmental geologist traced molybdenite float from about that spot to outcrops in a track of river-bed about 700 feet long beginning 500 feet south of the Sende-Fundiburu confluence. The riverbed there has cut through the duricrust to expose fresh metamorphic pillow lava. A flattish but rounded pebble of medium-grained granite containing pyrite and 5% or so of molybdenite was also picked up in the Sende opposite Sende camp, but the parent rock has still to be found. Molybdenite with galena, Zincblende, Aikinite and other metallic minerals described below, occurs in late-kinematic pegmatites and in hybrids of the late-kinematic granite and pegmatite with the country rock; also in joint planes in the country rock. Galena, Zincblende and Aikinite are more plentiful in the drusy quartz vein veins associating with the pegmatites and hybrids than in the pegmatite and granitic rocks themselves. An intrusion of late-Kinematic granite which is sodic, fluorite-bearing and rather curshed outcrops in a waterfall 500 feet to the south-east of the south end of the known molybdenite mineralization, and a pink granite dyke up to 4 feet wide, striking at 68°C crosses the river-bed within the mineralized area itself. The three principal galena and molybdenite-bearing hybrids strike at165° C to 170° C and fill tension joints, nearly normal to the foliation. Widths of hybrid are up to 18in.and dips are dominantly vertical or steep to W.S.W.

Two steeply-dipping drusy quartz and pink pegmatite veins, each less than 12 in. wide, that stride at 45°C.and 65°C accompany the most northerly hybrid which outcrops below water level. None of the mineralized veins is traceable for more than 90 feet and as widths are narrow and trenching and loaming on the banks of the Sende to about 100 feet above water level disclosed only one or two molybdenite-filmed joints, prospecting by ordinary means was stopped. A geochemical campaign in 1956 by a party from the Royal School of Mines found a small body of late-kinematic granite on the south-west, bank of the Sende within 300 feet of the river-bed together with evidence of a zone of molybdenite mineralization a little further to the south-west. The pegmatites, hybrids, the granite dyke and the small, body of late-kinematic granite south-west of the Sende suggest that the intrusion of late- kinematic granite 500 feet south-east of the south end of the molybdenite mineralization pitches upstream under the pillow lavas; the general setting thus quite favors the occurrence of mineralization.

Metallic minerals composing the suite at the Sende occurrence are, in order of abundance: magnet-

ite, +pyrite, chalcopyrite, galena, molybdenite, Zincblende, Aikinite. The order according to age, starting with the oldest mineral, is probably: magnetite, pyrite, chalcopyrite, molybdenite, zincblende, galena and aikinite, but no single specimen shows the complete mineral sequence and it seems likely that the first four minerals and the last three belong to different phases of mineralization possibly separated by a time-interval. At least some of the magnetite is an original constituent of the pillow lava and part of the pyrite probably derives from it. The Aikinite, which is a copper-lead sulpho-bismuthite, is clearly the latest metallic mineral. Common gangue minerals are quartz, tourmaline, epidote, ankeritic carbonate, calcite and fluorite. A sample of the galena and molybdenite-bearing drusy quartz assayed 96 dwt. bullion but only 0.2 dwt gold per long ton. Tungsten and the radio-active elements are not detectable in the mineralization, nor is any cassiterite-columbite, or ilmeno-rutile noticeable in it, though the department has reported all three of these minerals from the Sende gravels between Dalakuru and Kunya. Downstream from 1,600 ft. west of its confluence with the Sende the Fundiburu is strewn in lessening numbers with sub-angular blocks of gozzan. A piece of float assaying 68 dwt. Bullion and 58.5 dwt. gold per long ton was traced to a stretch of the Fundiburu north bank (lat. N. 09° 11', long. W, 11° 32' 20") between 1,500 ft. and 1,700 ft. from the Sende confluence. To explore the stretch three trenches normal to the east-west direction of the Fundiburu's flow were dug in ground which slopes towards the river at an average angle of 25° .

Limited geochemical prospecting in 1956 outlined a molybdenum geochemical anomaly. Subsequently the Geological Survey drilled seven bore holes totaling 5,000 feet beneath the anomaly and intersected several narrow bands of molybdenite and galena mineralization within a host rock which is principally amphibolite. One drill hole intersected a zone averaging 0.15 % Mo over 196 feet. More detailed work was carried (out by Northern Province Prospecting Venture between 1966 and 1969. The following work was done:

1. *Check stream and bank sampling in Lake Sonfon area.*
2. *Soil and duricrust sampling over the Geological Survey anomaly.*
3. *Studying the Geological Survey bore-hole cores, resampling and assaying of one part of the core.*
4. *Geophysical survey - IPM and EM revealed a number of conductors.*
5. *Diamond drilling: 3 additional holes were drilled in sites recommended from geophysics to investigate the conductors. A 27 inch zone assaying 2.49 % Pb in a location corresponding to the main mineralized zone of the Geological Survey was intersected; another 19 inch zone assaying 0.50% Mo, corresponding with the expected down dip location of the richest intersection of the G-borehole.*

Geochemical samples just on Mo, Core assaying just Mo+Pb. Mentioning of disseminated sulphides in amphibolitic, and quartzose rocks suggest further investigation for Au and base metals.

Mining techniques to extract gold from the area will be carried out here to proceed to full-scale commercial mine development with international investors' cooperation. SCRX commits to contribute to any mine development through its expert services for seeking investors and helping to successfully manage the operations

Historical mine records with local artisanal miners using crude and inefficient materials to extract gold from the Sonfon area do present useful information about the mine's geology and has provided an important cost savings to SCRX in its exploration phase.

In addition to historic patterns of gold extraction activities in the Sonfon Area, a major gold development company, Mano River Resources, Inc., has conducted various technical studies relating to the feasibility of the gold mining operation in the Sonfon area. Their work has provided well-researched assumptions that SCRX is capitalizing on as well as an alternative stand-alone gold mining feasibility assessment.

Our data, described above in section DALAKURU AREA in this Report, fully confirm the enormous potential of the gold-bearing area.

## KELSAKO AREA

The first indication of molybdenum-mineralization in Kelsako area was shown in stream sampling of Imperial College in 1963 when sediments from several of the western tributaries of the Tibabu River north of Kelsako revealed regionally anomalous molybdenum values up to 14 ppm. The area lies on the

western slopes of the valley of the River Tibabu about two miles north of the village Kelsako and may be reached by footpath from the latter. Elevation is between about 1,600 and 2,000 feet; the ground surface is not covered by duricrust. In 1967, the regional geochemical programme of Northern Province Prospecting Venture showed anomalously high molybdenum in the soil; this anomaly was delineated by detailed survey. The geophysical surveys, induced polarization and electro-magnetic, were made to determine the source of the geochemical anomaly.

Molybdenum-bearing intrusive granite with conspicuous flakes of molybdenite forms an irregular shaped body with a surface area of around 300,000 square feet.

**(a)** The western portion of the area shows, dominantly float and occasional outcrop of mainly hornblende Schist with rare gneissose granite, pegmatitic granite and mica Schist. A sinuous boundary between these hornblende Schists and the granitic rocks to the east is inferred to run N-S, as shown on the map.

**(b)** The eastern two-thirds of the area is occupied by variable granitic rocks with only occasional hornblende and mica Schists.

**(c)** Three granitic rock types are differentiated, viz:

1. *Gneissose granite generally coarse-grained, foliated, synkinematic granites, possibly granitised arsenaceous rocks, over the south and east of the area.*
2. *Pegmatitic granite, very coarse, micaceous, granitic pegmatite, cutting the other rock types in dykes, and also possibly present as irregular bodies, towards the centre and north of the area.*
3. *Molybdenum-bearing intrusive granite, generally medium grained, equigranular, unfoliated and slightly foliated granite, with conspicuous flakes of molybdenite forming an inferred irregular tooth-shaped body in the north of the area, roughly co-incident with the greater than 50 ppm soil molybdenum contour.*

Geochemical analyses, on composite 5 feet samples down the pits show bedrock molybdenum contents from 38-100 ppm although no visible molybdenite is present. Nevertheless these values are relatively high, for barren bedrock and may be indicative of a local primary dispersion of molybdenum. Northern Province Prospecting Venture carried out several exploration between 1966 and 1968:

The molybdenum-mineralization seems to be relatively equally distributed within the "Foliated" and "Unfoliated granites". The analytical results of all 787 samples taken in the three inclusive granite rock types indicate a mean tour of not greater than 200 ppm or 0.027 % Mo.

This molybdenite data is as important as it is an indicator of the pre-productive stage of gold deposition.

## KALMARO AREA

The Yirisen Prospect near Kalmaro was revisited to map and sample the underground openings of the Sierra Leone Development Company.

Sierra Leone Development Company is sinking a winze on the main ore body just to the north of the Yirisen River. The winze is to hole into an adit that has been driven north-eastwards from the river through a thrust fault. North-east of the fault, which dips at 520 south-east, the adit exposes the southern tip of the lenticular orebody in which the winze is being sunk; the orebody strikes at 10° and dips at 78° southeast. The pitch of the south end of the ore judging by the positions of its tip on the surface and underground is at 45° to the north-north-east. Whether this pitch has a more general structural application, remains to be seen; surface outcrops give no obvious clues.

Near its tip in the adit the orebody consists of laminae of bright green chrome-mica interbanded with fine-grained quartz. It may have been either a cherty quartzite or silicified talc-chlorite Schist; probabilities favor the second alternative. Northwards the Schistosity becomes less marked, the proportion of fine-grained quartz grows and there is impregnation with pyrite and arsenopyrite; ankeritic carbonate, tourmaline, biotite and chlorite are present as secondary and accessory minerals, but no fluorite is noticeable. Loellingite, leucopyrite and gudmundite are absent in specimens examined.

After the impregnation there was movement, for the arsenopyrite and pyrite are brecciated and rolled and crevices between the fragments are filled by comparatively coarse-grained quartz veinlets carrying in order of age, chalcopyrite, zincblende, and boulangerite and meneghinite two sulphantimonites of lead. Galena also occurs with pyrite, than which it is later, in stringers in the talc- chlorite Schist. No

other metallic minerals have been recognized. Just east of the lode in the adit, the, talc-chlorite Schist is sheared and strongly carbonated; auriferous quartz stringers occupy the shear Planes. Gold is not to be seen in any of the surfaces that have been polished, but according to the assays silver links with arsenopyrite and gold with the base metal ores, particularly the sulphantimonites.

While at the Yirisen Prospect the ridge to the north was followed for about 3,000 feet as far as the col that separates it from Pasabuma. On the way several pieces of gozzan were found and close prospecting, whether by geochemical or ordinary means, might result in new discoveries.

The area lies in hilly country about 1 1/2 miles due east of the village of Masumbiri. The River Yirisen flows in a steep-sided valley across the southern part of the area. The ground surface is soil covered and, where there is no farming, the vegetation is secondary bush.

The area is within the Sula Mountains Schist belt 2-3 miles north of the Pampana River, i.e. north of the more disturbed Kangari Schist belt. It is in the eastern part of the Schist belt about 1,300 feet, west of a small granite cupola and about 2 miles west of the true Schist belt boundary. The country rock is principally carbonate talc-chlorite Schist which strikes approximately north-north-east and dips sub-vertically generally to the east-south-east. Dykes of aplite, felsite and quartz are common and are frequently mineralized.Shearing and thrusting has taken place in an approximately north-south direction. Sulphide mineralization, principally pyrite and arsenopyrite, was first discovered by the Geological Survey in the Yirisen valley. Numerous small occurrences of sulphide mineralization were subsequently found along the Yirisen River and its tributaries, and also away from the water courses. The latter were exposed by trenching. One lode, No.4, was explored by an adit and by two diamond drill holes. Lode No. 7 was a1so explored by one diamond drill hole. The diamond drill holes revealed only very narrow scattered zones of mineralization. The mineralized zones, exposed by the adit exploring Lode No.4, have a total width of 4 to 5 feet and contain pyrite, arsenopyrite, gold and some galena. Estimated mean gold content for 3 lodes in. the vicinity of and including Lode 4 and for Lode 7 is 12 dwt. per, ton. Lode No.4 pitches at an angle of about 45 to the north-north-east. Wilson, 1958 p.81-82 writes about the Kalmaro Prospect. A prospecting in the hills between Masumbiri and the eastern edge of the Schist belt led to the discovery of gold-bearing aplitic sericitic quartz lodes in the upper Yirisen River a mile west of Kalmaro.

"An A.B.E.M. Turam 28 Unit was used for the, Electro-magnetic (EM) measurements. Primary fields were produced by rectangular loops of cable and readings were taken at 50ft. intervals using 50 ft. coil separation. A total of 18 traverses were measured with the EM equipment. For the induced polarization (IF) measurements a huntec 2 1/2 Kw pulse unit was used. Readings were taken using the gradient array with potential electrode separation of 100 ft. Interval between readings 2 was 100 ft; six traverses were measured with this instrument. The Turam results show ration values varying between 0.925 and 1.065 and phase difference values between +30 and -40.

## BAOMAHUN AREA

Gold was discovered in the Baomahun area in the late 1920s and was actively prospected during 1932 by Messrs. Maroc Limited. Alluvial gold mining started in 1933 with a production of 1,203 ounces. The gold is associated with a mineralized zone carrying sulphides. A lode occurrence near Pujehun north of Baomahun was discovered in the early 1930 and prospected more actively with compressors and machine drill in 1935.

Two auriferous zones were investigated. Each occurs on a hillside and was prospected by adits driven at different levels and connected by winzes and crosscuts. Values up to 9.3 dwt. over a width of 5.17 feet in the former and 7.9 dwt. over a width of 30 feet in the latter were reported. The gold occurs in an irregular shape sulphide impregnation in the quartzite rocks. Although these prospects were giving encouraging results further prospecting of them was stopped in 1937 pending the formation of a separate company to take over and develop the area.

The Yemen Company mined gold in Baomahun on the areas of two separate applications for mining leases for gold covering the gulleys in the hillside made by illicit miners in the strike of decomposed gold vein outcrops.

Along another tributary of the Wungi, also north of Baomahun, the source of anomalous arsenic values was found to be arsenopyrite, occurring in fractures and in the adjacent wall rocks. The arsenopyrite

is frequently associated with quartz veins localized in scattered zones within a 600 feet wide zone of metasediments. No gold was found in the heavy mineral concentrates from the stream sediments below the sources of the anomalous values.

In an area south-west of Pujehun the principal source of anomalous arsenic values was recognized as been sulphides occurring in irregular quartz veins within quartz-sericite Schist, and in quartz-feldspar rock. Gold was recognized in the heavy mineral concentrates.

# DESCRIPTION 0F ALLUVIAL GOLD

## GOLD IN KABALA AREA

According to available data area is located among the traditional gold mining "zone" within which local prospectors mined gold placer. Typically, gold represented the fraction> +0.1, are frequent nuggets size 1.3 cm or more and as a resul – is a free-milling (Fig. 4).

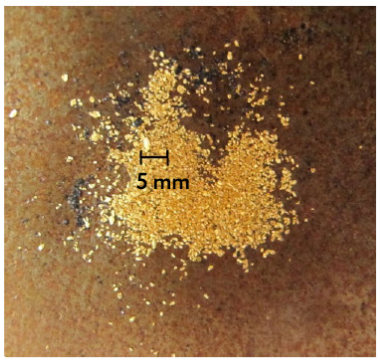




*Fig. 9. Monofractions of the native gold, purchased from local residents artisanal pits on the Area.*
*At the bottom part of the photo - fairly large (1.4 см) gold nugget.*

This area can be considered very promising both for finding new gold deposits both in crystalline rocks and in alluvial rocks of modern and ancient rivers.

## KAMPALA AREA

A prominent example of the gold-bearing deposits of the area is the Shanghai plecers (Kvikviya River), studied in 2013 by Style Research Co. The company carried out GPR profiling and mining and drilling exploration with the use of drilling and excavation.

The company has calculated the reserves of gold, after which it began mining.

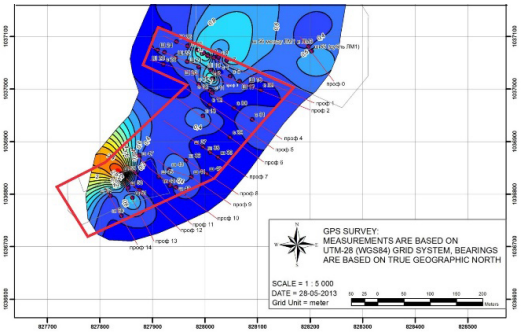



*Fig. 10. Isolines of gold content in the Area in the contour of exploration workings (values of contents in g / m3). One of Shanghai plecers.*
*Red outline - the boundaries of the exploration area*

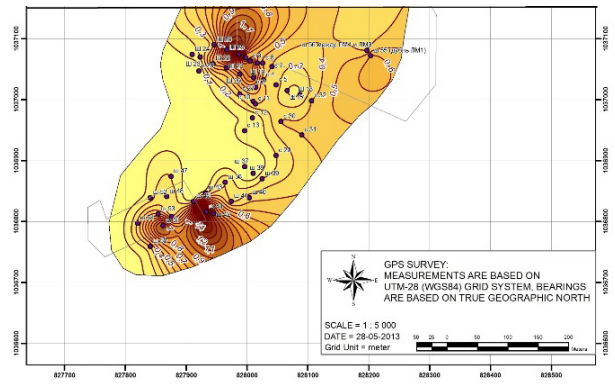



*Fig. 11. Isolines of power of the gravel in the area in the contour of exploration workings (values of contents in m)*

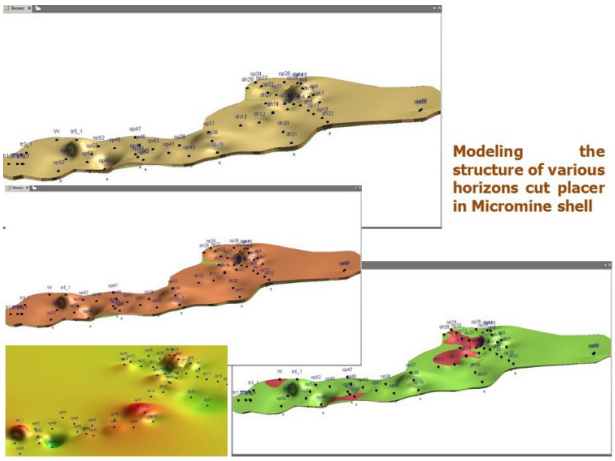



*Fig. 12. Result of 2D modelling this placer morphology in Micromine Software.*

## GOLD IN KAMAKWIE AREA

The gold area near Laminaia in the Sanda Loko Chiefdom, Karene District, was first discovered by the Geological Survey. The gold occurs in a series of swampy streams with wide alluvial flats that drain a ridge of hills consisting of hornblende Schists, etc. which is supposed to be a Schist belt relic. The whole area has a potential for placer gold deposits as well as lodes of gold and other base metals.

The quality and structure of alluvial deposits in this area can be examined with a vivid example of well and complexly studied placers with the use of not only the totality of geological, mineralogical and mining-technical methods of study, but with the use of various geophysical methods of study.

## GOLD IN SULA MOUNTAIN AREA

Gold was mined in 10 mining right~ mostly in the area northeast of Lake Sonfon along the road from Kondembaya to Alikalia.

## GOLD IN THE KANGARI HILLS AREA

Three mining rights are reported at the northern end of the Kangari Hills near Maketi and two, south of the hills near Manjaga and between Masaongbo and Manjaraya (Pendambu (Gowahun Cheifdom; Makari - Gbanti Chiefdom).

## GOLD IN SULA MOUNTAIN AREA

Significant finds of gold ore bodies and accumulations of gold in placers were found in areas Tilikoro, Biriwa Chiefdom, Rokel-Seli River north of Bumbuna (Diang Chiefdom), on the Tonkolili River and Gbulia.in the Signa Kolo River and the Seli River north of Bumbuna. On the south bank of the Yafarina River, Sende River, River 'Tongboten, Sende River.

## WOROWAIA - WANKATANA AREA

About 3/4 mile south-east of Worowaia a lenticular intrusion of late-kinematic granite measuring 3,600 ft. by 1,800 ft outcrops crossing the River Wankatana (Marmo 1956) are found (with decent gold mineralization).

Megascopically visible and regularly distributed, molybdenite is confined to two patches of late-kinematic granite, the one to the north measuring 1,200 ft., by 300 ft., the one to the south 750 ft. by 150 ft. At the western end of the first and larger area on the western bank of the Wankatana is a belt conforming to the strike of the intrusion and measuring 300 ft. by 150 ft. where molybdenum concentration is strongest.

Sierra Leone Chrome Mines Limited cut a trench right across the soft and deeply-weathered late-kinematic granite near the Wankatana and it is understood from them that in the patches described in the preceding paragraph the rock contains about 1/2 % of MoS2 and gold. No sampling or diamond drilling has been done by the department yet.

Also positive results for today were obtained by districts: Simiria Chiefdom (Pampana River and the Tebenko River, Waka River north of Makamba, in the southern tributaries of the Pampana around the villages -Malumpo and Mabeki). Gold was also mined in the Tonkolili River between the villages Bolia and Basaiya.

Important information on industrial gold content obtained from areas such as Randakuma and Kewali prospection, the Maruba anomaly near village Maruba, Tebenkaw River, near Makong and between Madibi and Mabai.

## ALLUVIAL GOLD AT MAKELE

Working commenced in November 1932. The main gold locality was 276.9 acres in area and included the Mapoko Stream near Makele. Some gold was also produced from a tributary of the Tebenkaw, just to the north of Makele. The gold deposits appeared to be defined to the present river beds. They were shallow, and entirely worked by hand labour paddocking methods. In 1933, the Makele area produced 492 troy ounces in 1936 and 1,480 troy ounces in 1937.

Several small gold-bearing quartz stringers and veinlets and a pyritic vein had been uncovered during mining operations in the upper Kwifuifui (Sheet 56, 29PKV 010 020-470 480). These veins contained megascopically visible gold. The largest nugget found was about 1 troy ounce by weight.

## GOLD IN THE NIMINI HILLS AREA

Gold was discovered near Titambaia and Komau in 1929. Alluvial gold was mined in the Nimini Hills between 1939 and 1945 in approximately 24 mining rights. Most of the mining rights were withdrawn.

Coarse pegmatite veins are common along the Bafi and to the north of Konkombodu (Sheet 58, 29PKV 632 650) veins of late kinematic aplite occur. At the eastern margin of the Schist belt tourmaline pegmatites are present in few localities and with the Schist belt to the east of the river Bafi one boulder of quartz vein carried a crystal of tourmaline up to 6 inches in length.

In the early 1960s a magnetometric survey was carried out by the Geological Survey in the duricrusted Nimini Plateau. This revealed an east-west trending narrow band of banded ironstone and magnetite quartz immediately to the south of the main grass-field. Samples taken from a pit sunk into this band carried up to 250 ppm of arsenic. This arsenopyrite mineralisation may be one of the sources of alluvial in the upper Wongo on the Nimini Plateau. Gozzan was found to the east of the grass-field and this carried up to 5 ppm of arsenic. The duricrusted laterite in the main grass-field immediately north of the Jaiama-Nimini-Koro-Peyima path carried lumps of tourmaline up to 2 x 1 inches in size. This tourmaline is present in the old gold tailings on the Wongo. Its presence in the Schist belt indicates the occurrence of late-kinematic activity.

In intensive programme of magnetometry, geochemical sampling, loaming and trenching was carried out at the Komau gold prospect on the western side of the Wongo Valley. It lies one mile SSW of the village of Komau, and is 5 miles by foot-path over easy terrain from Jagbwema on the Jaiama-Sewafe motor road. The mineralization consists of arsenopyrite with some pyrite in banded ironstone.

Significant mineralization was met in two trenches. In one, at 200 ft. west, there were six mineralized zones over a distance of 86 feet. These were channel sampled and assayed. The first zone averaged 44.66. dwt. of gold over 3.5 ft. The second zone averaged 15.4 dwt. of gold over 3.7 ft. and a third 6.2 dwt. over '9 ft. the fourth and fifth zones were only 2 feet wide and the sixth but 2 inches in width. In the second trench at 100 ft. E, the mineralization is arsenopyrite in magnetite quartz and quartz veins; it assayed 11.9 dwt. of gold over a width of 10 feet.

## GOLD IN THE GORI HILLS AREA

Gold (Gbense Chiefdom, Gbane Yawei Chiefdom and Paguia Chiefdom) is common in stream gravels along the flatter parts of the Schist belt which has several fairly wide bands of aluminous mica-quartz gneisses with numerous bands of quartzites.Extensive pitting and mining has been carried out with alluvial gravels on the flood-plains of the eastward flowing streams between Koidu and Bendu and along the upper parts of the Sunga River and its tributaries north of Bendu. Gold is also present in some of the streams on the western side of the Schist belt. The source of the gold is undoubtedly on the central part of the Schist belt. Geochemical work has indicated the presence of an arsenic anomaly (Garret 1966).

## GOLD IN THE GOLA FOREST AREA

Gold (Tunkia Chiefdom) was mined in 1940-1941 near the villages Nongowa and Pepe-Yama and from 1942-1945 near Lowrima. All these rivers are draining the southern Kambui Hills to the western side.

Low gold values were found in streams near Beodu which is about half-way between Lalehun and Beledu, where younger granite intruded the granulite and quartz magnetite hypersthene gneiss, and in streams about 1,600 yards south of Mano, Gaura Chiefdom, draining a band of pyritised hypersthene granulite rich in quartz and magnetite. A sample of the granulite contained 2 dwt. of silver, but no gold.

Low gold values seem fairly general east of the Moa in rivers draining granulite and ironstone bands that are intruded by younger granite. In 1956 Wilson found gold in the gravels of rivers rising on the eastern flank of the Tosien granulite and ironstone-ridge in the Tunkia Chiefdom, to the north of the path from Tanima to Nyemingy.

# CONCLUSION

All of the brief information on the gold potential of several regions of Sierra Leone presented here indicates a significant potential for the development of the gold mining industry. Many areas have not been studied enough and require exploration.

The most effective way to obtain industrially valuable objects is a reasonable performance of work in several stages with mandatory exploration, appraisal and exploration.

An approximate procedure procedure for exploration work for ELs Areas (in accordance with the international standard stages of work) as follows:

### Phase 1. Desktop study

Results of interpretation of all available distance and remote sensing (satellite image modelling, predictive geomorphological & neotectonic models), geological position and perspective of EL and main targets for the reconnaissance field work will be defined in that Report.

Desktop study Report will be as result of that phase. Also iIn a results of this activity will be selected local sites of the exploration works with the industrial potential.

### Phase 2. Reconnaissance field work

Reconnaissance work Report will be prepared.

Geological description of all area, description of **all rock types** and interpretation of laboratory analyses of samples will be written in that report. Existence and geological location of perspective areas will be presented as conclusions on that report.

Recommendations for further exploration (work program) will be presented as a conclusion.

No reserve or recourse calculations for that stage.

The first presentation about EL attraction and perspective can be prepared after that stage.

Terms of work: It depends on a size and relief of area (usually from 2 weeks to 2 months).

### Phase 3. Exploration work

Geological maps and sections will be prepared.

Ore bodies should be shown on the maps and on 3-D diagrams.

Technical report according with international (JORC) standard will be prepared (including recourse estimation).

Presentation for potential investors with all geological information, recourse estimation and preliminary finance calculation will be prepared.

Terms of work: depends on a size and geological complexity of area; from 6 months to 1 year

At the end of the full range of exploration and evaluation activities on the site and comprehensive examination the benefits and feasibility of further detailed geological exploration and mining shall be clear.

### Phase 4. Detailed Geological Exploration and Prefeasibility Study

Technical Report with reserves calculation in according with international (JORC) standards will be prepared.

Mining blocks with reserves and technology of extraction will be proposed.

First economical calculations will be proposed.

Terms of work: It depends on a size and geological complexity of area; from 6 months to 1 year

### Phase 5. Feasibility study

Mine valuation will be prepared.

Commercial viability of the project will be calculated.

All factors requiring considerations in a mining project feasibility study will be decided.

Terms of work: It depends on a size and geological complexity of project.

Such staging is generalized and is often violated in the direction of reducing the time of work. It all depends on the proper organization of geological exploration and strict adherence to the work plan agreed with the Investor.

And, most importantly, it all depends on a detailed distance study of the Licensed Area or a certain area before the start of field work. This allows you to clearly localize areas that may become industrial fields and not waste time on the work on obviously unpromising territories.

It is also equally important that geological exploration work is carried out using modern technological research methods (as a rule, = these are geophysical) and their integration. This significantly reduces the time of work and gives clear information to the geologist about the structure of the sites and their prospects.

Work in the old way, without experienced performers, without technology and advanced research methods - the path to nowhere.