# AN INTERIM REPORT OF

# MINERAL EXPLORATION IN THE KABWE WEST AREA,

# THE REPUBLIC OF ZAMBIA

JUNE, 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

METAL MINING AGENCY OF JAPAN



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# Preface

In response to the request of the Government of the Reopublic of Zambia, the Japanese Government decided to conduct a mineral exploration project in the Kabwe West area and entrusted the survey to the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ).

The JICA and MMAJ sent to the Republic of Zambia a survey team headed by Mr.Takashi Ono from October 29, 1989 to April 13, 1990.

The team exchanged views with the officials concerned of the Government of the Republic of Zambia and conducted a field survey of the Kabwe West area in cooperation with the staff of Zambia Industrial & Mining Corporation Ltd. After the team returned to Japan, further studies were made and the present report has been prepared.

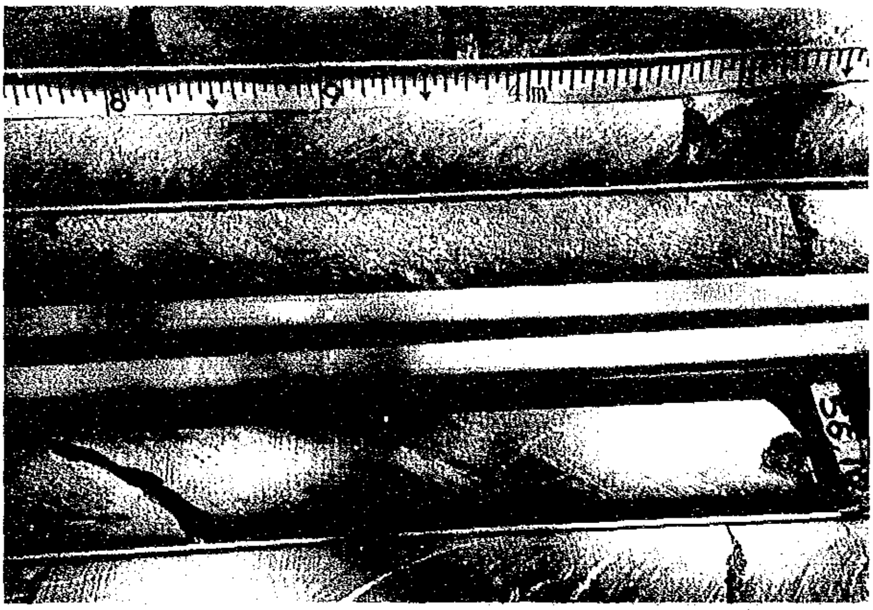
We hope that this report will serve for the development of the project and contribute to the promotion of friendly relations between the two countries.

We wish th express our deep appreciation to the officials concerned of the Government of the Republic of Zambia for their kind cooperation extended to the team.

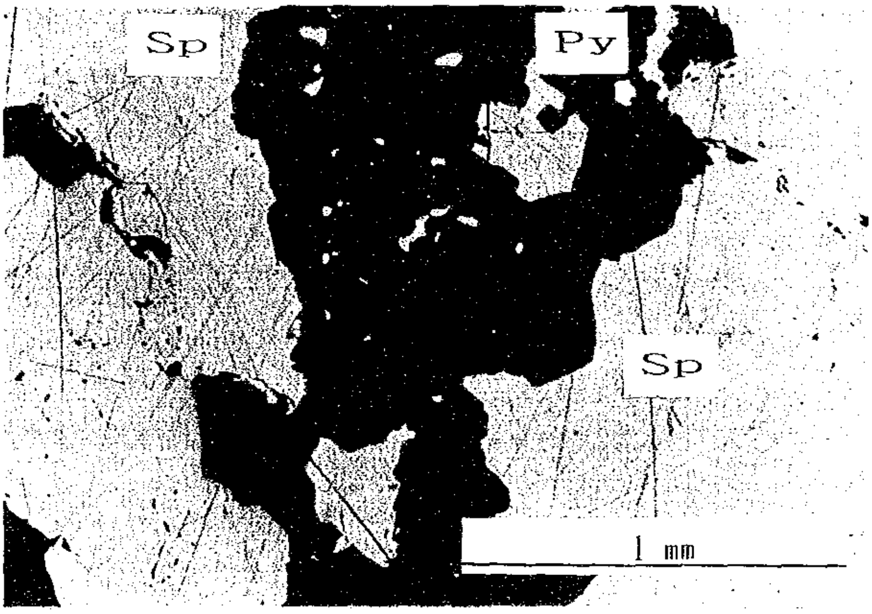
June, 1990

Kensuke Yanagiya
President
Japan International Cooperation Agency

Gen-ichi Fukuhara
President
Metal Mining Agency of Japan



Intersections of sphalerite veinlets
MJZK-10,Vicinity of 53 to 56m in depth




Sphalerite ore:MJZK-10,53.35m
Sp:Sphalerite　Py:Pyrite

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# PART I

# I General Statement

## 1. Introduction

Pursuant to the request made by the Government of Zambia, the Government of Japan has decided to conduct a study for exploration and assessment of mineral potential in the Kabwe West area. The Scope of Work was signed at Lusaka on 23rd June, 1989 between representatives of the Japan International Cooperation Agency (JICA) / Metal Mining Agency of Japan (MMAJ) and the Zambia Industrial & Mining Corporation Ltd.(ZIMCO) / Mineral Exploration Department (MINEX) officials.

The scheme of work is outlined in Table 1-1. Contributors to promotion and implementation of the project are listed in Table 1-2.

## 2. Objective of the study and its background

The main objective of the study is to explore and assess the mineral potential in the Kabwe West area.

Copper-bearing quartz veins in Sebembere, some 3 km northeast of zinc mineralization at Kabwe West were first reported in 1902. The recorded geological exploration of the area started during the 1950's, when Rio Tinto drilled a number of diamond drill holes in the Sebembere area. One of the drill holes intersected zinc mineralization with 6.16% of zinc, over a depth 96.08-105.23m (SLIWA & PODEMSKI, 1980). From 1970 to 1972, a Rumanian company, GEOMIN, drilled 9 holes to assess the copper deposits in Sebembere.

In 1976, MINDEX, the predecessor of MINEX, started soil sampling for zinc mineralization and a prospecting licence was granted as Kabwe West P.L. which covered the area of Sebembere copper deposits. There have been delineated three anomalous areas in zinc contents by the geochemical prospecting. This was followed by an auger drilling programme to investigate the behavior of zinc in the overburden. Despite some uncertainties in the subsurface distribution, noticeable values up to 30 %Zn were recorded within the overburden immediately overlying the bedrocks. The field works, which included geochemical, geophysical prospecting and implemented auger drilling of 403 holes, were suspended in 1978, owing to financial difficulties.

Three years later, MINEX acquired the Prospecting Licence over an area of 20 $km^2$ centering at a zone of zinc mineralization, but no work has been done since the absolute priority was given to exploration for fertilizer raw material.

The operation of the Kabwe mine plays an important role on local economy, especially from a view point of job opportunities and inflow of foreign currencies. Due to decrease of minable sulphide ores in the Kabwe mine, exploitation of new sources was warranted to feed the mine with ores, and the Kabwe West prospect was envisaged to be of the best target with a high potential, being indicated by the existence of geochemical anomalies and by the assay results from the auger drilling.

Table 1-1 Outline of the scheme

| | |
|---|---|
| **Drilling:** | |
| Number of holes | 12 |
| Total length | 2,400 m |
| **Microscopic Investigation:** | |
| Number of thin sections | 36 |
| Number of polished sections | 24 |
| **Geochemical assay:** | |
| Number of elements to be assayed (Au,Ag,Cu,Pb,Zn,Co,Ni,V) | 8 each |
| Number of samples | 84 |

Table 1-2 Contributors

| Japanese side | | Zambian side | |
|---|---|---|---|
| **Project finding** | | | |
| Yoshio MATSUKAWA, | MMAJ | R.L.BWALYA, | ZIMCO |
| Toshihiko HAYASHI, | MMAJ | L.P.MABSON, | ZCCM |
| Kenji SAWADA, | MMAJ | P.V.FREEMAN, | ZCCM |
| | (Nairobi) | A.S.SLIWA, | MINEX |
| | | G.R.RAO, | MINEX |
| | | L.BORSCH, | MINEX |
| | | D.MULELA, | MINEX |
| | | E.MBUMBA, | MINEX |
| **Project planning and prior negotiation** | | | |
| Naoto YOSHIDA, | MFA | R.L.BWALYA, | ZIMCO |
| Ryoichi KOUDA, | MITI | A.S.SLIWA, | MINEX |
| Yoshio MATSUKAWA, | MMAJ | G.R.RAO, | MINEX |
| Hideya METSUGI, | MMAJ | L.BORSCH, | MINEX |
| Kenji SAWADA, | MMAJ | D.MULELA, | MINEX |
| | (Nairobi) | E.MBUMBA, | MINEX |
| **Field survey** | | | |
| Takashi ONO, | NED | G.R.RAO, | MINEX |
| Tadamasa UENO, | NED | D.MULELA, | MINEX |
| Hidemitsu ITODA, | NED | D.NG'ANDU | MINEX |
| Shouichi KOBAYASHI, | NED | C.KAYVWA | MINEX |

MFA:Ministry of Foreign Affairs

MINEX:Mineral Exploration Department,ZIMCO.

MITI:Ministry of International Trade and Industry

MMAJ:Metal Mining Agency of Japan

NED:Nikko Exploration & Development Co.,Ltd.

ZCCM:Zambia Consolidated Copper Mines Ltd.

ZIMCO:Zambia Industrial & Mining Corporation Ltd.

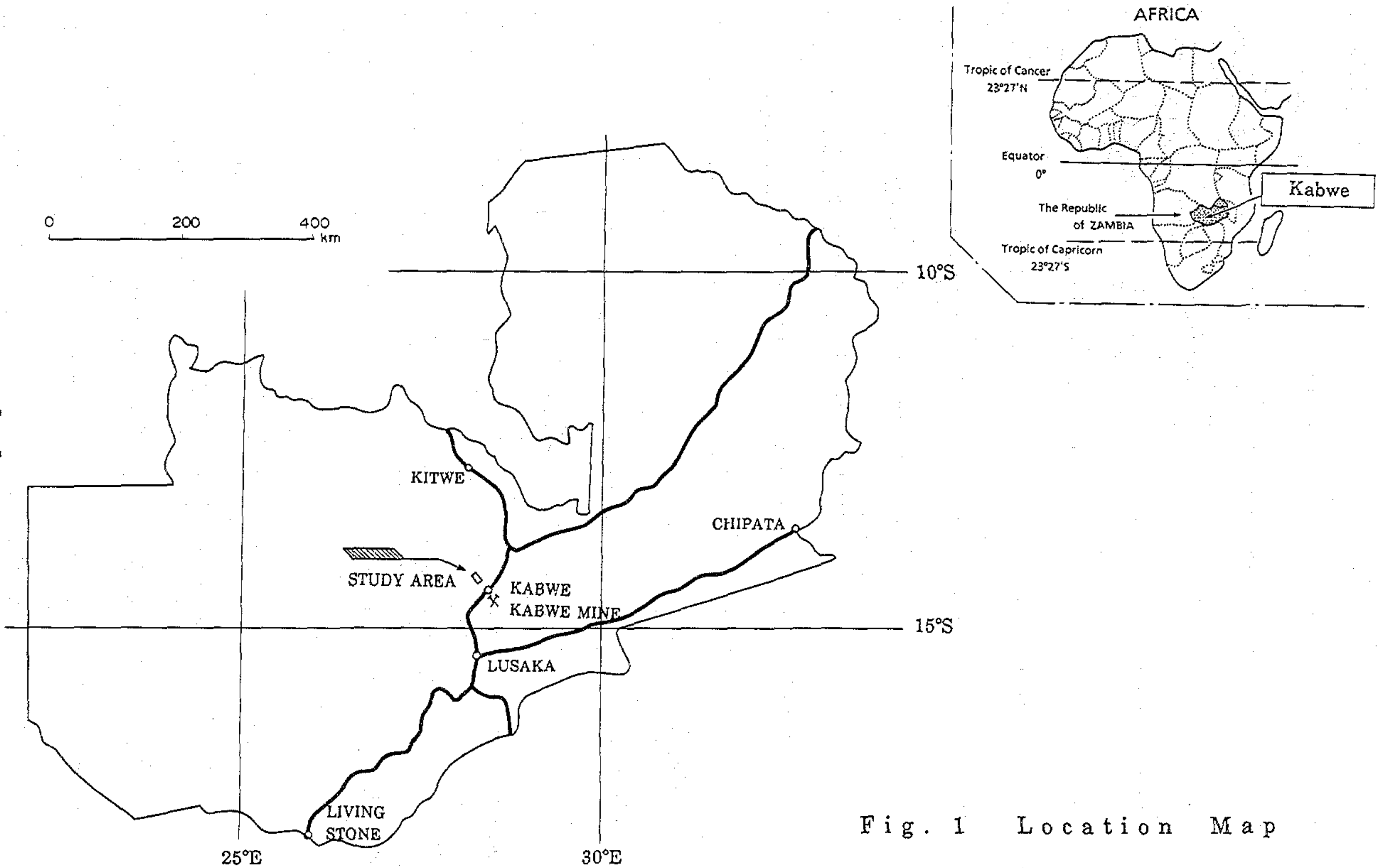


Fig. 1 Location Map

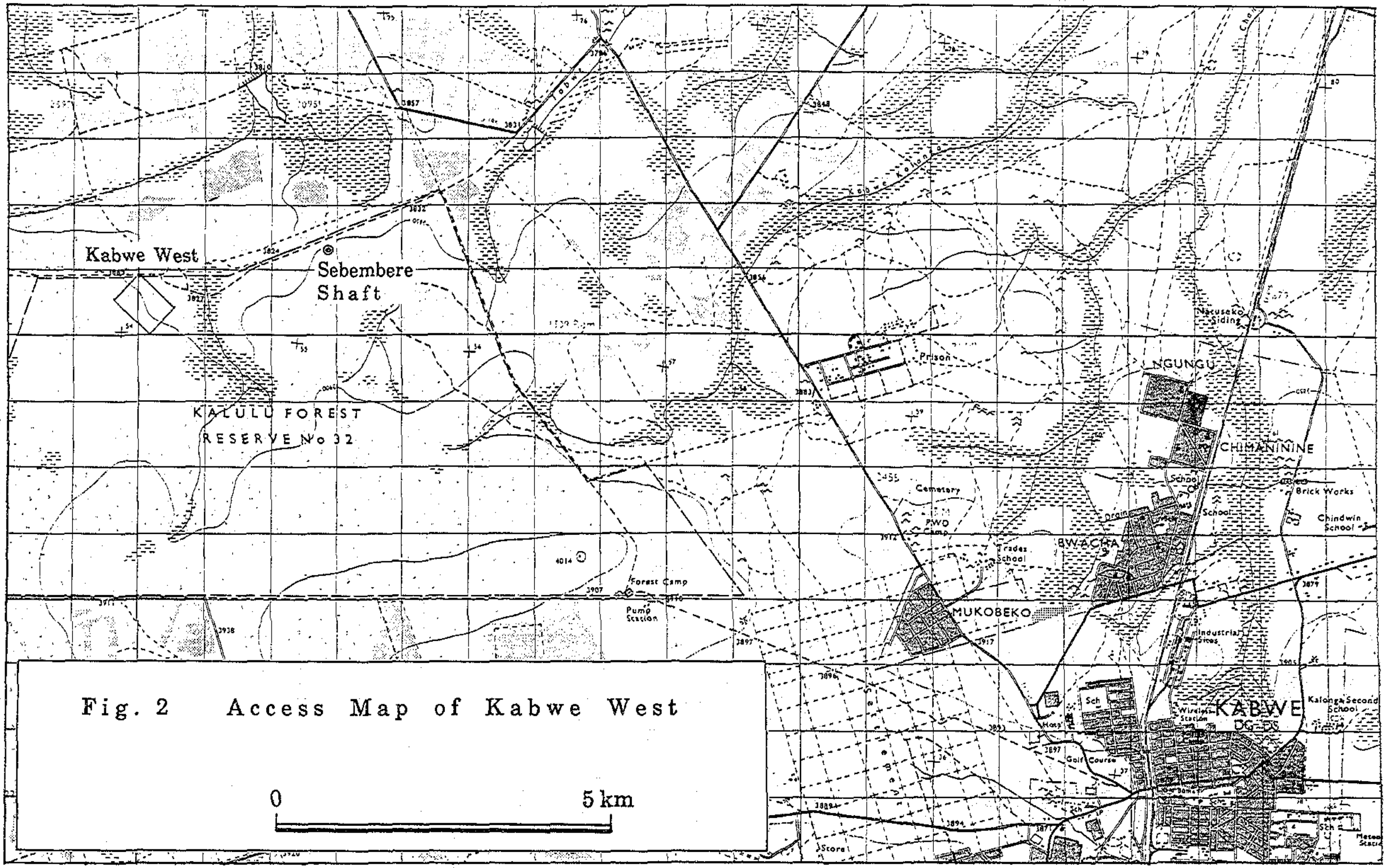


Fig. 2 Access Map of Kabwe West

## 3. Study area

### 3.1 Location

The prospect is in the vicinity of latitude 14° 23′ S and longitude 28° 17′ E, some 20 km northwest of Kabwe, the principal town in the Central Province with a population of about 70,000. Kabwe is situated at a distance of some 140 km to the north of Lusaka on the Great North Road.

Lead-zinc deposits at Kabwe were first discovered in 1902, and was initially called Broken Hill after the name of lead and zinc deposits in Australia. The Rhodesia Broken Hill Development Company was formed in 1904 and continuous operations started in 1915. Following the Mines and Minerals Act of 1970, the company was reorganised as a division of Nchanga Consolidated Copper Mines Ltd., and as a result of merger of mining companies in 1981, the mine became as a part of Kabwe Division of Zambia Consolidated Copper Mines Limited (ZCCM). Mine production at Kabwe accumulated up to 11 million tonnes of ores, comprising 25% Zn and 15% Pb.

The camp for present investigation has been set up in the vicinity of the shaft sunk for Sebembere prospect. It is situated 20 km northwest of Kabwe, of which 9 km via Mukobeko to the entrance of prison are of a sealed road and following 8 km to the mouth of branch road are of a graded one.

### 3.2 Geomorphology and Climate

The area lies on a flat plain at an elevation of 1,150 to 1,200 metres above sea level. Drainage is by dambos, only slightly below the level of interfluves.

The hot dry season of September to October has average temperatures in a range of 30 to 33°C. Average precipitation is on the order of 900 to 1,000 mm annually, most of which falls mainly in brief cloudbursts from November to March. Between middle December and middle February, rainfall ranges from 600 to 750 mm.

The area is moderately timbered with shrubs, and is covered with dense grass during the rainy season.

### 3.3 General Geology

The Kabwe area is very poorly exposed and the geological succession is largely based on the results of regional pitting and diamond drilling.

The overall structure of the area comprises a south-westerly plunging antiform with a core of basement granite gneiss and schistose rocks. The basement is unconformably overlain by Katanga sediments of pre-Cambrian in age, which strike parallel to the basement contact. The base of the Katanga System is often conglomeratic. Arkose and quartzites form a unit of variable thickness immediately above the base. Phyllite and dolomite unit consists dominantly of argillaceous dolomite and limestone, with beds of phyllite and clear crystalline dolomite. A lava or sill, described as an andesite or diabase occurs near the top of the unit. Stratigraphy of the region is summarized in Table 2.

The area of the present investigation is mainly underlain by dolomitic rocks of Upper Roan Group which is often referred as Broken Hill Dolomite. Phyllite series of Muwashia Group are encountered in the western part of the area.

Table 2 Stratigraphy

(after ZCCM: unpublished geological map, 1988)

| | | |
|---|---|---|
| KATANGA SYSTEM | | |
| | KUNDELUNGU GROUP | Dolomite |
| | MWASHIA GROUP | Phyllites with minor arkose quartzite, minor dolomite |
| | ROAN GROUP | |
| | Upper Roan Group | Dolomite with limestone and dolomitic limestone |
| | Lower Roan Group | Phyllites & meta-siltstones with quartzites, minor micaceous quartzite, tremolite rocks. Arkosites & feldspathic quartzites with basal conglomerate. |
| BASEMENT COMPLEX | | Porphyroblastic and crushed, biotite feldspathic & granitic gneisses with minor biotite schists. |
| IGNEOUS ROCKS | | Metamorphosed basic igneous rocks, probably volcanic or minor intrusives, including epidosites & amphibolitic types. |

4. Previous work

The area of the present study has been well known as a southern extension of the Copper Belt. In 1953, Rio Tinto commenced prospecting works for copper in the area, using detailed geochemical soil survey and geophysical survey. Between 1955 and 1959, a number of 28 diamond drilling holes were put down over the area of Sebembere. One of these holes, SB 20, was collared at an angle of -70° and intersected the mineralized zone of 6.16% Zn in massive dolomite, between 96.08 and 105.23 m of drilling length. In 1976, Mindex undertook systematic geochemical soil survey over the area broadly surrounding the location of the zinc intersection and three main anomalies A, B and C, with zinc content over 1,000 ppm in soils were delineated. The areas of prominent anomalies A and B were covered by auger drilling programme to investigate the behavior of zinc in the overburden and to confirm the topography of the bedrock. The third anomaly C was found 2 to 3 km north of these two anomalies.

A sum of 253 of drilled 403 holes encountered the bedrock and a number of 133 holes did not reach the bedrock. The overburden was about 15 m thick on the dolomite area in the northeast side and more thick on the schist area in the southwest where a maximum depth of 69 m was recorded. Zinc assays were generally very low within the schist area and distinctly higher within the dolomite area. Zinc distribution over the dolomites showed an increase in value with depth. The zinc assays reached as much as 5-30% Zn at the bottom of holes in several locations and some chips of gossan and even sphalerite were encountered. More than 1% Zn values were recorded in a 200 x 400 m area which roughly coincided with the soil anomaly A of the northwest. The SB 20 is located at the western edge of the anomaly. Due to the fact that the existence of sulphide mineralization in the overburden has been confirmed, its occurrence in the bedrock should be located. This forms the main target of the present drilling programme.

# II Drilling

## 1. Outline of the present investigation

### 1.1 Purpose of the investigation

During geochemical prospecting in 1976, two zones of anomaly were delineated in the east and southeast of SB-20, a diamond drilling hole sunk by Rio Tinto, and are called Area A and B respectively. The Area A has been taken up for the target of the first phase of the investigation to assess the mineral potential.

### 1.2 Scheme of the investigation

In the Scope of Work, tentatively 7 diamond drilling holes of 200m each were allotted in a grid pattern at 100 m intervals over the area of Anomaly A. Initially, 10 verticall holes, totalling 2,000 m, were planned, of which, sites for six holes from MJZK-1 to -6 were fixed and following four sites were to be selected from resulting information. Later, two inclined holes of 200m each were added to supplement information between vertical holes.

Scheme of the investigation is shown in Table 3-1.

#### 1.2.1 Method of drilling

For the drilling purpose, the wire-line diamond drilling method was used with the minimum diameter of B-size at the bottom.

Overburden was drilled with tri-cone bits of 3" 7/8 and NW casing pipes were inserted. Then, NQ wire-line bits were used for basement rocks and after casing with pipes of BW size, holes were completed with BQ wire-line method.

#### 1.2.2 Equipment

Main equipment is listed in Table 3-2.

### 1.2.3 Drilling operation

Drilling operation was conducted by 3 shifts a day of 8 hours each. Preparation of drill sites, moving, installation and dismantlement were principally on a basis of one shift a day.

### 1.2.4 Cores

Cores were placed in plastic trays and sent to Minex in Lusaka. Most of them were cut with a diamond saw and one part of samples was submitted to analysis. Remaining parts have been kept in storage.

### 1.2.5 Accommodation

A camp comprising huts and canteens has been set up in the north of Sebembere shaft.

### 1.2.6 Access

Access roads were provided by clearing shrubs. Most of them easily became impassable due to heavy rain, soft earth and flat topography.

## 1.3 Members

Members of the Japanese team are as follows.

| | |
|---|---|
| ONO, Takashi | Leader, geologist |
| UENO, Tadamasa | Drilling engineer |
| ITODA, Hidemitsu | ditto |
| KOBAYASHI, Shouichi | ditto |

A drilling crew comprises one Japanese engineer, one Zambian trainee, and three helpers. Water was carted by drivers with or without helpers. In addition, one or two groups were introduced for construction and maintenance of roads.

Table 3-1 Scheme of the investigation

Scheme

| | Initial | Revised |
|---|---|---|
| Drilling | | |
| No. of holes | 10 | 12 |
| Total length | 2,000m | 2,400m |
| Microscopic investigation | | |
| No. of thin sections | 30 | 36 |
| No. of polished sections | 20 | 24 |
| Geochemical Assay, 8 elements each (Au, Ag, Cu, Pb, Zn, Co, Ni, V.) | | |
| No. of samples | 50 | 84 |

Meterage drilled in the first phase

| DDH No. | Planned | Actual | Bearing | Inclination |
|---|---|---|---|---|
| MJZK- 1 | 200m | 201m | | Vertical |
| MJZK- 2 | 200m | 201m | | Vertical |
| MJZK- 3 | 200m | 201m | | Vertical |
| MJZK- 4 | 200m | 201m | | Vertical |
| MJZK- 5 | 200m | 201m | | Vertical |
| MJZK- 6 | 200m | 201m | | Vertical |
| MJZK- 7 | 200m | 201m | | Vertical |
| MJZK- 8 | 200m | 201m | | Vertical |
| MJZK- 9 | 200m | 201m | | Vertical |
| MJZK-10 | 200m | 201m | | Vertical |
| MJZK-11 | 200m | 201m | N40° E | -45° |
| MJZK-12 | 200m | 201m | N40° E | -45° |
| TOTAL | 2,400m | 2,412m | | |

Table 3-2 Main equipment

Rig:

KOKEN OE-8L

with MITSI-DEUTZ diesel engine F2L912

Drilling Pump:

KOKEN WLMG-10

with YAMMER diesel engine NF-110K

Mud Mixer:

TONE MCE-100

with YAMMER diesel engine NF50C

Wire-line Hoist:

KOKEN WLH-4

with YAMMER diesel engine NF80K

Pipe Derrick:

KOKEN PD-9.5K

Generators:

YAMMER YSG10ETN

with YAMMER diesel engine NS130CE

YAMMER YSG2000B

Sand Pumps:

TSURUMI LB480

TSURUMI KTV22H

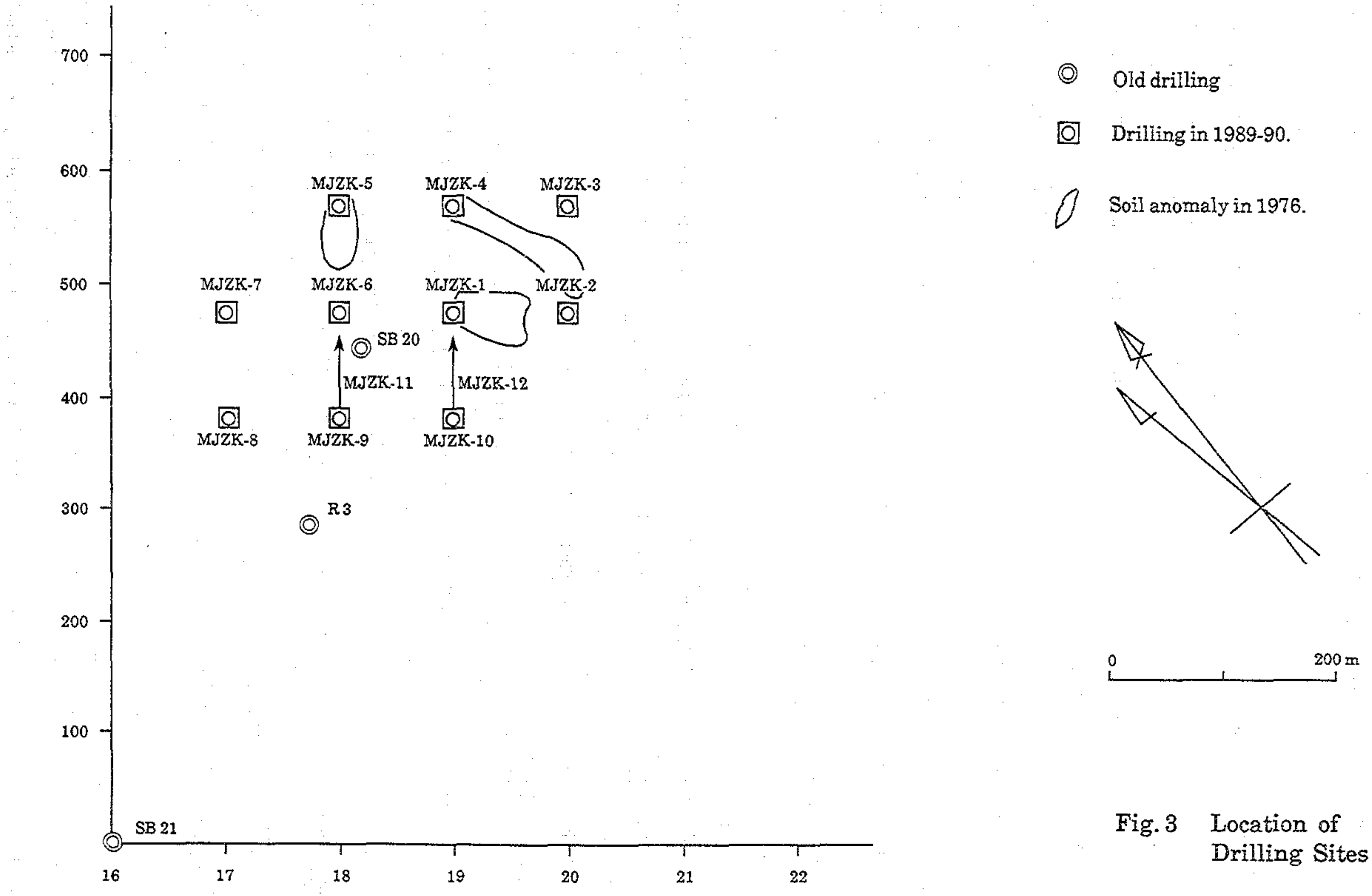


Fig. 3 Location of Drilling Sites

## 2. Results of the investigation

### 2.1 Outline of geology

The area is covered with a thick succession of overburden ranging from 8 to 38 meters in thickness. The bottom of the overburden is usually of pebble-bearing clay beds or unsorted sandy beds with clayey matrix. Quartz grains are not rare, which are seldom in the basement rocks. These beds are considered to have been formed with sediments delivered from out-side of the area.

The area is mainly underlain by dolomitic rocks of Upper Roan Group of the Katanga System. Phyllites have been encountered at the top of basement rocks drilled in the southwestern margin of the area and are assigned to the Mwashia Group of Katanga System.

### 2.2 Description of geology

Geology of each hole is shown in attached geological columns. Characteristic features only are described in this section.

#### 2.2.1 MJZK-1

After passing through surface soil, the hole encountered dark brown sticky clay beds at 11.0 m and then sandy beds at 15.4 m. These beds are assumed to account for geochemical anomalies delineated by auger drilling. Sections above and beneath the boundary with dolomite yielded 13 to 14 %Zn.

The hole entered into the dolomite of basement rocks at the depth of 22.2 m. The dolomite is banded and stained in reddish brown in oxidized zone and assay values up to 15.6 %Zn have been returned from the secondary mineralization zone to a depth between 22.2 and 54.4 m.

An argillaceous intercalation is observed between 64.1 and 65.5 m with an angle of 15°. The oxidized zone is terminated at the depth of 71.9 m, and pyrites are sporadically disseminated in the primary zone. Sphalerite specks and stringers are noticed at depths of 97.9, 142.3, 159.4, and 185.2 m. Minute sphalerite stringers occur at 188.4 to 191.1 m and 197.3 to 198.8 m.

Main intersections are as follows.

| | | | |
|---|---|---|---|
| 21.37m to | 26.10m | 4.73m | 10.1%Zn |
| 28.10 | 29.10 | 1.00 | 8.8 |
| 31.10 | 33.10 | 2.00 | 9.3 |
| 34.10 | 36.30 | 2.20 | 5.6 |
| 40.40 | 41.40 | 1.00 | 5.2 |
| 43.40 | 48.40 | 5.00 | 11.5 |
| 49.50 | 50.40 | .90 | 5.4 |
| 52.40 | 54.40 | 2.00 | 7.7 |

2.2.2 MJZK-2

The sticky clay beds were penetrated between 11.0 and 13.4 m. Quartz-bearing sand beds are at 13.4 to 15.4 m. One meter section at the bottom of the overburden grades 25.0 %Zn.

Pyrite-sphalerite stringers of 1 to 3 mm wide are noticed at 76.6 and 77.4 m in a non-oxidized zone, and also between 92.0 and 115.0 m in the primary zone.

2.2.3 MJZK-3

The hole reached to the dolomite at the depth of 8.9 m and entered into the primary zone at 13.7 m. Sphalerite stringers are observed to a depth of 34.2 m.

2.2.4 MJZK-4

Surface soil continues to a depth of 11.5 m. The oxidized zone reaches to the depth of 120.4 m. Brick-brown stainings with dull crusts are observed and values more than 5 % Zn are obtained at 27.2 to 29.2 m, 45.1 to 47.1 m, and 79.1 to 80.1 m.

2.2.5 MJZK-5

Oxidized zone is of a shallow depth of 21.6 m. Sphalerite patches and stringers are recorded between 25.1 to 29.2 m in the primary zone.

2.2.6 MJZK-6

Pebble-bearing clay beds reached to a depth of 33.4 m. Oxidized zone continued to the depth of 119.5 m. Within the zone, dolomite is stained with oxidized iron and secondary zinc minerals in forms of rims, patches or veinlets. More than 5 %Zn values were obtained at depths of 68.0 to 69.0 m, 97.0 to 98.0 m, 105.0 to 107.0 m and 111.0 to 112.0 m.

Sphalerite veinlets remain within narrow unozidized zones at 73.6 m and 98.2 m and occur in the form of pyrite-sphalerite veinlets associated with recrystallized dolomite veins at 190.0 and 194.0 m of the primary zone.

2.2.7 MJZK-7

Surface soil reaches to a depth of 38.5 m.

Sphalerite patches, vienlets and networks are widely distributed in the non-oxidized zone between 65.0 m and 94.8 m and also in the primary zone of 123.0 to 134.6 m.

Sections which exceed 5 %Zn are located in the oxidized zone at 120.1 to 122.1 m where dolomite is porous and stained with brick-brown and white mammillary crusts.

2.2.8 MJZK-8

The hole intersected phyllites between 27.5 and 43.5 m, and alternation of phyllites and dolomites between 44.6 and 50.1 m. Thin intercalations of phyllites were seen to a depth of 69.2 m. The phyllites are white to pale-greenish gray in color and talcose in places. Bandings of oxidized iron are not uncommon.

Unconsolidated fault clay is noticed at 77.5 to 80.3 m in depth.

A section between 94.1 and 95.1 m yielded 5.0 %Zn in the non-oxidized zone, but this value seems to have derived from brick-brown staining along recrystallized dolomite veinlets.

Brick-brown staining is widespread in the oxidized zone and sections exceeding 5 %Zn were recorded at 144.0 to 145.0, 150.0 to 153.0, 181.0 to 182.0 and 190.0 to 192.0 m. The hole ended within the oxidized zone.

2.2.9 MJZK-9

The hole entered into phyllites at 29.5 m and passed through alternations of phyllites and dolomites between 34.3 to 37.4 m. A non-oxidized extends from 47.6 to 92.7 m in depth.

Secondary zinc mineralization is widespread within an oxidized zone between 92.7 and 172.8 m where dolomites are stained in general with dull brick-brown crusts along recrystallized dolomite patches and veinlets. Sphalerites remain in parts at 143.8 to 148.0 m but are accompanied with secondary zinc minerals.

Main intersections are as follows.

| | | |
|---|---|---|
| 93.1m to 95.1m | 2.0m | 11.0 %Zn |
| 105.1 to 109.1 | 4.0 | 12.4 |
| 113.1 to 114.1 | 1.0 | 5.6 |
| 122.0 to 125.0 | 3.0 | 10.1 |
| 129.0 to 133.0 | 4.0 | 7.0 |
| 134.0 to 135.0 | 1.0 | 5.6 |
| 136.0 to 137.0 | 1.0 | 10.0 |
| 141.0 to 145.0 | 4.0 | 13.7 |
| 153.0 to 160.0 | 7.0 | 10.1 |
| 163.0 to 165.0 | 2.0 | 8.8 |
| 167.0 to 170.0 | 3.0 | 9.0 |
| 172.0 to 173.0 | 1.0 | 6.4 |

2.2.10 MJZK-10

The hole entered from phyllites to dolomites at a depth of 26.0 m. Strata-bound sphalerite veinlets are found in rapidly banded black dolomite between 52.1 and 60.9 m. A value of 8.7 %Zn was obtained at 1.0 m section from 53.1 to 54.1 m.

An oxidized zone from 78.9 to 169.2 m is stained in brown to brick-brown. Within the oxidized zone, several sphalerites have been noticed with willemites, being surrounded with secondary zinc veinings.

Main intersections in the oxidized zone are as follows.

| | | |
|---|---|---|
| 92.1m to 94.1m | 2.0m | 7.1 %Zn |
| 98.5 to 99.5 | 1.0 | 5.1 |
| 103.5 to 105.0 | 1.5 | 10.1 |
| 123.0 to 125.0 | 2.0 | 5.1 |
| 152.0 to 153.0 | 1.0 | 5.0 |
| 156.0 to 157.0 | 1.0 | 5.6 |

2.2.11 MJZK-11

Due to the fact that inclinations of bandings in dolomites appear to be steep, the hole was sunk to fulfil information between vertical holes MJZK-6 and 9. The hole was collared at the same site of MJZK-9 and drilled N40°E, at an inclination of -45°. Brownish, brick-brown to yellowish brown stainings are widespread in oxidized zones from 56.1 to 89.6 m, and 94.8 to 164.8 m.

Sphalerite specks and stringers are found at 165.3 to 168.4 m, 177.4 to 180.4 m and 190.9 to 192.0 m.

2.2.12 MJZK-12

This hole was located at the same site of MJZK-10 and drilled N40°E, at an inclination of -45°. Sphalerite specks and stringers were intersected at 147.6 to 147.8, 149.7 to 155.0, 161.5 to 162.6m, and at 167.0 m.

## 2.3 Summary of logging

Under the surface soil, an existence of allochthonous sediments has been confirmed. Geochemical anomalies on the surface are not likely to be of residual soil directly derived from weathering product of the basement rocks. Assay results recorded from the auger drilling are probably of these sediments.

The geochemical anomalies in the Area A are of zinc values and free from lead and copper. This fact coincides with those of features observed in the basement rocks.

Mineralization in the basement rocks is widespread beyond the anomalous area of geochemical sampling on the surface and the target area of the present investigation has not be confined within the projected area assumed at the outset.

The basement rocks comprise phyllites of Mwashia Group and massive dolomites of Upper Roan Group. The boundary of these groups is not necessarily certain and transitional zones of alternation exist between phyllites and dolomites.

The phyllites occur in the southwest of the drilled area and are assumed to dip to the southwest. Oxidized iron stain bands are not rare.

The dolomites are saccaroidal and often undergo re-crystallization. Specks and stringers of pyrite are common but usually decomposed in oxidized zone.

Strata-bound sphalerite veinlets have been observed in the dolomite near the boundary with phyllites. Sphalerite stringers or veinlets are usually associated with recrystallized veins or veinlets of dolomite and generally of low grade in non-oxidized zones. Noticeable assay values come from stained sections in oxidized zones.

Sections more than 5 %Zn are shown in Table 3-3.

Table 3-3 Sections over 5 %Zn.

| | from(m) | to(m) | % Zn |
|---|---|---|---|
| MJZK-1 | | | |
| | 21.37 | 22.22 | 12.6 |
| | | 22.80 | 14.2 |
| | | 23.30 | 7.0 |
| | | 23.83 | 6.0 |
| | | 24.80 | 5.8 |
| | | 25.90 | 12.8 |
| | | 26.10 | 12.4 |
| | 28.1 | 29.10 | 8.8 |
| | 31.10 | 32.10 | 12.4 |
| | | 33.10 | 6.0 |
| | 34.10 | 35.30 | 5.1 |
| | | 36.30 | 6.3 |
| | 40.40 | 41.40 | 5.2 |
| | 43.40 | 44.40 | 8.4 |
| | | 45.40 | 7.8 |
| | | 46.40 | 11.8 |
| | | 47.40 | 13.8 |
| | | 48.40 | 15.6 |
| | 49.50 | 50.40 | 5.4 |
| | 52.40 | 53.40 | 7.6 |
| | | 54.40 | 7.8 |
| MJZK-2 | | | |
| | 11.00 | 14.40 | 5.0 |
| | | 15.40 | 25.0 |
| MJZK-4 | | | |
| | 27.20 | 28.20 | 13.7 |
| | | 29.20 | 12.1 |
| | 45.10 | 46.10 | 5.5 |
| | | 47.10 | 9.5 |
| | 79.10 | 80.10 | 10.7 |
| | 108.1 | 109.1 | 6.3 |

Table 3-3 (cont.)

| | | | |
|---|---|---|---|
| MJZK-6 | | | |
| | 68.00 | 69.00 | 6.8 |
| | 97.0 | 98.00 | 5.5 |
| | 105.0 | 106.0 | 8.6 |
| | | 107.0 | 5.0 |
| | 111.0 | 112.0 | 5.3 |
| MJZK-7 | | | |
| | 120.1 | 121.1 | 16.4 |
| | | 122.1 | 5.3 |
| MJZK-8 | | | |
| | 144.0 | 145.0 | 6.6 |
| | 150.0 | 151.0 | 6.6 |
| | | 152.0 | 5.8 |
| | | 153.0 | 6.2 |
| | 181.0 | 182.0 | 6.2 |
| | 190.0 | 191.0 | 6.2 |
| | | 192.0 | 5.6 |
| MJZK-9 | | | |
| | 93.10 | 94.10 | 16.4 |
| | | 95.10 | 5.6 |
| | 105.1 | 106.1 | 8.0 |
| | | 107.1 | 8.6 |
| | | 108.1 | 16.6 |
| | | 109.1 | 16.2 |
| | 113.1 | 114.1 | 5.6 |
| | 122.0 | 123.0 | 6.8 |
| | | 124.0 | 14.0 |
| | | 125.0 | 9.6 |
| | 129.0 | 130.0 | 6.8 |
| | | 131.0 | 6.4 |
| | | 132.0 | 7.6 |
| | | 133.0 | 7.2 |

Table 3-3 (cont.)

| | | | |
|---|---|---|---|
| | 134.0 | 135.0 | 5.6 |
| | 136.0 | 137.0 | 10.0 |
| | 141.0 | 142.0 | 11.6 |
| | | 143.0 | 18.0 |
| | | 144.0 | 18.0 |
| | | 145.0 | 7.2 |
| | 153.0 | 154.0 | 12.4 |
| | | 155.0 | 10.8 |
| | | 156.0 | 12.0 |
| | | 157.0 | 14.0 |
| | | 158.0 | 10.3 |
| | | 159.0 | 5.8 |
| | | 160.0 | 5.1 |
| | 163.0 | 164.0 | 5.8 |
| | | 165.0 | 11.8 |
| | 167.0 | 168.0 | 5.8 |
| | | 169.0 | 13.2 |
| | | 170.0 | 8.0 |
| | 172.0 | 173.0 | 6.4 |
| MJZK-10 | | | |
| | 53.10 | 54.10 | 8.7 |
| | 92.10 | 93.10 | 6.7 |
| | | 94.10 | 7.4 |
| | 98.50 | 99.50 | 5.1 |
| | 103.5 | 104.5 | 7.7 |
| | | 105.0 | 15.0 |
| | 123.0 | 124.0 | 5.0 |
| | | 125.0 | 5.1 |
| | 152.0 | 153.0 | 5.0 |
| | 156.0 | 157.0 | 5.6 |

Table 3-3 (cont.)

| | | | |
|---|---|---|---|
| MJZK-11 | | | |
| | 74.30 | 75.30 | 5.6 |
| | 139.6 | 140.6 | 6.7 |
| MJZK-12 | | | |
| | 55.90 | 56.90 | 6.5 |
| | 89.90 | 90.90 | 5.2 |
| | 149.8 | 150.8 | 6.2 |
| | | 151.8 | 5.5 |

## 2.4 Geological Consideration

### 2.4.1 Stratigraphy

Due to an existence of thick cover on the surface, geology of the area has been inferred from information obtained by pitting, trenching, and drilling in the past.

Only two facies of basement rocks have been encountered, one being of phyllites which can be correlative with those of Mwashia Group and the other being of dolomites of Upper Roan Group, which are often referred as Broken Hill Dolomite. Both groups belong to the Katanga System of upper Precambrian.

### 2.4.2 Phyllites

Phyllites are white to pale-greenish gray in colour, and often stained with oxidized iron bands. When weathered, the rocks are mottled in white, yellow, brown or gray. Sericite and chlorite are common and talcose facies are also not rare. Sometimes rocks exhibit corrugated cleavage.

### 2.4.3 Dolomites

Dolomites are usally massive or faintly banded, and black, light-gray or white in colour. Strata-bound sphalerite veinlets occurred in rapidly banded black dolomite. But the rocks are usually light-gray to white, with a brownish tint in places.

The dolomites appear compact or fine-graind saccaroidal. Often recrystallized dolomite patches and veinlets predominate and rocks become speckled. These recrystallization patches and veinlets are usually vuggy or rich in voids. Most of bandings formed with veinlets are considered to be in parallel with argillaceous bandings and bedding planes.

Chemical compositions of the dolomites from MJZK-10 are given as follows.

| | | |
|---|---|---|
| 53.1 to 54.1m | 52.09%$CaCO_3$ | 46.13%$MgCO_3$ |
| 58.1 to 59.1 | 52.19 | 46.13 |
| 65.1 to 66.1 | 50.04 | 45.19 |
| 68.1 to 69.1 | 52.24 | 46.30 |
| 70.1 to 71.1 | 51.94 | 45.36 |
| 73.1 to 74.1 | 52.24 | 45.09 |
| 74.1 to 75.1 | 50.04 | 46.20 |
| 76.1 to 77.1 | 52.09 | 45.36 |
| 77.1 to 78.0 | 53.24 | 42.52 |

#### 2.4.4 Gelogical structure

Discussion of regional structure is beyond the present investigation. In the Kabwe West area, the rocks appear to trend N45°W and dip southwest. Intraformational microfolding can be seen in places but is not common. Intersection between banding and vertical ranges from 10° to 25° and the structure is inferred to be of monoclinic dipping southwest with an angle of 65 to 80°.

#### 2.4.5 Mineralization

Sphalerite mineralization is primarily of strata-bound sulphide veinlets in dolomites. Minute veinlets are often associated with vuggy or porous patches and veinlets of recrystallized dolomite, but sulphide mineralization usually does not exceed 5 %Zn over one meter. Sphalerite appears to have been concentrated to some extent with recrystalization of dolomite but not remobilized to form massive orebodies due to weakness of metamorphism.

In an oxidized zone, sphalerite with willemite occurs in a form of a cay surrounded by atoll of brick-brown crusts. Brownish dull crusts often fill voids and form veinlets. High values of zinc content are usually reported from these sections where brick-brown veinlets prevail. The fact suggests an existence of secondary enrichment process in oxidized zones.

Pyrites are more common than sphalerites and occur in forms of specks, stringers, impregnation or dissemination. They are also accompanied with recrystallized dolomite veins. Pyrite-sphalerite veinlets also can be seen.

Secondary zinc staining is rather weak where decomposed pyrites predominate. From this, an environment where pyrites are decomposed seems not to offer suitable conditions in which secondary zinc precipitates.

### 2.4.6 Alteration

For an explanation purpose, tentatively three zones of weathered, oxidized and non-oxidized, have been set according to degrees of decomposition.

The weathered zone refers a zone of unconsolidated sediments and some of phyllites which have not been recovered as a solid core. In the oxidized zone, rocks are decomposed to some extent and stained with iron. In the non-oxidized zone, rocks are fresh in appearance and free from iron staining even if only pyrite crystals are decomposed. The lowest non-oxidized zone has been named as the primary zone.

It has been noted that most of high zinc values have been reported from the oxidized zone. This suggests leaching and concentration in the oxidized zone to yield higher zinc contents.

## Ⅲ Conclusion

### 1. Summary of the present investigation

A drilling programme has been implemented over the Area A, an area of geochemical anomalies delineated by geochemical sampling and auger drilling in Kabwe West.

Ten vertical holes of 200 m each were put down on a grid of 100 m interval and two additional inclined holes were added to supplement information related to mineralization revealed by vertical holes.

An existence of pebble-bearing soil or sand beds was found below the sourface cover and the geochemical anomalies seem to have reflected metal content in the sediments. Relationship between the geochemical anomalies and mineralization in the basement rocks becomes indirect.

The area is underlain by phyllites of Mwashia Group and dolomites of Upper Roan Group. Zinc mineralization is widespread in the dolomites beyond an area indicated by geochemical anomalies on the surface.

Sulphide zinc occurs primarily as strata-bound sphalerite veinlets in the dolomites. Sphalerite seems to have been concentrated to some extent in forms of patches, stringers or veinlets along recrystallization of dolomite but not remobilized to form massive orebodies due to weakness of metamorphism. Sulphide mineralization is usually narrow and of a low grade. An existence of massive ore has not been confirmed.

In oxidized zones, recrystallized veinlets of dolomite are often stained with brownish crusts and from these parts, high assay values have been reported. Zinc seems to have been enriched with a secondary process.

Strata-bound sphalerite veinlets were encountered between 52.1 m and 55.0 m in depth of MJZK-10. Sizable mineralizations of secondary zinc have been detected at a shallow depth of 21 to 54 m in MJZK-1, and at a depth of 93 to 173 m in MJZK-9.