REPUBLIC OF ZIMBABWE

REPORT ON THE COOPERATIVE MINERAL EXPLORATION OF KADOMA AREA

PHASE I

MARCH 1987

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

REPUBLIC OF ZIMBABWE: REPORT ON THE COOPERATIVE EXPLORATION OF KADOMA AREA PHASE I MARCH 1987

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PREFACE

At the request of the Government of the Republic of Zimbabwe, the Japanese Government planned a mineral exploration programme consisting of several method to examine the possibility of the existence of mineral deposits in the Kadoma and Kwekwe Districts located in the central part of the country. The Japanese Government entrusted the execution of the general plan to the Japan International Cooperation Agency (JICA), and in turn JICA entrusted the execution of this survey to the Metal Mining Agency of Japan (MMAJ), since this survey was a professional survey programme of mineral exploration.

This year's programme is the first year's one. MMAJ organized a survey team of three members, and dispatched the team to Zimbabwe during the period from 4 August to 1 November 1986. The on-site survey was completed as scheduled with the cooperation of the Zimbabwe Government, particularly the Geological Survey Department of the Ministry of Mines.

This report describes the survey results of the first year programme of the Kadoma Project, and will form a part of a final report.

Lastly, we would like to express our hearty gratitude to the members concerned of the Zimbabwe Government, the Ministry of Foreign Affairs of Japan, the Ministry of International Trade and Industry of Japan, Japanese Embassy in Zimbabwe, and all of whom extended their kind cooperation to us in executing the above mentioned survey.

February, 1987

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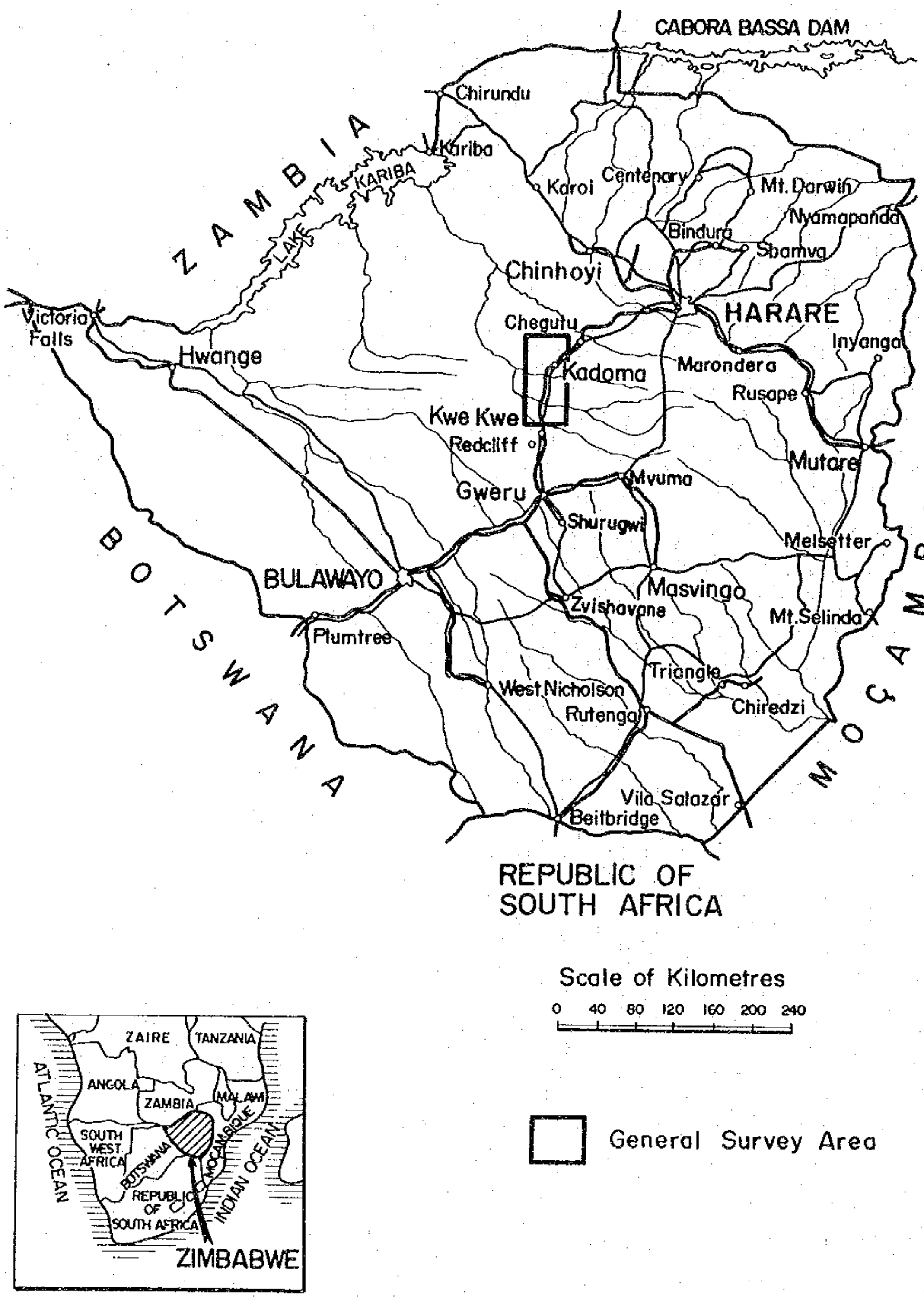

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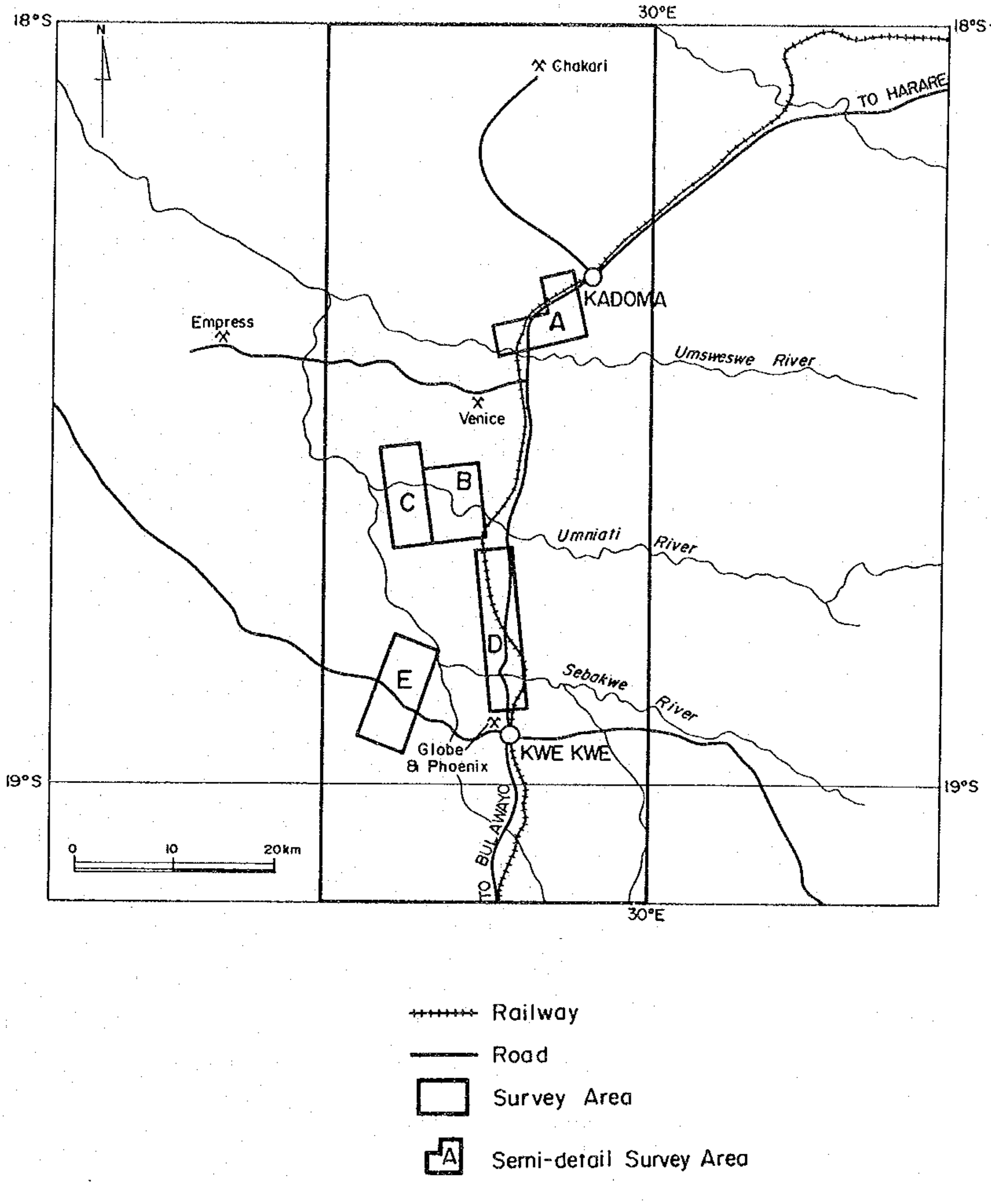

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ABSTRACT

ABSTRACT

The Kadoma Project was started from this year to evaluate the potential of mineral resources in the area by means of clarification of the details of the geological setting and geochemical environment.

As a start of the first year's programme, all known data on mineral occurrences of gold, copper, lead, zinc, nickel, chromium, and antimony were compiled to select target areas for the survey. Based on this compilation study, five areas from Area A to Area E were selected.

The on-site survey was conducted from 4th August to 1st November 1986 during the period of 90 days by three Japanese members and one counterpart member. The programme included geological and soil geochemical surveys. The 8,000 soil samples collected were sent to an analytical laboratory in Zimbabwe, however other rock and ore samples collected for various laboratory tests such as X-ray diffraction and EPMA were afterward examined in Japan. The path-finder elements applied for the geochemical survey are different, area by area as follows; Au, Cu and W for Area A, Au, Sb and As for Area B, Au, Pb and Zn for Area C, Au, Ni and Cr for Area D, and Au, Sb and As for Area E.

As the results of the geological survey, it was confirmed that all areas are in favourable geological environments, close to tonalite intrusive bodies, which seem to be ore bringers, locating large numbers of mineral occurrences, etc. In the geochemical survey, many hopeful anomalies were detected in the all areas, and some of them are guaranteed for further exploration activity. Specially following anomaly zones are significant; large-scale W anomaly zones in the northeastern, northwestern, and southwestern Area A, a small-scale strong Au and As anomaly zone in the northern Area B, small-scale strong Au and Zn anomaly zones in the northwestern and northeastern Area C, a small-scale strong Au and weak Ni and Cr anomaly zones in the northwestern Area D, and a large-scale strong Au and Sb anomaly zone in the northeastern Area E.

GENERAL DESCRIPTION

CHAPTER 1 INTRODUCTION

1-1 Purpose of the Survey

The first project of Co-operative Mineral Exploration between Japan and Zimbabwe was started in 1983, and completed during the 1986 fiscal year. A second project area, named as the Kadoma project, was selected for subsequent exploration in the country lying between the towns of Kadoma and Kwekwe in central Zimbzbwe.

The purpose of the project is to evaluate the potential of mineral resources in the area defined in Fig. 2 by means of clarification of the geological setting and geochemical environment.

1-2 Outline of the Survey

As a start to the first year's programme, all known data on gold, copper, lead, zinc, nickel, chromium, and antimony mineral occurrences within the area were compiled and represented on a map. Five potential blocks for similar minerals were then chosen from the general area based on this compilation.

The geological and geochemical survey programmes were conducted in the chosen potential blocks, and characteristics of the mineralization in the area were defined to evaluate these blocks from an economical point of view.

Details of the surveys are as follows.

* Compilation of the general area	5,000	km^2
* Area covered by geological and geochemical survey	500	km^2
* Geochemical soil samples		
Au, Sb, As	3,074	
Au, Pb, Zn	2,006	
Au, Ni, Cr	1,508	
Au, Cu, W	1,511	
* Rock thin sections	52	
* Ore polished sections	22	
* X-ray diffraction analysis	34	
* EPMA		
Qualitative	17	
Quantitative	12	
Composition image	6	
* Age dating (K/Ar)	3	

* Liquid inclusion (Homogenization temperature, Salinity) 20

The field survey was conducted between 4 August and 1 November, 1986, a period of 90 days which included travel time. The programme was completed by the survey team with the co-operation of staff of the counterpart agency, the Geological Survey Department of Zimbabwe.

1-3 Organization of the Survey Team

The members who were involved in the planning, managing, and field survey were as follows:

(1) Planning and Managing

<u>Japanese Members</u>

Makoto ISHIDA	Metal Mining Agency of Japan
Kohei ARAKAWA	Do.
Yoshiyuki KITA	Do.
Kenji SAWADA	Do. , (Nairobi)
Ryuuji KAMIKI	Japan International Cooperation Agency

<u>Zimbabwean Members</u>

E. R. Morrison	Geological Survey Department
C. B. Anderson	Do.

(2) Field Survey

<u>Japanese Members</u>

Akiyoshi KOMURA	Dowa Engineering Co., Ltd.
Tetsuo HATASAKI	Do.
Makoto TAKEDA	Do.

<u>Zimbabwean Members</u>

T. J. Broderick	Geological Survey Department
D. Shoko	Do.

CHAPTER 2 GENERAL CIRCUMSTANCES IN THE SURVEY AREA

2-1 Location and Transportation

The survey area is located between 100 and 230 kilometres southwest of the capital city, Harare, besides the main highway and railway connecting Harare and the second major city of Zimbabwe, Bulawayo. Two major industrial and farming centres, Kadoma and Kwekwe, occur in the north and south of the general project area respectively. It takes about one and three quarters hours to travel 140 kilometres from Harare to Kadoma by car on a good highway, and one hour to travel 80 kilometres from Kadoma to Kwekwe. A good local road network connecting farming land and local villages is well developed in the area.

2-2 Topography and Climate

The survey area is located on the Southern African Plateau at an altitude of 1,000 to 1,300 metres above sea level. Topography in the main part of the area is quite flat, but there is some hilly (approximately 100 metres high) topography in the area south of Kwekwe. Three major rivers, the Umsweswe, Munyati, and Sebakwe, flow to the west where they join and continue to the northwest as the Munyati River.

Generally scarce shrubs grow in the area, and locally thorn trees grow thickly.

The climate of the area is not tropical because of the high altitude, despite the latitude ranging from 18° 00′ to 19° 10′ south. Seasons are clearly divided into two, being dry from April to October and wet between November and March. Precipitation per year is usually 700 to 900 millimetres. This year's survey programme was conducted in the dry season, but the last stage of the programme was in the rainy season. The temperature is maximum 30℃ and minimum 16 ℃ in summer, and maximum 21℃ and minimum 7℃ in winter. October is the hottest month of the year, then the temperature is reduced because of cloud covers.

2-3 General Social Circumstances

Six years have passed since Independence in 1980, and the society is gaining stability. Unity talk between the two parties, ZANU (Zimbabwe Africa National Union) and ZAPU (Zimbabwe Africa People's Union), is proceeding, and such conclusion is expected in the near future.

A Non-Alignment Movement Summit Meeting was held in Harare in August 1986, and the Prime Minister, Robert Mugabe, has been selected as Chairman for the next two years. The standpoint of the Prime Minister in the domestic political ground as well as in the world is getting firmer.

Improvement in foreign trade and in the balance of payments continued into 1985, and Zimbabwe's 1985's GDP is approximately Z$ 3.7billion, keeping around same level in recent years. Exchange rate of US$ per Z$ is 0.6, also maintaining the same rate level for two years. However, import control continues, and shortage of some machines and their parts is encountered.

Agriculture, heavy and light industries, and mining are active in the area. Large scale farming is common, producing wheat, maize, coffee, citrus fruits, cotton, and vegetables. Stockfarming is also quite active here. Various heavy and light industrial factories such as textile mills, iron and steel plant, chemicals (ammonia for fertilizer and explosive), and beverages are distributed in the Kwekwe and Kadoma districts. Mining activity is concentrated in the Chakari district which includes the Dalny Mine, the Golden Valley area, the Venice mine district, and around Kwekwe itself where the Globe and Phoenix and other mines occur. Gold is the major commodity produced, and the Midlands of Zimbzbwe represents the most active mining area in the country. The Empress mine has ceased production due to a lack of ore reserves. The nickel refinery at Effel Flats near Kadoma, however, has been recommissioned using concentrates from Botswana. A Government-supported roasting plant at Kwekwe provides a service for the treatment of refractory gold ores which are common in the area. Magnesite is produced from the Barton Farm deposit southeast of Kadoma.

CHAPTER 3 GEOLOGY

3-1 Geology of Zimbabwe

This country is divided into two geological environments, Rhodesian Craton occupying the central major part of the country and the younger geological terrains occupying the rest of the country.

The Rhodesian Craton is one of the oldest geological terrains in the world being 3.5 to 2.7 billion years in age, and consists mainly of granitic and gneissic complex terrains containing some greenstone belts. The greenstone belts consist mainly of felsic to mafic lavas and pyroclastic rocks accompanied by some sedimentary rocks, metamorphosed up to greenschist facies. The general stratigraphy of the greenstone belts is as follows.

Fig. 3 Stratigraphy of the greenstone belts in Zimbabwe

(Wilson, 1979)

Group	Sub-unit	Lithology	
	Great Dyke	- - - - - - - - - - - - - - - - -	2,500 Ma
Shamvaian		shallow marine sediments pyroclastic rocks	
~~	~~~~~	unconformity ~~~~~	2,700 Ma
Bulawayan	Upper Greenstones	calc-alkaline rock series --- bimodal series --- mafic/ultramafic volcanics sedimentary rocks ---tholeiite series --- ---komatiite series --- ---thin sedimentary formation	
	~~	unconformity ~~~~~	2,800 Ma
	Lower Greenstones	volcanic rocks(partly ultramafic) sedimentary rocks (incl. B. I. F.)	
~~	~~~~~	unconformity ~~~~~	3,000 Ma
Sebakwian		volcanic rocks(partly ultramafic) sedimentary rocks (incl. B. I. F.)	3,500 Ma

The Sebakwian Group consists of mainly Mg-rich mafic lavas, and some ultramafic bodies, pyroclastic rocks and banded iron formation. The Group contains many gold deposits and particularly pod-like chromium deposits in some serpentinite bodies.

The Bulawayan Group unconformably overlies the Sebakwean, and is divided into two sub-groups, the Upper Greenstones and the Lower Greenstones. The former unconformably overlies the latter. The Group is characterized by large amounts of andesitic and basaltic lava with some pyroclastic rocks. Pillow lava structure is well preserved in some lava flows. In the Upper Greenstones, mafic to ultramafic volcanic rocks are predominant, and sometimes komatiitic rocks and serpentinites are seen as well as some felsic volcanic rocks and banded iron formation. Many nickel deposits such as Trojan, Madziwa, Epoch, Perseverence, Empress, Hunters Road, and Shangani are associated with komatiitic rocks, serpentinites, and gabbros. Chrysotile in ultramafic bodies is mined in the Zvishavane and the Mashava areas where there are centres of asbestos mining. Many Gold deposits are distributed throughout the area of the Group.

The Shamvaian Group is distributed in the northern part of the craton, and consists of shallow marine sediments such as conglomerate, arkosic sandstone, and graywacke as well as felsic volcanic rocks.

Soda-rich tonalites intruded during the period of deposition of the greenstone belts, but the metamorphic grade of the greenstone terrains is generally low except close to contact zones, greenschist facies, sometimes amphibolite facies. In the Shurugwe area, granulite facies are reported in some greenstone relics in the basement gneissic terrain. The geological structure of the greenstone belts is very complex due to composite deformation by the diapir-like plutonic activities.

Some contact zones between granitic bodies and greenstone belts are economically important because of their rich gold occurrences in quartz reefs or metasomatic deposits due to hydrothermal mineralization. About 6,000 gold mines have been operated to date. The Bikita Mine east of Masvingo, presently producing lithium ore, and some small beryllium-tantalum-tin deposits in the Mutoko and Harare areas occur in pegmatites of post-Shamvaian age.

The Limpopo Mobile Belt (2,700 ± 200 Ma) divides the Rhodesian and the Kaapvaal Cratons in southern Zimbabwe. The Belt is said to be highly metamorphosed terrain of the greenstone belts and basement rocks of the both Cratons. Mineralized zones of magnesite and corundum commonly occur in the Belt, and gold and chromite are produced from a highly metamorphosed terrain in the northern rim area of the Belt.

The Great Dyke consists of four ultramafic lopoliths which were gravitationally differentiated in places, extending 540 kilometres north-northeast to south-southwest in central Zimbabwe. The thickness of the body reaches 1,500 metres, and it's width shows 3 to 11 kilometres. Each lopolith has a cap of norite and associated anorthosite, and consists of at least ten recycling ultramafic units. Perfect units have an arrangement of orthopyroxinite - herzbergite - dunite from the top, and are accompanied by chromite seems at the bottoms. The basal part of the norite unit is accompanied by platinum group minerals together with copper-nickel sulphide minerals. The age of the Great Dyke is about 2.5 billion years, and it is supposed that a tentional graben formed within the Rhodesian Craton at that time was filled out by the ultramafic intrusion materials.

As post-Archaen formations, the Umkond System in areas near the border between Zimbabwe and Mozanbique, the Piriwiri Series in northwestern Zimbabwe, and the Lomagundi System and the Deweras Series in north-central Zimbabwe were deposited. They have been compared to the Katangan-Copper Belt Series of Zaire-Zambia, and with the Nama-Transvaal Series of South Africa. The sediments are not exactly similar to the Copper Belt, as no carbonates are reported, and volcanic rocks are present. Their degree of metamorphism is also higher, locally reaching amphibolite facies. They consist of basal sequences of conglomerates, overlain by lavas, conglomerates, arkoses sandstones, and schists. Copper is disseminated in the upper arkoses and conglomerates, below the schists but above the lavas. The thickness of the sediments reaches 5,000 metres, and the sediments are cut by pegmatites in places.

The Zambezi Mobile Belt (700± 200 Ma) in northern Zimbabwe is a part of the Pan-African Mobile Belt, extending along the northern rim region of the Rhodesian Craton, and consists of highly metmorphosed rocks including charnockite. No mineral occurrence has been reported here up date.

After the Pan-African Movement, the Karroo System deposited in the grabens, which started with glacial deposits in the Carboniferous age and continued deposition of arenites, conglomerates, shales, coals, and basalts with thin sedimentary sequences in the Permian to Jurassic age. Particularly, the Wankee Coal Deposit being in the Karroo in northwestern Zimbabwe, contributes major energy source to the country.

A carbonatite activity occurred about 0.13 billion years ago. However, they are poor in rare metals, and only the Dorowa and Shawa areas are being mined in small operation for phosphate fertilizer.

3-2 Geology and Ore Deposits in the survey area

The area is located in the western part of the Archaen Rhodesian Craton, and consists of granite, gneiss, greenrocks, and various intrusive rocks.

The western edge of the Rhodesdale Granite-Gneiss Complex Body is exposed in the eastern to southeastern part of the area, and the greenstone belt consisting of the Lower Greenstones, Upper Greenstones, and Shamvaian Groups is distributed in the rest of area. The Sesombi Tonalite and Whitewaters Tonalite Stocks intruded in the greenstone belt, as well as other small-scale various dykes. In the southeastern part of the area, the Kwekwe Ultramafic Body is distributed along the western edge of the Rhodesdale Complex Body. In the greenstone belt, the Lower Greenstones mainly consisting of komatiitic~tholeiitic volcanic rocks is located in the eastern area, and the Upper Greenstones mainly consisting of bimodal~ calc-alkalic volcanic rocks is located in the western area. The Shamvaian Group consisting of sedimentary rocks such as sandstone and conglomerate is located in the northeastern to southeastern area in a belt shape. Accordingly, the geological structure is controlled by an anticline extending north-northeast to south-southwest. The dips of the formations are nearly vertical.

Regarding mineralization, gold-bearing quartz reefs and gold-bearing sulphide veins are principal one in the area. It occurred in sheared and carbonatizes zones of quartz-sericite schists and serpentinites which were made by the thrust faulting due to the intrusion of the Sesombi and Whotewaters Stocks. These gold mineralized parts are distributed in the edge zones of the Rhodesdale Complex

Body in the eastern area, in the mafic rocks of the Lower Greenstones, and the Shamvaian and Upper Greenstones Groups in the southern area.

General strikes of the gold reefs in the edge of the Rhodesdale Complex Body are concordant to the border, north-northwest to northeast, but some are perpendicular to them. Those in the northern edge of the Whitewaters Stock are east-west, and those in the greenstone belts are north-northeast or north-northwest.

Accessory minerals associated in the gold mineralization are characteristic in each district and different geology. An As-Sb-W assembly is common in the area from Chakari to Golden Valley, occasionally accompaned with a Cu-Pb-Zn assembly. Tungsten is characteristic in the Whitewaters Stock, in where sheelite is commonly seen. A Pb-Zn assembly is common in the veins in the edge of the Rhodesdale Complex Body. Cu, Ni, Mo and Sb are commonly associated with the ores around the Kwekwe Ultramafic Body distributing in the south of Buttlefields.

In the Redcliff to Hunters Road area, some nickel-sulphide ore deposits associated with ultramafic bodies are distributed, however no economical ore has been found.

SURVEY RESULTS

CHAPTER 1 DATA COMPILATION

Before starting the survey, a compilation study was conducted using all collected data such as concerned geological bulletins, papers and reports. Five semi-detail survey blocks were selected from the general target area covering 5,000 square kilometres, based on this compilation study with reference of the proposed areas from the Geological Survey Department of Zimbabwe, considering about the available land situation with regard to mining leases or E.P.O. A geological and soil geochemical survey programme was proposed to conduct in the selected five blocks covering 100 square kilometres each. The reasons why the blocks were selected are as follows.

Area A

The area is situated in the southeast side of the Sesombi Tonalite Body, which is located to the southwest of Kadoma. Many tungsten-gold-bearing quartz veins are distributed in the contact zones between the Tonalite Body and the greenstones of the Bulawayan Group. A swarm of veins in the Glasgow region is located to the north, and the geological environment of the area is quite similar to that of the Glasgow. Therefore, it was evaluated that the area has a high potential for such type of ore.

Specially, areas where contact zones between different type of rocks or some kind of sheared zones are distributed, are seemed favourable for making spaces for such mineralization. Based on such geological information, two areas covering total 30 square kilometres, were selected for a geochemical survey applying Au, Cu and W as path-finders.

Area B

The area is locate to the west of Umniati, and situated in between the Rhodesdale Complex and the Sesombi Tonalite Body. The area is underlain by the mafic and felsic volcanic rocks of the Bulawayan Group, containing bimodal rock series. In the southern area, the strike of the formation, and the trend of faults and dykes are mainly north-northwest. However, in the northern area, a north-northeastern trend is significant. Therefore, it is said that the area is situated on the bend zone of the geological structure. It means that the area is in a favourable geological environment for making cracks and shears, which would be suitable spaces for veins. Actually, gold- bearing quartz veins containing arsenopyrite and stibnite are distributed in the area. Furthermore, many small-scale intrusive bodies, which are presumablly good ore bringers, are distributed. Therefore, it was evaluated that the area has a high potential for such ore.

An area covering 15 square kilometres was selected for a geochemical survey, based on such geological information. Areas involving known ore deposits were neglected from the choice, and an area situated in the geological trend from such mineralized area was picked up for the selection. Au, Sb and As were selected as path-finders.

Felsic rocks belonging to the calcalkalic series appear in the upper part of the Bulawayan. Some strata-bound massive sulphide ore deposits are known in such horizon in the world, therefore, some potential for such type of ores is expected in the area.

<u>Area C</u>

The area is located on the west of Area B, and the geology of the area is similar to that of Area B. The Cuba Mine containing Cu, PB, Sb and As minerals is located in the eastern edge of the Sesombi Body, however, no other known mineral occurrence is located in the area. The geological environment in the area is similar to that of Area B, having a north-northwestern trend of the formation and north-northeast trend of the faults, and small-scale quartz porphyry dykes. Therefore, it was evaluated that the area has a high potential for such ore.

An area covering 20 square kilometres was selected from the northwestern area, adjacent to the Sesombi Body, for a geochemical survey. Au, Pb and Zn were selected as path-finders, because of their versatile applicability.

<u>Area D</u>

The area is mainly underlain by the Kwekwe Ultramafic Body which elongates north to south to the north of Kwekwe. The Rhodesdale Complex Body is distributed in the eastern edge of the area, and the greenstones of the Bulawayan are in the western area. The Cupprum, Chlirite schist, and Rosstack nickel-copper deposits are in the

Kwekwe Ultramafic, and the well-known Hunters Road Nickel Deposit is located to the south of the area, in the same geological trend. In the Battlefields region, some gold occurrences are in the Ultramafic, and a large number of quartz veins are in the Rhodesdale Body. Based on such geological environment, it was evaluated that the area has a high potential for nickel sulphide ore deposits, as well as quartz and gold.

An area covering 30 square kilometres in the main part of the Ultramafic was selected for a geochemical survey applying Au, Ni and Cr as path-finders.

Area E

The area is situated to the southwest of the Sesombi Body, and underlain by the bimodal and calc-alkalic rock suits of the greenstones of the Bulawayan, as same as Areas B and C. Some gold deposits are located in the contact metamorphic zone near by the Sesombi Body, aligning north-northeast. Therefore, it was evaluated that the area has a high potential for gold ore.

An area covering 30 square kilometres, where a quartz porphyry intrusive body is distributed, was selected for a geochemical survey , applying Au, Sb and As as path-finders.

Table 1-1 Five Semi-detail Survey Blocks in the Kadoma Area

Area	Extent km²	Geology	Mine or Mineral Occurrence	Appraisal Criteria	Programme of Geochemical Exploration			Potential type of Ore	Priority
					Path finder	Area • Sampling grid	Number		
A	100	Lower Greenstones of Bulawayan Group	Aurora (Au) Cobhurst (Au) Affaire (Au W)	• Geological extension to south of the Lion Hill group of ore deposits and Glasgow area	Au Cu W	A1:5Km×3Km 200m/100m A2:5Km×3Km Vicinity of lithological contact be surveyed	750 750 Total 1500	• W-Au—quartz reef	1
B	100	Upper Bulawayan Group	Cricket (Au As) Oro Bredo (Au As Sb) Somerset (Au As)	• Turning point of geological trend,NNW,NNE-faults well deve-loped • Acid intrusives to be heat con-vection • Bi-modal rock series	Au Sb As	5Km×3Km 200m/ 50m Extension of the known deposits be semi-detail survey area	1500	• Au-quartz reef • Massive sulphide	2
C	100	Maliyami Formation Upper Bulawayan Group	Cuba (Au Cu Sb Pb As)	• Bi-modal rock series with ore potential of massive sulphide as well as gold • A swarm of acid stock in the periphery of Sesombi Suite	Au Pb Zn	8Km×2.5Km 200m/ 50m Extension of the known deposits be area of semi-detail survey	2000	• Au-quartz reef • Massive sulphide	4

Area	Extent Km^2	Geology	Mine or Mineral Occurrence	Appraisal Criteria	Programme of Geochemical Exploration			Potential type of Ore	Priority
					Path finder	Area · Sampling grid	Number		
D	100	Rhodesdale Gneiss Kwekwe Ultramafic Complex	Joanern (Au) Cupprum (Cu) Chlorite schist (Cu) Rosstack (Cu)	· Geochemical anomalies of Ni, Cr reported in the previous work · Rim part of Rhodesdale Gneiss	Au Ni Cr	10Km×3Km 200m/100m Ultramafic complex be in-vestigated	1500	· Au-quartz reef · Massive Ni sulphi-de	5
E	100	Maliyami Formation Upper Bulawayan Group	Black prince (Au?) Green Granite (Au?)	· Bi-modal rock series with ore potential of gold and massive sulphide · A group of acid stock in the periphery of Sesombi Suite	Au Sb As	6Km×5Km 200m/100m Extension of the known occurrences	1500	· Au-quartz reef · Massive sulphide	3

CHAPTER 2 GEOLOGICAL SURVEY

2-1 Outline of Geology

The area is underlain by a granitic-gneissic terrain, greenstone belts, and various intrusive bodies of the Archean age.

The western edge of the Rhodesdale Granite-Gneiss Complex Body exposes in the eastern area. Partly, highly metamorphosed rocks of the Sebakwian Group, the oldest group in the area, are enclosed in the body.

The greenstone belt consists of the Bulawayan and Shamvaian Groups. The Bulawayan Group is distributed in the large parts of the area, and divided into two sub-groups, the Lower Greenstones and the Upper Greenstones. Both sub-groups mainly consist of mafic volcanic and pyroclastic rocks, accompanied with felsic volcanic and pyroclastic rocks, banded ironstone, and various sedimentary rocks. The Shamvaian Group is distributed in a belt zone from the northeast to the southwest of the area, and consists of shallow marine sediments such as graywacke sandstone and conglomerate.

With regard to intrusive bodies, the Whitewaters Tonalite Body and the Sesombi Tonalite Body are located in the northern and western areas respsctively. In the survey, K/Ar radiometric age determination tests were conducted for the both rocks. The results showed that the age of the Whitewaters was 1,829 ± 91 Ma, and that of the Sesombi was 2,251 ± 112 Ma. The two bodies are important from the economical point of view, due to their association with gold and tungsten minerals. Other small-scale quartz porphyry and dolerite dykes are scattered troughout the area. In the south-central area, the Kwekwe Ultramafic Body is located in the adjacent zone to the Rhodesdale Complex Body. The occurrences of the body look like of a lava flow in the greenstone belt, but some geologist proposed a different assumption, which suggests that intrusion along sheared zones occurred in contact zones between the Rhodesdale Body and the greenstones.

2-2 Stratigraphy

The greenstone belt in the area is divided into following units, the Sebakwian Group (3,000 Ma), the Bulawayan Group (3,000 ~ 2,700 Ma), and the Shamvaian Group (2,700 ~ 2,500 Ma).

The Sebakwian Group, consisting of highly metamorphosed rocks enclosed in the Rhodesdale Complex Body, is isolated from other greenstone belts. Therefore, no relation to other groups is seen in the area. However, judging from evidences seen in other areas, it is said that the Group is unconformablly overlain by the Bulawayan Group. Furthermore, it is probablly said that some parts of the schistose gneiss of the Rhodesdale Complex Body are originated from rocks of the Sebakwian Group.

The Bulawayan Group is divided into two sub-groups, the Lower Greenstones and the Upper Greenstones. The Lower Greenstones unconformablly overlies the Sebakwean Group, as mentioned before, and is unconformablly overlain by the Uppe Greenstones. The Shamvaian Group unconformablly overlies the Bulawayan Group.

The following figure shows the above mentioned relations.

Group	Sub-Group	Facies
Shamvaian		sandstone, conglomerate, slate, phyllite, basal conglomerate
~~	~~~~~~~~~~~~	~~unconformity~~~~~~
	Upper Greenstones	mafic volcanic and pyroclastic rocks, felsic volcanic and pyroclastic rocks, banded ironstone, arcose sandstone, ultramafic rocks
Bulawayan	~~~~~~~~~~~~	~~unconformity~~~~~~
	Lower Greenstones	mafic volcanic and pyroclastic rocks, banded ironstone
~~	~~~~~~~~~~~~	~~unconformity~~~~~~
Sebakwian		micaceous and grunerite metaquartzite, metadiorite

The greenstones in the groups mainly consist of basaltic lavas, with some amounts of andesitic lavas. In some places, where have good exposure, such as river banks, pillow lava textures sizing a half to one metre are frequently seen. It is sometimes possible to judge their top-bottom relations from such texture. Chilled margins consisting of one to two centimetres-thick dark-green to black glassy parts are seen on the surface of the pillows. Plenty of bubbles

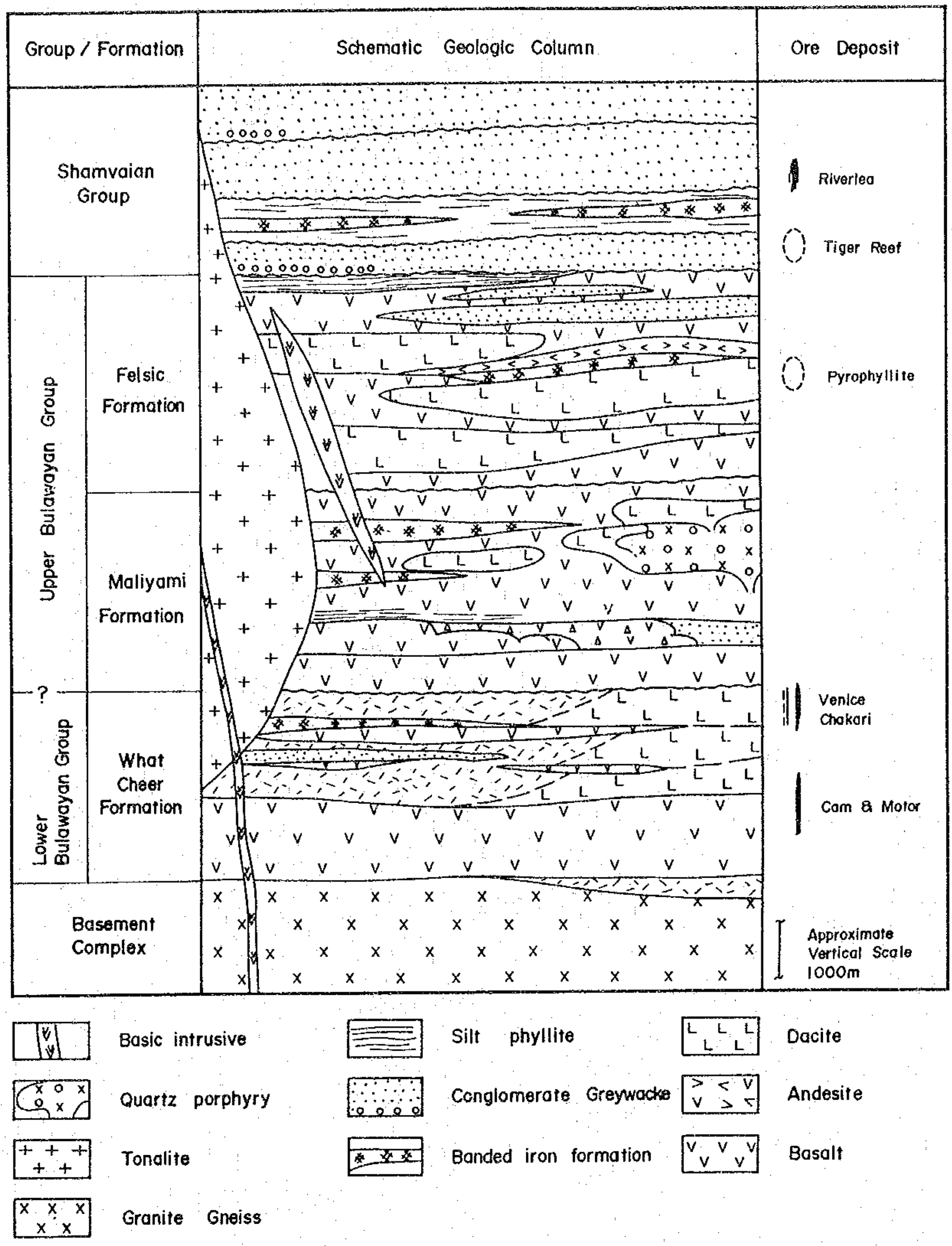


Fig. 2-2-1 Schematic Geologic Columnar Section of the Kadoma Area

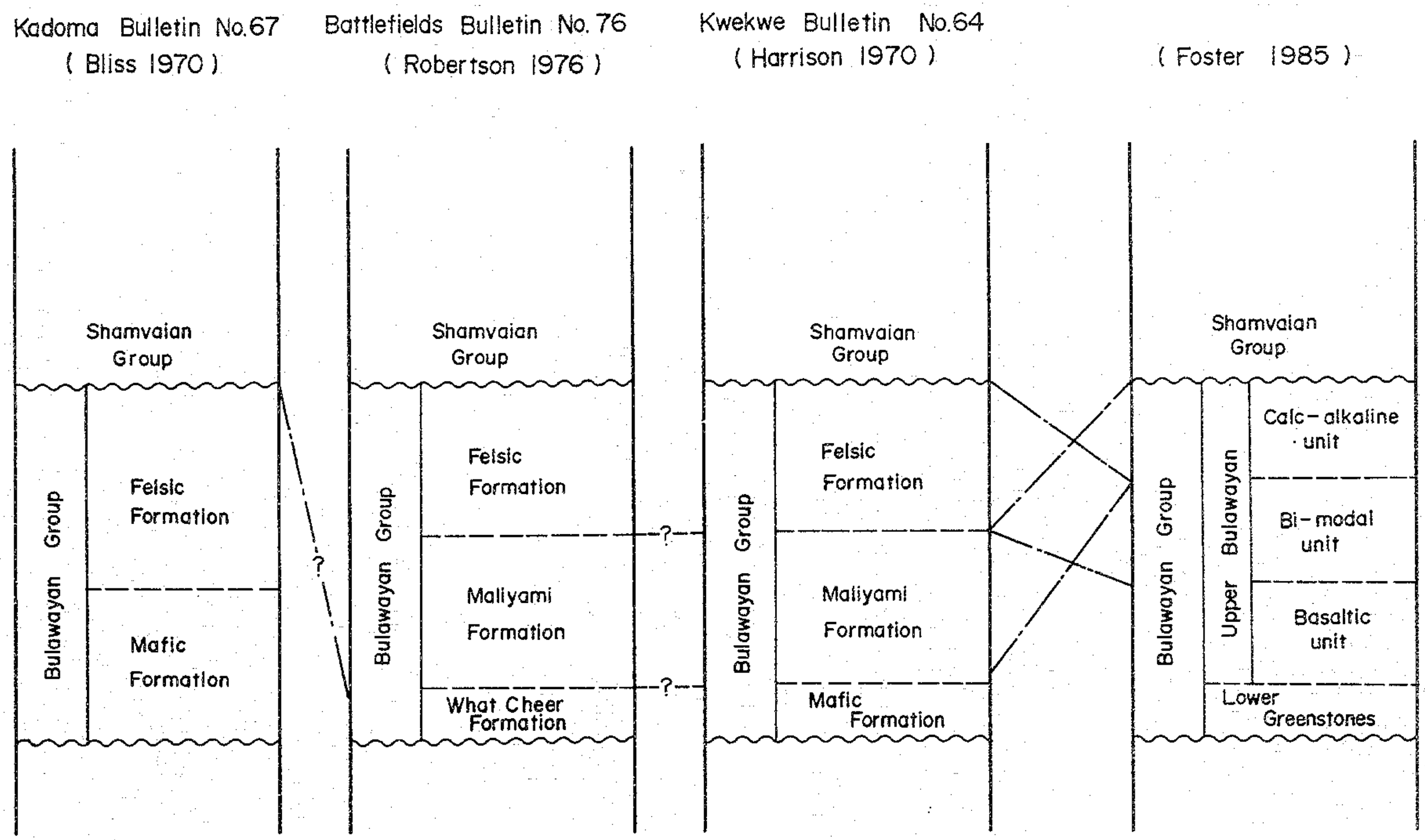


Fig. 2-2-2 Correlation of the Bulawayan Group, from different Bullet and Authers

are included inside of the chilled margin, which is usually 3 centimetres thick. Big bubbles, about one centimetre diametre, are rich further inside of the chilled margins. In the bubbles, calcite, albite and chlorite are filled in radial patterns. In the short axis direction, parallel fractures are seen. Under the microscope, subophitic texture is seen in the matrix, which consists of plagioclase, hornblende, clinopyroxine, and iron minerls. Generally, mafic minerals were subjected to alteration, specially pyroxenes were almost completely altered to chlorite and calcite, and so did plagioclase to sericite and calcite. On the other hand, pegmatitic facies consisting of large amounts of amphibole, and small amounts of quartz and plagioclase are locally seen in the lava facies.

Pyroclastic rocks, consisting of pillow breccia to fine volcanic ash, are associated with the lavas. It is judged that the rocks are products of submarine volcanic activity at that time, due to their good size-grading in the formations. Under the microscope, pyroclastic fragments mainly consist of scoria-like material rich in bubbles, and elongate lenticularly or show ameoboid shapes. The groundmass is mainly filled with plagioclase and some alteration minerals such as calcite, sericite, and chlorite, which were altered from mafic minerals. It is presumed that the quartz seen in the groundmass is products of silicification.

Felsic volcanic rocks have phenocrysts of corroded quartz and replaced plagioclase (presently sericite), and felsic pyroclastic rocks have essential and accidental fragments such as tuff and slaty materials. Silicification and carbonatization are significant in the rocks.

There are several grouping ways of the Bulawayan Group. In the Kadoma-Battlefields district, the What Cheer Formation consisting of mafic lavas, the Maliyani Formation consisting of felsic lavas and pyroclastic rocks, and the Felsic Formation consisting of mafic and felsic lavas and pyroclastic rocks with some banded iron formations, from the lower to the top, were classified. In the Kadoma area, the Felsic Formation and the Mafic Formation, from the lower, were divided. In the recent year, Foster (1985) classified the Bulawayan Group into two sub-groups, the Lower Greenstones and the Upper Greenstones. Furthermore, he divided the Upper Greenstones into three units, the Basaltic, the Bimodal, and the Calc-alkaline. In this survey, those detailed relations were not investigated because of the limited time schedule.

According to Foster, the Bulawayan Group in the area mainly belongs to the Upper Greenstones, except an area to the south of Kadoma. The Basaltic Unit is located to the north of Kadoma, in the Cam and Moters area, and in the western Area D, the Bimodal Unit previously classified as the Felsic Formation is in an area on the west of the Shamvaian in the central to southern area, and the Calc-alkaline Unit is in an area previously classified as the Miliyani Formation. The difference from the previous stratigraphy is the reverse relation of the Felsic and Maliyani Formations, and unification of the Felsic Formation and a part of the Bulawayan in the north of the Venice Mine area. The Foster's stratigraphy seems quite understandable, judging from the views of the whole distribution pattern of the formations and geological texture in the area.

2-3 Intrusive Rocks

The greenstone belt and the granite-gneiss terrain were intruded by several intrusive bodies. Facies and occurrences of those bodies are as follows.

Intrusive Facies of the Rhodesdale Granite-Gneiss Complex Body

Some parts of the body show intrusive facies, which could have been afterward reactivated from the basement granitic terrain. Specially, the western edge of the body, which is named as the Kwekwe Gneiss, consists of massive granite, schistose gneiss, and partly adamelite.

Under the microscope, two facies, granodiorite and granite, are recognized. The former consists of biotite, amphibole, and minor amounts of muscovite, with relatively less amounts of potash-feldspar, and the latter consists of biotite, and large amount of microcline and quartz. Mafic minerals were subjected to alteration, weak chloritization and epidotization, and feldspars were altered to sericite. It is not clear whether the both facies compose individual bodies or not.

Kwekwe Ultramafic Rock

The body is located in the south-central area, lying adjacent to the Rhodesdale Complex. There are two interpretations of the occurrence of the body, lava flows of the greenstone members and a intrusive body. Judging from its distribution pattern, it looks like lava flows of the Upper Greenstones, but some geologist suggested that the body intruded along shear zones occurred in the contact zone between the Rhodesdale Complex Body and the greenstones. It was unable to investigate such relations this time, due to the limited time schedule.

Under the microscope, it is clearly observed that the intensity of the serpentinization widely ranges, completly disappearing of the original texture of the rocks in some cases, and remaining olivine's pseudomorphs and pyroxene crystals. Judging from its volume ratios and kinds of the pyroxines, parts of the original rocks are presumed as wheerlite. Amphibolite consisting of colourless amphiboles (presumably cummingtonite) is partly seen in the rocks. Alteration minerals caused by serpentinization are large amounts of calcite, serpentine, talc, etc., which show a typical network texture. The major iron mineral is magnetite, which scatters irregularly or dustily. Magnetite-ilmenite paragenesis showing a significant idiomorphic Widmanstatten figure is seen in some parts.

Whitewaters and Sesombi Tonalite

The Whitewaters Tonalite is located to the west of Kadoma, and the Sesombi Tonalite is located to the west of Battlefields. The rocks are coarse-grained and homogeneous, containing large amounts of biotite, which generally shows pinkish colour. It is supposed that the presently exposed surface of the bodies would be the top parts of large scale intrusive stocks , because the shape of the edges of the bodies show irregular patterns, and the bodies are accompanied with large numbers of small intrusive bodies around. Gold mineralization is associated with the both bodies. Particularly, gold-tungsten mineralization is characteristic in the Whitewaters Tonalite.

Under the microscope, a sample from the southern part of the Whitewaters Body consists of biotite, hornblende, plagioclase, and potash feldspar. The rocks are closer to adamelite rather than tonalite. On the other hand, a sample from the southeastern part of the Sesombi Body shows biotite-amphibole tonalite facies, mainly consisting of quartz and plagioclase with poor amounts of potash feldspar.

In this survey, K/Ar radiometric age determination was conducted for the both bodies. The results showed that the Whitewaters was 1,829 ± 91 Ma, and the Sesombi was 2,251 ± 112 Ma. It means that the bodies intruded after the Shamvaian age.

Quartz Porphyry

Quartz porphyry stocks and dykes intruded in the surrounding area of the Whitewaters and the Sesombi Bodies. In this survey, it was made clear that some parts of the bodies showed brecciated lava facies. Therefore, it is more reasonable to interpret those parts as members of the Upper Greenstones. However, those parts showing massive intrusive facies were interpreted as intrusive bodies.

Under the microscope, the massive rocks contain phenocrysts of quartz, plagioclase, and amphibole, and the groundmass consists of granular to small columner crystals of quartz, plagioclase, and potash feldspar. The quartz phenocrysts show a characteristic corroded patern. Sericitization, chloritization, and calcitization are significant throughout the phenocrysts and groundmass.

In this survey, K/Ar radiometric age determination was conducted for a quartz porphyry body. The results showed that the age of the rock was 2,554 ± 128 Ma. It means that the rock intruded at the last stage of the Shamvaian age, about the same time of the Great Dyke's intrusion.

Table 2-3-1 K-Ar Dating of Felsic Intrusive Rocks

Sample No.	Name	Rock Type	Analysis	Isotopic Age Ma
G-1	Whitewaters Tonalite	Hornblende-biotite adamelite	Whole rock	1,829 ± 91
G-2	Sesombi Tonalite	Hornblende-biotite tonalite	Whole rock	2,251 ± 112
C41-4	QP stock	Quartz porphyryk	Whole rock	2,554 ± 128

Others

Some small-scale (ten to several-tens meters width) dolerite dykes and gabbroic intrusive bodies intruded throughout the area. Surface topography of such areas shows certain high ridges, which are particular in those kinds of rocks. According to the results of the microscopic observation, some rocks previously recorded as dolerite or gabbro are better to be classified as quartz diorite or amphibole tonalite, because they contain certain amounts of quartz, in spite of containing pyroxines.

Mafic intrusive rocks consist of plagioclase, hornblende, clino-pyroxine, iron minerals, small amounts of orthopyroxine, and a minor amount of quartz. Mafic minerals were occationally altered to chlorite and calcite. It is supposed that some of those secondary minerals were primarily olivine, judging from their pseudomorph.

Porphyritic lavas seen in the Venice Mine show pillow textures, as well as basaltic lavas. Phenocrysts are sub-rounded with about one centimetre diametre. Under the microscope, they are assemblages of brown fragmental products, presumably olivine xenocryst, judging from their shapes and fractures. The groundmass mainly consists of clinopyroxine and plagioclase, and shows subophitic texture.

Granophyre seen in the same mine consists of porphyritic potash feldspar, granular plagioclase, biotite, clino-pyroxine, hornblende, and small amounts of quartz.

2-4 Geological Structure

The geological structure in the area is basically controlled by the oldest folding structure running northwest to southeast. Furthermore, some later deformations due to tectonic movements made the structure complex.

The oldest deformation is represented by the direction of the schistosity of the gneiss and schist of the Rhodesdale Complex, and controls the distribution of the rocks and formations in the area. The Kadoma Anticline, which plunges from the northeastern corner of the area to the south-southwest, is the most significant one in the area. To the east of the anticline, a syncline and another anticline run parallel to the Kadoma Anticline. The Shamvaian Group is distributed in the syncline axis zone.

The second deformation is of isoclinal folding extending north-northwest to south-southeast appearing in the north-central area.

The complex structure, which appears in the western Area B, is supposed to have been made at this stage. The north-northwest trend of the greenstone belt in Area C is also supposed to have been caused by the folding.

The third deformation was caused by the intrusion of the tonalite, and is represented by shearing and revolving. An anti-clockwise revolving is supposed to have occurred in the case of the Sesombi intrusion. It is supposed that several different shearing systems were associated with different deformations occurred in the area. A north to south system and a north-northeast to south-southeast system are significant in the north to central area, and a north to south system and a northwest to southeast system are significant in the southern area. Among them, the north to south and northwest to southeast systems are occasionally accompanied with quartz veins.

2-5 Metamorphism

The area was subjected to several time's deformations and metamorphism, up to the time of the Shamvaian. Generally, chlorite, sericite and calcite with recrystallized amphibole and epidote were produced in the greenstones. Therefore, their metamorphic grade is of low-temperature greenschist facies, even if all the minerals are metamorphic products.

Argillaceous rocks in the greenstones near by the Biri, Whitewaters, and Sesombi Tonalites were significantly metamorphosed to hornfel, producing cordierite and biotite.

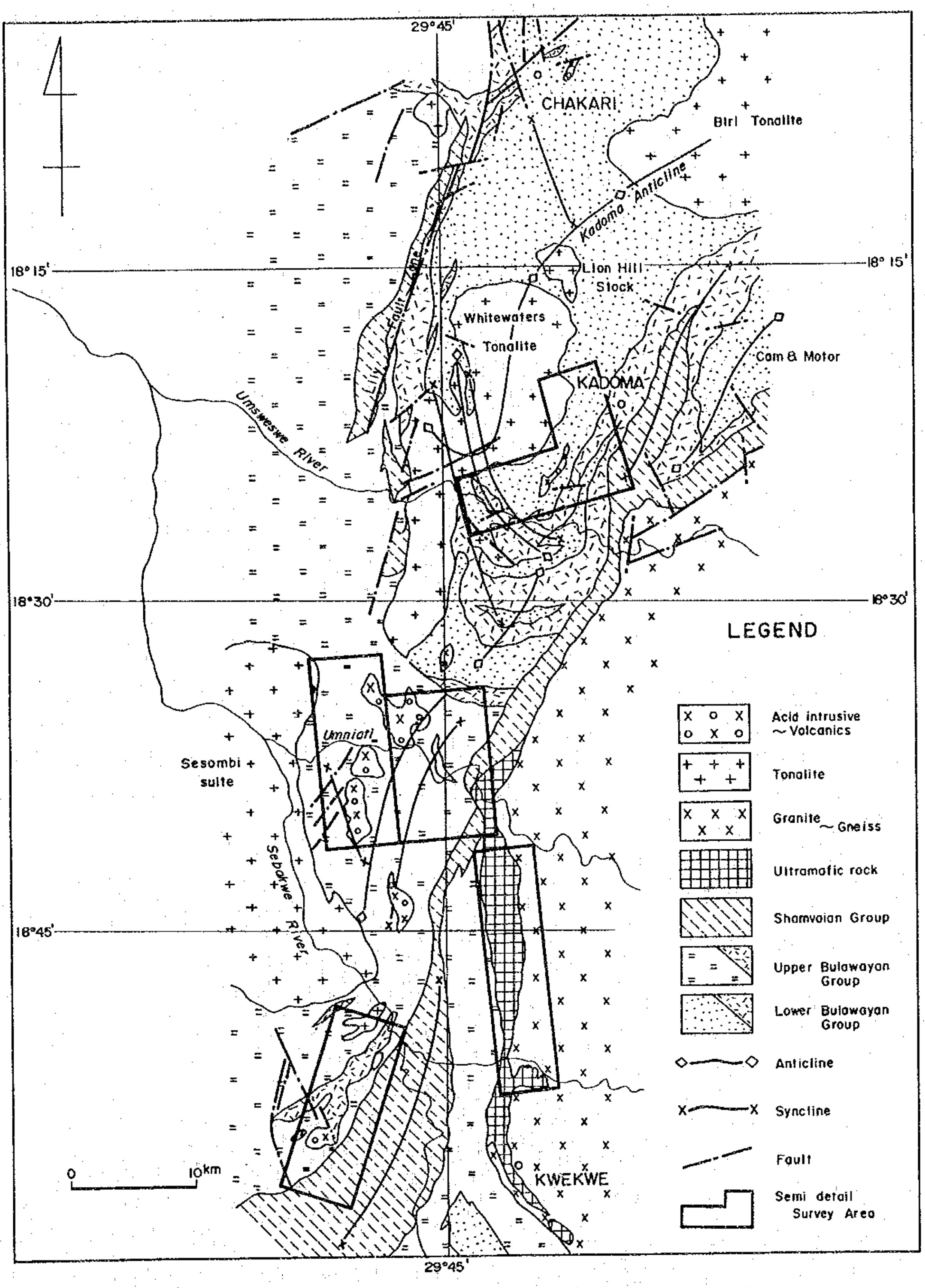


Fig. 2-4-1 Outline of the Geological Structure of the Kadoma Area

CHAPTER 3 ORE DEPOSIT

3-1 Outline of Ore Deposits

The area is one of the main gold producing areas in the country, involving the Dalny, Venice, Riverlea, Tiger Reef, Globe and Phoenix, etc. Furthermore, many other old workings and mineral occurrences of gold are distributed in the area. On the other hand, the Hunters Road Nickel Ore Deposit is located in the southern end of the area, and other base metals and tungsten deposits are distributed in the area. Appendix 2 shows principal metal mines and mineral occurrences in the general survey area.

Based on their host formations, gold deposits are classified as follows.

(1) In greenstones of the Bulawayan.
Gold deposits in the Chakari - Golden Valley area, Cam and Motor

(2) In graywacke sandstone and banded ironstone of the Shamvaian.
Tiger Reef, Unit

(3) In the Kwekwe Ultramafic Rock
Globe and Phoenix, Gaika

(4) In the Rhodesdale Complex Body
Piper Moss

According to such classification, those of the category (1) are generally large-scale and high-grade, those of the (2) are medium-scale and low-grade, those of the (3) are small-area but high-grade and large-quantity, and those of the (4) are large-numbers but small -scale and low grade.

On the other hand, gold deposits in Zimbabwe are genetically classified as follows.

(1) Ores in banded ironformation --------------- about 13 per cent
(2) Strata-bound massive sulphide ore deposit --less than 1 per cent
(3) Gold-bearing quartz vein, network, etc.
 a. Reef type ---------------------------------about 62 per cent
 b. Sheared zone type --------------------------about 20 per cent
(4) Strata-bound disseminated type in clastic rock--about 5 per cent

Among them, important types from the economical point of view are (3) and (4). The Cam and Motor , and the Globe and Phoenix Mines belong to (3), and the Dalny and the Venice Mines belong to (4).

3-2 Surveyed Ore Deposits

Followings are the description of the visited mines and workings in this survey.

(1) Venice Mine

The mine is situated in the central area, together with other many mines and mineral occurrences such as the What Cheer and the Nando, forming a major gold producing district in the area. The mine is the principal one in the district.

Ore deposits are in shared zones occurred in the boundary zone between two different formations, the massive greenstone and the porphyritic lava of the What Cheer Formation, which mainly consists of basaltic greenstones. It is said that the gold of the deposits is primarily of syngenetic ocean-floor exhalative products. It was then removed along shared zones occurred by later tectonic movements, and finally concentrated in vein-like ore zones. generally, quartz is not associated with the ore zones.

General strike of the ore zones is east-west, dipping 40～50° to the south. The width of the ore zones is several centimetres to one metre. Reddish argillization and pyrite dissemination commonly occurred in the zones. A bonanza part in the eastern zone, which strikes west-northwest to east-southeast, plunges to the southwest, but another one in the western zone, which strikes east-northeast to west-southwest, plunges to the southeast, therefore, both bonanzas are supposed to join in the depth. However, a dolerite dyke running north-northeast to south-southwest cuts them.

A branch gold-bearing quartz vein running north to south crosses the main zone in the western part. Characteristics of the vein are similar to those of the main zone, therefore it is judged that the genesis of the vein is just same as that of the main zone.

Generally, the width of the ore zones are 50 centimetres to one metre, coinciding with that of the shared zones, and the average grade is 7 to 10 g/t, with fluctuating grade distribution. In the cases of the sampling in this survey, six divided sections along a 2 metres sampling line showed the grades ranging from trace to 10.3 g/t, and nine divided sections along a 3 metres line showed the grades ranging from 0.2 to 30.2 g/t.

granophyre intrusion near the time of the ore formation did not affect to the displacement of the ores.

A X-ray diffractive analysis was conducted to determine altered minerals in the samples collected from the hanging and foot walls of the ore zones this time. The results are shown in the Appendix 5.

According to the results, the host rock alteration is weak, just increasing calcite and chlorite in bleached parts.

(2) Globe and Phoenix Mine

The mine is located in the southern area, in the western Kwekwe town site. The mine is one of the historical gold mines in the country, opened in the late 1800s. The ore deposits are in the Kwekwe Ultramafic Body, and consist of gold-bearing quartz veins and gold-bearing sulphide quartz veins. Two principal deposits are the Globe Deposit in the northwest and the Phoenix Deposit in the southwest. At present, they are producing about 3,000 tons of ore, grading 3 to 5 g/t, from the Phoenix Deposit.

The Phoenix Deposit consists of the Phoenix Principal Vein, Phoenix Hanging Wall Parallel Vein, Apple Vein, No.4 Parallel Vein, No.5 Parallel Vein, etc., generally striking north to south and dipping about 50° , occasionally 80 ° to the east. Some thin veins cross cut the above mentioned veins. The presently operating strike-length is about 200 metres, and the deepest operating level is 1,550 metres from the surface. The width of the veins is 1.2 to 2.5 metres, and rocks around the veins are suffered talk and dolomite alteration. The scale of the ore deposits is large, in spite of high grade ores, ranging a section area of 150 x 90 metres from the level 14th to 19th (420 to 570 metres from the surface) with a grade of above 156 g/t in a case of the old workings, which is the best section in the mine, and perhaps the best and largest record in the world.

Constituent minerals of the ore are pyrite, native gold, arsenopyrite, sphalerite, galena, and enargite in cases of gold-bearing quartz veins, and pyrrhotite, galena, pyrite, sphalerite, and tetrahedrite in cases of gold-bearing sulphide quartz veins. Under the microscope, the native gold shows about 2 millimetres amoeba-like shape, and paragenesis with pyrite. This paragenesis is different from that of other deposits, which normally show paragenesis with

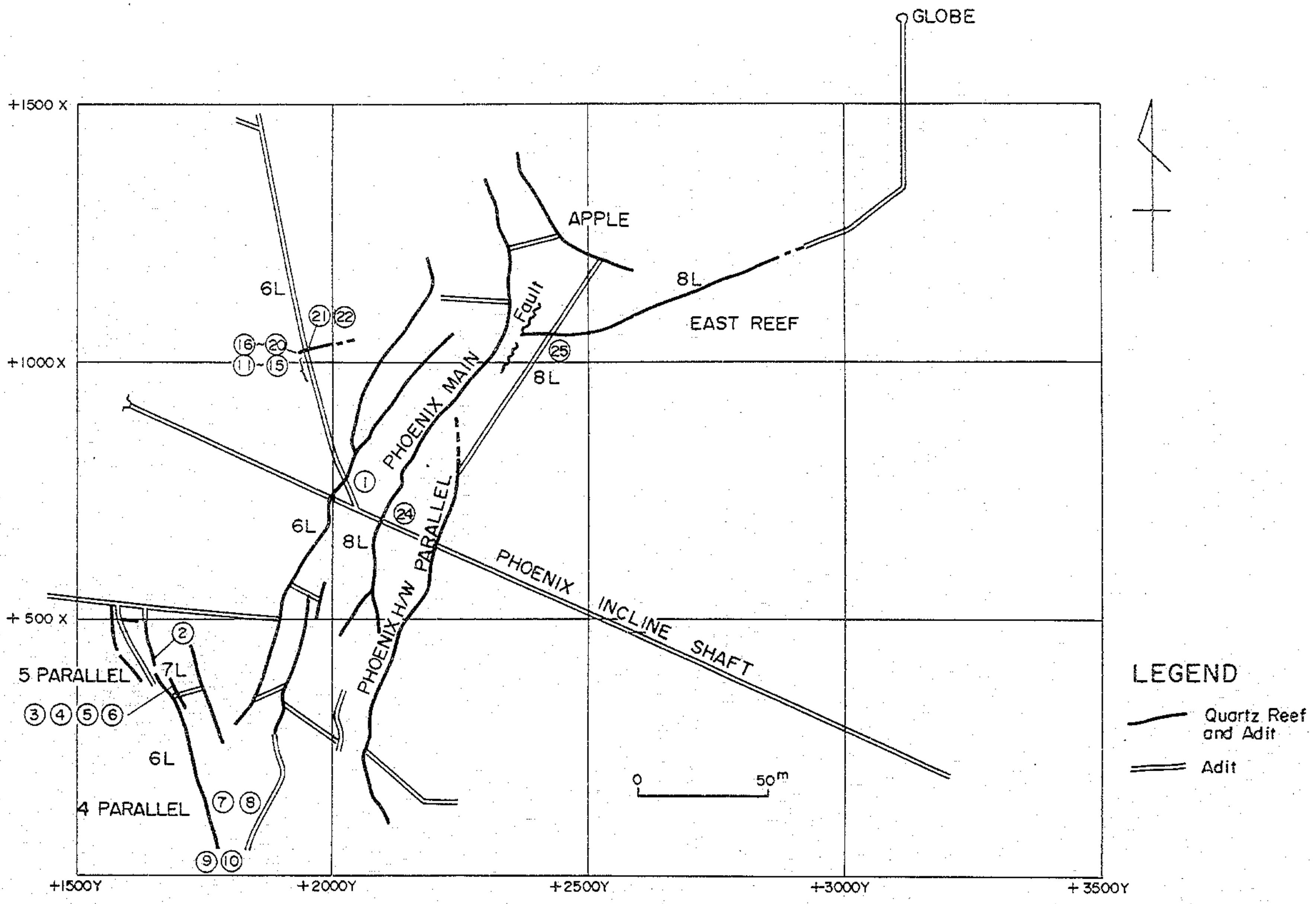


Fig. 3-2-1 Vein Map of the Globe and Phoenix Mine

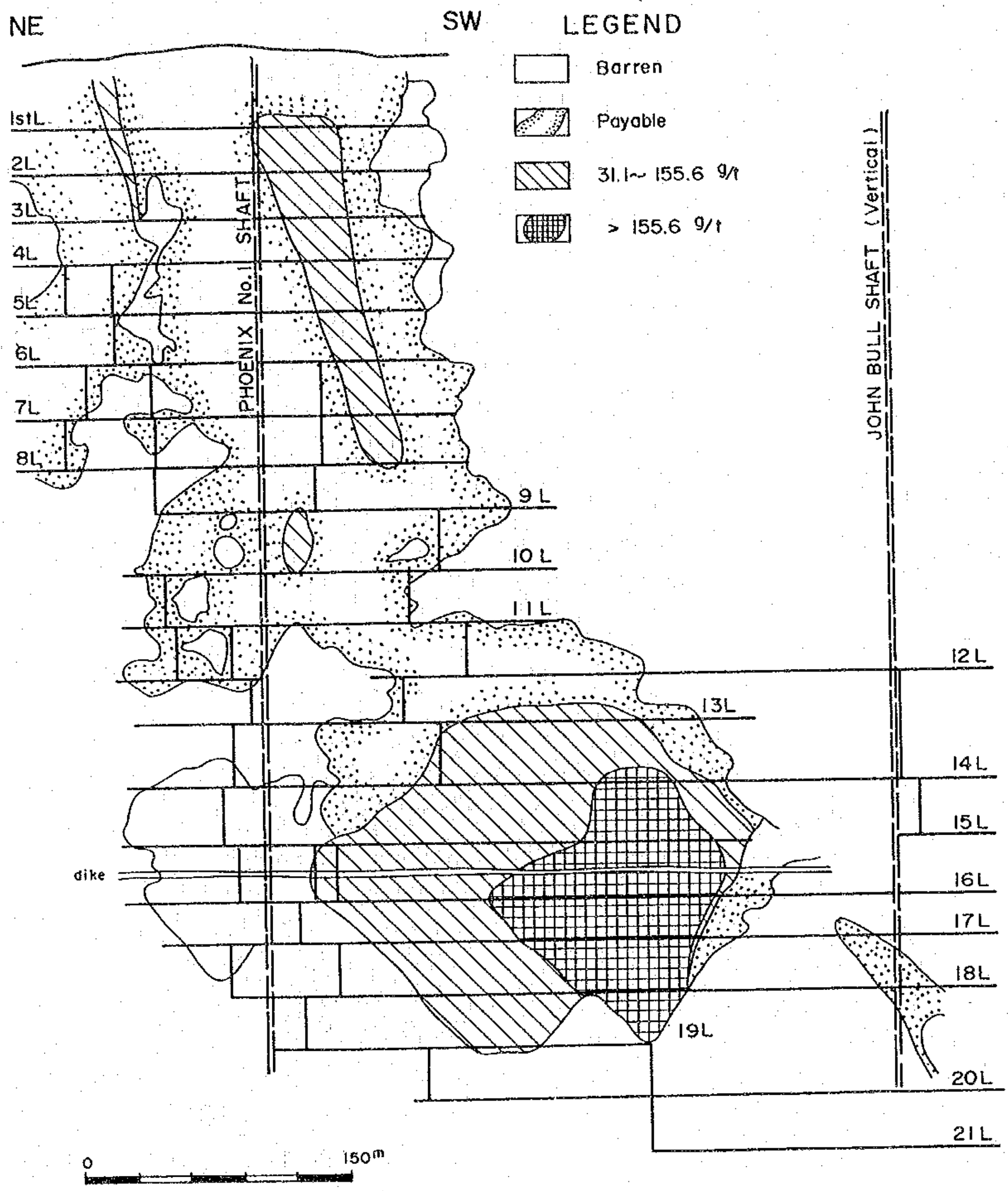


Fig. 3-2-2 Cross Section of the Phoenix Gold Reef

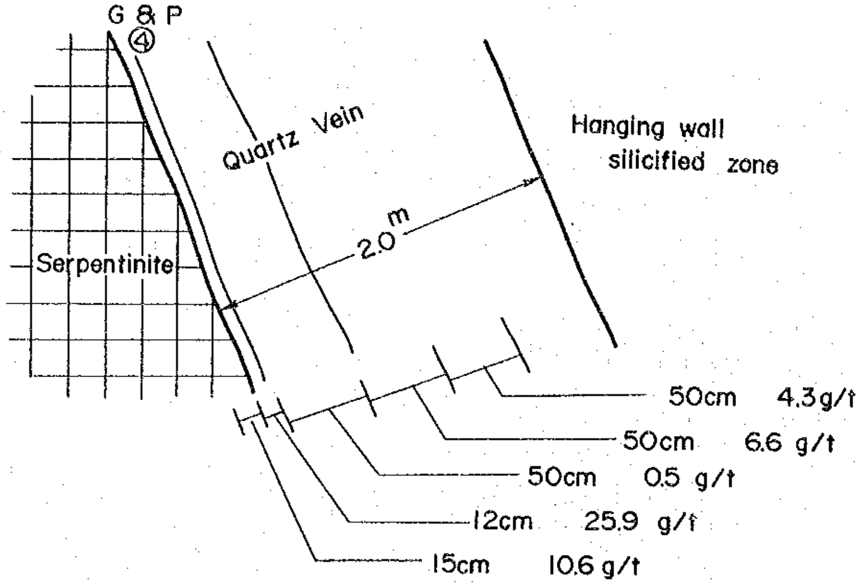


Fig. 3-2-3 Gold Assay Results of the No.4 Parallel Reef, 7th Level, Globe and Phoenix Mine

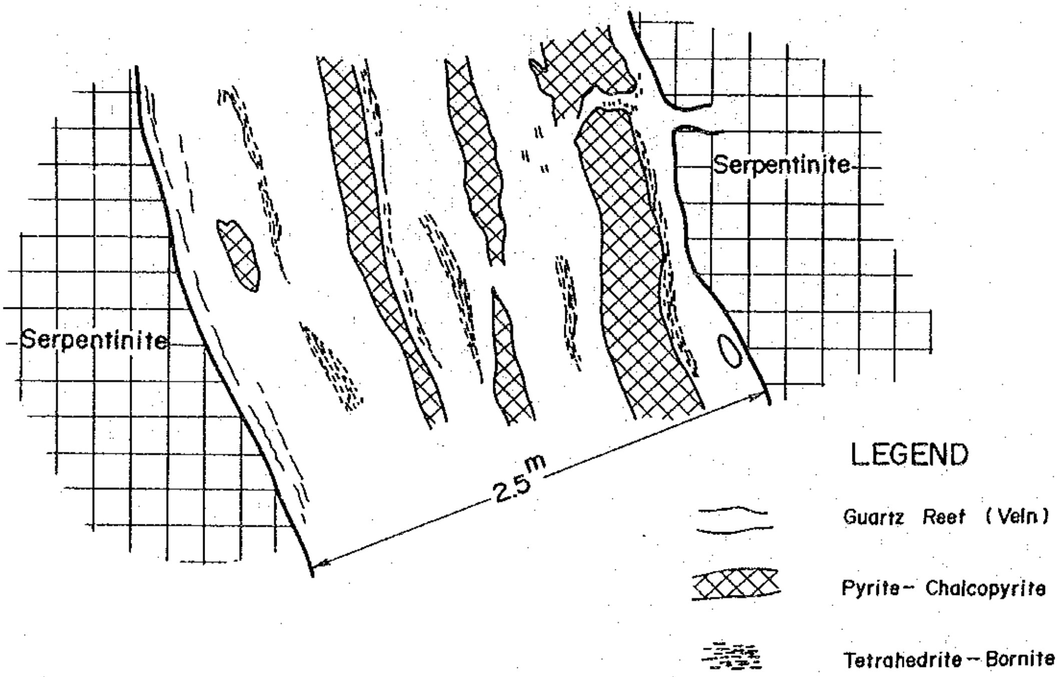


Fig. 3-2-4 Mineralization of the East Reef, 6th Level, Globe and Phoenix Mine

arsenopyrite. This difference was probably resulted from different genetical stages or different constitutions of ore fluids. Pyrite usually shows idiomorph, that means it was crystallized earlier than other minerals such as sphalerite, galena, bornite, tetrahedrite, pyrrhotite, etc.

A X-ray diffractive analysis was conducted to determine altered minerals in the samples collected from the hanging and foot walls of the ore zone this time. The results show that sericite and chlorite increase and talc decreases to the ore.

(3) Tiger Reef Mine

The mine is located in the southwestern area, about 10 kilometres northwest of Kwekwe. The ore deposit is of disseminated gold in pod-shapes in the graywacke sandstone of the Shamvaian.

In the years between 1920 and 1940, about 24,000 tons ore with the grade of 3.4 g/t was mined from the shallow part of the surface. Lonrho started development of the mine in 1980, and started production in 1982. At present, they are producing 7,000 tons of ore with the average grade of 3.5 g/t by 320 workers and staff.

The deposit strikes northeast to southwest, dips 85° to the southeast, and extends 350 metres along the strike with the average width of 5 metres. The present deepest operating level is 245 metres from the surface, but the bottom of the ore has not been reached yet. The principal constituent mineral of the ore is pyrite, with minor amount of chalcopyrite, sphalerite, and native gold. Pyrite content rates in the ore are about 10 per cent. Alteration zones seen in the hanging and foot walls of the ores are principally of sericitization, chloritization, and carbonatization, with local silicification.

Generally, sheared zones are seen in the hanging wallside of the ores, and the boundary of the ores shows a sharp contact. However, the boundary of the ores in the foot wall side is gradual. The assay results of the samples, which were continuously taken from the both sides of the ores, show relatively abrupt drop of the grade in the foot wall side.

A X-ray diffractive analysis was conducted to determine altered minerals in the samples collected from the hanging and foot walls of the ore zone this time. The results show that sericite and chlorite are produced in the hanging wall sheared clay zone. on the other

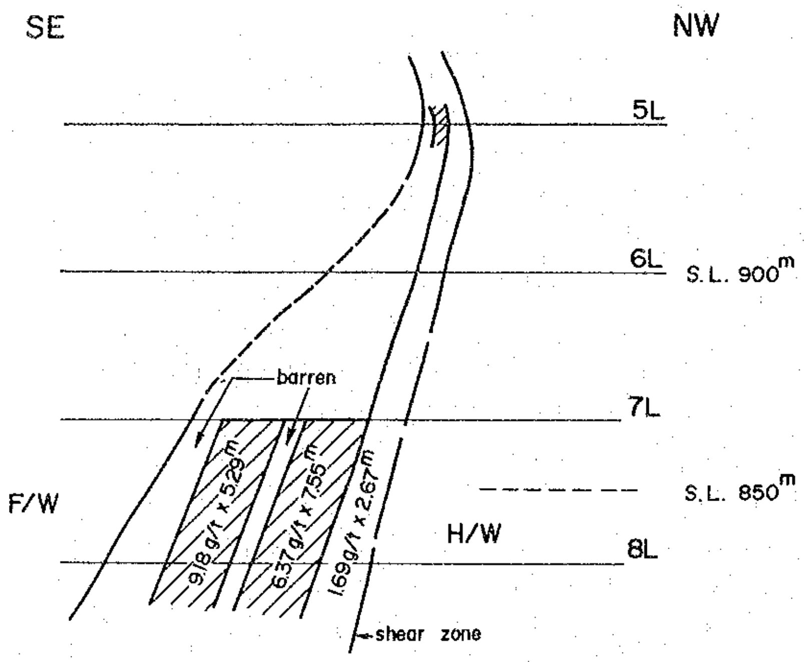


Fig. 3-2-5 Cross Section of the Mineralized Zone below 5th Level, Tiger Reef Mine

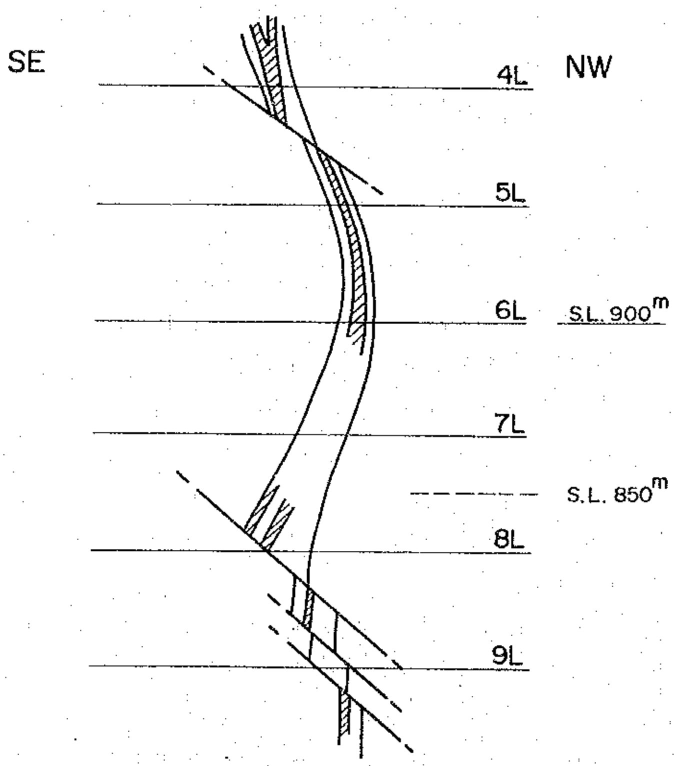


Fig. 3-2-6 NE-SW Faults Dislocating Mineralized Zones, Tiger Reef Mine

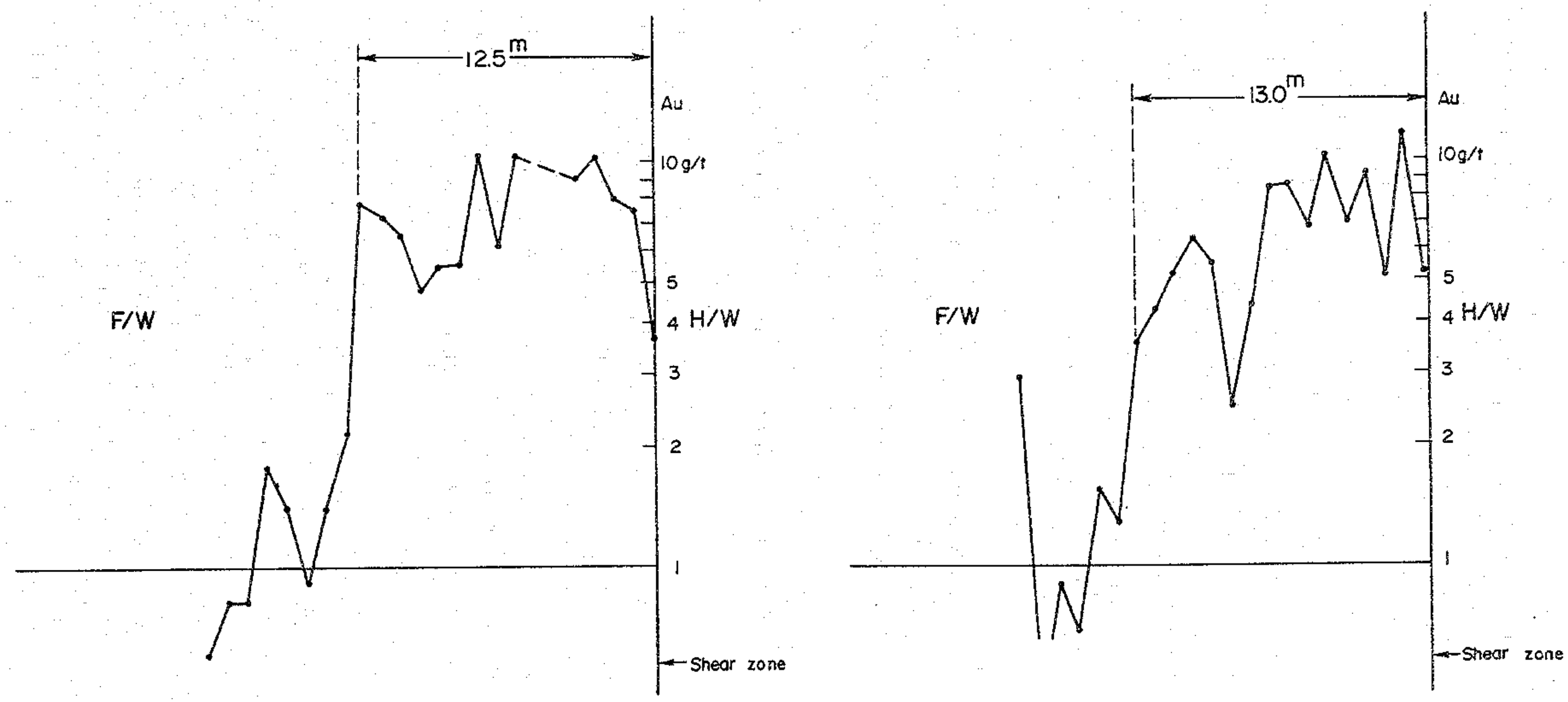


Fig. 3-2-7 Cross Section of Gold Contents in the Ore Body, 6th Level Tiger Reef Mine

hand, large amounts of albite are seen in the ends of the ore zone. It means that the width of alteration zones associated with mineralization is quite narrow.

(4) Riverlea Mine

The mine is located in the southern area, 4 kilometres west of Kwekwe. There are two deposits, the Bell Deposit in the east and the Riverlea Deposit in the west. At present, only the Riverlea Deposit is operated by 400 workers and staff, and the Bell Deposit is waited on the reopening near future. The present production rate of the Riverlea is 6,000 tons of gold ore per month, with the average grade of 5 to 6 g/t. The ores of the both deposits show different characteristics as shown in the following table.

	Bell	Riverlea
Host Rock	conglomerate	arenaceous sedimentary rocks
Ore Mineral	principally free gold	gold in arsenopyrite and pyrite
Shape of ore	------------	lenticular, width 2 m
Depth of Development	18th level (aprx.540m)	7th level (aprx. 240m)

The sulphide content rate of the Riverlea Deposit is about 0.5 per cent, and about 30 tons of sulphide concentrate per month are recovered from the ore by flotation method. The concentrate is sent to a roasting factory near Kwekwe, which is operated by the government, then, about 30 kilogrammes of gold is recovered from the roasted concentrate, which contains about 0.1 per cent of gold.

(5) Bristol Mine

The mine is located in a gold region involving the Indarama, Bee Hive, Eva, Sherwood Star, etc., about 5 kilometres north of Kwekwe, and recently started the development. The ore is of gold-bearing quartz veins in banded ironstones of the Bulawayan. On the top of the mountain ridge there, the vein shows the average one metre width, with the average grade of 40 to 50 g/t, trending north to south with the dip of 70 ° to the east. It is said that the vein was mined out down to about 200 metres below the top of the ridge. At present, an adit has been digged from the eastern flank of the ridge to the west, about 200 metres below the top, then a vertical shaft is sinking at the end of the adit, about 50 metres from the opening, to mine the ore reserves underneath the level.

It seems very interesting to explore the extension of this type of ore to the south of the Sebakwe River and to the north.

A X-ray diffractive analysis was conducted to determine altered minerals in the samples collected from the hanging wall of the ore zone this time. The results show that only hematite occurred in the alteration zone.

(6) Unit Mine

The mine is located about 10 kilometres west of Kwekwe. It was opened in 1977, and produced about 1.5 kilogrammes of gold per month by 54 workers, however it was closed in April 1986. The gold-bearing quartz vein with 30 to 60 centimetres width, striking north-north-west was mined down to 240 metres from the surface. The strike length of the vein is about 100 metres.

(7) Gold Dump Mines, Anzac, Monte Crist, Eva, Piper Moss, Manjoro, and Oro Bredo

Allthese mines were reopened recently to extract gold from old dumps, reacting to the recent price up of gold. The average gold content in those dumps ranges from 2 to 3 g/t. They produce several kilogrammes of gold per month.

3-3 Laboratory Tests and Examinations

Some rock and ore samples collected from the field were afterward examined in Japan. The results of those are as follows.

(1) X-ray Diffractive Analysis

Some rock samples collected from various mines were analyzed by this technique to determine altered minerals. Thirty-four tested samples are as follows.

Bristol Mine --------------1 sample from the reddish altered rock

Globe and Phoenix Mine ---4 samples from the hanging and foot wall rocks in the high grade quartz vein, and 7 samples from the average quartz vein.

Tiger Reef Mine ----------4 samples from the hanging and foot wall rocks of the ore

Venice Mine --------------11 samples from the hanging and foot wall rocks of the ore

Pyrophyllite Mine---------6 samples from the alteration zone

Instrument used for the test is Rigakudenki D8C, and conditions of the measurement are as follows.

Voltage 30 kv, Current 15 mA, Full Scale 2,000 C.P.S.
Scanning Speed 2 ° /min, Range $\theta = 2° \sim 40°$,
Chart Speed 2 cm/min,

Appendix 5 shows the results of the test. Generally, alteration near by ores is weak, only sericite and chlorite are recognized. Pyrophyllite is determined in the samples from the so-called Feldspar Mine in Area E.

(2) Observation of polished sections

To determine ore minerals in the samples collected from various mines and mineral occurrences, 25 polished sections were observed under the microscope.

Samples provided for the observation are; 4 from the Dalny Mine, 2 from the Unit Mine, 2 from the New Topaz Mine, 6 from the Globe and Phoenix Mine, 2 from the Somerset Mine, 1 each from the Rise Up, Scheelite King, Cato, Riverlea, Cuba Syndicate, and Criket Mines.

Appendix 4 shows the results of the observation, and Appendix 6 shows microphotographs of the polished sections.

Native gold from the Globe and Phoenix Mine occurred in 2 millimetres amoeba-like shape normally with pyrite, however gold from the Pixy vein of the Dalny Mine and from the Rise Up Mine occurred in pyrite. On the other hand, gold from the New Topaz Mine occurred in pyrite, arsenopyrite and sphalerite, and in some cases as free gold. Almost all samples contain arsenopyrite, however, some samples contain pyrrhotite in case of no arsenopyrite contained. It is presumed that constitutions of ore solution or ore forming stages for those types are different. In all cases, pyrite and arsenopyrite show ideomorph, which indicates that they were crystallized earlier than other minerals such as sphalerite, galena, bornite, tetrahedrite and pyrrhotite.

(3) EPMA Analysis

Some minerals were not determined by the microscopic observation of the polished sections because of their fineness and complexity. Therefore, 17 samples for the EPMA analysis were selected from the polished sections. Numbers of samples are 17 for the qualitative analysis, 12 for the quantitative analysis, and 6 for the composition images.

Conditions Of the analysis are as follows.

Instrument used JEOL 5A, Voltage 25 kv, Current 0.005μA,

Beam 3 $\mu\phi$, Chart Speed 20 mm/min,

Table 3-3-1 ~ 3-3-3 show the results of the EPMA qualitative and quantitative analyses.

Followings are significant in the results; Electrum containing about 50 per cent of silver from the New Topaz Mine, and native gold containing less amount of silver from the Globe and Phoenix Mine. The results of the quantitative analysis of sphalerite from the New Topaz Mine show that the content of Fe is about one mol, which is similar to that of kuroko ores in Japan. No cadmium is contained in the sample.

Stibnite is a common associating mineral with gold in the area, however it is not seen in the samples. Bournonite ($PbCuSb_3$), stibioenargite (Cu_3SbS_4) and tetrahedrite were determined in the samples from the Globe and Phoenix Mine, the former two minerals were recognized in high-grade ore in the principal vein, and the latter was recognized in the crossing quartz vein. Gersdorffite (NiAsS) is contained in the vein, presumably because of ultramafic host rock.

(4) Homogenization Temperature and Salinity of Fluid Inclusions

To know temperatures of genesis, homogenization temperatures of fluid inclusions in quartz were determined. Some samples collected from the areas do not contain enough numbers of inclusions, or sizes of the inclusions are too small to determine, or inclusions are not

Table 3-3-1 EPMA Qualitative Analysis of Ore Minerals

	Sample No.	Locality	Mineral	Detected Element											Note
				Au	Ag	Cu	Pb	Zn	Sb	As	Fe	Ni	Co	S	
1	Unit-2	Unit Mine	Chalcocite			◎					•			○	◎: Abundant
2	ditto	ditto	Galena			•	◎							◎	○: Medium
3	Scheelite King	Scheelite King Mine	Chalcopyrite			○					○			○	• : Present
4	New Topaz-1	New Topaz Mine	Arsenopyrite							◎	◎			◎	
5	ditto	ditto	Electrum	◎	◎										
6	ditto	ditto	Pyrite								◎			◎	
7	ditto	ditto	Sphalerite					◎			○			◎	
8	New Topaz-2	ditto	Galena				◎							◎	
9	G&P-4-1	Globe&Phoenix Mine	Bournonite			◎	◎		◎					◎	
10	ditto	ditto	Galena				◎		○					◎	
11	ditto	ditto	Stibioenargite			◎			◎					◎	
12	ditto	ditto	Tripuhyite						◎						
13	ditto	ditto	Native gold	◎	•										
14	G&P-17	ditto	Tetrahedrite			◎		○	○	○	○			◎	
15	G&P-18	ditto	Tetrahedrite			◎		•	◎	•				◎	
16	G&P-19	ditto	Gersdorffite							◎		◎	•	◎	
17	ditto	ditto	Tetrahedrite		•	◎		○	◎		○			◎	

Table 3-3-2 EPMA Quantitative Analysis of Sulphide Minerals

Sample No.	Locality	Atomic molecule percentage									Composition	Mineral
		Zn	Fe	Cu	Mn	Ag	Cd	Sb	As	S		
9-3-2	New Topaz Mine	46.31	4.53	0.03	0.00	0.02	0.00	0.00	0.00	49.11	ZnS	Sphalerite
		Cu	Zn	Fe	Ag	Pb	Sb	S				
15-1-1	Globe & Phoenix Mine	16.00	0.08	0.09	0.06	16.51	16.72	50.54			$Pb Cu Sb S_3$	Bournonite
		Kg	Sb	Cu	Fe	As	Zn	S				
15-1-3	ditto	0.00	12.68	34.34	0.25	0.45	0.00	52.28			$Cu_3 Sb S_4$	Stibioenargite
18-1	ditto	1.09	10.54	31.86	4.06	3.46	4.37	44.61			$(Cu, Ag)_{10}(Fe, Zn)_2 (As, Sb)_4 S_{13}$	Tetrahedrite
19-2	ditto	1.30	15.22	37.71	3.66	9.41	5.23	26.19			ditto	ditto
		Fe	Ni	Co	Cu	Sb	As	S				
19-1	ditto	0.92	31.64	2.22	0.00	0.43	33.66	31.13			(Ni Fe Co)As S	Gersdorffite

Table 3-3-3 EPMA Quantitative Analysis of Gold Minerals

Sample No.	Locality	Weight %			Composition	Mineral
		Ag	Au	Total		
9-1-2	New Topaz Mine	30.32	71.09	101.41	Au 56.22 Ag 43.78	Electrum
9-2-1	New Topaz Mine	29.52	67.84	97.35	Au 55.73 Ag 44.27	Electrum
15-2-1	Globe & Phoenix Mine	3.14	96.21	99.36	Au 94.37 Ag 5.63	Native Gold
15-2-2	ditto	3.26	96.15	99.41	Au 94.16 Ag 5.84	ditto
15-2-3	ditto	3.14	96.33	99.47	Au 94.38 Ag 5.62	ditto
15-2-5	ditto	3.14	96.39	99.53	Au 94.38 Ag 5.62	ditto

adequate for the test because they are secondary quartz. Therefore, 20 samples, which are adequate for the determination, were selected among them. Instrument used for the determinations was Linkom TH-600.

The grain size of fluid inclusions normally ranges from 3 to 10 μ, and quite few samples contain grains larger than 15 μ. The highest limit of the temperature was set at 320 ℃ for normal samples. However, some samples were not homogenized at 350 ℃, therefore they were represented as 350℃ for convenience sake. Fig. 3-3-1 shows the results of the determination.

A normal distribution with the peak value of 150℃ and a range from 100 to 300℃ is seen in the frequency distribution diagram. Samples showing above 300 ℃ are quite rare. Those not homogenized at 350℃ are tungsten-bearing quartz samples from the Scheelite King Mine. The arithmetic mean value of the all samples including those showing above 320 ℃ is 193 ℃. Some cases, great deviations are seen in samples from same mines.

There are two groups recognized from averaged homogenization temperature distribution diagram, ranging from 100 to 210 ℃ and from 210 to 300 ℃. Large-scale high-grade mines such as the Dalny, and the Globe and Phoenix belong to the high temperature group.

Salinity was determined for the same samples used for the homogenization temperature test. It was measured from the freezing points of the fluid inclusions, and the results were shown as wt % of NaCl equivalent values. Table 3-3-4 shows the results of the test.

Five samples from the Globe and Phoenix, Arlandzer, Cuba, Comonner, and Cuba Syndicate Mines, out of 20 samples have no determination values because fluid inclusions in the samples are not big enough to determine the salinity, smaller than 10 μ. For the rest of 15 samples, two points for each sample were determined. The temperature was got down to -35～ -60℃ to freeze the fluids, then got up at the rate of 0.5 ℃ /min to read the temperatures of conversion points from freezed state to complete fluid state.

It is difficult to interpret the results carefully, because details of the geological background of the samples determined are not available. However, as a general tendency, the difference of salinity between samples is significant, and there is a positive correlation between homogenization temperatures and salinities. Almost all the samples show higher values of NaCl equivalent salinity than those of the Japan's epithermal gold-silver deposits (0 ~ 3 wt%) and kuroko deposits (2 ~ 5 wt %). Some samples from the Globe and Phoenix Mine and some mines in the Chakari District show above 10 wt%.

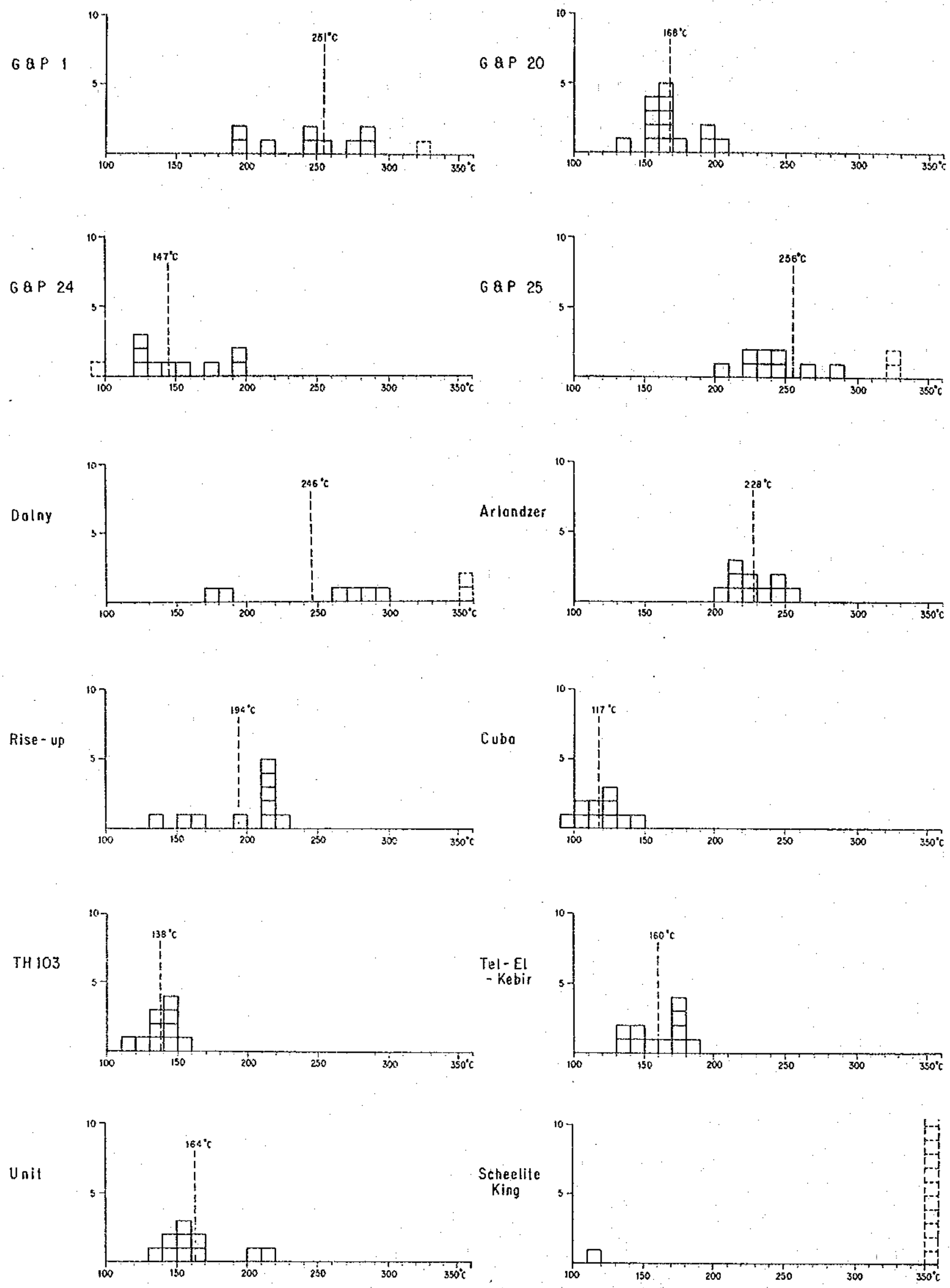


Fig. 3-3-1 Homogenization Temperature of Fluid Inclusions in Quartz

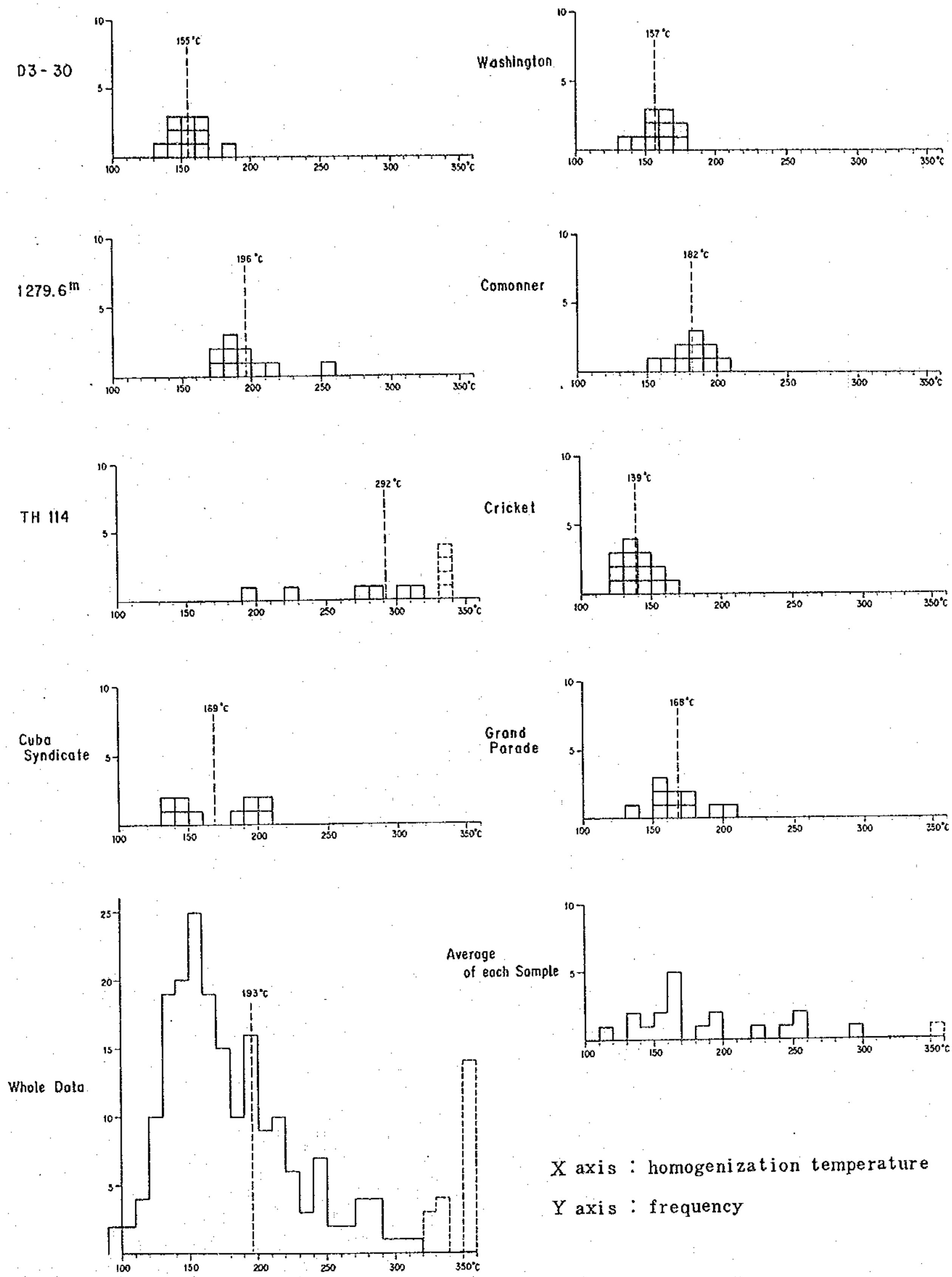


Fig. 3-3-1 Homogenization Temperature of Fluid Inclusions in Quartz

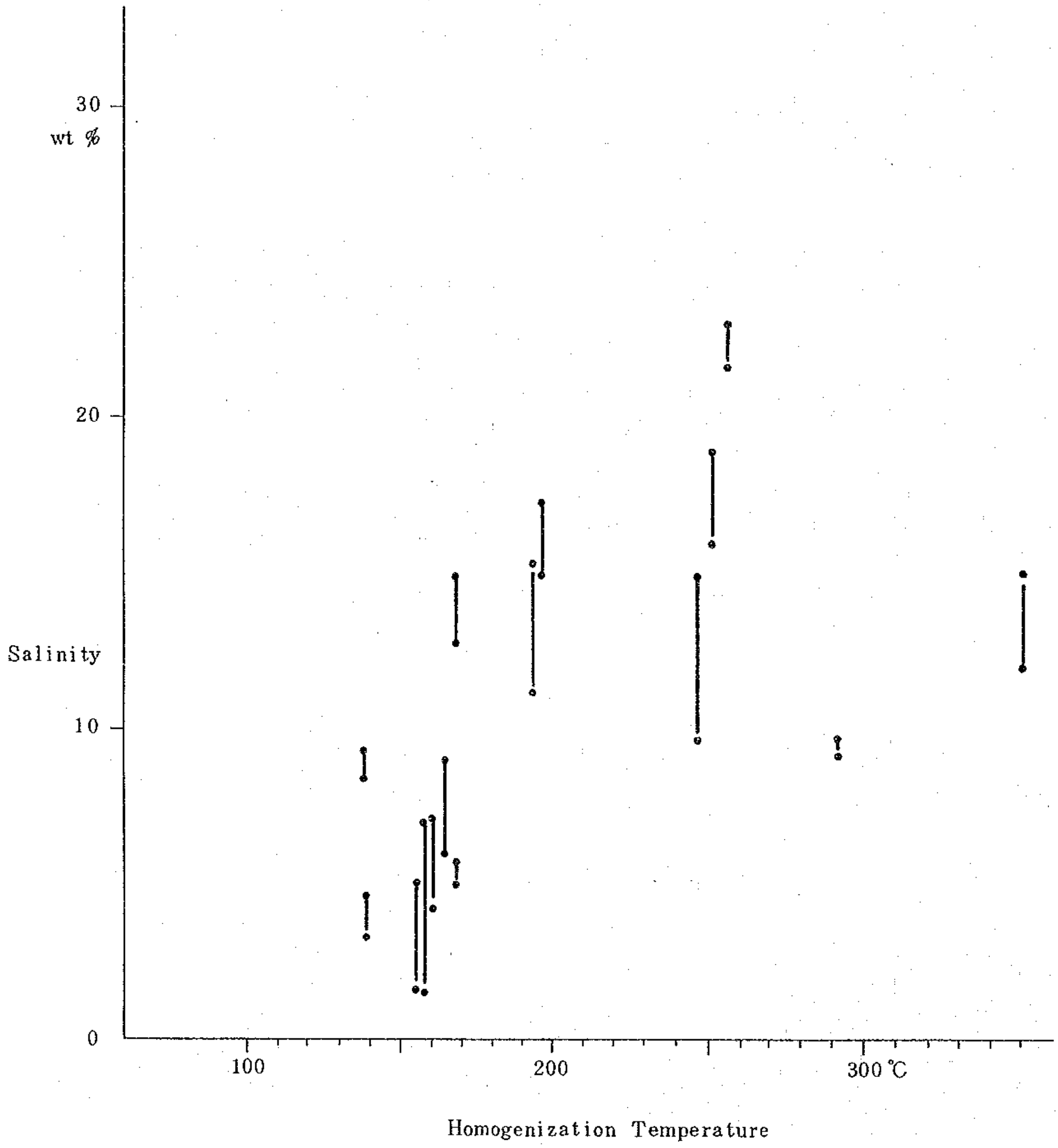


Fig. 3-3-2 Relationship between NaCl eq. Sanlinity and Homonization Temperature

Table 3-3-4 Homogenization Temperature and Salinity of Fluid Inclusions in Quartz

No.	Sample No.	Homogenization Temp.		Salinity
		Average	σ (Deviation)	wt% NaCl
1	G & P-1	251	39	16.0 ～ 18.9
2	G & P-20	168	18	12.9 ～ 14.9
3	G & P-24	147	32	
4	G & P-25	256	36	21.7 ～ 23.0
5	Dalny	246	49	9.7 ～ 14.9
6	Arlandzer	228	15	
7	Rise Up	194	29	11.2 ～ 15.3
8	Cuba	117	15	
9	TH 103	138	10	8.4 ～ 9.3
10	Tel-El-Kebir	160	17	4.2 ～ 7.1
11	Unit	164	23	6.0 ～ 9.0
12	Scheelite King	>350		12.0 ～ 15.0
13	D3-30	155	13	1.6 ～ 5.0
14	Whashington	157	12	1.5 ～ 7.0
15	1279.6m	196	23	15.0 ～ 17.3
16	Comonner	182	14	
17	TH 114	292	45	9.2 ～ 9.7
18	Cricket	139	11	3.3 ～ 4.6
19	Cuba Syndicate	169	28	
20	Grand Parade	168	21	5.0 ～ 5.7
	Total	193		

CHAPTER 4 GEOCHEMICAL SURVEY METHOD

4-1 Sampling and Preparation of Soil Samples

In this survey programme, different combinations of path-finder elements were selected for each area based on its geological setting. Total number of 8,099 soil samples were collected and assayed. The elements selected for each area and the numbers of soil samples are as follows.

Area	Number of Samples	Path-finder Elements
A	1,511	Au, Cu, W
B	1,547	Au, Sb, As
C	2,006	Au, Pb, Zn
D	1,508	Au, Ni, Cr
E	1,527	Au, Sb, As

Soil sampling was done at points every 50 or 100 metres apart along survey lines which were set at 200 metres line spacing, based on their own geological settings. In Area B and C, 50 metres sampling separation was adopted. Generally, the development of the soil is poor in the area, therefore samples were collected from the B layer, 10 to 20 centimetres depth from the surface.

Soil samples collected were sieved down to - 20 mesh on site, then down to - 80 mesh in the camp, getting about 80 grammes of the final products for analysis.

4-2 Analytical Method

Chemical analysis was asked to the Rio Tinto Analytical Laboratories in Eiffel Flatts, except tungsten because of a problem of its detection limit. Analysis of tungsten was asked to the Chemex Labs. in Vancouver, Canada. The analytical method applied for gold was fire assay preconcentration with atomic absorption, and that for other elements was ICP-AES (Inductively Coupled Plasma-Atomic Emission Spectrometry).

4-3 Treatment of Assay Results

Statistical analysis and mapping of the results were asked to the Dowa Information System Corporation. The computer and plotter used for the treatment was NEC Corp. Model COS-430 and CALCOMP Corp.

Model 9100.

As the results of the analysis, mean values and standard deviations for gold show quite similar values in different rock types in a same area, however those in different areas are fluctuated. Therefore statistics for whole samples in each area were applied for the interpretation, and histograms and cumulative frequency distribution diagrams for each area were drawn. For other elements, means and standard deviations for different type rocks are deviated in some degrees in each area, therefore statistic values for different rock types in each area were applied for the interpretation, and histograms and cumulative frequency distribution diagrams for different rock types in each area were drawn.

The elements and main rock types classified in each area for drawing histograms and cumulative frequency distribution diagrams are as follows.

Area	Elements	Rock Types
A	Cu, W	Mafic Volcanics, Felsic Volcanics, Granitic Rocks, Mafic Intrusives, and Schist
B	Sb, As	Mafic Volcanics, Conglomerate, Banded Ironstone, and Felsic Intrusives
C	Pb, Zn	Mafic Volcanics, Felsic Volcanics, Phyllite, and Felsic Intrusives
D	Ni, Cr	Mafic Volcanics, Banded Ironstone, Ultramafic Rock, and Schist
E	Sb, As	Mafic Volcanics, Felsic Volcanics, Banded Ironstone, and Felsic Intrusives

After studying such statistical figures, the classification of the anomalies and its presentation way on the maps were decided as follows.

Over $\mu + \sigma$ "B" class anomaly presented in small circle
Over $\mu + 2\sigma$ "A" class anomaly presented in large circle

4-4 Colour of Soil

Colour of soil samples was determined in the final products for assay using a rock colour chart. Soils from the mafic volcanics, ultramafic rock, and granitic-gneissic terrains show brownish, dark brownish, and orange colours respectively. As a result, it can be said that the soil colours well reflect their geological background. Fig.s 5-1-5, 5-2-5, 5-3-5, 5-4-5 and 5-5-5 show soil colour distributions of Areas A, B, C, D and E.

CHAPTER 5 SURVEY RESULTS OF EACH AREA

5-1 Area A

(1) Geology

The area is located to the southwest of Kadoma, and mainly undederlain by the greenstones of the Bulawayan Group. In the northwestern edge of the area, the eastern edge of the Whitewaters Tonalite Body exposes. The tonalite is coarse-grained, pale pinkish gray, commonly containing biotite and amphibolite with albite-rich plagioclase. In the edge zones of the body, the rock facies show porphyritic texture with significant schistose texture. The shape of the body in the surface is rather simple. However, it is suggested that the subsurface structure of the body would be complex, judging from various evidences, existence of large number of small scale felsic intrusive bodies around the main body and spotted-cordierite-hornfel metamorphosed from argillaceous rocks about 2 kilometers apart from the edge of the main body.

Rock formations of the greestone belt generally strike north-northwest to north-northeast, and steeply dip to the west. Some disturbance is seen near the Whitewaters Body. Rocks are mainly dark green massive basaltic lavas, which quite rarely show pillow and brecciated textures. The formations are partly accompanied with some felsic volcanic and pyroclastic rocks showing brecciated and sheared textures, and some bedding structure in some parts. A large amount of sericite is associated with such parts. Banded ironstones are mainly distributed in the south side of the Umniati River, and accompanied with large numbers of complecated quartz veinlets, which presumably penetrated into the rocks after remelting of the charty parts.

The Shamvaian Group mainly consisting of graywacke sandstone and conglomerate is distributed in the eastern area, unconformablly overlying the Bulawayan. However the trend of the formations, north-northeast to south-southwest, is parallel to that of the Bulawayan.

Gold and tungsten are characteristic ore elements in the area. Tungsten occurs as oxide minerals, and is seen inside of the Whitewaters Body and its surrounding areas. Tungsten minerals are formed in a high temperature environment, therefore it is suggested that the mineralization is directly associated with the intrusion of the Whitewaters.

No presently operating mine exists in the area, however many old workings such as the Heroine, Umsweswe, Rise Up, Cob, etc., which align west-northwest to east-southeast in the central area, are distributed. The grade of ores is reported as 3 to 14 g/t Au, however the scale of ore deposits is quite small. It is judged that the area has a high potential for gold and tungsten, because of its favourable geological setting such as its location near by the Sesombi Body, which is accompanied with such mineralization as that of the Golden Valley district to the north of the area.

(2) Geochemical Survey

Au, Cu and W were selected as path-finder elements for the survey in the area, because the area has a high potential for gold and tungsten. The results of the assay show that the contents of each element vary in different rock types. Therefore, statistics of each element were calculated for each rock type. However, specially for Au, statistics for the whole samples were appliedused, because its geometric means and logarithmic standard deviations for different rocks are quite close to the whole samples values; 15 ppb (0.54) for the whole, 16 ppb (0.55) for mafic volcanics, 16 ppb (0.45) for felsic volcanics, 15 ppb (0.56) for conglomerate, 26 ppb (0.40) for phyllite, 17 ppb (0.50) for banded ironstone, 12 ppb (0.51) for granitic rocks, 14 ppb (0.56) for mafic intrusives, and 15 ppb (0.55) for schist.

Table 5-1-1 shows fundamental statistics of each element for each rock type, Table 5-1-2 shows correlation coefficients between elements, Fig. 5-1-1 shows histogram and cumulative frequency distribution diagram for Au, Cu and W, and Fig. 5-1-2～5-1-4 show histograms and cumulative frequency distribution diagrams for Cu and W in different rock types.

No significant correlation coefficient is seen between the elements throughout all the types, except weak positive and negative correlations between Au and-Cu, and Au and W in phyllite, which has a small number of samples.

Based on above mentioned statistical data, figures above $\mu + \sigma$ and $\mu + 2\sigma$ were picked up as anomalous values, and marked with small-circles and large-circles, respectively, in the geochemical anomaly maps attached in the separate case. Followings are the description of the survey results, mentioning "A" class anomaly for values above $\mu + 2\sigma$, and "B" class anomaly for values above $\mu + \sigma$.

A-1 Block

Nine medium to small-scale anomaly-zones consisting of 2 "A" class to 12 "B" class anomalies spread over the block. Followings are anomaly-zones worth to be recognized.

Au; *In the west-central block, a small-scale strong anomaly-zone consisting of 4 "A" class and 1 "B" class anomalies in mafic volcanics.

-In the southwestern block, a medium-scale anomaly-zone consisting of 1 "A" class and 11 "B" class anomalies, and a small scale anomaly-zone consisting of 1 "A" class and 9 "B" class anomales in mafic volcanics.

Cu; -In the northwestern block, 2 small-scale anomaly-zones consisting of 5 to 6 "B" class anomalies in mafic volcanics.

-In the east-central block, a small-scale anomaly-zone consisting of 9 "B" class anomalies in schist.

W; *In the northeastern block, a wide-spread strong anomaly-zone consisting of 52 "A" class and 22 "B" class anomalies in mafic volcanics.

*In the central block, 2 small-scale anomaly-zones consisting of 2 to 4 "A" class anomalies in schist.

A-2 Block

Au; -In the central to northern block, 12 small-scale anomaly-zones consisting of 3 to 4 "A" and "B" class anomalies in mafic volcanics and granitic rocks.

-In the southern block, 4 small-scale anomaly-zones consisting of 2 to 4 "A" and "B" class anomalies in mafic and felsic volcanics, and schist.

Cu; -In the central to southern block, 9 small-scale anomaly-zones consisting of 3 to 7 "B" class anomalies in mafic volcanics and schist.

-In the northwestern block, 2 small-scale anomaly-zones consisting of 2 to 4 "B" class and 1 "A" class anomalies in mafic volcanics.

W; *In the northwestern corner, a medium-scale anomaly-zone consisting of 6 "A" class and 29 "B" class anomalies in mafic volcanics.

*In the central block, a small-scale anomaly-zone consisting of 3 "A" class and 5 "B" class anomalies in mafic and felsic volcanics.

*In the southwestern block, a large-scale strong anomaly-zone consisting of 23 "A" class and 37 "B" class anomalies in felsic and mafic volcanics.

-In the eastern to northeastern block, 3 small-scale anomaly-zones consisting of 3 to 7 "B" and "A" class anomalies in mafic volcanics and schist.

Specially important anomaly-zones are marked with "*".

Regarding Au, an anomaly-zone in the west-central A-1 Block is worth to recognize because of its strength. However, this point is coincident to the position of the Rise Up Mine, therefore the anomaly-zone seems to be caused by the mineral occurrence. A medium-scale anomaly-zone in the southwestern A-1 Block is also worth to recognize because of its scale, in spite of consisting of only "B" class anomalies. Other anomaly-zones are not good enough for picking up by themselves, however it is worth to study together with anomalies of other elements.

Regarding Cu, no significant anomaly-zone is recognized by itself. However, an anomaly group appearing in the southern A-2 Block is locationally coincident to a "B" class anomaly-group of W, and it worth to recognize as mentioned in the part of W.

Regarding W, a wide-spread strong anomaly-zone in the northeastern A-1 Block is significant. It is possible to say that the anomaly-zone resulted from a wide-spread tungsten mineralized zone. Specially, points, which are accompanied with spot-like Au anomalies on the zone, are favourable targets for further exploration activity. An anomaly-zone in the central A-1 Block is also worth to recognize because of its strength and accompanied Au anomalies, in spite of its small-scale. An anomaly-zone in the northwestern A-2 Block is worth to recognize because of its scale, strength, and accompanied spot-like Au and weak Cu anomalies, together with its favourable geological position, near by the Sesombi Body. An anomaly-zone in the southwestern A-2 Block is as large and strong as the former, and being accompanied with spot-like Au and W anomalies. These two zones would be the most favourable targets for further exploration activity in the surveyed area. An anomaly-zone in the central A-2 Block, which is fairly strong in spite of small-scale, is coincident to the position of the Cob Old Working.

(3) Interpretation

The area is situated in a favourable geological environment, close to the Whitewaters Body, which is accompanied with gold-tungsten ores nearby. Furthermore, known ore deposits such as the Rise Up and the Cob, and large numbers of quartz floats, trenches, and old workings are scattered throughout the area.

The Whitewaters Body is accompanied with large numbers of small-scale felsic intrusive bodies near by, and gave hornfels metamorphism to the surrounding argillaceous rocks. In addition, the geological structure around there were disturbed by the body. Therefore the shape of the body in the subsurface seems to be very complex, and such kind of circumstances would be very favourable for mineralization.

As a result of the geochemical survey, several interesting anomaly-zones were detected. Significant anomaly-zones among them are as follows.

* A wide-spread strong W anomaly-zone, which is accompanied with spot-like Au anomalies, in the northeastern A-1 Block is seemed to be caused by wide-spread tungsten mineralization, and assured for further exploration activity. A small-scale W anomaly-zone in the central A-1 Block is also a good target for further exploration activity because of its strength.
* An Au anomaly-zone in the southwestern A-1 Block is worth to study furthermore because of its scale in spite of no other anomaly accompanied.
* A medium-scale W anomaly-zone in the northwestern A-2 is accompanied with spot-like Au and weak Cu anomalies, and situated in a favourable geological environment, close to the Whitewaters Body. Therefore, it is evaluated that the zone is one of good targets for further exploration activity.
* A large-scale W anomaly-zone in the southwestern A-2 Block is

accompanied with spot-like Au and Cu anomalies. Therefore, it is evaluated that the zone is a good target for further study.

* Other anomaly-zones in the west-central A-1 Block and central A-2 Block are coincident to known ore deposits, the Rise Up and Cob.

Table 5-1-1 Fundamental Statistics of Each Element for Each Rock Type

Element	Rock Type	Numbers of Smp.	Min. ppm	Max. ppm	Arith. Mean ppm	Std. Dev. ppm	Geomet. Mean ppm	Std. Dev. log
Au	Whole	1,511	L 10	1,864	42	112	15	0.54
Cu	Whole	1,511	L 1	130	32	20	24	0.41
	ML	805	L 1	130	40	20	32	0.36
	FL	196	4	64	26	15	21	0.31
	CG	22	7	62	33	13	30	0.21
	PH	11	25	60	42	13	40	0.14
	BI	27	5	66	41	14	37	0.24
	GR	54	L 1	71	14	17	8	0.47
	MI	46	2	70	30	21	20	0.46
	SH	350	L 1	76	21	17	14	0.43
W	Whole	1,511	L 1	250	3	10	1	0.31
	ML	805	L 1	250	3	13	1	0.36
	FL	196	1	7	1	1	1	0.18
	CG	22	1	9	2	2	1	0.27
	PH	11	1	2	1	0.5	1	0.14
	BI	27	1	4	2	1	1	0.22
	GR	54	1	7	1	1	1	0.22
	MI	46	1	9	2	2	1	0.26
	SH	350	L 1	125	2	7	1	0.28

Note 1 ML ; Mafic Lava, FL ; Felsic lava, CG ; Congomerate and sandstone, PH ; Phillite, BI ; Banded ironstone, GR ; Grnitic Rock, MI ; Mafic Intrusive, SH ; Schist

2 Grade of Au is ppb.

3 L 1 means less than detection limit (1 ppm).

Table 5-1-2 Correlation Coefficient Between Elements

( ) ; Logarithmic Data

	Significance Level		Correlation Coefficient		
	5%	1%	Au-Cu	Au-W	Cu-W
Whole	0.0504	0.0662	* 0.0517	0.0273	0.0286
			(** 0.0923)	(0.1029)	(0.1477)
ML	0.0691	0.0907	0.0432	0.0382	0.0052
			(* 0.0732)	(** 0.1372)	(** 0.1125)
FL	0.1402	0.1836	0.0581	- 0.0297	0.0638
			(* 0.1447)	(0.0049)	(* 0.1807)
CG	0.4227	0.5368	- 0.1575	- 0.0626	0.0399
			(- 0.1636)	(0.1153)	(0.1730)
PH	0.6021	0.7348	- 0.2826	0.4305	0.0395
			(- 0.4632)	(0.3902)	(0.1207)
BI	0.3809	0.4869	- 0.2064	- 0.0948	0.0553
			(- 0.1055)	(- 0.0794)	(0.1514)
GR	0.2681	0.3477	- 0.0648	- 0.0064	0.1459
			(0.0424)	(- 0.0812)	(0.1292)
MI	0.2907	0.3761	- 0.0405	0.0065	- 0.0080
			(- 0.0296)	(0.0518)	(0.1282)
SH	0.1048	0.1375	* 0.1148	- 0.0110	- 0.0175
			(0.1008)	(0.0592)	(** 0.1870)

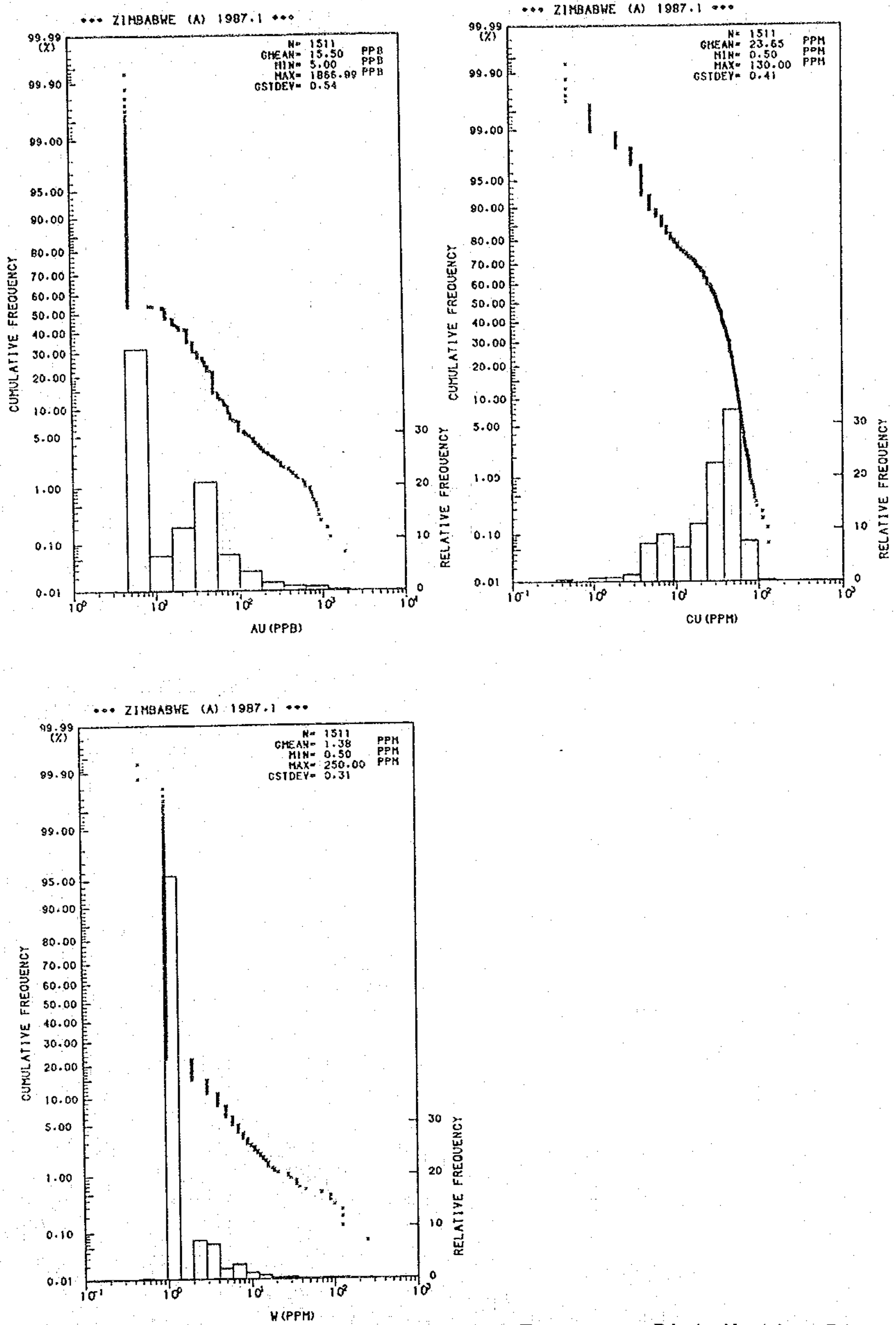


Fig. 5-1-1 Histogram and Cumulative Frequency Distribution Diagram for Au, Cu, and W in Area A.

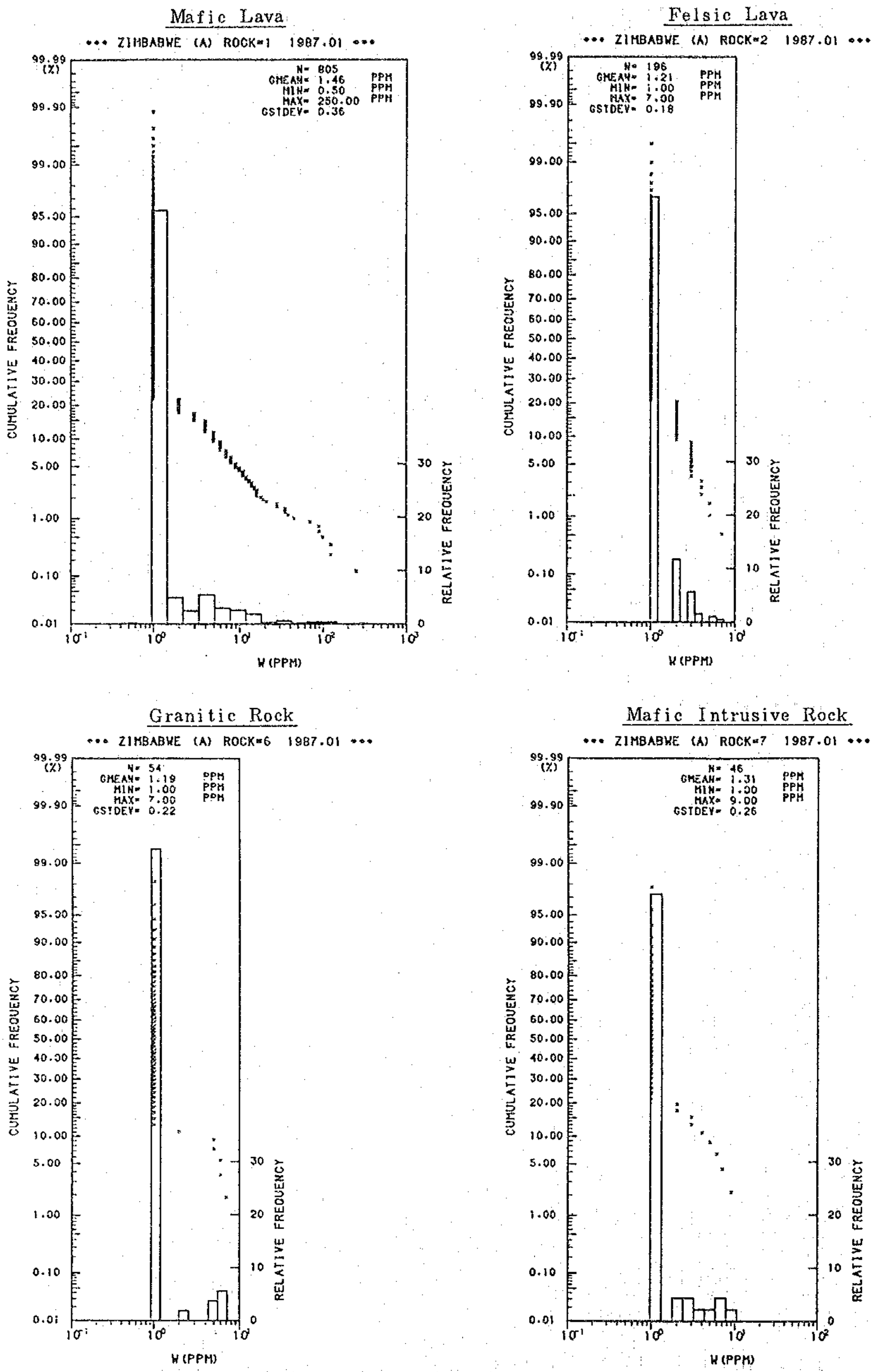


Fig. 5-1-2 Histogram and Cumulative Frequency Distribution Diagram for W in different rock types in Area A.

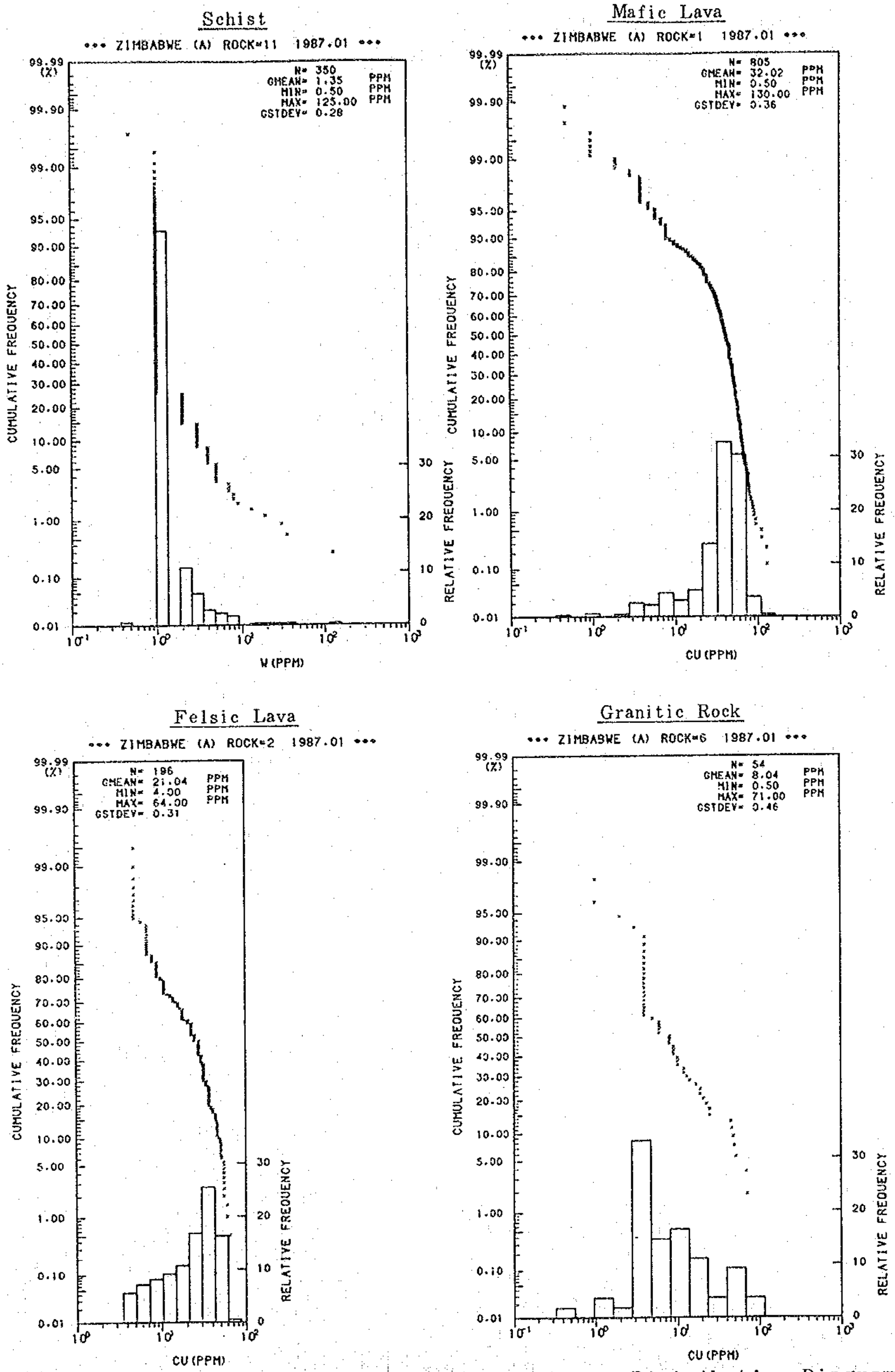
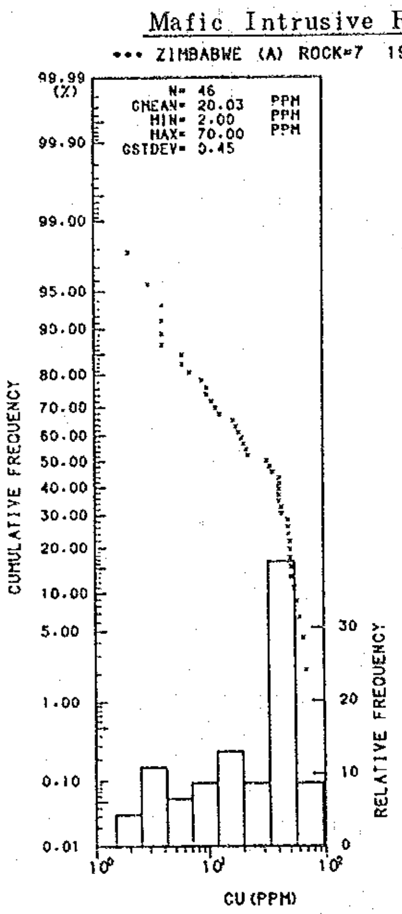


Fig. 5-1-3 Histogram and Cumulative Frequency Distribution Diagram for W and Cu in different rock types in Area A.



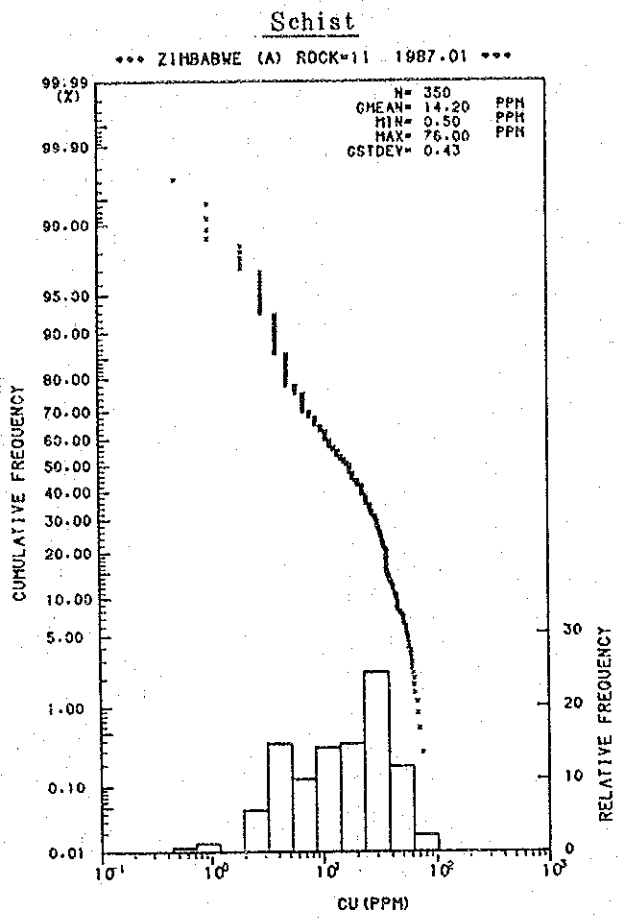


Fig. 5-1-4 Histogram and Cumulative Frequency Distribution Diagram for Cu in different rock types in Area A.

5-2 Area B

(1) Geology

The area is located in between Kadoma and Kwekwe, and situated in the greenstons in between the Rhodesdale Complex to the east and the Sesombi Tonalite to the west. The area is underlain by mafic volcanic rocks, carbonated pillow lava, tuffs, tuffaceous conglomerate, felsic volcanic rocks, graywacke sandstone, phyllitic slate, etc., of the Upper Greenstones with a small area of sandstone and conglomerate of the Shamvaian Group in the southeastern area. In the southeastern corner, the northern end of the Kwekwe Ultramafic Rock exposes.

The Upper Greenstones is situated in the anticline axis zone extending from the northeast of the area, therefore the formations strike northwest to southeast. The Shamvaian Group, which unconformablly overlies the Upper Greenstones, trends north-northeast to south-southwest.

The mafic volcanic rocks of the Upper Greenstones consist of mainly pillow lavas with amygdaloidal texture, which are seen in good exposures in the banks along the Umniati River, and were partially subjected to carbonatization. The size of the pillows is normally 80 x 120 centimetres, and the edges of each pillow show glassy childd margins of about three centimetres thick.

The felsic volcanic rocks are seen in the northeastern area, consisting of quartz porphyritic volcanic breccia and intrusive facies. Some parts of the felsic volcanic rocks were previously classified as intrusive bodies of quartz porphyry. However, it is judged that those parts should be classified as parts of the lava facies of the Upper Greenstones, because brecciated lava facies were found inside of the so-called quartz porphyry bodies in this survey programme. In the geological map produced this time, rocks are shown as their dominant facies. It is evaluated that the area has certain potential for volcanogenic massive sulphide deposits, because the rocks are represented by the bimodal volcanic activity, and accompanied with partial pyritization.

The graywacke sandstone formation is exposed in the south bank of the Umniati River, with a little of phyllitic slate, and was subjected to significant limonitization. The rocks are coarse sandstone and granule conglomerate with fine-grained quartz rich matrix.

Sandstones of the Shamvaian are well sorted, and poor in quartz. The Kwekwe Ultramafic Rock apparently cuts parts of the sandstone.

Small to medium-scale gold mines ranging several-tens to several hundreds kilogrammes production, such as the Cricket, Cato, Oro Bredo, and Somerset are distributed in the area. The Oro Bredo Mine is presently in operation, treating its dump ores containing about 2 g/t Au. The Cato is well-known because of its tungsten ore. In the western area, a swarm of quartz veins trending north-northeast is located in the mafic lavas, and many trenches and pits are scattered there, however no sulphide contamination is seen.

(2) Geochemical Survey

Au, Sb and As were selected as path-finder elements for the survey in the area, because the area has a high potential mainly for gold. The results of the assay showed that the contents of each element vary in different rock types. Therefore, statistics for each element were calculated for each rock type. However, specially for gold, statistics for the whole samples were applied, because its geometric means and logarithmic standard deviations for different rocks are quite close to the whole samples values; 33 ppb (0.63) for the whole, 35 ppb (0.63) for mafic volcanics, 18 ppb (0.48) for conglomerate, 13 ppb (0.43) for banded ironstone, 13 ppb (0.46) for mafic intrusives, and 43 ppb (0.62) for felsic intrusives.

Table 5-2-1 shows fundamental statistics of each element for each rock type, Table 5-2-2 shows correlation coefficients between elements, Fig. 5-2-1 shows histograms and cumulative frequency distribution diagrams for Au, Sb and As, and Fig. 5-2-2 and 5-2-3 show histograms and cumulative frequency distribution diagrams for Sb and As in different rock types.

No significant correlation coefficient is seen between the elements throughout all the types, except fairly strong positive correlations between Au and Sb, Au and As, and Sb and As in felsic intrusive rocks. Fairly strong positive correlations between Au and Sb, and Au and As in schist are not reliable because the number of the samples is quite small.

Based on above mentioned statistical data, figures above $\mu + \sigma$ and $\mu + 2\sigma$ were picked up as anomalous values, and marked with small-circles and large-circles, respectively, in the geochemical anomaly maps attached in the separate case. Followings are the description of the survey results, mentioning "A" class anomaly for values above $\mu + 2\sigma$, and "B" class anomaly for values above $\mu + \sigma$.

Au; Many small-scale anomaly-zones are scattered in the central to western area. Significant ones among them are as follows.

*In the west-central area, a small-scale anomaly-zone consisting of 1 "A" class and 5 "B" class anomalies, and 2 satellite anomaly-zones consisting of 1 "A" class and 2 "B" class anomalies to 5 "B" class anomalies in mafic and felsic intrusives.

*In the northern area, 6 small-scale anomaly-zones consisting of 4 "B" class anomalies to 3 "A" class and 6 "B" class anomalies in mafic volcanics.

*In the west-central area, a small-scale strong anomaly-zone consisting of 8 "A" class and 11 "B" class anomalies in mafic volcanics.

-In the western area, 10 medium to small-scale anomaly-zones consisting of 1 "A" class and 2 "B" class anomalies to 3 "A" class and 9 "B" class anomalies in mafic volcanics.

Sb;*In the northeastern area, a large-scale but weak anomaly-zone consisting of 5 to 65 "B" class anomalies in mafic volcanics.

-In the southern area, 5 medium to small-scale anomaly-zones consisting of 5 "B" class anomalies to 35 "B" class anomalies in mafic volcanics, mafic intrusives, and conglomerate.

As;*In the northern area, a small-scale strong anomaly-zone consisting of 4 "A" class anomalies in mafic volcanics.

*In the eastern area, 2 small-scale strong anomaly-zones consisting of 2 "A" class and 1 "B" class anomalies, and 4 "A" class and 3 "B" class anomalies in mafic volcanics.

*In the northeastern area, a small-scale but fairly strong anomaly-zone consisting of 3 "A" class and 6 "B" class anomalies in mafic volcanics.

*In the western area, a large-scale strong anomaly-zones consisting of 18 "A" class and 21 "B" class anomalies, and surrounding 3 small-scale strong anomaly-zones consisting of 3 "A" class and 7 "B" class anomalies to 8 "A" class and 2 "B" class anomalies in mafic volcanics.

-In the southern area, 5 small-scale anomaly-zones consisting of 3 "B" class anomalies to 3 "A" class and 7 "B" class anomalies in mafic volcanics.

Specially important anomaly zones are marked with "*".

Regarding Au, anomaly-zones in the northern, northeastern, and western areas are worth to recognize because they are accompanied with Sb and As anomalies. The northern anomaly-zone is completely coincident to a As anomaly-zone, and the others are nearly coincident to weak As anomalies on a fairly wide-spread weak Sb anomaly-zones.

Regarding Sb and As, anomaly-zones duplicated with Au anomalies were mentioned above. Among other anomaly-zones, only one of Sb located in the southern area is worth to recognize because of its strength.

(3) Interpretation

The area is situated in a favourable geological environment, in between the Rhodesdale Complex Body and the Sesombi Tonalite Body, which are accompanied with some small-scale gold ore deposits such as the Cricket, Cato, Oro Bredo, and Somerset. Furthermore, large numbers of quartz veins, trenches, and old workings are located in the area.

As a result of the geochemical survey, several interesting anomaly-zones were detected. Significant anomaly-zones among them are as follows.

* A small-scale strong Au and As anomaly-zones are duplicated in the northern area. This is one of the attractive target for further exploration activity.
* Several duplicated Au and As anomaly-zones on a weak Sb anomaly-zone in the northeastern to west-central area is worth to study for further exploration.
* Several medium to small-scale Au·anomaly-zones in the west-central area are accompanied with As anomalies. Furthermore, some trenches are seen on the ground. Therefore, Those are worth to study furthermore.

Table 5-2-1 Fundamental Statistics of Each Element for Each Rock Type

Element	Rock Type	Numbers of Smp.	Min. ppm	Max. ppm	Arith. Mean ppm	Std. Dev. ppm	Geomet. Mean ppm	Std. Dev. log
Au	Whole	1,547	L 10	3,429	90	177	33	0.63
Sb	Whole	1,502	L 10	487	126	62	108	0.26
	ML	1ä319	L 10	342	128	62	110	0.25
	FL	2	156	156	156	0	156	0.00
	CG	59	22	487	100	77	76	0.33
	BI	54	62	226	151	27	148	0.19
	MI	26	34	276	136	66	120	0.24
	FI	34	L 10	187	67	42	57	0.26
	SH	6	49	60	55	4	55	0.03
As	Whole	1,544	L 8	510	35	34	29	0.24
	ML	1,360	L 8	510	36	35	29	0.24
	FL	3	13	150	65	74	39	0.54
	CG	59	15	45	26	10	24	0.16
	BI	54	15	105	54	26	48	0.23
	MI	26	8	89	27	20	23	0.23
	FI	34	L 8	68	25	17	21	0.27
	SH	6	15	45	29	13	27	0.19

Note 1 ML ; Mafic Lava, FL ; Felsic Lava, CG ; Conglomerate,
BI ; Banded Ironstone, MI ; Mafic Intrusive,
FI ; Felsic Intrusive, SH ; Schist

2 Grade of Au is ppb.

3 L 1 means less than detection limit (1 ppm).

Table 5-2-2 Correlation Coefficient Between Elements

( ) ; Logarithmic Data

	Significance Level		Correlation Coefficient		
	5%	1%	Au-Sb	Au-As	Ab-As
Whole	0.0506	0.0664	- 0.0384	** 0.1526	0.0004
			(*- 0.0602)	(** 0.0955)	(0.0440)
ML	0.0540	0.0709	- 0.0475	** 0.1609	- 0.0303
			(**-0.0760)	(** 0.1261)	(- 0.0177)
CG	0.2564	0.3328	- 0.0043	*- 0.2690	0.0837
			(0.1965)	(- 0.2248)	(0.1603)
BI	0.2681	0.3477	- 0.0874	- 0.2152	0.2580
			(- 0.1836)	(- 0.1789)	(0.1547)
MI	0.3882	0.4958	- 0.0696	- 0.1425	- 0.0763
			(- 0.0760)	(- 0.3087)	(0.0627)
FI	0.3388	0.4357	** 0.5101	** 0.4480	** 0.7978
			(** 0.4625)	(0.3049)	(** 0.5457)
SH	0.8114	0.9172	0.7493	- 0.6684	- 0.2398
			(0.6426)	(- 0.5493)	(- 0.3099)

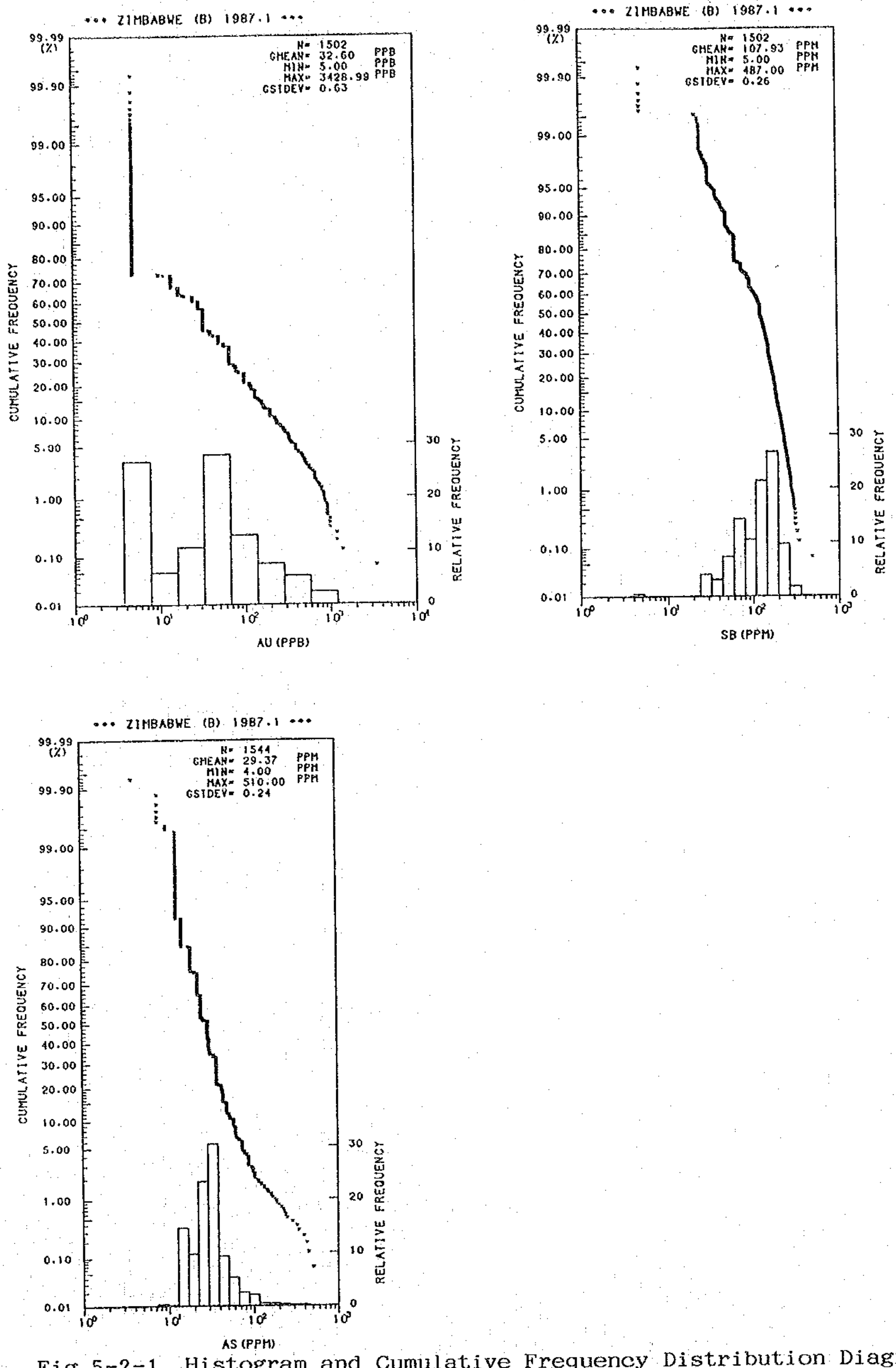


Fig. 5-2-1 Histogram and Cumulative Frequency Distribution Diagram for Au, Sb, and As in Area B.

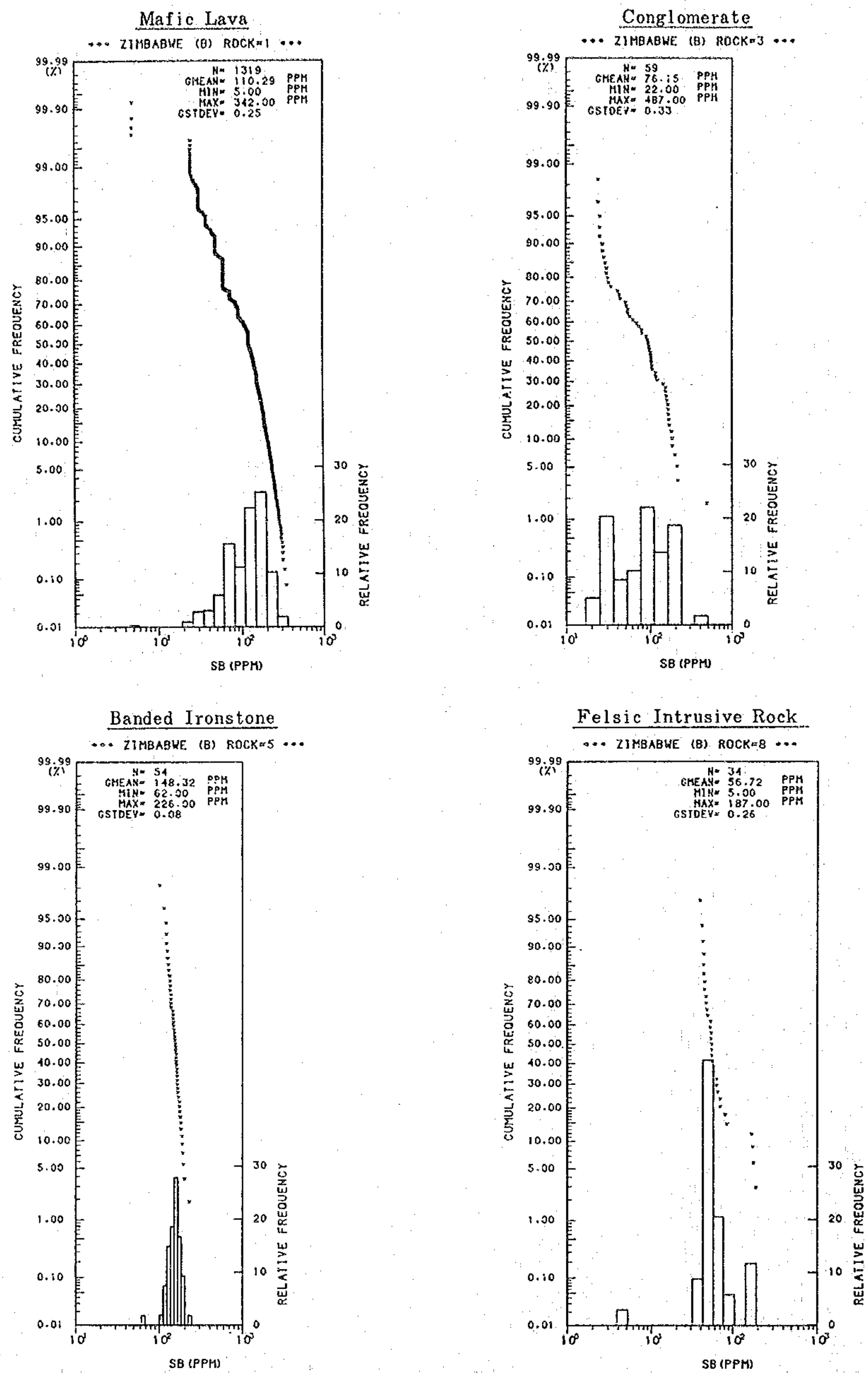


Fig. 5-2-2 Histogram and Cumulative Frequency Distribution Diagram for Sb in different rock types in Area B.

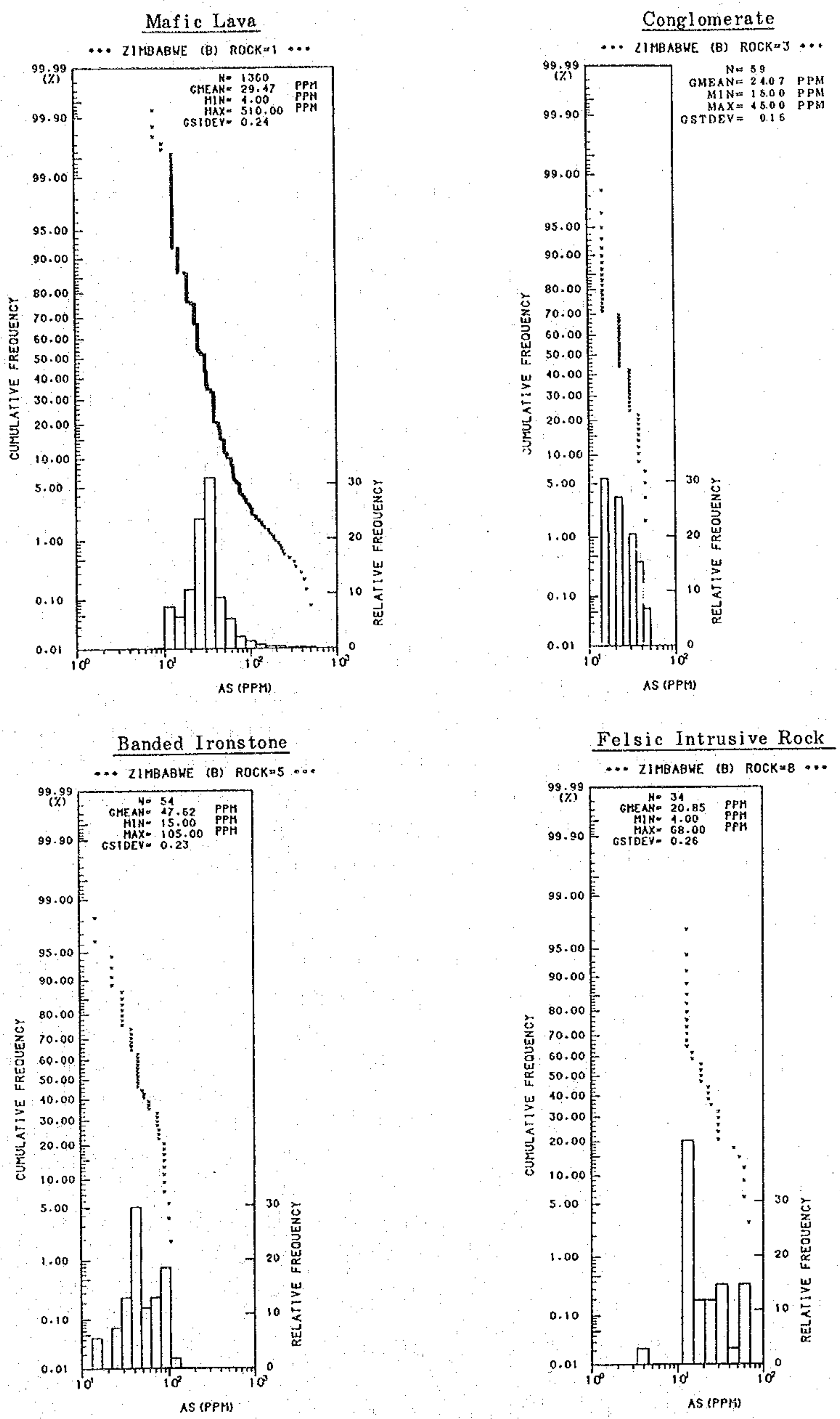


Fig. 5-2-3 Histogram and Cumulative Frequency Distribution Diagram for As in different rock types in Area B.