REPORT
ON
THE MINERAL EXPLORATION
IN
THE SNAKE HEAD AREA,
THE REPUBLIC OF ZIMBABWE

PHASE I

MARCH, 1996

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

REPORT
ON
THE MINERAL EXPLORATION
IN
THE SNAKE HEAD AREA, THE REPUBLIC OF ZIMBABWE

PHASE I

MARCH, 1996

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

Preface

In response to the request of the Government of Zimbabwe, the Japanese Government decided to conduct a Mineral Exploration in the Snake Head Area Project and entrusted the survey to the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ).

The JICA and MMAJ sent to Zimbabwe a survey team headed by Mr. Yoshioki Nishitani from 10 October to 17 December, 1995.

The team exchanged views with the officials concerned of the Government of Zimbabwe and conducted a field survey in the Snake Head area. After the returned to Japan, further studies were made and the present report has been prepared.

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

We wish to express our deep appreciation to the officials concerned of the Government of Zimbabwe for their close cooperation extended to the team.

March 1996

Kimio FUJITA
President
Japan International Cooperation Agency

Shozaburo KIYOTAKI
President
Metal Mining Agency of Japan

J1128566

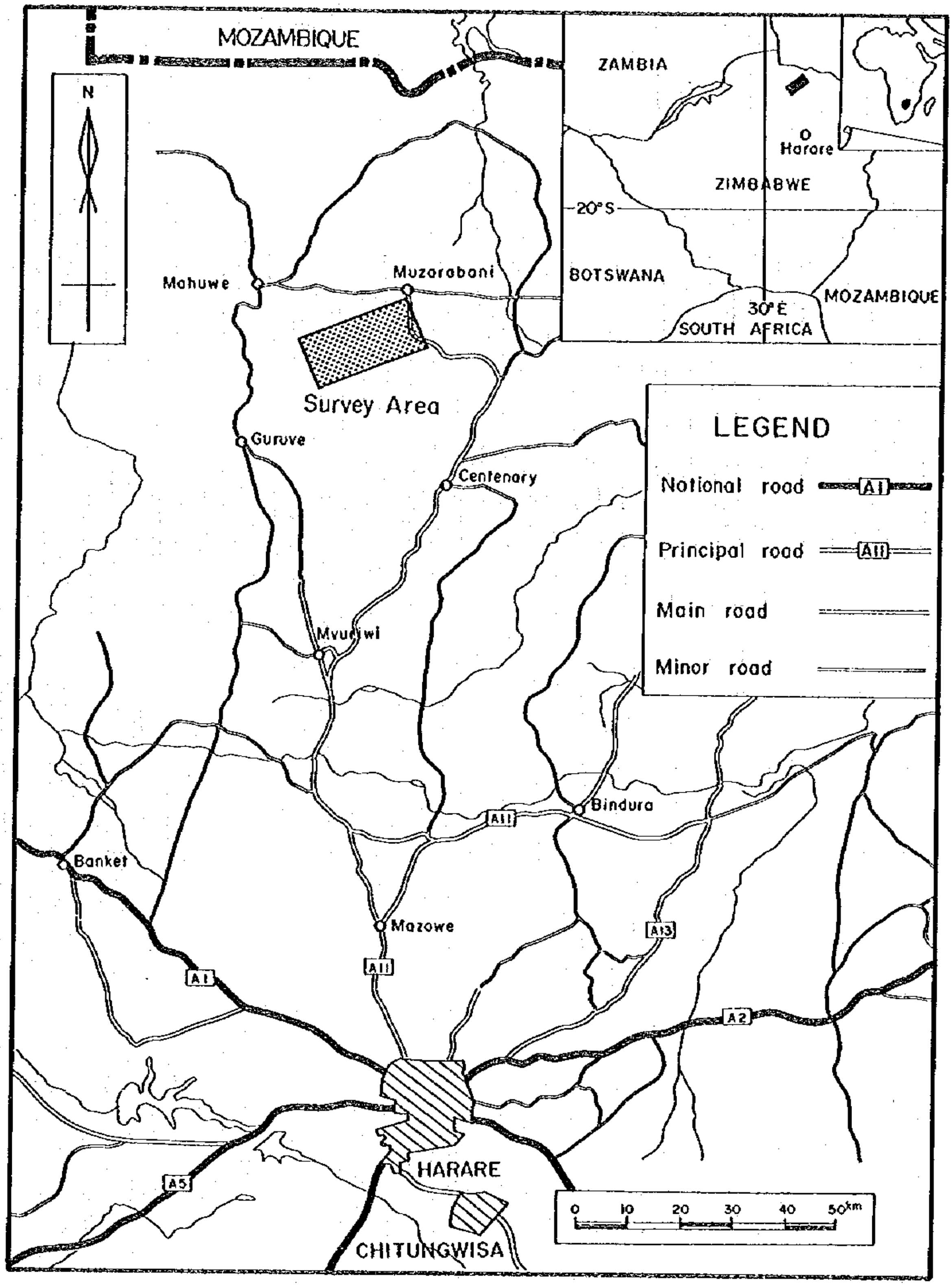


Fig.I-1-1 Locality of the survey area

Abstract

This survey was carried out in order to study the situation of geology and explore new ore deposits of platinum group metals in the Snake head area, the Republic of Zimbabwe.

The literature search covering the area of 150 square kilometres, geological survey, geochemical rock sampling covering the area of 22.25 square kilometres, and geophysical survey covering the area of 9 square kilometres, were carried out in this fiscal year as the Phase I of this project. The results are summarized below.

The literature search was carried out in order to understand the characteristics of geology and mineralization of this area, and made geological map by the data compiling. The geology of this area consists of Archaean granites of the basement complex and ultramafic to mafic rocks of the Great Dyke. Platinum group metals (PGM) were concentrated in the uppermost horizon of ultramafic rocks.

Geological examination of the area indicated that though occasionally faulted, Pyroxenite No.1 layer of the uppermost of ultramafic rocks is distributed continuously along the range, and some sulphide mineralization closely related to PGM was recognized.

Rock geochemical surveys indicated high concentrations of Au and PGM distributed in a narrow and continuous zone in the WS area, north-eastern portion of the WN area and northern portion of CB area, and this suggested a possibility of the existence of a new ore deposit.

On the geophysical survey, Chargeability anomalies obtained from a deep source below No.6 to 10 stations on E, H, I, J, K, L, M, N survey lines suggested an existence of polarizable body below the P1 layer or down-dip. extension of serpentinite layer.

Based on the survey results mentioned above, the method of the survey of the phase II are proposed as follows :

1. The detailed geological and geochemical survey

Detailed geological, and geochemical surveys be carried out in portion of WS area, north-eastern portion of the WN and northern portion of CB. The survey should include closely spaced rock sampling and trenching across P1 locate the mineralized horizon.

2. The geophysical survey

Geophysical survey should be carried out in areas of geochemical anomalies in the north-eastern portion of the WN area and northern portion of CB area to investigate the possibility of sulphide horizon.

3. Drillings

Drilling in the most anomalous areas outlined in Phase I survey must be carried out in order to investigate the possibilities of the existence of Au and PGM mineralization.

CONTENTS

Pages

Part III Conclusion and Recommendation

Figures Pages

Pages

Tables

Appendices Pages

Part I General Remarks

Part I General Remarks
Chapter 1 Introduction

1-1 Background and Purpose of the Survey

This survey will be carried out within a period of three years commencing from 1995. This year,1995, is the phase I of this project.The Great Dyke is generaly known as main producing region of nickel, cobalt, and platinum group metals in the world. In the Snake Head area, the target area of this survey, is the last expected area where a high potetial for existance of Platinum group metals deposit such as those at Hartley, Serious, Zinka, and Mimoza mines. Therefore, the Government of the Republic of Zimbabwe requested the Government of Japan for a Technical Cooperation to carry out Mineral Exploration the Snake Head area. The Government of Japan responded to the request and conducted literature search, geological survey, geochemical surveys by rock geochemistry and, geophysical surveys. A surveys team was dispatched to carry out the fundamental survey in order to explore new deposits.

1-2 The Survey Area and the Outline on the Works of the Phase I

The survey area is shown in the following coordinates and Fig.I-1-1.

①	S16° 25.46'	E31° 02.58'	②	S16° 29.82'	E31° 04.13'
③	S16° 33.27'	E30° 53.79'	④	S16° 28.78'	E30° 52.16'

The outline of the survey of the Phase I is as follows :

1. Literature Search

The analyses of the previous works such as E.P.O.s (Exclusive Prospecting Orders) and Geological papers kept in the Geological Survey Department, Ministry of Mines (hereinafter called GSD) were done. The results of the study about the characteristics of geology and mineralization based on the existing data were summarized and compiled in geological map on a scale of 1:25,000.

2. Geological Survey

The compiled geological map was confirmed and amended by field investigation. In the mineralized zone, assessment of mineralization characteristics and occurrence was carried out and samples collected for laboratory analyses.

3. Geochemical Surveys

Rock samples were collected at an interval of every 50 metres on the survey lines in selected areas. The GPS (Global Positioning System) was used to confirm the position of the sampling. Descriptions of rock type and facies were carried out in order to recognize the characteristics of geology and mineralization at same time.

4. Geophysical Surveys

Geophysical survey using the IP method was carried out in order to obtain a geophysical anomalies caused by the sulphide mineralization.

Specification of each survey are shown in Table I-1-1.

Table I-1-1 List of specification of survey

Specification of the survey	Numbers of survey		
Literature search	Geologic map (1:100,000)		3sheets
	Reports of the past survey		1 set
	Geological Documents		1 set
Geological survey	Extension of survey line		68.30km.
Geochemical surveys	Extension of survey line		64.55km.
	Number of samples	Rock	1,366
Geophysical surveys	Extension of survey line		32km.
	Number of Measurement		1,280km.
	Number of samples Rock		35

Specifications of laboratory test	Amounts of samples
1. Microscopic observation of rock thin section	34
2. Microscopic observation of polished ore samples	18
3. X-ray diffraction rock samples	38
4. EPMA Analysis	6
5. Chemical analyses 2) Rock: Au,Ag,Cu,Co,Ni,Pt,Pd,Rh	1,366
6. Measurement of resistivity and chargeability	35

1-3 Members of the Survey Team

The following members were organized as the survey team, who negotiate the survey planning and conducted and actual survey.

Planning and Negotiation:

(Japanese Members)

Mr.Toyo MIYAUCH :Leader,Director of Overseas Activity Department,MMAJ

Mr.Katsuhisa ONO :MMAJ

Mr.Yoichi OKUIZUMI :Johhanesburg Office, MMAJ

(Zimbabwean Members)

Mr.Surrender Mdunyiswa Nyahwa NCUBE	:Director of GSD
Mr.Temba Mabasa HAWADI	:GSD
Mr.Forbes MUGUMBATE	:GSD

Field Survey

(Japanese)

Yoshioki NISHITANI	:DOWA Engineering.,Ltd.
Hiroshi YOKOYAMA	:DOWA Engineering.,Ltd.
Kunio KIMURA	:DOWA Engineering.,Ltd.
Masatoshi MAEKAWA	:DOWA Engineering.,Ltd.
Tadashi NYUI	:DOWA Engineering.,Ltd.

(Zimbabwean)

Wishes MAGALEIA	:GSD
Forbes MUGUMBATE	:GSD
Fadzanai Bornewell MUPAYA	:GSD
George KWENDA	:GSD
Warren MAKAMURE	:GSD
Manhando MUTENDA	:GSD
Madgen NHAMBURO	:GSD

1-4 Terms of the Survey

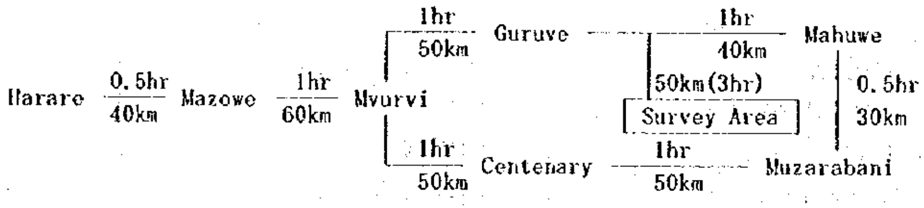
Field survey was carried out as follows:

Field survey;	from 10 October to 17 December, 1995
Literature search;	from 12 October to 22 October, 1995
Geological and geochemical survey;	from 23 July to 10 December, 1995
Geophysical surveys;	from 30 October to 10 December, 1995

Chapter 2 Physical features

2-1 Location and Traffics

The Snake Head area is located in the northern part of Zimbabwe. The distance and travel time by car from Harare are as follows:



There are paved national roads and local roads from the Capital to the north of Guruve, From north of Guruve to survey area is by gravel and mountain roads. Only the 4WD cars can drive in the dry season, however during the rainy season of November to March, it is impossible to access to the survey area.

During the field survey, Japanese engineers and counterpart stayed in Guruve. Labors were employed in the survey area.

2-2 Topography and River System

The topography of the survey area generally affected by fault system, and shows mountain brock. Gabbroic rocks and pyroxenite rocks were distuributed charactaristcally along to the mountain range. Elevation are between 500 metres to 1,600 metres. The topography shows steep with valleys that were cloded strongry by river system.

Each streems and rivers flow pararel to the mountain range with the direction of the south-west or the north-east, and flow into Musengezi river which runs to the north to flow into Zambezi river.

All the rivers flow only in the rainy season. There is no water in the river except some pools in the dry season.

2-3 Climate and Vegetation

The climate of the survey area is divided into the dry season (from April to October) and the rainy season (from November to March). Climatic elements of each month are are shown in Table I-2-1.

As regards vegetation, except short broad-leaved tree as oaks which distributes in the mountainous district, the vegetation is generally thin in the survey area. Many bamboo characteristically grow along the river.The serpentinite zone shows poor vegitation especially, only grass is glowing.

Big wild animals like a elephant and antelope live in the survey area, howevere, a carnivorous fierce animals can not recognize.

Table I-2-1 Temperature and rainfall of each month

	Guruve (1994/04-1995/03)			Muzarabani (1994/04-1995/03)		
	Temperature (°C)		Rainfall (mm)	Temperature (°C)		Rainfall (mm)
	Maximum	Minimum		Maximum	Minimum	
April	28.3	13.8	-	33.2	18.6	-
May	26.5	10.7	1.5	32.3	11.3	-
June	23.8	7.2	-	26.2	10.7	-
July	23.0	6.6	-	27.2	9.3	-
August	25.3	9.4	-	28.9	11.2	-
September	29.2	13.7	-	35.6	16.2	-
October	28.1	15.2	38.7	34.9	13.4	?
November	32.7	18.7	2.4	38.1	20.5	7.5
December	29.4	17.9	245.3	34.8	16.9	139.5
January	28.5	17.6	102.1	33.9	12.1	215.0
Feburuary	28.2	17.4	133.1	34.1	12.5	96.0
March	28.7	16.3	50.8	34.9	15.3	41.0

Chapter 3 Previous Works

3-1 Outline of Previous Works

As regards the geology of this area and the surrounding area, geological maps of Zimbabwe, distribution map of mineral resources of Zimbabwe on a scale of 1:1,000,000, geological map on a scale of 1:100,000(SIPOLILO, CENTENARY) published by GSD. Southern Rhodesia Geological Survey Bulletin No.47(hereinafter called Bulletin 47) describes the geology and mineralization of the Great Dyke.

As regards the exploration data of this survey area, 2 explorations was carried out by Union Carbide Rhomet (Pvt.) Ltd.(hereinafter called Union Carbide) between 1967 and 1972, and Cluff Resources Zimbabwe Ltd.(hereinafter called Cluff), between 1989 and 1992, under Exclusive Prospecting Orders (hereinafter called E.P.O.).

Bulletin 47 clearly describes all the rock types of the Great Dyke, and mineralization with respect to Nickel, Cobalt, and PGM metals. The Great Dyke is divided in to 5 complexes(Musengezi complex, Hartley complex, Selukwe complex, Wedza complex, and satellite complex), and characteristics of each complex were described. PGM mineralization was described as being confined to the pyroxenite No.1 layer(hereinafter called P1) just under the gabbroic rocks. Distribution of P1 must therefore be considered for exploration.

Union Carbide carried out soil geochemical prospecting with about 30m of sampling distance, and confirmed the layer with PGM mineralization. In addition, trenching survey and detailed geochemical sampling with about 3 to 6m of sampling distance was carried out. Based on this prospecting, drilling was carried out at 4 sites. 2 to 3 zones of mineralization were recognized.

Cluff considered the probability for mining development using the open cast method, high mechanized operation, and large scale of ore processing. For the purpose of this, Cliff carried out detailed topographic mapping on the scale of 1:12,500, constructing an access road, and geological survey confirming the distribution of P1 and main fault system. Based on this survey, drilling was carried out on 5 sites. It was concluded that 2 zones of mineralization occur(0.88 to 1.16g/t,Pt+Pd).

3-2 General Geology of the Survey Area

This survey area is located in northern end of the Great Dyke which pass through the center of the Republic of Zimbabwe as shown in Fig.I-3-1.

Geology of this area consists of gneiss and granites of Archaean era which forms the basement, and ultramafic to mafic rocks of the Great Dyke which intruded in to the basement rocks.

The basement rocks mainly consists of augen gneiss with remarkable feldspar, and distributed in the northwestern and southern side of the survey area.

The Great Dyke is a layered basic intrusion whose geology consists of a topmost layer of gabbroic rocks distributed widely in the center part of the survey area. Gabbro is black to deep green in color, massive, holocrystallinte texture. Below gabbro are multi- layers of pyroxenite with deep green to green color, coarse grained, holocrystalline texture. Followed by peridotite(dunite, harzburgite) from top to bottom.

PGM is mainly in the upper most layer(P1) of multi- layered pyroxenite, and chromite occur in the

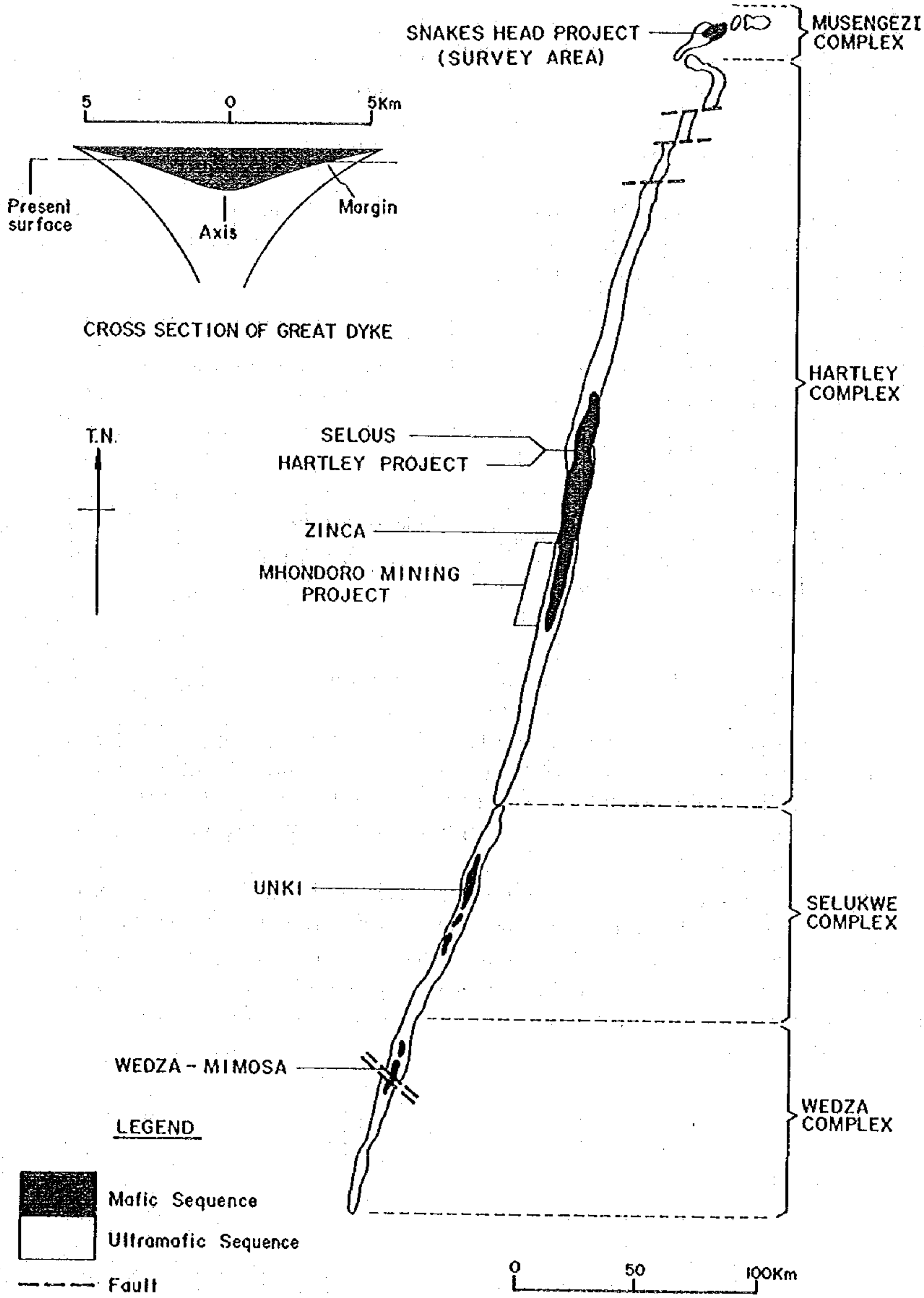


Fig.I-3-1 Outline of the Great Dyke

lower pyroxenite layers.

The Great Dyke in the survey area is curved like an "S" form due to the structural movements of the Pan-Africa Zambezi Mobile Belt. In addition, the area is cut by fault systems striking of N-S and E-W direction which resulted in the formation the western mountain block forming the Botera range, the central mountain block forming the Guyu range, and the eastern mountain block of the east bank of the Musengezi river.

The western block strikes N-S to NE-SW and dips to the E to SE direction whereas the central block strikes N-S and dips towards the E in the northern portion and W in the southern portion. the eastern block shows a N-S to NE-SW strike and W to NW direction of dip.

3-3 Geological Situation

The Great Dyke is the main mining area of PGMs in Zimbabwe. The Mimosa mine in the Wedza complex, the Unki area in the Selukwe complex, and the Zinka, Selous, Hartley mines in the Hartley complex are generally known. In these areas , continuous exploration were carried out from 1960 to early 1980 by Union Carbide, Anglo American, Rio Tinto, Plateau Mining, Delta Gold, and BHP-Utha International, etc.. These exploration work led to the subsequent re-opening and new opening of the mines. The ore deposit close to the top of pyroxenite layer just under the gabbroic rocks in these areas. Therefore the Snake Head area has similar geology as the other PGM bearing horizons, it can be considered to be the last potential area for PGM exploration on the Great Dyke.

3-4 Mining History

Union Carbide and Cluff carried out a geological survey and exploration by E.P.O..

Union Carbide carried out the geochemical soil sampling with sampling distance of 30m at the main sulphide zone(hereinafter called MSZ), and Pt, Pd, Cu, Ni were analyzed from these samples. For the obtained PGM occurring layer, 4 holes of drillings crossing the layer with 160m distance of each hole(direction N65W, inclination 45W) were carried out. As the result, MSZ(1.4g/t 0f Pt+Pd, thickness 14m) and lower sulphide zone(hereinafter called LSZ) 50m under from MSZ(1.2g/t of Pt+Pd, thickness over 7.6m) were recognized.

Cluff carried out making a topographic map on the scale of 1:25,000, constructing a access road to the survey area, and geological survey confirming a distribution of the PI layer and fault system to decide the priority of drilling. Based on the result, 5 holes of drillings were carried out, and Cu, Ni, Pt, Pd, Rh, Au, As were analyzed from 212 of core samples. As the result, 2 layer of PGM mineralized zone(0.88 to 1.16g/t of Pt+Pd, thickness 4.2 and 5.2m) were recognized. Distribution of mineralized zone were estimated to 7km x 4km.

Chapter 4 Considerations of the Survey Results

4-1 Controls on Mineralization Related to the Geological Structure and Characteristics of the Mineralization

The Great Dyke is a layered basic intrusion, whose PGM, Ni, and Co ore deposits are reported to occur mainly in the P1 layer just under the gabbroic rocks.

Same mineralized zone was recognized in the Mimosa Mining area of Wedza complex, The Unki area of the Selukwe complex, and the Zinka, Selous, Hartley mining area of the Hartley complex.

Upper gabbroic rocks are widely distribute in the center portion of the survey area. Rock facies move to lower peridotite(dunite, harzburgite) pass through multi layered pyroxenite.

The sulphide mineralization which can be observed with naked eye mainly occur in the P1 layer of the upper most pyroxenite layer. Chromite occur mainly in the lower pyroxenite layer.

Sulphide minerals in the mineralized zone consist of pyrrhotite, pentlandite, chalcopyrite as essential minerals and the pyrite, magnetite, chromite as a accessory minerals. Small quantities of violarite, millerite, goethite occurring as secondary minerals were also recognized.

Layering in the western block shows a N-S to NE-SW direction of strike and E to SE direction of dip, whereas the layering in the central block shows a N-S direction of strike and E direction of dip in the northern portion and W direction of dip in the southern portion. The layering in the eastern block shows a N-S to NE-SW direction of strike and W to NW direction of dip.

These layering can be pursued in the field.

4-2 Relationship between Geochemical Anomaly and Mineralization

(1) Metal concentration and geological position

Gold, platinum, and palladium show a narrow continuous distribution, confined to the middle portion of the P1 layer. Platinum and palladium were also partially detected in the serpentinite layer, below P1 pyroxenite.

Silver and rhodium show low grade and wide a distribution, not corresponding to geology. Silver has no correlation with other elements, suggesting that it has a different condition of concentration compared to these elements. Distribution of the population of Rhodium is difficult because samples shown above the detectable limit are very few.

Copper is divided into 2 clear different populations, continuously concentrated in upper portion of P1 layer. Sulphide dissemination which correspond to high copper concentrated zone is recognized in the field, therefore, copper concentrated zone suggest to existence of mineralization.

Cobalt and nickel show a clear and continuous zone of high concentration in the lower portion of P1 layer and lower serpentinite layer. The distribution of cobalt and nickel seem to reflect the geology.

Gold-platinum-palladium group, copper, and cobalt-nickel group have no clear correlation each other, and have different distributions in the field. These groups seem to have no related mineralization.

(2) Comparison of each geochemical survey area

As regard gold and PGM elements, the area expected to high concentration of metals is the WS area, followed by the northeastern portion of the WN area and northern portion of CB area. though the southwestern portion of the WN area is divided into small area by faulting, local metal concentration are recognized. Southern portion of the CB area shows weak metal concentrations, distribution of concentrations become patchy. EN and ES areas show no concentration.

4-3 Relationship between Geophysical Anomalies and Mineralization

The characteristics of high chargeability anomalies in this area is not accompanied by low resistivity distribution.

As a result of physical property tests, it was proved that the sample which has sulphide content are in the order of 1.0mV/V to 2.5mV/V and do not show a great deal of contrast with the host rock. This probably results from minor quantities of sulphide. On the other hand, Serpentinite with chromite($FeCr_2O_4$) shows high chargeability(50mV/V), and also shows high resistivity(over 500 W×m). Difference was found between this sample and other rocks in chargeability.

As a result of 2-D simulation analysis, it was estimated that the anomaly in the western part of area result from polarizable body which correspond to Serpentinite. And it was also estimated that the anomaly at the deep part between stations No.6 and No.10 on E, H, I, J, K, L, M, N survey lines result from polarizable body which correspond to the extension part of Serpentinite or the basal part of Pyroxenite(P1).

The relationship between grade of sulphide and chargeability can not be decided because of the variety of resistivity of host rock or connection between each sulphide minerals. But it can be stated that it is difficult to find out low-grade sulphide target(under %-order) by IP survey.

4-4 Potentialities of Expected Ore Deposits

Expected ore deposits in this area are stratabound PGM, nickel, cobalt, and copper ore deposits.

As the result of the geological survey, the P1 layer which is thought to host ore deposits was investigated in the field. It was identified that the P1 layer occurs under the gabbroic rocks in the central and north eastern portion of the survey area. Sulphide dissemination was recognized in upper portion of the P1 layer, suggesting the existence of the mineralization.

Geochemical survey indicated that gold and PGM elements are concentrated in the WS area, followed by northeastern portion of the WN area and northern portion of CB area.

Geophysical surveys identified chargeability anomalies deep below No.6 to 10 stations on E, H, I, J, K, L, M, N survey lines suggesting existence of a chargeable body at the bottom of the P1 layer, or extension of serpentinite layer.

Based on the above facts, WS area, northeastern portion of the WN area and northern portion of CB area in this survey area are considered to have high potential for occurrence of new ore deposits similar to the Mimosa mine in the Wedza complex, the Unki area in the Selukwe complex, and the Zinka, Selous, Hattley mine in the Hartley complex.

Chapter 5 Conclusion and Recommendation

5-1 Conclusion

Expected ore deposits in this area are strata-bound PGM nickel, cobalt, and copper ore deposits.

P1 layer which is thought to host ore deposits was geologically investigated in the field, and it was identified that the P1 layer occurs under the gabbroic rocks in the central and north eastern portion of the survey area. Sulphide dissemination was recognized upper potions of the P1 layer, suggesting existence of the mineralization.

Result of the geochemical survey indicate that gold and PGM element concentrations are expected in the WS area, followed by the northeastern portion of the WN area and northern portion of CB area.

Result of the geophysical surveys identified chargeability anomalies deep below No.6 to 10 stations on E, H, I, J, K, L, M, N survey lines suggesting existence of chargeable body in bottom of the P1 layer or extension of serpentinite layer below P1.

Based on the above facts, WS area, northeastern portion of the WN area and northern portion of CB area in this survey area is considered to have high potential for occurrence of new ore deposits similar to the Mimosa mine in the Wedza complex, the Unki area in the Selukwe complex, and the Zinka, Selous, Hattley mine in the Hartley complex.

5-2 Recommendation for the Phase II

Based on the survey results mentioned above, the method of the survey for the phase II are proposed as follows :

1. The detailed geological and geochemical survey

Detailed geological, and geochemical surveys be carried out in portion of WS area, north-eastern portion of the WN and northern portion of CB. The survey should include closely spaced rock sampling and trenching across P1 locate the mineralized horizon.

2. The geophysical survey

Geophysical survey should be carried out in areas of geochemical anomalies in the e north-eastern portion of the WN area and northern portion of CB area to investigate the possibility of sulphide horizon.

3. Drillings

Drilling in the most anomalous areas outlined in Phase I survey must be carried out in order to investigate the possibilities of the existence of Au and PGM mineralization.

Part II Details of the Surveys

Part II Details of the Surveys
Chapter 1 Literature Search

The localities of previous works are shown in Fig.II-1-1. List of the literature is shown in Table II-1-1.

Explorations of PGM ore deposit by Union Carbide and Cluff under E.P.O.s were carried out in the survey area from 1967 to 1992.

1-1 Geology and Economic Geology

As regards the geology of this area and the surrounding area, geological maps of Zimbabwe(Stagman, 1978), distribution map of mineral resources of Zimbabwe (Bartholomew, 1986) on a scale of 1:1,000,000, geological map on a scale of 1:100,000(SIPOLILO(Worst,1957, Wiles,1965, CENTENARY(Bace,et,al,1983)) and Southern Rhodesia Geological Survey Bulletin No.47(B.G.Worst,1960) are published by GSD.

As regards the exploration data of this survey area, 2 explorations was carried out by Union Carbide between 1967 and 1972, and Cluff between 1989 and 1992, with E.P.O..

Table II-1-1 List of the literature

The leterature	Amount
Geological Maps a scale of 1:1,000,000 a scale of 1:100,000	 2 sheets 3 sheets
The previous E.P.O.s.	2 (No.193 & 651)
Air Photograph	25 sheets
Others	3 papers

1. Outline of Geology

The compiled geological map is shown in Fig.II-1-2.

Geology of this area consists of gneiss and granites of Archaean era which forms the basement, and ultramafic to mafic rocks of the Great Dyke which intruded in the basement rocks.

The basement rocks mainly consists of augen-gneiss with remarkable feldspar, and distributed in the northwestern and southern side of the survey area.

The Great Dyke is a layered basic intrusion. The geology of the Great Dyke change from upper mafick rock to lower ultramafick rocks. Upper gabbroic rocks distributed widely in the center part and northeastern part of the survey area, and shows black to deep green in color, massive, holocrystallinte

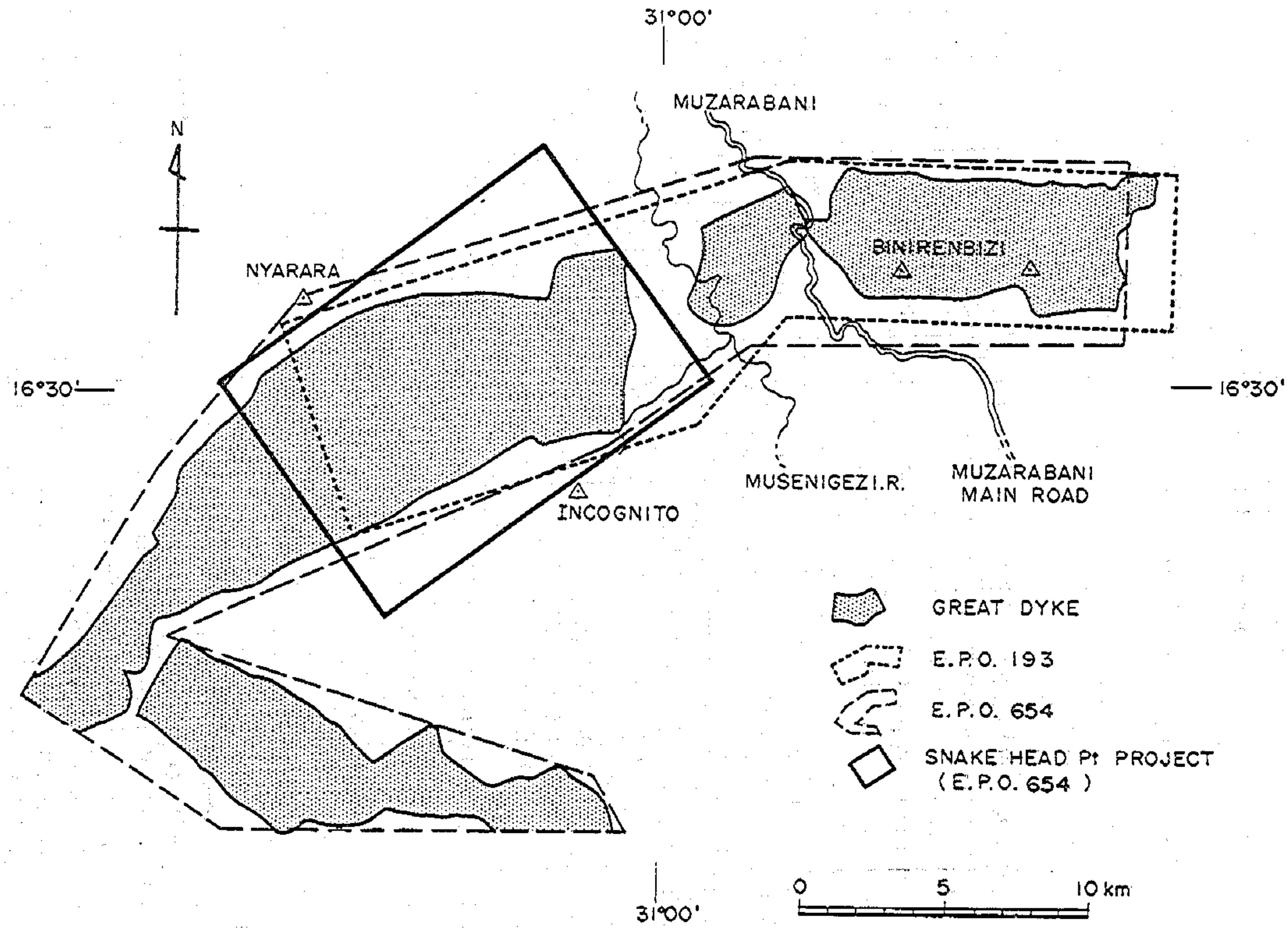


Fig.II-1-1 Locality of previous works

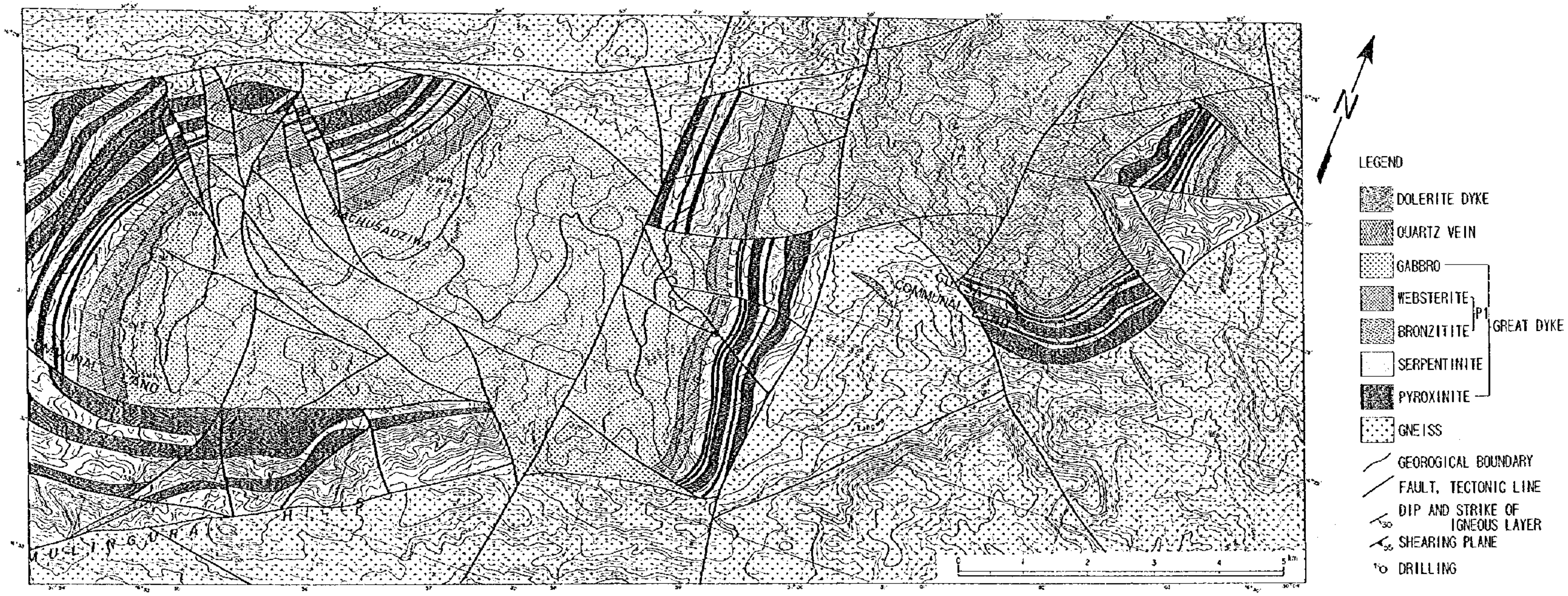


Fig II-1-2 Compiled geological map

texture. Multi- layer of the pyroxenite with deep green to green color, coarse grain, holocrystalline texture, distribute under gabbroick rocks. Lower peridotite(dunite, harzburgite), in many case, is subjected to serpentinization. Pyroxenite and peridotite shows multi- layer each other, and formed so called cyclic units.

PGM is mainly in the upper most layer(P1) of multi layered pyroxenite, and chromite showing occur in the lower pyroxenite layer(Bulletine,47). Multi zone of sulphide concentration with PGM minerals were recognized in the pyroxenite, upper zone shows higher concentration than lower zone(Allen H.Wilson and Marian Tredoux 1990).

2. Geological structure

The Great Dyke is divided by fault system of N-S and E-W direction to the western mountain block, the central mountain block, and the eastern mountain block of the east bank of the Musengezi river.

The western block strikes a N-S to NE-SW and dip to the E to SE whereas the central block strikes N-S and dips towards the E the northern portion and W in the southern portion, the eastern block shows a N-S to NE-SW strike and N to E direction of dip.

3. The known ore deposits

Expected ore deposits in this area are stratabound PGM nickel, cobalt, and copper ore deposits on a view point of the economic feasibility. Union Carbide and Cluff discovered some mineral showing, however, there is no developed mine in the past.

1-2 E.P.O.'s Reports

The history of mining activities in the survey area is comparatively new. The surveys of ore deposits are carried out under the E.P.O. No.93 and 654. Final reports of surveys are filed in GSD, and are available to examine.

E.P.O. No.93

This E.P.O. was established by Union Carbide between 1967 and 1972.

Union Carbide carried out a soil geochemical prospecting with about 30m of sampling distance, and 15 to 45cm of depth. Then after shook off under 60 mesh, Pt, Pd, Cu, Ni were analyzed from these samples. PGM mineralization zone was confirmed, in addition, trenching survey and detail geochemical sampling with about 3 to 6m of sampling distance was carried out. based on this prospecting, 4 drilling were carried out. As the results, it is concluded that 2 and 3 zone of mineralized were recognized.

E.P.O. No.654

This E.P.O. was established by Cluff between 1989 and 1992.
Cluff considered the probability for mining development using the open cast method, high mechanized operation, and large scale of ore processing. For the purpose of this, Cluff carried out a making of detail topographic map on the scale of 1:12,500, constructing a access road, and geological survey confirming a distribution of P1 and main fault system. Based on this survey, 5 drillings were carried out. As the result, it is concluded that 2 zone of mineralized were recognized(0.88 to 1.16g/t,Pt+Pd).

1-3 Others

1. Air photograph

Airphotographs all covered survey area were published at the Survey General Office.

1-4 Summary

The Great Dyke is the main mining area of the PGM in Zimbabwe. the Mimosa mine in the Wedza complex, the Unki area in the Selukwe complex, and the Zinka, Selous, Hattley mine in the Hartley complex are generally known. These ore deposits are in the upper most of pyroxenite layer just under the gabbroic rocks in these areas.

Summary of previous works was shown in Fig.II-1-3.

As the results of analysis of the existing data, in the Snake Head area continuous distribution of pyroxenite P1 just under the gabbroic rocks was recognized same to known platinum mining area, and Union carbide and Cluff obtained some platinum showing by the drilling, therefore, it is considered to have high potentiality of occurrence of new ore deposits.

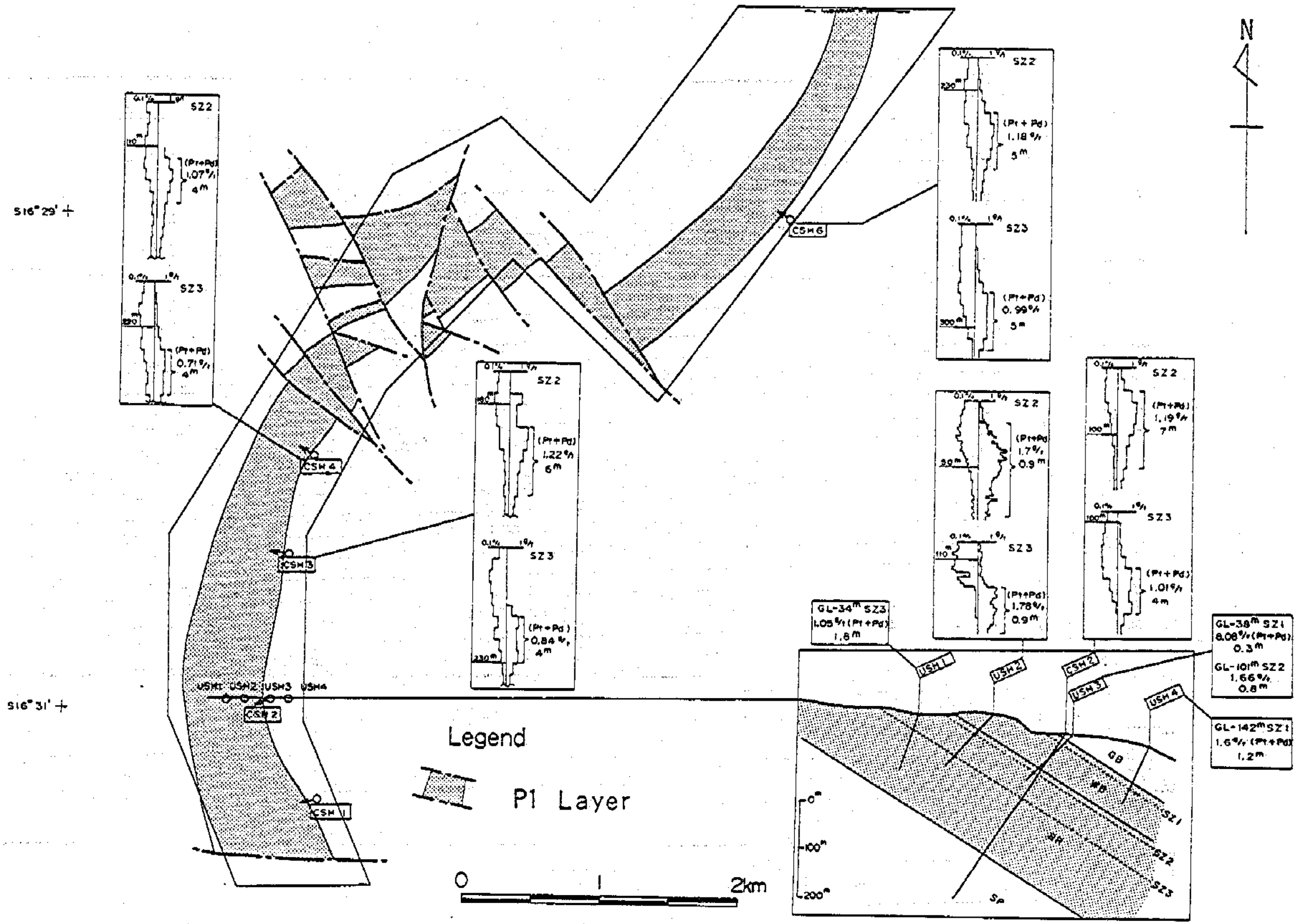


Fig.II-1-3 Summary of previous works

Chapter 2 Geochemical survey

2-1 Outline of the Geology

Geology of this area consists of gneiss and granites of Archaean era which forms the basement, and ultramafic to mafic rocks of the Great Dyke which intruded in the basement rocks.

The Great Dyke curved like a "S" form affected by structural movement of the Pan-Africa Zambezi Mobile Belt. in addition, the area is divided by fault system of N-S.

Schematic geological column, geological cross section, geological map, and locality of sampling sites of rocks for laboratory works are shown in Fig.II-2-1. to II-2-4, respectively.

The List of samples for laboratory works, the result of the microscopic observation of thin sections and the result of the X-ray diffraction is shown in Table II-2-1. to Table II-2-3. Microphotography of the thin section is shown in Appendices A-1.

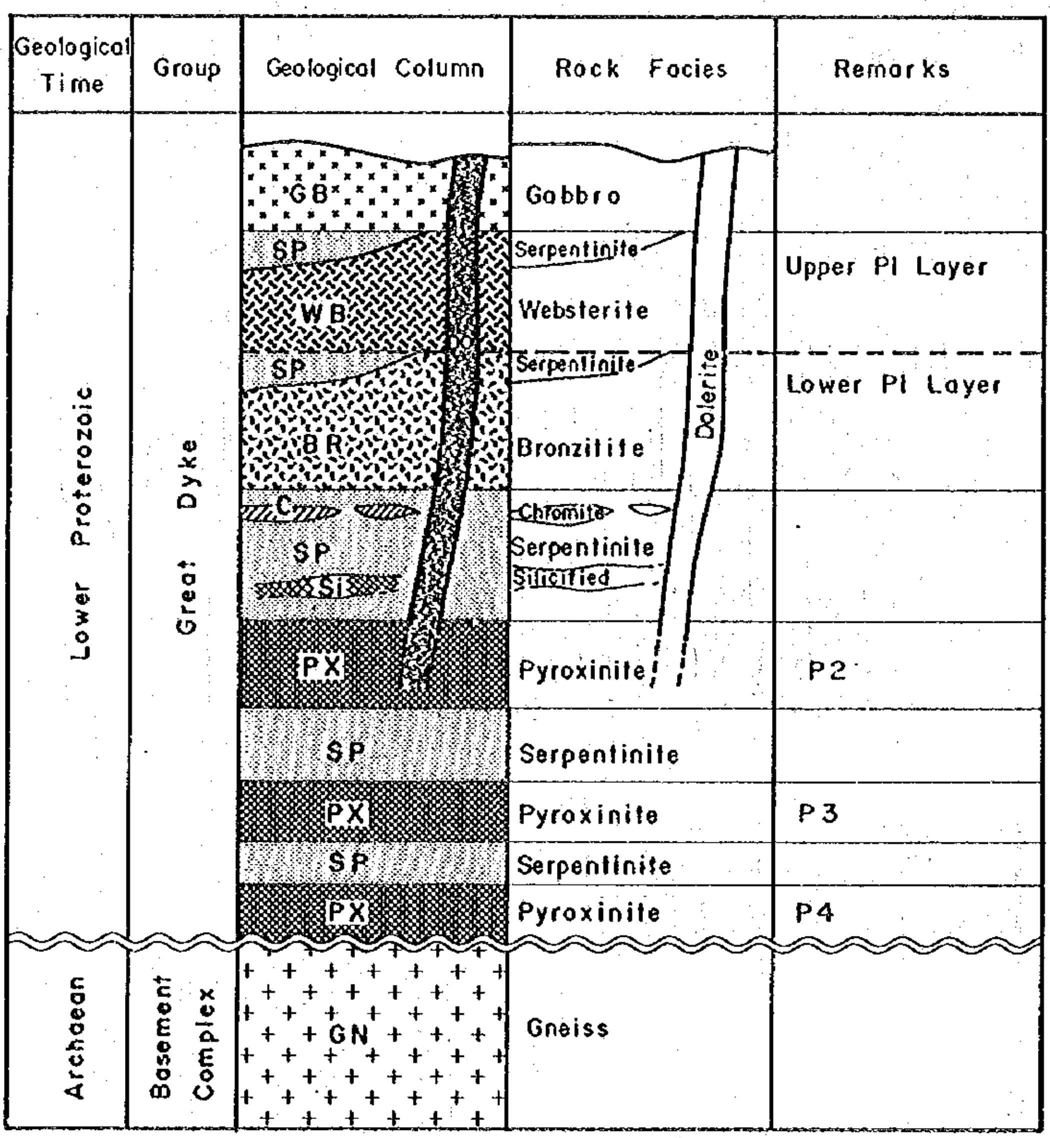


Fig.II-2-1 Schematic geological column

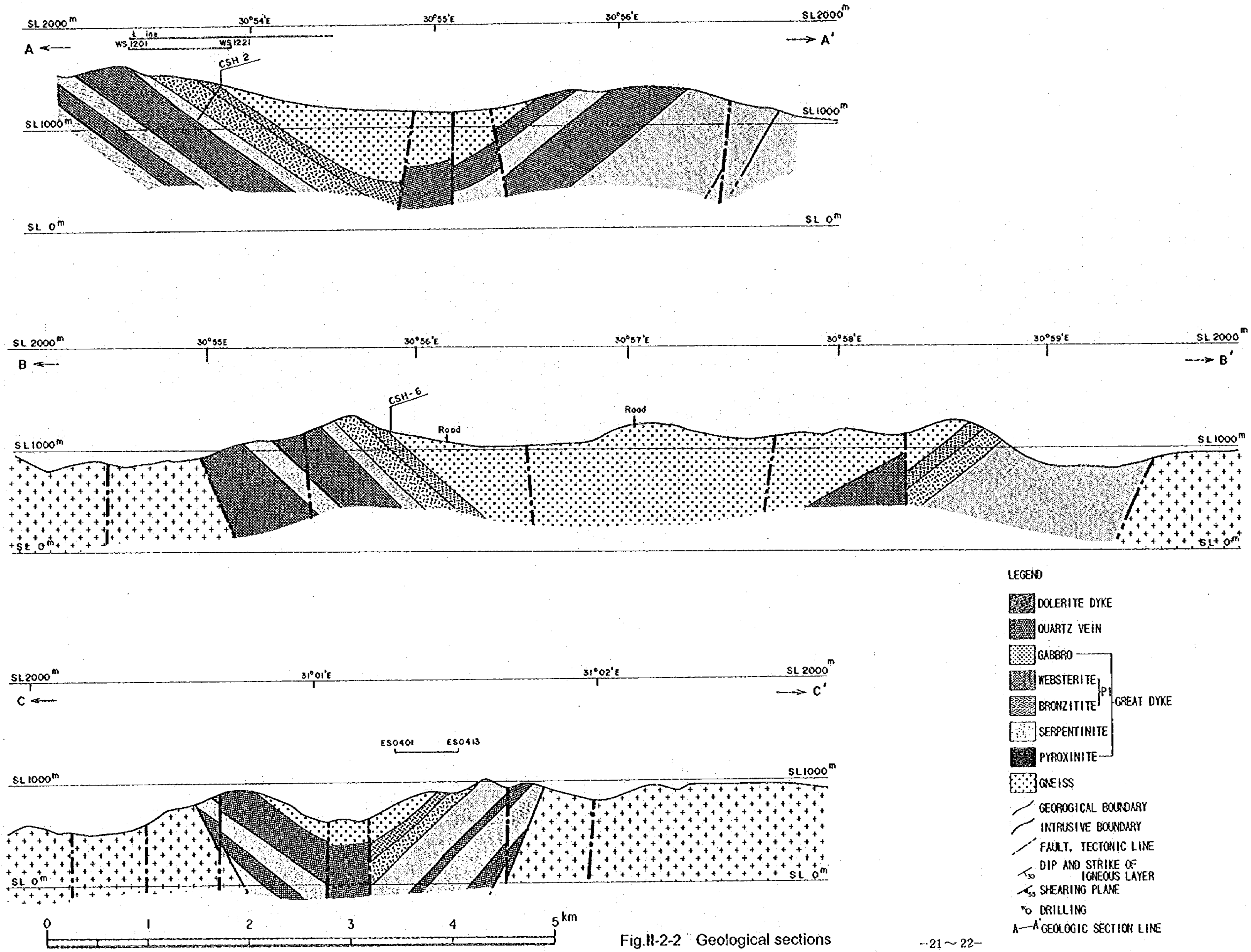


Fig.II-2-2 Geological sections

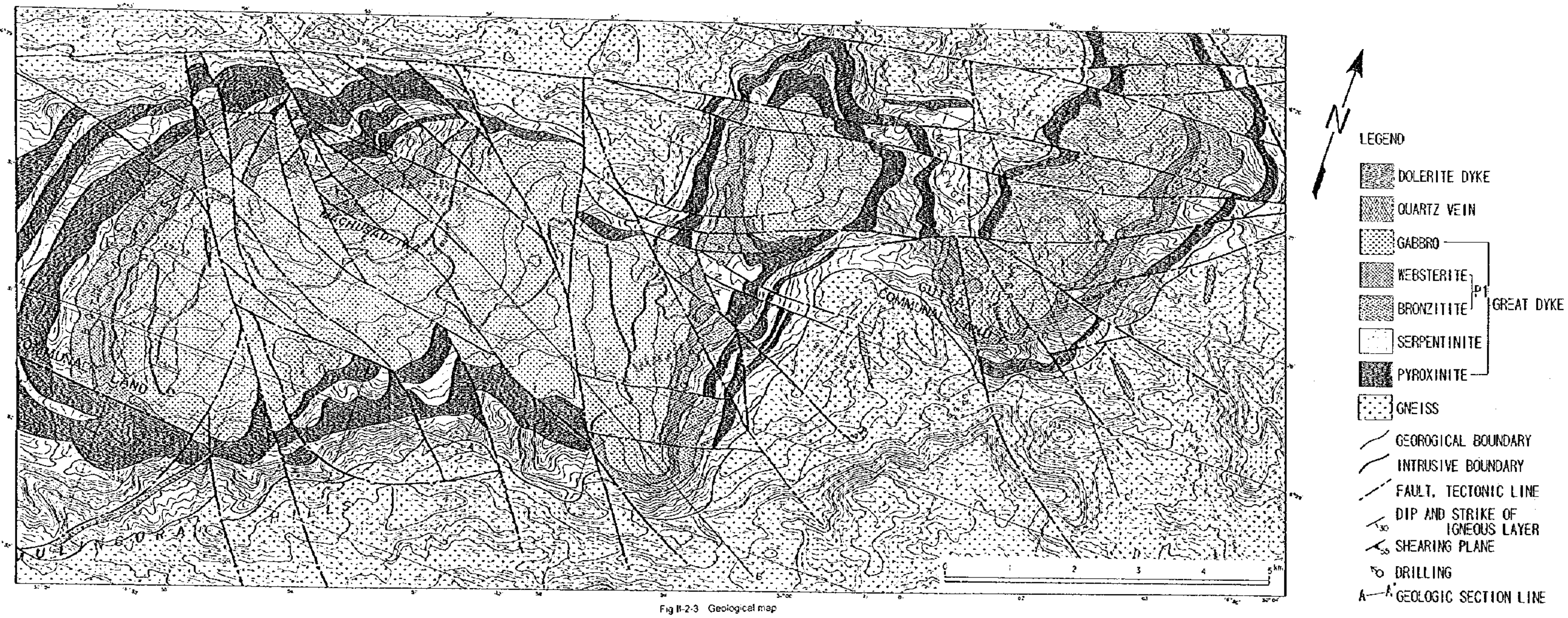


Fig II-2-3 Geological map

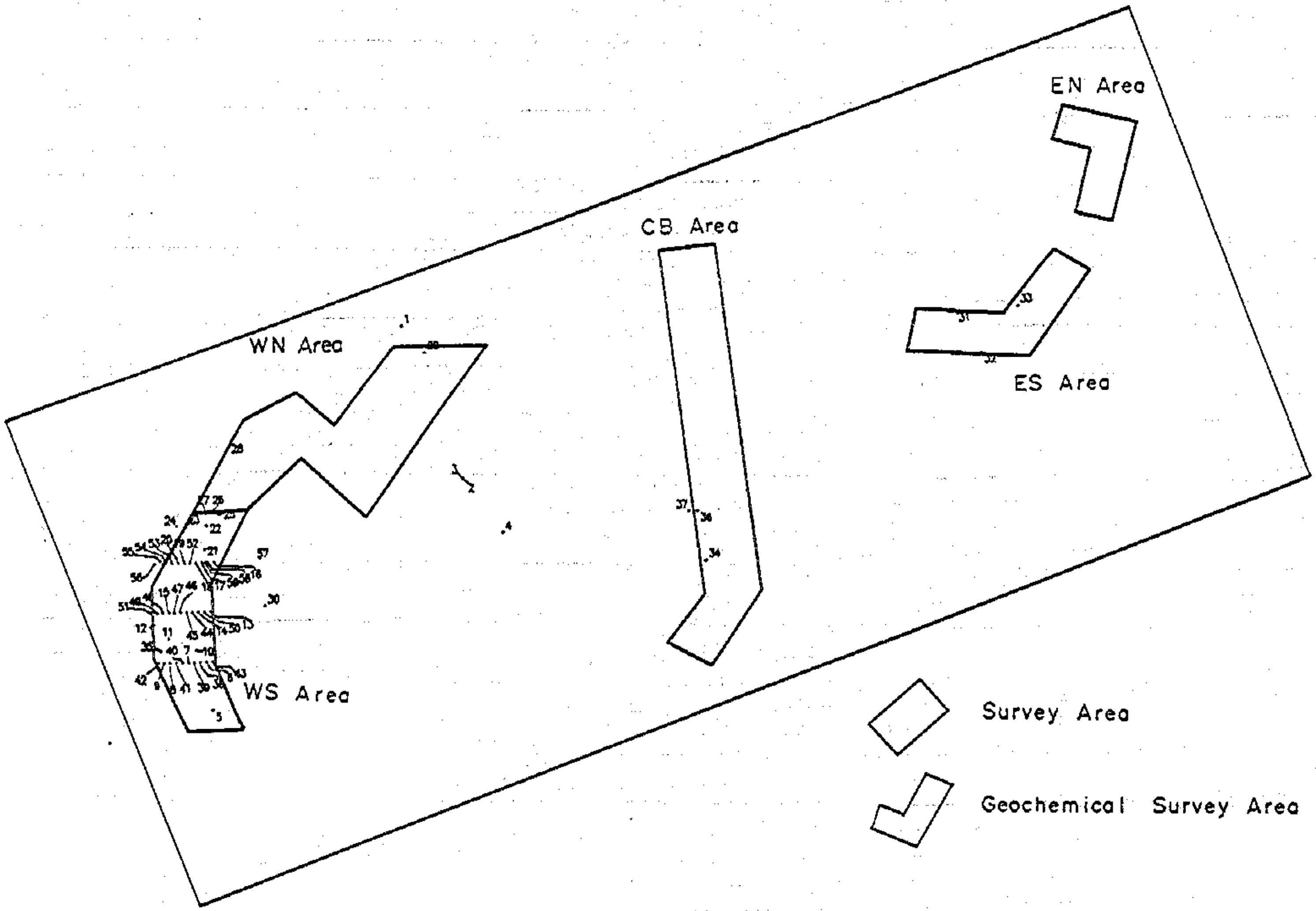


Fig.II-2-4 Locality of sampling sites of rocks for laboratory tests

Table II-2-1 List of samples for laboratory tests

NO.	Cordinate E	Cordinate S	Rock Type	Remarks	Geochemical Survey			Thin Sec.	Polish Sec.	X-ray	EPMA	Physical Property Test
					Block	Line	No.					
1	E 30 · 55.83'	S 16 · -28.11'	GN					Z05				
2	E 30 · 56.35'	S 16 · -29.51'	PG					Z04		Z04		
3	E 30 · 56.35'	S 16 · -29.51'	GB					Z03				
4	E 30 · 56.70'	S 16 · -30.01'	Amphb					Z01		Z01		
5	E 30 · 53.94'	S 16 · -31.50'	PX-PY	Sulphyde	WS	17	15	WS1715	WS1715		WS1715	
6	E 30 · 53.89'	S 16 · -31.07'	PX		WS	13	21	WS1321		M10		M10
7	E 30 · 53.72'	S 16 · -31.07'	PX		WS	13	15	WS1315	WS1315	M7		M7
8	E 30 · 53.56'	S 16 · -31.07'	PX		WS	13	9	WS1309		M4		M4
9	E 30 · 53.50'	S 16 · -31.07'	SP		WS	13	7	WS1307		M3		M3
10	E 30 · 53.81'	S 16 · -30.96'	PX	Sulphyde	WS	12	18	WS1218	WS1218			
11	E 30 · 53.55'	S 16 · -30.85'	PX		WS	11	9	WS1109				
12	E 30 · 53.39'	S 16 · -30.74'	SP		WS	10	3	WS1003				
13	E 30 · 53.95'	S 16 · -30.62'	GB		WS	9	21	WS0921		I11		I11
14	E 30 · 53.84'	S 16 · -30.62'	PX-PY	Sulphyde	WS	9	17	WS0917	WS0917	I9		I9
15	E 30 · 53.56'	S 16 · -30.62'	PX		WS	9	7	WS0907		I4		I4
16	E 30 · 54.00'	S 16 · -30.18'	GB		WS	5	21	WS0521		E12		E12
17	E 30 · 53.89'	S 16 · -30.18'	PX	Sulphyde	WS	5	17	WS0517	WS0517	E10		E10
18	E 30 · 53.83'	S 16 · -30.18'	PX	Sulphyde	WS	5	15	WS0515	WS0515	E9	WS0515	E9
19	E 30 · 53.72'	S 16 · -30.18'	PX	Sulphyde?	WS	5	11	WS0511	WS0511	E7		E7
20	E 30 · 53.66'	S 16 · -30.18'	PX		WS	5	9	WS0509		E6		E6
21	E 30 · 53.91'	S 16 · -30.07'	PX	Sulphyde	WS	4	16	WS0416	WS0416			
22	E 30 · 53.94'	S 16 · -29.85'	PX-PY		WS	2	11	WS0211	WS0211		WS0211	
23	E 30 · 53.74'	S 16 · -29.85'	PX-BR		WS	2	4	WS0204				
24	E 30 · 53.66'	S 16 · -29.85'	DO		WS	2	1	WS0201				
25	E 30 · 54.02'	S 16 · -29.74'	PX-PY	Sulphyde	WS	1	14	WS0114	WS0114			
26	E 30 · 54.00'	S 16 · -29.74'	PX-PY	Sulphyde	WS	1	13	WS0113	WS0113		WS0113	
27	E 30 · 53.94'	S 16 · -29.74'	PX-PY	Sulphyde	WS	1	11	WS0111	WS0111			
28	E 30 · 54.20'	S 16 · -29.10'	PX		WN	17	1	WN1701				
29	E 30 · 56.04'	S 16 · -28.36'	TLSCH		WN	1	11	WN0111		WN0111		
30	E 30 · 54.46'	S 16 · -30.59'	GB					I20		I20		I20
31	E 31 · 0.98'	S 16 · -28.17'	MCSCH	Amphb?	ES	7	4	ES0704				
32	E 31 · 1.18'	S 16 · -28.54'	PX-PY	Sulphyde	ES	6	10	ES0610	ES0610			
33	E 31 · 1.52'	S 16 · -28.13'	PX	sulphyde	ES	3	5	ES0305	ES0305			
34	E 30 · 58.57'	S 16 · -30.33'	PX		CB	18	7	CB1807	CB1807		CB1807	
35	E 30 · 53.47'	S 16 · -30.96'	SP	Cr	WS	12	6		WS1206			
36	E 30 · 58.50'	S 16 · -29.87'	PX-PY	Sulphyde	CB	15	7		CB1507		CB1507	
37	E 30 · 58.43'	S 16 · -29.87'	PX-PY	Sulphyde	CB	15	4		CB1504			
38	E 30 · 53.84'	S 16 · -31.07'	PX		WS	13	19			M9		M9
39	E 30 · 53.78'	S 16 · -31.07'	PX		WS	13	17			M8		M8
40	E 30 · 53.67'	S 16 · -31.07'	PX		WS	13	13			M6		M6
41	E 30 · 53.61'	S 16 · -31.07'	PX		WS	13	11			M5		M5
42	E 30 · 53.44'	S 16 · -31.07'	SP		WS	13	5			M2		M2
43	E 30 · 53.95'	S 16 · -31.07'	GB		WS	13	23			M11		M11
44	E 30 · 53.78'	S 16 · -30.62'	PX		WS	9	15			I8		I8
45	E 30 · 53.73'	S 16 · -30.62'	PX		WS	9	13			I7		I7
46	E 30 · 53.67'	S 16 · -30.62'	PX		WS	9	11			I6		I6
47	E 30 · 53.61'	S 16 · -30.62'	PX		WS	9	9			I5		I5
48	E 30 · 53.50'	S 16 · -30.62'	SP		WS	9	5			I3		I3
49	E 30 · 53.45'	S 16 · -30.62'	SP		WS	9	3			I2		I2
50	E 30 · 53.89'	S 16 · -30.62'	PX		WS	9	19			I10		I10
51	E 30 · 53.39'	S 16 · -30.62'	SP		WS	9	1			I1		I1
52	E 30 · 53.78'	S 16 · -30.18'	PX		WS	5	13			E8		E8
53	E 30 · 53.61'	S 16 · -30.18'	PX	Sulphyde?	WS	5	7			E5		E5
54	E 30 · 53.55'	S 16 · -30.18'	SP		WS	5	5			E4		E4
55	E 30 · 53.52'	S 16 · -30.18'	SP							E3.5		E3.5
56	E 30 · 53.44'	S 16 · -30.18'	PX		WS	5	1			E2		E2
57	E 30 · 54.43'	S 16 · -30.17'	DO							E17		E17
58	E 30 · 53.94'	S 16 · -30.18'	GB		WS	5	19			E11		E11
59	E 30 · 53.92'	S 16 · -30.18'	PX							E10.5		E10.5

Table II-2-2 Results of the microscopic observations of thin sections

No.	Sample Name	Rock name defined by microscopic obervation	Coordinate Latitude	Coordinate Lngitude	Qz	Pl	Ab	Kf	Mc	Bt	Ms	Hb	Cpx	Opx	Ov	Ur	Opg	Tr	Zo	Ca	Sph	Ap	Zr	Cr	All	Mg	Spe	Chl	Spt	Leu	Iho	Texture
1	Z05	Porphyroclastic Muscovite-Biotite Granite	E 30 · 55.83 '	S 16 · -28.11 '	◎	○		◎	◎	△									·		·	·	·		△							Porphyroclastic
2	Z04	Uralitized Quartz-diorite	E 30 · 56.35 '	S 16 · -29.51 '	△	◎				△		◎				◎			△	△	·	·	·									Holocrystalline equigranular
3	Z03	Uralite Gabbro	E 30 · 56.35 '	S 16 · -29.51 '	·	◎				·						◎			○	△		·				·						Holocrystalline equigranular
4	Z01	Quartz-bearing Hornblendite	E 30 · 56.7 '	S 16 · -30.01 '	○	○						◎					○		△			·										
5	WS1715	Websterite	E 30 · 53.94 '	S 16 · -31.6 '		△							◎	○		○												△				Holocrystalline equigranular
6	WS1321	Websterite	E 30 · 53.89 '	S 16 · -31.07 '		△							◎	○												△						Holocrystalline equigranular
7	WS1315	Websterite	E 30 · 53.72 '	S 16 · -31.07 '		△							○	◎												·						Holocrystalline equigranular
8	WS1309	Websterite	E 30 · 53.56 '	S 16 · -31.07 '		·							○	◎												·						Holocrystalline equigranular
9	WS1307	Peridote	E 30 · 53.5 '	S 16 · -31.07 '											◎					△				△					◎			
10	WS1208	Websterite	E 30 · 53.81 '	S 16 · -30.96 '		△							◎	○												·						Holocrystalline equigranular
11	WS1109	Websterite	E 30 · 53.55 '	S 16 · -30.85 '		·							○	◎												·						Holocrystalline equigranular
12	WS1003	Banded Fe-hydroxides and cryptocrystallone~microcrystallin	E 30 · 53.39 '	S 16 · -30.74 '	◎												○														◎	
13	WS0921	Gabbro	E 30 · 53.95 '	S 16 · -30.62 '		◎							○	○										·		·						Holocrystalline equigranular
14	WS0917	clinopyroxenite	E 30 · 53.84 '	S 16 · -30.62 '	△	△							◎	△						△						△						Holocrystalline equigranular
15	WS0907	Websterite	E 30 · 53.56 '	S 16 · -30.62 '		△							○	◎												·						Holocrystalline equigranular
16	WS0521	Gabbro	E 30 · 54 '	S 16 · -30.18 '		◎							○	○								·				·						Holocrystalline equigranular
17	WS0517	Websterite	E 30 · 53.89 '	S 16 · -30.18 '		△							◎	○								·				△						Holocrystalline equigranular
18	WS0515	Websterite	E 30 · 53.83 '	S 16 · -30.18 '		△							◎	○												△						Holocrystalline equigranular
19	WS0511	Orthopyroxenite	E 30 · 53.72 '	S 16 · -30.18 '		△							△	◎												△						Holocrystalline equigranular
20	WS0509	Websterite	E 30 · 53.66 '	S 16 · -30.18 '		△							○	◎												·						Holocrystalline equigranular
21	WS0416	Websterite	E 30 · 53.91 '	S 16 · -30.07 '		△							◎	○												·						Holocrystalline equigranular
22	WS0211	Websterite	E 30 · 53.94 '	S 16 · -29.85 '		△				·			◎	○										·		·						Holocrystalline equigranular
23	WS0204	Orthopyroxenite	E 30 · 53.74 '	S 16 · -29.85 '		△							△	◎												△						Holocrystalline equigranular
24	WS0201	Uralitized Quartz-beartz Dolerite	E 30 · 53.66 '	S 16 · -29.85 '	△	◎										◎						·				△				△		Doleritic
25	WS0114	clinopyroxenite	E 30 · 54.02 '	S 16 · -29.74 '		△				·			◎	△												△						Holocrystalline equigranular
26	WS0113	Websterite	E 30 · 54 '	S 16 · -29.74 '		△							◎	○												△						Holocrystalline equigranular
27	WS0111	Websterite	E 30 · 53.94 '	S 16 · -29.74 '		△							◎	○												△						Holocrystalline equigranular
28	WN1701	Webeterite	E 30 · 54.2 '	S 16 · -29.1 '		△							○	◎												△						Holocrystalline equigranular
29	WN0111	clastic hornblende containing chlorite-sericite rock	E 30 · 56.04 '	S 16 · -28.36 '													△								·		◎	△				Lepidobrastic
30	1-20	Gabbro	E 30 · 54.46 '	S 16 · -30.59 '		◎							◎					△				·				·	·					Holocrystalline equigranular
31	ES0704	Quartz Biotite-bearing Hornblendite	E 31 · 0.976 '	S 16 · -28.17 '	△	○				△		◎										△	·			○						Holocrystalline equigranular
32	ES0610	Websterite	E 31 · 1.178 '	S 16 · -28.54 '		△							◎	○												△	△	·				Holocrystalline equigranular
33	ES0305	Websterite	E 31 · 1.523 '	S 16 · -28.13 '		△							◎	○												·	·					Holocrystalline equigranular
34	CB1807	clinopyroxenite	E 30 · 58.57 '	S 16 · -30.33 '		○							◎										·	△		△						Holocrystalline equigranular
35																																

※ ◎ : abundance ○ : common △ : minor · : rare

Abbreviation of mineral names

Qz:quartz Pl:plagioclase Ab:albitc Kf:potassium feldspar Mc:microcline Bt:biotitc Ms:muscovite Hb:hornblende Cpx:clinopyroxene Opx:Orthopyroxene Ov:Olivine Ur:Uralite Opg:Opaguemineral Tr:tremolite Zo:zoisite Ca:calcite Sph:sphene Ap:apatite Zr:zircon Cr:chromite All:allanite Mg:magnetite Ser:sericite Chl:chlorite Spt:serpentine Leu:leucoxene Iho:Iron hydroxide

Table II-2-3 Results of X-ray diffraction

No.	Sample Name	Rock Type	Cordinate E	Cordinate S	Ch	S	Serp	K	Pp	Tc	Q	Sod	Cor	Spn	Gp	Ca	Do	Sd	Pl	Ho	Cpx	Opx	Ol
17	E-10	Pyroxenite	E30°53.89′	S16°-30.2′															6	1	3	3	
59	E-10.5	Pyroxenite	E30°53.89′	S16°-30.2′	2															13	8	3	
58	E-11	Gabbro	E30°53.94′	S16°-30.2′						3									20	2	6	7	
16	E-12	Gabbro	E30°54.00′	S16°-30.2′						2									15	3	5		
57	E-17	Dolerite	E30°54.43′	S16°-30.2′		2													10	3	2		
56	E-2	Pyroxenite	E30°53.44′	S16°-30.2′	5				15				3				10			2			
55	E-3.5	Pyroxenite	E30°53.52′	S16°-30.2′	9					2				8									
54	E-4	Serpentinite	E30°53.55′	S16°-30.2′			11			1				5									
53	E-5	Pyroxenite	E30°53.61′	S16°-30.2′						1						<1		<1				41	
20	E-6	Pyroxenite	E30°53.66′	S16°-30.2′						1												21	
19	E-7	Pyroxenite	E30°53.66′	S16°-30.2′																		27	
52	E-8	Pyroxenite	E30°53.72′	S16°-30.2′																1	9	7	
18	E-9	Pyroxenite	E30°53.83′	S16°-30.2′								1		3						1	8	5	
51	I-1	Serpentinite	E30°53.39′	S16°-30.6′			17			1	1												
50	I-10	Pyroxenite	E30°53.89′	S16°-30.6′										4						2	8	4	
13	I-11	Gabbro	E30°53.95′	S16°-30.6′						1				3					16	1	5	14	
49	I-2	Serpentinite	E30°53.45′	S16°-30.6′				4	10		75												
30	I-20	Gabbro	E30°54.46′	S16°-30.6′						1				2					17	2	5	8	
48	I-3	Serpentinite	E30°53.50′	S16°-30.6′			9			2					4								5
15	I-4	Pyroxenite	E30°53.59′	S16°-30.6′						1							20		1	<1		40	
47	I-5	Pyroxenite	E30°53.62′	S16°-30.6′													21					19	
46	I-6	Pyroxenite	E30°53.67′	S16°-30.6′																		21	
45	I-7	Pyroxenite	E30°53.73′	S16°-30.6′	1					1						3	30			2		10	
44	I-8	Pyroxenite	E30°53.78′	S16°-30.6′																1	11	5	
14	I-9	Pyroxenite	E30°53.84′	S16°-30.6′										5						1	6	10	
6	M-10	Pyroxenite	E30°53.89′	S16°-31.1′										3						1	9	6	
43	M-11	Gabbro	E30°53.95′	S16°-31.1′						1				3					10	1	7	15	
42	M-2	Serpentinite	E30°53.44′	S16°-31.1′						1	50												
9	M-3	Serpentinite	E30°53.50′	S16°-31.1′			11			1													8
8	M-4	Pyroxenite	E30°53.56′	S16°-31.1′						1				2						1		30	
41	M-5	Pyroxenite	E30°53.61′	S16°-31.1′						<1				3						1		25	
40	M-6	Pyroxenite	E30°53.67′	S16°-31.1′															4			15	
7	M-7	Pyroxenite	E30°53.72′	S16°-31.1′															3			30	
39	M-8	Pyroxenite	E30°53.78′	S16°-31.1′																1	9	8	
38	M-9	Pyroxenite	E30°53.84′	S16°-31.1′																1	8	7	
29	WN01-11	Talc-Schist	E30°54.48′	S16°-30.6′	14				15							8				6	2		
4	ZO-1	Amphibolote	E30°56.70′	S16°-30.0′							6								3	30			
2	ZO-4	Pegmatite	E30°56.35′	S16°-29.5′	1	1					4					1				17			

Legend

Ch:Chlorite
S:Sericite
Serp:Serpentine
K:Kaolin-Minerarl
Pp:Pyrophyllite
Tc:Talc
Q:Quartz
Sod:Sodalite
Cor:Cordierite
Spn:Spinel
Gp:Gypsum
Ca:Calcite
Do:Dolomite
Sd:Siderite
Pl:Plagioclase
Ho:Hornblende
Cpx:Clino-pyroxine
Opx:Ortho-pyroxine
Ol:Olivine

2-1-1 Basement Rocks

The basement rocks are widely distributed in north western and south eastern part of the survey area.

The basement rocks mainly consists of orthogneiss of granodiorite component and granite. These rocks sometimes shows banded structure with few cm to ten and more cm thick alternation of white felsic part and biotite concentration part, and sometimes formed clear augengniss in the outcrop.

Microscopic observation is as follows :

Sample Z-05 is petrologically identified as Muscobite-biotite granite which shows porphyroclastic texture. Quartz, K-feldspar, microcline, and plagioclase, are the major component minerals and there are small quantity of muscobite, biotite, allanite, apatite, sphene, zircon and zoisite.

2-1-2 Great Dyke

The Great Dyke is a layered basic intrusion. The geology of the Great Dyke consists of gabbroic rocks which distributed widely in the center part of the survey area, shows black to deep green in color, massive, holocrystallinte texture, multi layer of the pyroxenite with deep green to green color, coarse grain, holocrystalline texture, and peridotite(dunite, harzburgite) from upper to lower.

1. Gabbro

It is distributed widely from Botera range to Guyu range, north east of Guyu range and east bank of Mosengezi river.

Gabbroic rocks are situated in upper most of the Great Dyke, increase the thickness in the axial zone.

The main rock facies shows generally dark green to black color, massive holocrystalline equigranular texture. Gabbroic rocks change to the facies from lower gabbro mainly consist of orthopyroxenite, clinopyroxenite and plagioclase to upper quartz diorite with quartz and amphibole , and amphibolite include large quantity of amphibole.

Microscopic observation is as follows :

Samples WS0921, WS0521, I20 are from lower portion of gabbro, show holocrystalline equigranular texture. Large to middle quantity of plagioclase, orthopyroxenite and clinopyroxenite are the major component minerals and there are small to extremely small quantity of magnetite, apatite, tremolite chromite. Extremely small quantity of sericite by alteration is also recognized partly.

Samples Z03, Z04 are from upper portion of gabbro, show gabbro to quartz diorite facies with holocrystalline equigranular texture. Large to middle quantity of plagioclase, amphibole, uralite are the major component minerals and there are small to extremely small quantity of quartz, biotite, apatite, magnetite, zoisite, zircon, calcite.

Samples Z01, ES0704 are from upper most portion of gabbro, show quartz containing amphibolite facies. Large quantity of amphibole is the major component minerals and there are middle tosmall quantity of plagioclase, quartz, biotite, opaque minerals, and small to extremely small quantity of apatite, epidote magnetite, zircon.

Result of X-ray diffraction is as follows :

Gabbro mainly consists of orthopyroxenite, clinopyroxenite and there is small quantity of amphibole. Small quantity of talc is recognized in samples from lower portion of gabbro and large quantity of amphibole and quartz are recognized in samples from upper portion of gabbro.

2. Pyroxenite

It is distributed characteristically formed a range of the Botera range, Guyu range and east bank of Musengezi river.

Pyroxenite shows accumulated layer with serpentinite, formed so called cyclic units.

Pyroxenites mainly consist of olivine bronzitite, bronzitite, felspasic bronzitite and websterite From lower to upper(Allen H. Wilson and Marian Tredoux 1990).

The main rock facies are upper websterite which shows generally dark green to black color, medium to fine grain, holocrystalline equigranular texture, and lower orthopyroxenite(bronzitite) which shows generally dark green to green and olive green color, coarse grain, holocrystalline equigranular texture with clear pyroxene crystal in the field.

Microscopic observation is as follows :

Samples WS1715, WS1312, WS1315, WS1218, WS0517, WS0515, WS0113, WS0111 are from upper websterite, show holocrystalline equigranular texture. Large to middle quantity of orthopyroxenite and clinopyroxenite with 7 to 0.5mm of grain size are the major component minerals and there are small quantity of plagioclase and extremely small quantity of magnetite. Small quantity of uralite and extremely small quantity of sericite by alteration in marginal place of plagioclase are also recognized partly.

Samples WS0511, WS0204 are from lower orthopyroxenite, show holocrystalline equigranular texture. Large quantity of orthopyroxenite and small quantity of clinopyroxenite, plagioclase filled in a space of pyroxene crystals are the major component minerals and there is small to extremely small quantity of magnetite.

Result of X-ray diffraction is as follows :

Websterite mainly consists of about equal quantity of orthopyroxenite and clinopyroxenite and there is small quantity of amphibole. Orthopyroxenite mainly consists of orthopyroxenite and there are small quantity of amphibole, plagioclase, spinel partly. Extremely small quantity of chlorite, sericite, talk are recognized but there is almost no alteration.

3. Serpentinite

It is distributed along to the range and formed cyclic units with Pyroxenite.

Origin of serpentinite is the dunite and harzburgite(Bulletin 47), (E.P.O.654), (Allen H. Wilson and Marian Tredoux 1990).

The main rock facies shows generally pale yellow to pale brown and pale green color, fine grain. and containing chromite in many case. Fresh dunite and harzburgite are not recognized in this field. some times a range of serpentinite enriched silicate was formed by weathering.

Microscopic observation is as follows :

Sample WS1307 is the peridotite. Large quantity of olivine with 5 to 1mm of grain sizes and serpentine replaced and filled in crack of olivine are the major component minerals and there are small quantity of chromite and small vein of calcite.

Sample WS1003 is a siliceous rock in serpentinite, show cryptocristallin to microcristalline texture. Large quantity of layer to lenticular microcristalline quartz, iron hydro oxide and opaque minerals(pyrite?) are the major component minerals. This is consider to be products of weathering.

Result of X-ray diffraction is as follows :

This rock mainly consists almost of serpentine. Olivine as a origin remain in only few case. Quartz and pyrophyllite concentrate partly.

4. Chlorite-sericite rock

It is distributed characteristically along to the Fault zone.

This rock shows generally white to metallic silver color, strongly stripped, and soft and soapy.

Microscopic observation is as follows :

Sample WN0111 is from fault contact zone between basement rocks and the Great Dyke. Large quantity of lepidoblastic sericite and small quantity of chlorite, hornblende, albite and opaque minerals are the major component minerals.

Result of X-ray diffraction is as follows :

This rock mainly consists of chlorite, pyrophyllite, calcite, and hornblende, clinopyroxene from origin.

5. Dyke

Dolerite dyke is recognized in only limited scale.

Microscopic observation is as follows :

Sample WS0201 is the dolerite dyke. Large quantity of uralite originated from pyroxenite, plagioclase and small quantity of quartz are the major component minerals. and there are extremely small quantity of magnetite, leucoxene, apatite.

Result of X-ray diffraction is as follows :

This rock mainly consists of large quantity of plagioclase and hornblende, clinopyroxene, sericite.

2-1-3 Geological structure

The Great Dyke in the survey area is curved like an "S" form due to the structural movements of the Pan-Africa Zambezi Mobile Belt. In addition, the area is cut by fault system striking of N-S and E-W direction to the western mountain block forming the Botera range, the central mountain block forming the Guyu range, and the eastern mountain block of the east bank of the Musengezi river.

The western block strikes N-S to NE-SW and dips to the E to SE direction whereas the central block strikes N-S and dips towards E in the dip in the northern portion and W in the southern portion. The eastern block shows a N-S to NE-SW strike and W to NW direction of dip.

Each cyclic units of the Great Dyke increase the thickness from marginal to axial zone , at the same time gently sloped in to axial zone.

2-1-4 Mineralization

The Great Dyke is the main mining area of the PGM in Zimbabwe. the Mimosa mine in the Wedza complex, the Unki area in the Selukwe complex, and the Zinka, Selous, Hartley mine in the Hartley complex are generally known.

In the Snake Head area Union Carbide and Cluff carried out a geological survey and exploration.

Union Carbide carried out the geochemical soil sampling with sampling at the MSZ and 4 holes of drillings were carried out. As the result, MSZ(1.4g/t 0f Pt+Pd, thickness 14m) and MSZ(1.2g/t of Pt+Pd, thickness over 7.6m) were recognized.

Cluff carried out 5 holes of drillings and 2 layer of PGM mineralized zone(0.88 to 1.16g/t of Pt+Pd, thickness 4.2 and 5.2m) were recognized.

PGM minerals are closely related to the sulphide minerals like the pyrite, pyrrhotite, chalcopyrite and petlandite, etc., and accompanied with marginal zone of sulphide(E.P.O.654).

Survey of the mineralization zone of PGM was carried out using sulphide mineralization as an indicator.

Results of the survey for mineralization areas are shown in Fig.II-2-5

The sulphide mineralization which can observe with naked eye continuously occur in the upper portion of the P1 layer in the WS area. Small scale of mineralization was recognized in the northeastern portion of the WN area and northern portion of CB area.

The result of the microscopic observation of ore polish sections and the result of the EPMA analysis are shown in Table II-2-4. to Table II-2-5. Microphotography of the polish section is shown in Appendices A-2.

Microscopic observation is as follows :

Sulphide mineralization zone in this area generally consist of pyrrhotite, pentrandite and chalcopyrite. these show euhedral to subhedral, coexist with sandwich form. Pyrite also coexist with pyrrhotite, pentrandite and chalcopyrite. There are small quantity of marcasite, magnetite and chromite as accessory minerals. Small to extremely small quantity of violarite, millerite, bornite, covelline and goethite replaced in crack or marginal place of the pyrrhotite, pentrandite and chalcopyrite are also recognized as secondary minerals.

On the other hand, PGM minerals could not observed by microscopic observation and EPMA analysis.

2-2 Geochemical Survey

2-2-1 Purpose and method of Rock Geochemical Survey

The Great Dyke accompanied with charactaristic metal ore deposits, well known as the prominent producing area of PGM, cobalt, nickel and chrome in the world.

From the economical point of view, the metal resources which can be profitably worked are the PGM, cobalt, nickel and copper in the Snake Head area.

The purpose of this survey is to confirm the concentration of these metals using the method of the rock geochemical survey.

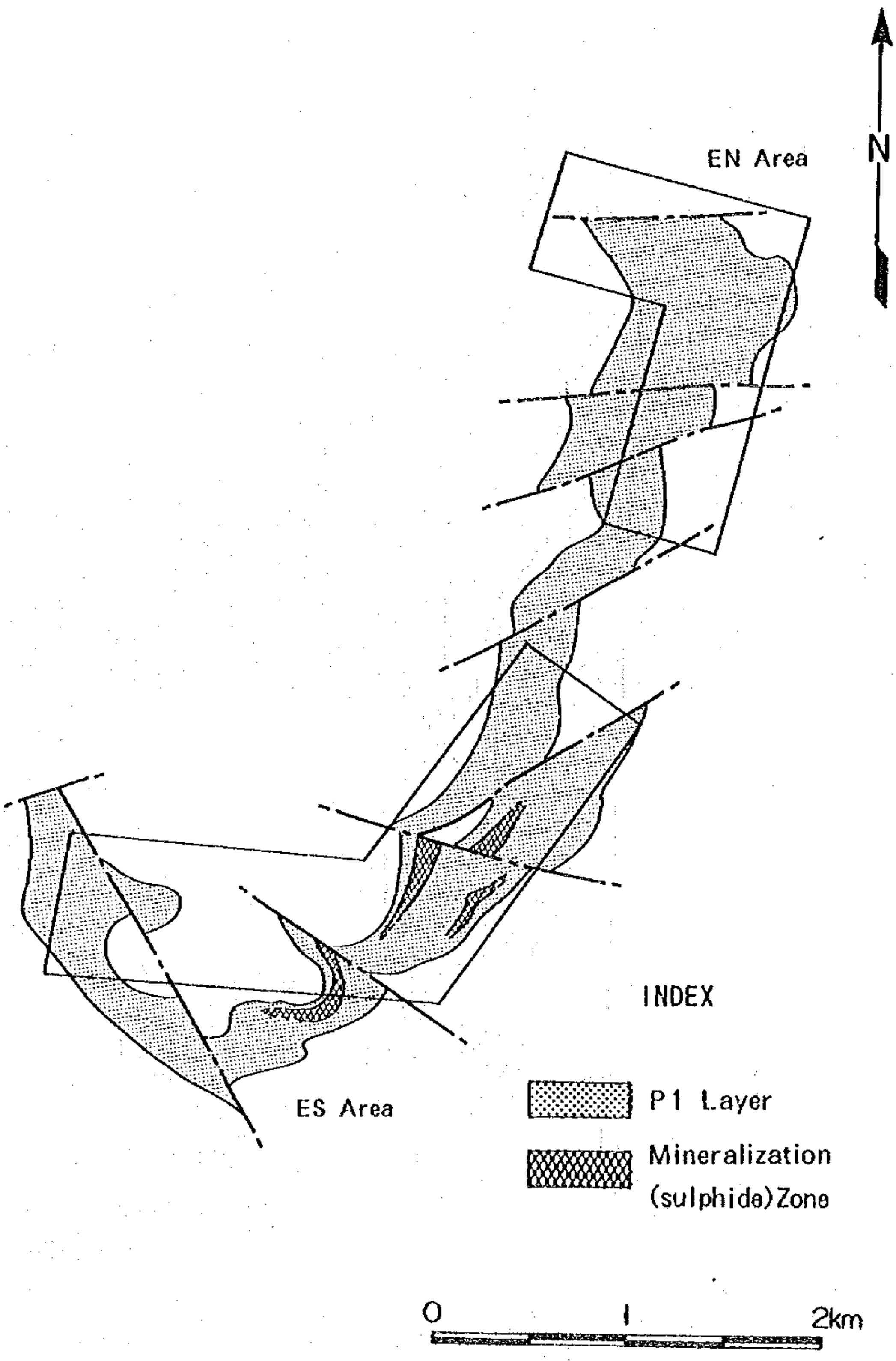


Fig.II-2-5-1 Distribution of sulphide mineralization (EN, ES area)

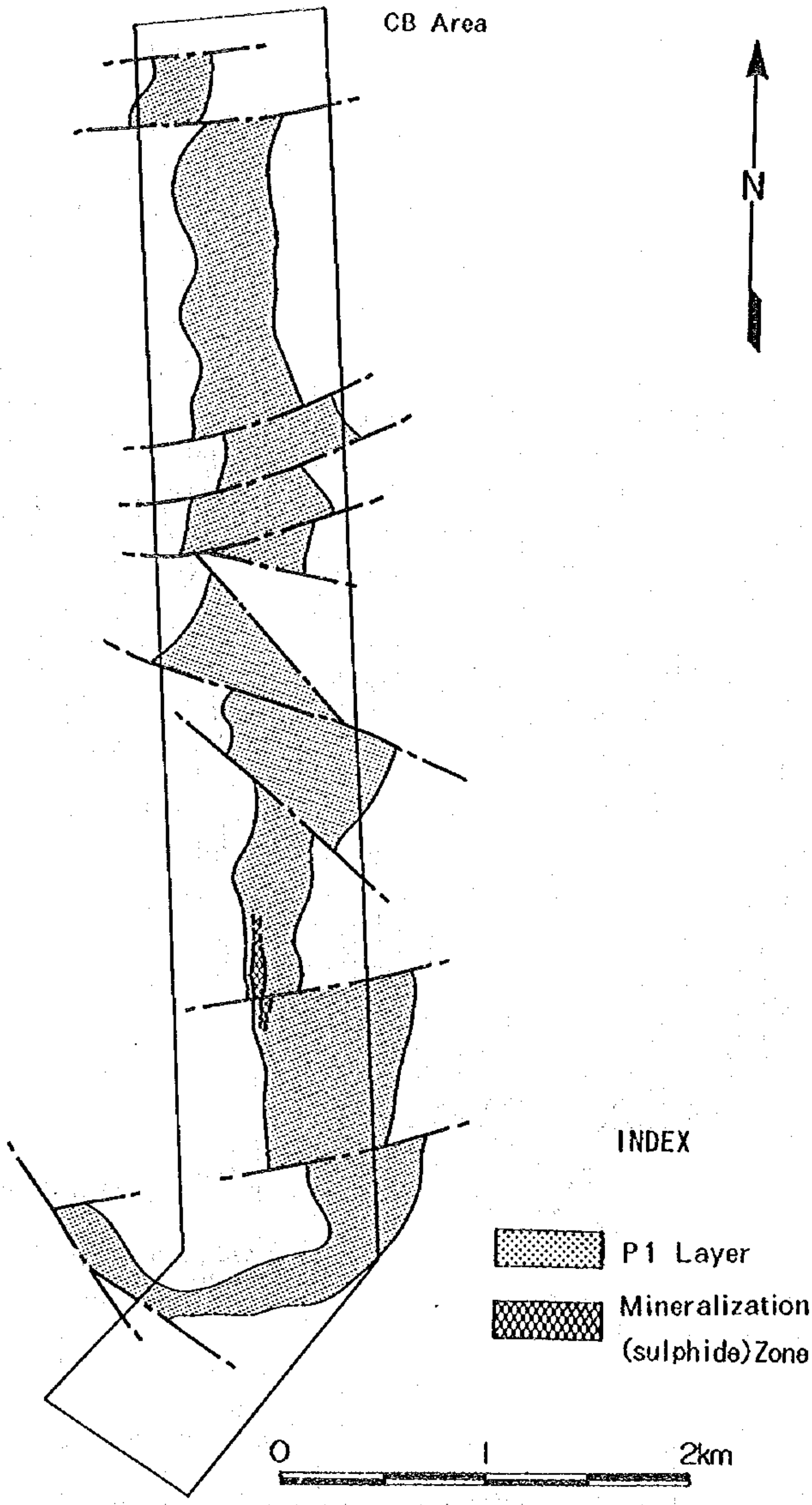


Fig.II-2-5-2 Distribution of sulphide mineralization (CB area)

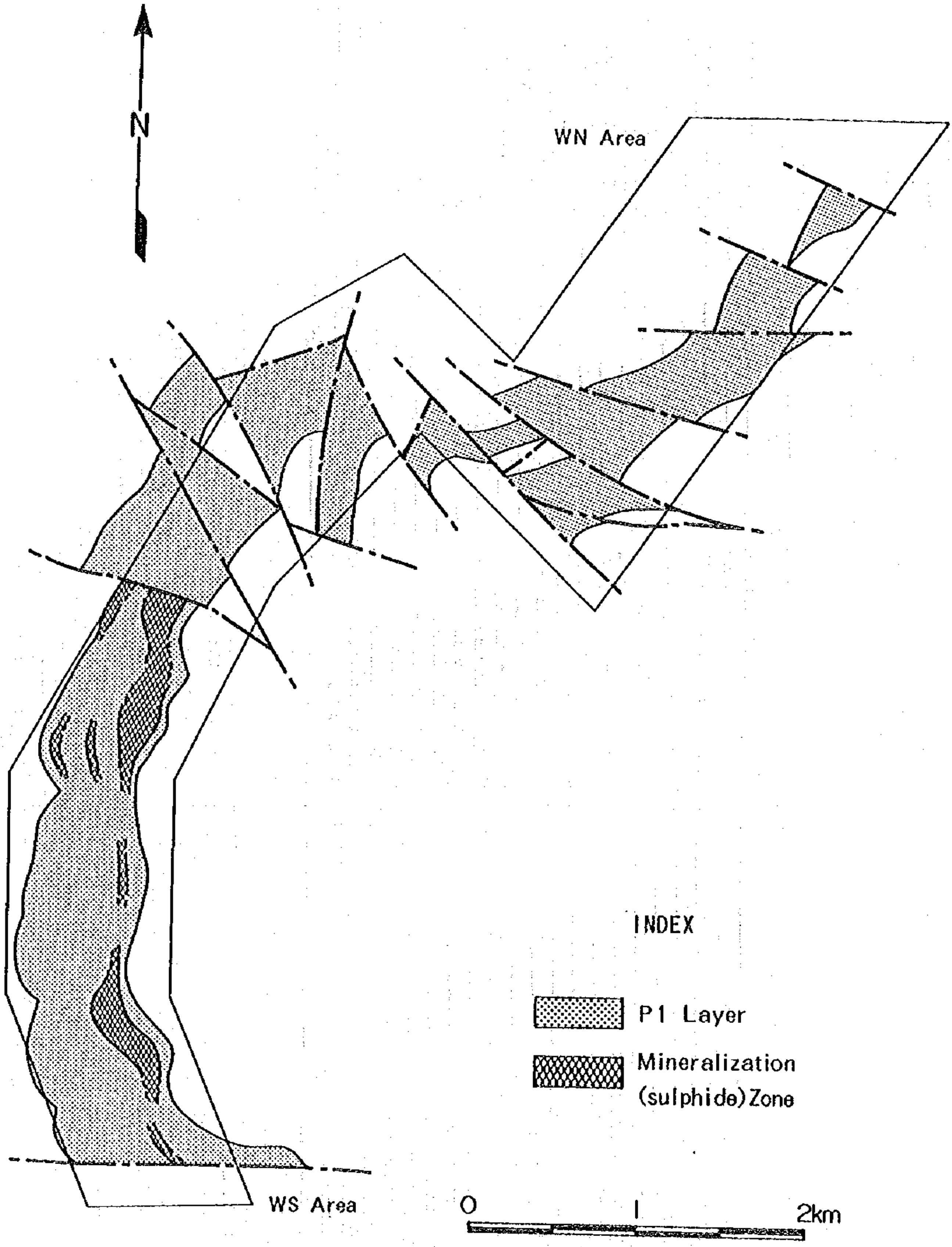


Fig.II-2-5-3 Distribution of sulphide mineralization (WN, WS area)

Table II-2-4 Results of the microscopic observations of polished section

No.	Sample Name	Rock name defined by microscopic obervation	Coordinate		Sulphides									Oxide minerals					Others			Texture
			Latitude	Lngitude	Py	Mc	Po	Pt	Cp	Bo	Cu	Vi	Ml	Mt	Go	Hem	Cr	Mal	Qtz	Ca	Ot	
5	WS1715	Websterite	E 30 ・ 53.94 ′	S 16 ・ -31.50 ′			◎	○	△	・		・		△								disseminate
7	WS1315	Websterite	E 30 ・ 53.72 ′	S 16 ・ -31.07 ′	△		○	◎	○			△										disseminate
10	WS1208	Websterite	E 30 ・ 53.81 ′	S 16 ・ -30.96 ′			○	△	△		・				◎							disseminate
14	WS0917	Clinopyroxenite	E 30 ・ 53.84 ′	S 16 ・ -30.62 ′		・	○	◎	○			△	・		△							disseminate
17	WS1208	Websterite	E 30 ・ 53.89 ′	S 16 ・ -30.18 ′		△	◎	○	○			・			△							disseminate
18	WS0515	Websterite	E 30 ・ 53.83 ′	S 16 ・ -30.18 ′	◎		○	○	○			・					・					disseminate
19	WS0511	Orthopyroxenite	E 30 ・ 53.72 ′	S 16 ・ -30.18 ′	◎		○	○	○			△			○							disseminate
21	WS0416	Websterite	E 30 ・ 53.91 ′	S 16 ・ -30.07 ′	◎	・	○	・	○	・												disseminate
22	WS0211	Websterite	E 30 ・ 53.94 ′	S 16 ・ -29.85 ′	・		◎	◎	○					・	・							disseminate
25	WS0113	Clinopyroxenite	E 30 ・ 54.02 ′	S 16 ・ -29.74 ′			○	○	○						・							disseminate
26	WS0113	Websterite	E 30 ・ 54.00 ′	S 16 ・ -29.74 ′	・	・	◎	○	○						・							disseminate
27	WS0111	Websterite	E 30 ・ 53.94 ′	S 16 ・ -29.74 ′			◎	○	○			・			・	・						disseminate
32	WS0211	Websterite	E 31 ・ 1.18 ′	S 16 ・ -28.54 ′			○	○	△	・					・							disseminate
33	ES0305	Websterite	E 31 ・ 1.52 ′	S 16 ・ -28.13 ′		・	○	◎	△			○			・							disseminate
34	CB1807	Clinopyroxenite	E 30 ・ 58.57 ′	S 16 ・ -30.33 ′			◎	○	○			・			△							disseminate
35	WS1206		E 30 ・ 53.47 ′	S 16 ・ -30.96 ′																		non sulphyde
36	CB1507		E 30 ・ 58.50 ′	S 16 ・ -29.87 ′	・		◎	△	・			・			○		△					disseminate
37	CB1504		E 30 ・ 58.43 ′	S 16 ・ -29.87 ′			◎	△	○						・							disseminate

※ ◎ : abundance ○ : common △ : minor ・ : rare

Abbreviation of mineral names

Py:pyrite Mc:marcasite Po:pyrrhotite Pt:penlrandite Cp:chalcopyrite Bo:bornite Cv:covelline Vi:violarite Ml:millerite

Mt:magnetite Go:goethite Hem:hematite Cr:chromite Mal:malachite Qtz:quartz Ca:carbonates Ot:other gangue minerals

Table II-2-5 Results of EPMA analysis

Samples		Fe(%)	Cu(%)	Ni(%)	Co(%)	S(%)	Total(%)
Sample :WS0113 Mineral:Pentlandite	Wt(%) Atm(%)	29.966 24.718	0.106 0.077	35.358 27.743	0.776 0.607	32.614 46.856	98.820 100.000
Sample :WS0113 Mineral:Pyrrhotite	Wt(%) Atm(%)	61.028 46.758	0.033 0.022	0.638 0.465	0.153 0.112	39.449 52.643	101.302 100.000
Sample :WS0211 Mineral:Pentlandite	Wt(%) Atm(%)	28.405 23.157	0.107 0.077	33.283 25.811	5.640 4.357	32.817 46.598	100.253 100.000
Sample :WS0211 Mineral:Violarite	Wt(%) Atm(%)	24.965 19.530	0.102 0.070	29.404 21.881	5.913 4.384	39.732 54.136	100.116 100.000
Sample :WS0515 Mineral:Pentlandite	Wt(%) Atm(%)	31.261 25.289	0.101 0.072	35.642 27.426	0.641 0.491	33.161 46.722	100.805 100.000
Sample :CB1807 Mineral:Pyrrhotite	Wt(%) Atm(%)	61.040 46.691	0.019 0.013	0.446 0.325	0.137 0.099	39.684 52.872	101.326 100.000
Sample :CB1807 Mineral:Chalcopyrite	Wt(%) Atm(%)	30.993 25.525	33.355 24.143	0.158 0.124	0.062 0.048	34.968 50.161	99.536 100.000

Samples		TiO2	V2O3	Al2O3	Cr2O3	Fe2O3	FeO	MnO	MgO	ZnO	Total
Sample :WS1715-1 Mineral:Magnetite	Wt%	0.38	0.09	0.72	1.17	66.68	31.25	0.08	0.26	0.00	100.64
Sample :WS1715-2 Mineral:Magnetite	Wt%	0.75	0.13	0.44	0.61	66.85	31.28	0.06	0.42	0.00	100.55
Sample :WS1507-1 Mineral:Chromite	Wt%	0.85	0.68	9.23	42.45	11.83	31.80	0.71	0.74	0.57	98.85
Sample :WS1507-2 Mineral:Chromite	Wt%	0.86	0.61	9.45	41.89	12.06	31.74	0.72	0.75	0.46	98.53

2-2-2 Selection of Areas for Soil Geochemical Survey

The areas of potentialities of PGM ore deposit occurrences are considered to be the distribution area of the P1 layer.

The rock sampling areas were determined based on the results of the existing data snalysis and geological survey.

The selected 5 areas based on the above criteria are listed as follows:

The locations where geochemical surveys were conducted are shown in Fig.II-2-6.

(EN area)

①	S16°26.17'	E31°01.91'	②	S16°26.35'	E31°02.60'
③	S16°27.28'	E31°02.34'	④	S16°27.19'	E31°02.02'
⑤	S16°26.60'	E31°02.19'	⑥	S16°26.49'	E31°01.80'

(ES area)

①	S16°28.05'	E31°00.45'	②	S16°28.12'	E31°01.32'
③	S16°27.52'	E31°01.79'	④	S16°27.75'	E31°02.13'
⑤	S16°28.52'	E31°01.54'	⑥	S16°28.44'	E31°00.38'

(CB area)

①	S16°27.37'	E30°58.15'	②	S16°27.32'	E30°58.67'
③	S16°30.64'	E30°58.84'	④	S16°31.30'	E30°58.34'
⑤	S16°31.03'	E30°57.94'	⑥	S16°30.63'	E30°58.32'

(WN area)

①	S16°28.85'	E30°54.32'	②	S16°28.59'	E30°54.77'
③	S16°28.94'	E30°55.10'	④	S16°28.15'	E30°55.73'
⑤	S16°28.15'	E30°56.58'	⑥	S16°29.76'	E30°55.38'
⑦	S16°29.19'	E30°54.80'	⑧	S16°29.68'	E30°54.32'
⑨	S16°29.68'	E30°53.80'			

(WS area)

①	S16°29.68'	E30°53.80'	②	S16°29.68'	E30°54.32'
③	S16°30.31'	E30°53.99'	④	S16°31.04'	E30°53.98'
⑤	S16°31.70'	E30°54.26'	⑥	S16°31.72'	E30°53.70'
⑦	S16°31.03'	E30°53.42'	⑧	S16°30.29'	E30°53.44'

2-2-3 Sampling

Survey lines wrer established crossing the P1 layer. The samples were collected in the interval of every 50 metres on th survey line. The locations were positioned with the pocket compass, measurering rope and GPS. When the samples were collected, the rock facies, the tone of colour,and the mineralization were described to understand the adjacent geology.

Summary of the rock sampling is as folloes.

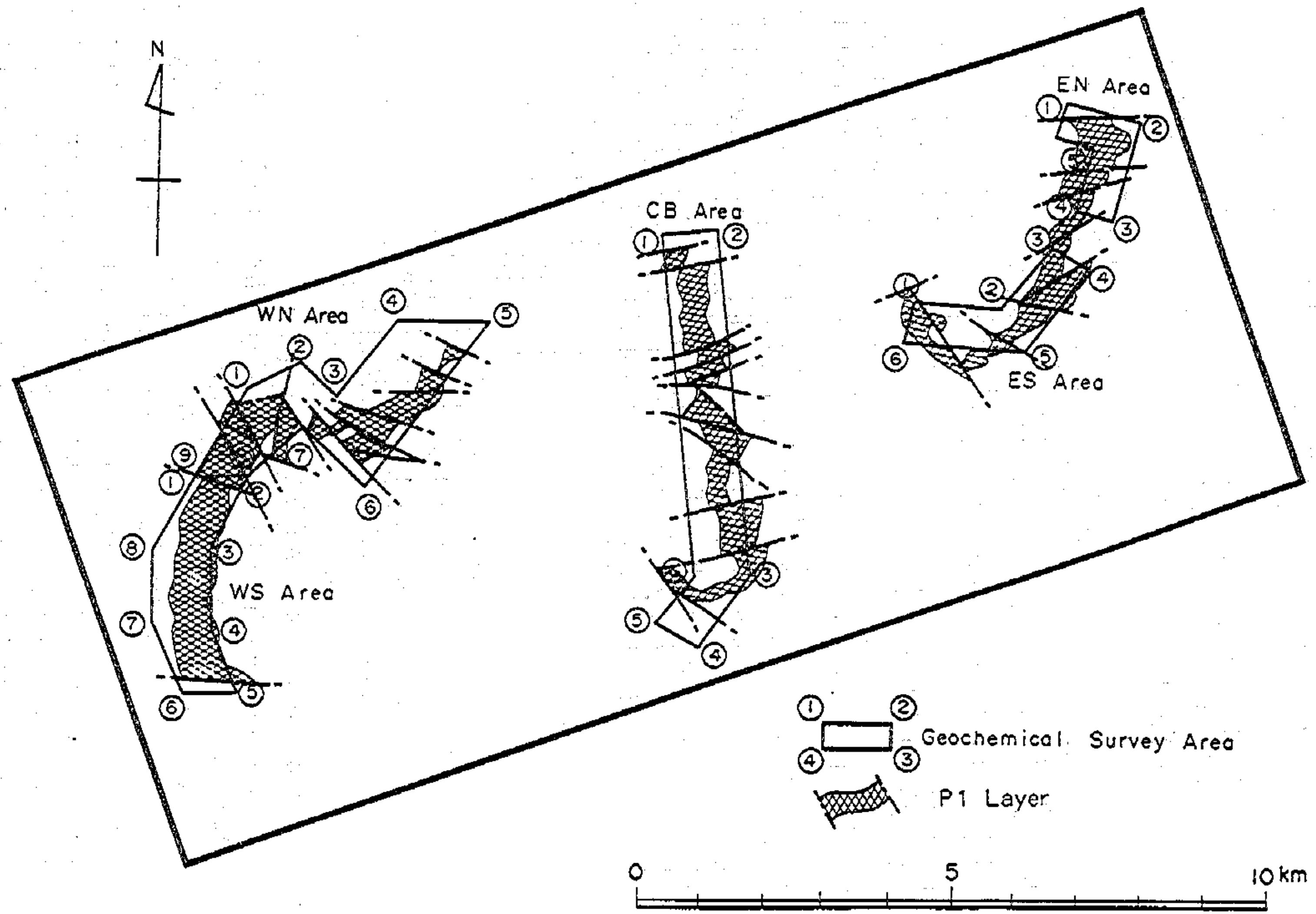


Fig.II-2-6 Locality of geochemical exploration area

Table II-2-6 Outline of the geochemical survey

Area Name	Square(km^2)	No.of lines	No.of samples
E N Area	1.5	6	78
E S Area	3.75	9	114
C B Area	7.0	20	340
WN Area	6.2	23	473
W S Area	3.8	17	361
Total	22.25	75	1,366

The sampling positions are shown in Fig. II-2-7-1 to 3.
The list of samples are shown in Appendix A-3.

2-2-4 Indication Elements

The numbers of the analyzed elements are 8. They are Au, Ag, Cu, Co, Ni, Pt, Pd and Rh. The analyzing methods and detectable limits for all the chemical elements are shown in Table II-2-7. The results of chemical analyses are shown in Appendix A-4.

Table II-2-7 Analytical methods and detectable limits of the chemical analyses

Element	Analytical method 1)	Detectable limit	
Au	AAS (Frameless)	1	ppb
Ag	AAS	0.01	ppm
Cu	AAS	1	ppm
Co	AAS	1	ppm
Ni	AAS	1	ppm
Pt	AAS (Frameless)	10	ppb
Pd	AAS (Frameless)	10	ppb
Rh	AAS (Frameless)	10	ppb

1) AAS: Atomic Absorption Spectrochemical method

2-2-5 Statistical Processing of the Analyzed Values

In case of the geochemical data analysis, the frequencies of the population of trace elements are empirically known to follow logarithmic normal distribution (Lepeltir, 1969). It is general that actual populations of geochemical data consist of several kinds of population whose geochemical characteristics are different. Therefore, anomalous values are generally determined by focusing the deviation (anomalous populations) from the logarithmic normal distribution (the background population) which is formed by most of the indication elements. For the univariate analysis in this study, however, the gap between the standard deviation multiplied by an integer and the geometrical mean value are adopted as a threshold in order to define the density distribution of the content of each component, that is, the concentration contour value I_{ij} for i times of the standard deviation is calculated as ;

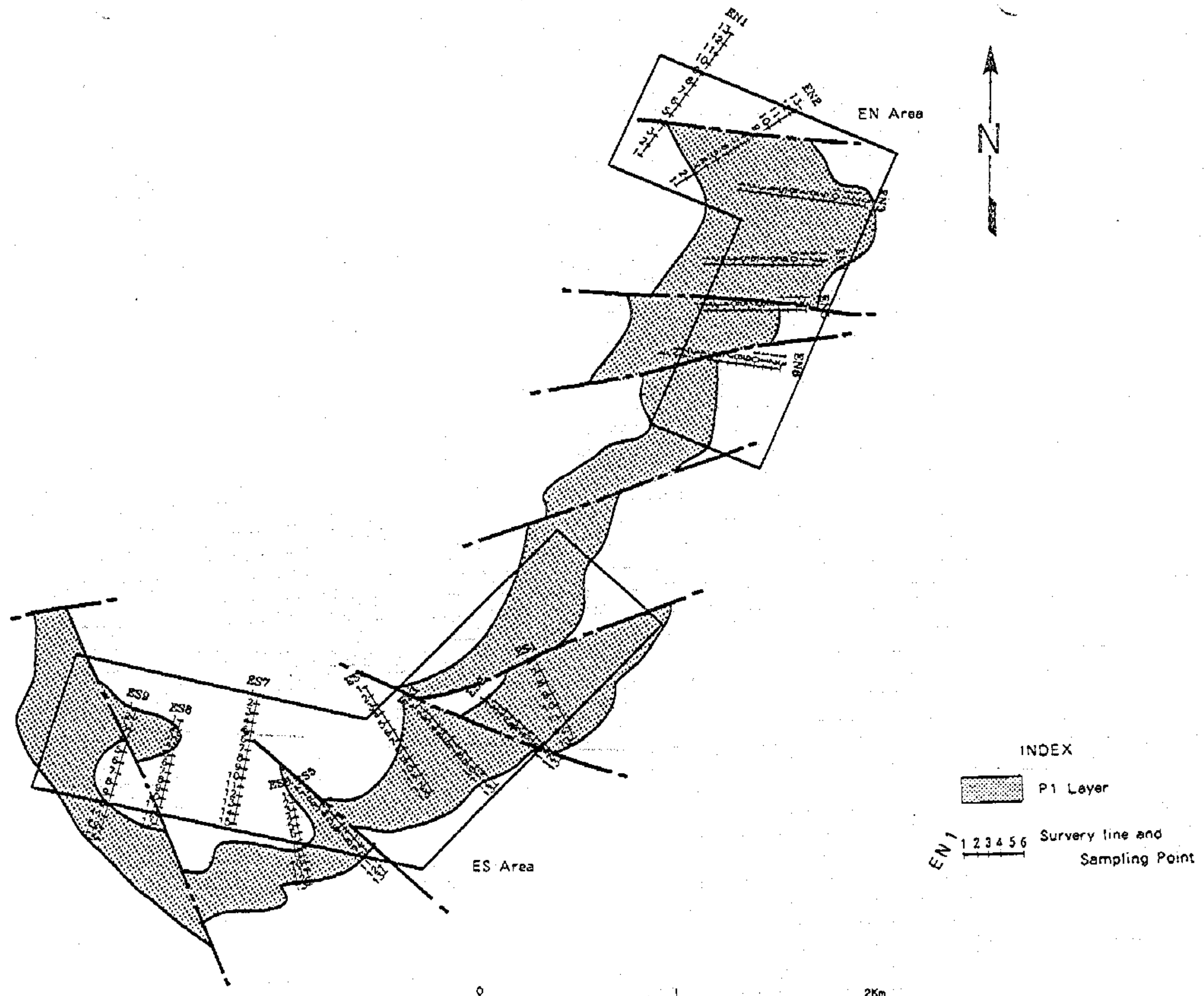


Fig.II-2-7-1 Locality of geochemical sampling sites (EN, ES area)

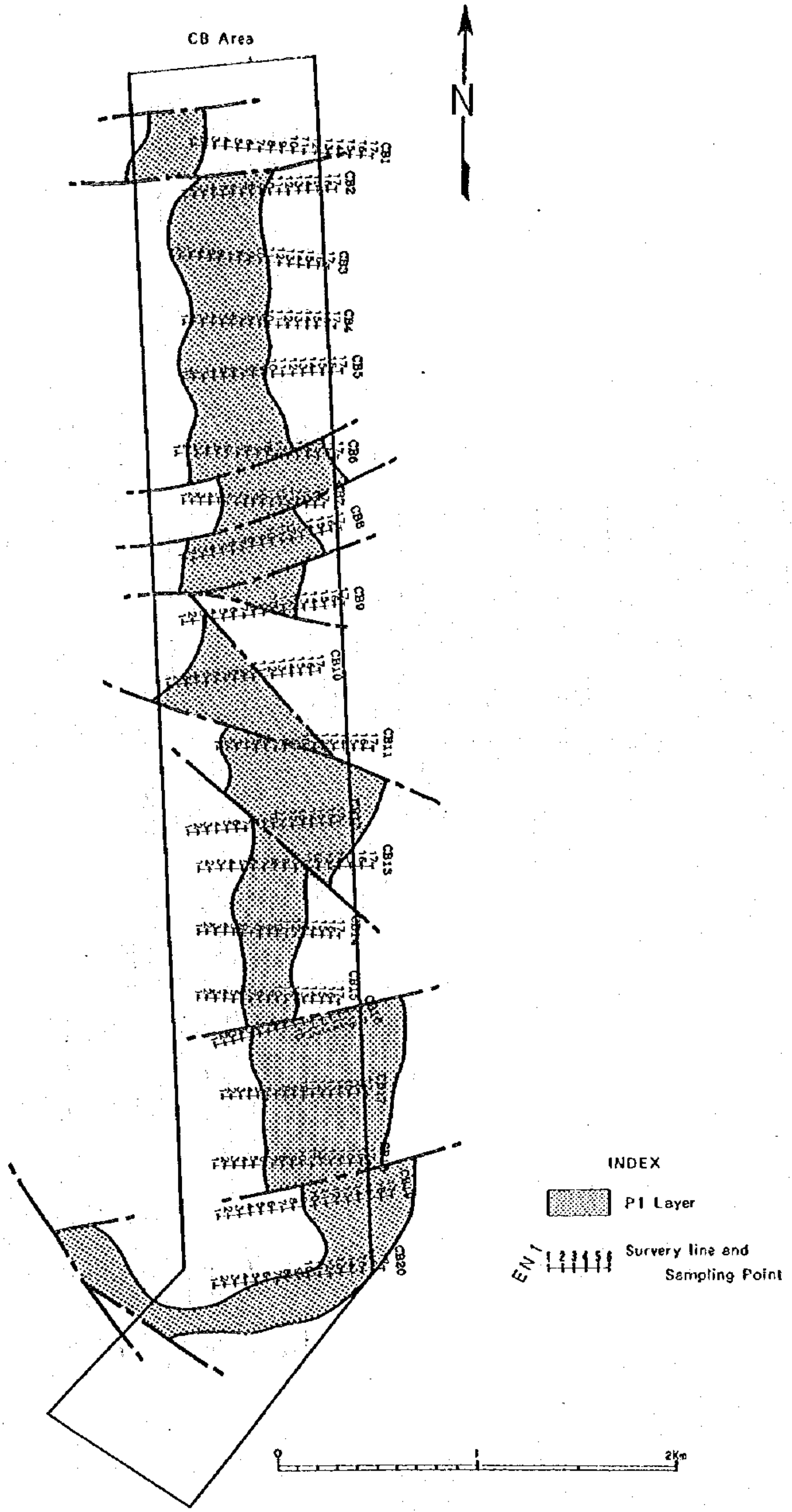


Fig.II-2-7-2 Locality of geochemical sampling sites (CB area)

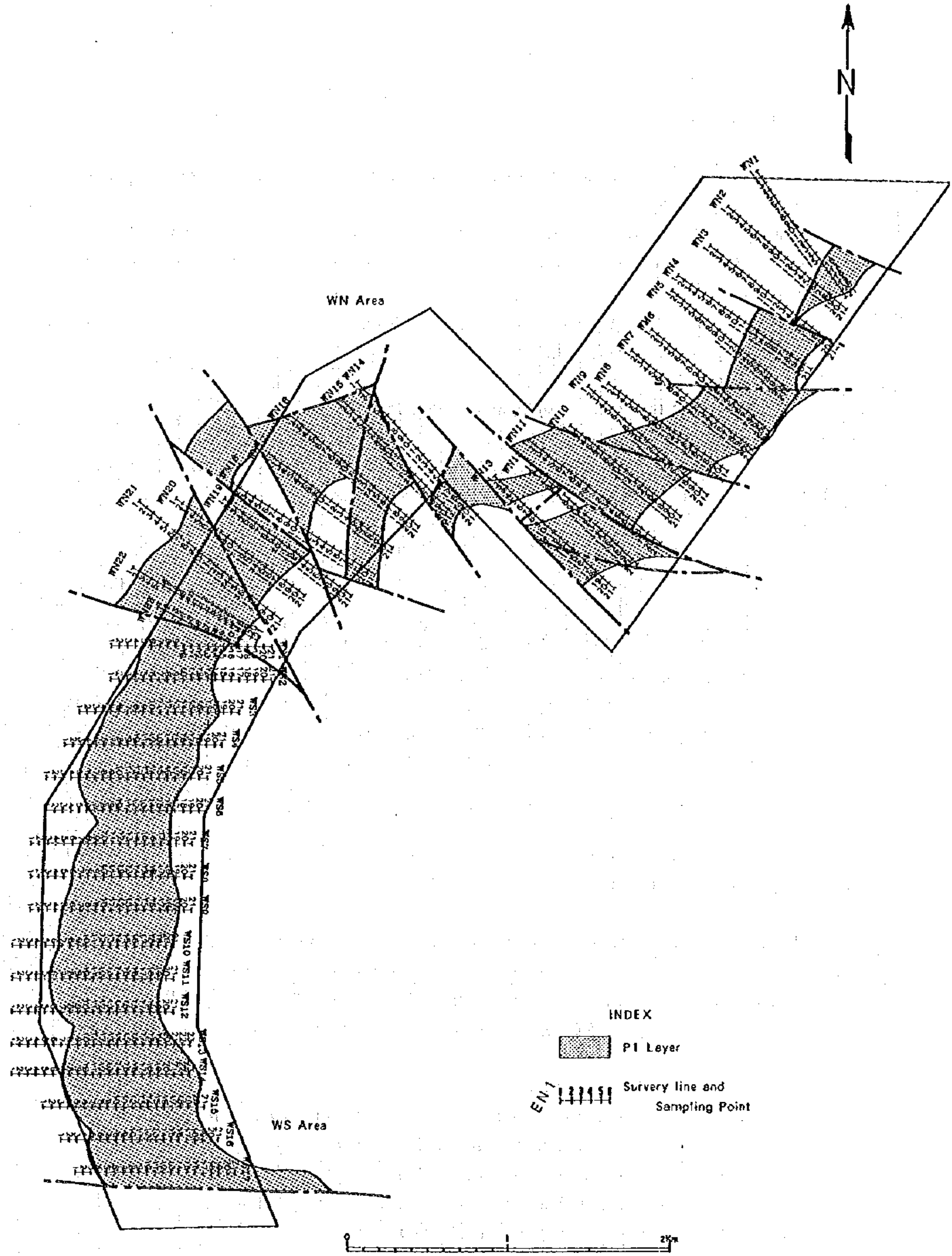


Fig.II-2-7-3 Locality of geochemical sampling sites (WN, WS area)