REPORT

ON

THE MINERAL EXPLORATION

IN

THE ZACUALPAN AREA,

THE UNITED MEXICAN STATES

(PHASE Ⅰ)

Preface

The Japanese Government decided to conduct a mineral exploration program consisting of geological, geochemical and geophysical surveys in the Zacualpan area, in response to the request from the Government of the United Mexican States. The purpose of the program is to estimate its potential for mineral deposits. The Japanese Government entrusted the implementation of this plan to the Japan International Cooperation Agency (JICA) and JICA entrusted the enforcement of the program to the Metal Mining Agency of Japan (MMAJ) due to the specialty of the program. MMAJ started the survey program in the fiscal year of 2001 and dispatched a five members survey team to Mexico from January 31 to March 12, 2002.

The field survey program in the area has completed as scheduled in cooperation with the Consejo de Recursos Minerales and the concerned Governmental organizations of Mexico.

Finally, We would like to express a deep appreciation for the cooperation of the concerned Governmental organizations of Mexico and Japan.

March 14, 2002

Takao Kawakami
President
Japan International Cooperation Agency

Norikazu Matsuda
President
Metal Mining Agency of Japan

Summary

The survey has been performed in the Zacualpan area to estimate the mineral potential for volcanogenic massive sulfide ore deposits and other types of gold, silver, copper and zinc deposits, through an interpretation of results of geological and mineral occurrence surveys.

A regional geological survey, total survey line length 500 kilometers, for the whole survey area and a geological description for the existing drilling cores have been performed as the first year's program.

The result of the geological survey has revealed that the survey area is underlain by the Tejupilco Schist, Villa Ayala Formation, Acapetlahuaya Formation and calcareous sedimentary rocks in the Guerrero terrene and the Morelos Formation in the Mixteco terrene. Those are overlain by Cenozoic Balsas Formation and Tilzapotla Rhyolite Formation and are intruded by intrusive rocks. It has been made clear that the rocks of the Guerrero terrene have undergone strong deformation.

The mineralization in the area is of two types, massive sulfide type and vein type. It has been made confirmed that the massive sulfide ore deposits in the Guerrero terrene were formed at the last stage of the green volcanic rocks activity of the Villa Ayala Formation. Furthermore, the stratigraphic horizon of the deposits has been defined. This stage of volcanic activity is of a little acidic compared with that of their footwall activity. The hanging wall is composed of alternation beds of volcanic and sedimentary rocks. It means that the sedimentary environment of the rocks was under specific condition. The mineral occurrences in the Manto Rico, Tlanilpa, Aurora and Azulaquez districts are in this specific geological environment. The detailed geological-structure of those districts is not clear due to the strong deformation.

The vein-type ore deposits in the area are mainly of silver, lead and zinc, and some mines nearby Zacualpan are in operation at present. It is, however, judged that the potential for economically valuable ores is low.

Based on the above-mentioned results, following surveys are recommended for the second year's program.

1. Geological and geochemical surveys for the areas distributing the hanging wall tuff

and sedimentary rocks.

2. Structure drilling in the hanging wall area.

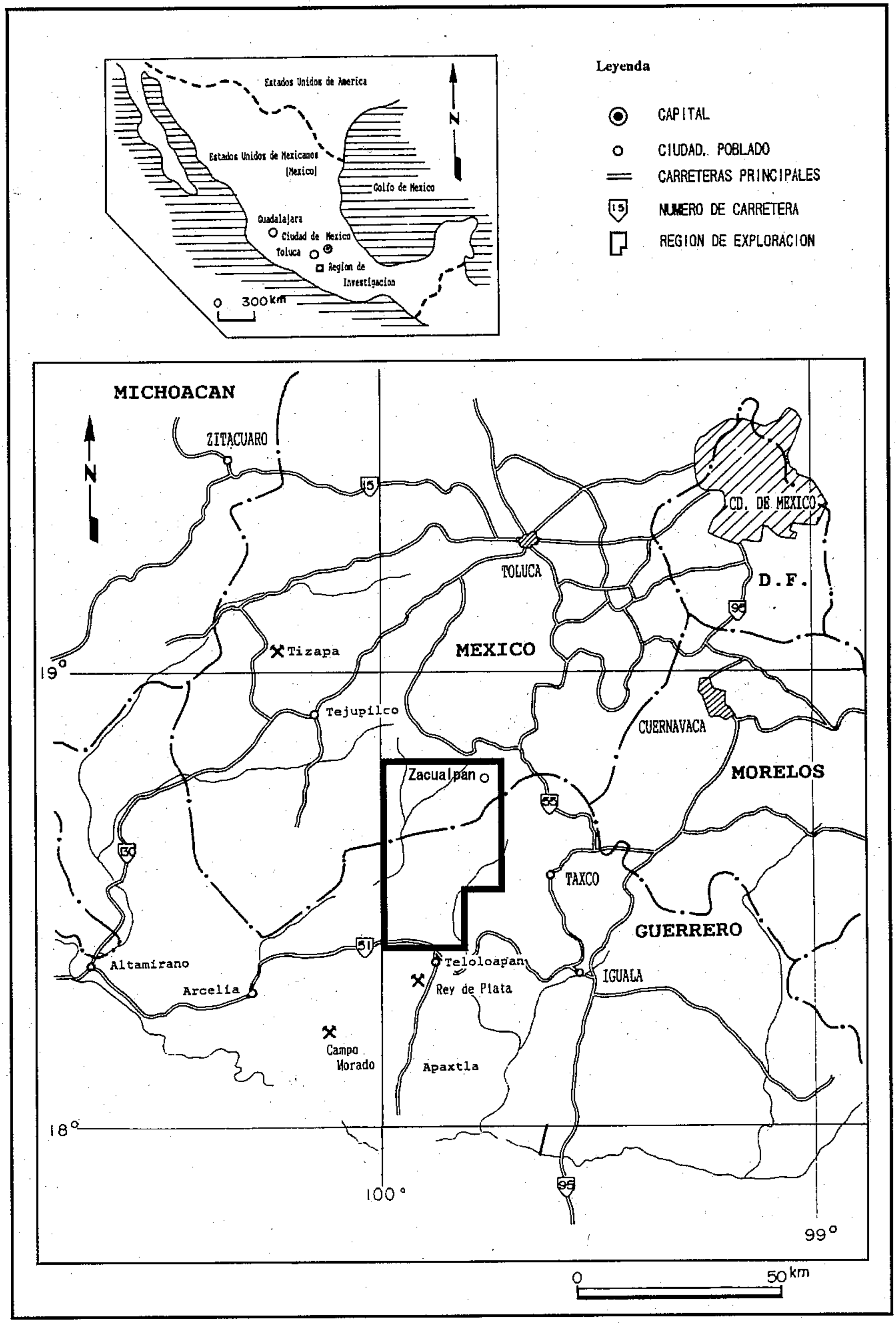

Fig. 1 Location map of survey area

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Part Ⅰ The General

Chapter 1 Introduction

1-1 The background and objective of the survey

The Zacualpan area in the United Mexican Sates, target area for the survey, is of high potential for the massive sulfide deposits containing polymetallic ore, similar type of the Japanese Kuroko ore deposits. The Consejo de Recursos Minerales, (hereafter noted as CRM) has aggressively conducted some exploration programs for the area in the past. The Mexican government requested the Japanese government to survey for mineral resources in the Zacualpan area.

The Japanese government responded to the request and decided to conduct an exploration program to locate some potential zones for gold, silver, copper, lead and zinc minerals of the massive sulfide and other types of ore deposits. The program was planed to survey the geology and mineral occurrences in the field and to analyze those results.

1-2 Contents of the survey

The survey area is shown in Fig.1 and covered an area of about 1,100 km^2 and defined by following points.

NW corner : North latitude 18° 45′00″, West longitude 100° 00′00″
NE corner : North latitude 18° 45′00″, West longitude 99° 45′00″
SE side : North latitude 18° 30′00″, West longitude 99° 45′00″
SE center : North latitude 18° 30′00″, West longitude 99° 47′00″
SE down : North latitude 18° 23′00″, West longitude 99° 47′00″
SW corner : North latitude 18° 23′00″, West longitude 100° 00′00″

Contents and amount of the survey are listed in following table.

Contents	Amount	Object
Geological Survey	500km linear route	1,100km^2(whole area)
Description of Core	4,000m	Preserved core of previous surveys

1-3 Participant member list of the survey

(1) Members participating in planning and negotiation.

Japanese side

Naotoshi Sugiuchi	Executive Director, MMAJ
Hitoshi Nakamura	Assistant Section Chief, Mineral Natural Resources Division Ministry of Economy, Trade and Industry
Shyobu Nagatani	Deputy director, Energy and Mining Development Study Division, JICA
Hiroshi Shimotori	Director, Mineral Resources Survey Department, MMAJ
Yuri Torizawa	Technical Cooperation Division, MMAJ
Masayoshi Itoh	Representative of Mexico City office, MMAJ
Hidemitu Sakurai	Director of Operation, JICA Mexico office

Mexican side

Dr. Francisco Escandon Valle	Director General, CRM
Ing. Enrique Gómez de la Rosa	Director de Operación
Dr. Francisco Querol Suñe	Assesor de la Coordinación Gneral de Mineria
Dr. Francisco Querol Suñe	Assesor de la Coordinación Gneral de Mineria
Ing. Raul Morales Garcia	Subdirector de Servicios Técnicos CRM
Ing. Felix Ubaldo Alarcón López	Gerente de Proyectos Mineros CRM

(2) Members participating in the field survey in Mexico.

Survey team

Japanese side

Shigehisa Fujiwara	Head of survey team, Dowa Engineering co. ltd
Kazuyuki Ueda	Dowa Engineering co. ltd
Naoyuki Doi	Dowa Engineering co. ltd
Akira Saito	Dowa Engineering co,ltd
Masahiro Suzuki	Dowa Engineering co,ltd

Mexican side

Ing. Felix Ubaldo Alarcón López	CRM
Ing. Gerardo Mercado Pineda	CRM

Ing. Arturo Ruiz Ortiz	CRM
Ing. Diego Edgar Cruz López	CRM
Ing. Oniver Cruz Lemus	CRM
Ing. Enrique Ontiveros Escobedo	CRM

<u>Supervisor in Mexico</u>

Tadashi Itoh	Director, Mineral Resources Survey Department, MMAJ
Masayoshi Itoh	Representative of Mexico City office, MMAJ

1-4 Period of the survey

Field survey was carried out as follows.

Whole term stayed in Mexico:

January, 31, 2002 ～ March, 12 , 2002

Field survey term:

February, 6, 2002 ～ March, 1, 2002

Analysis and compilation of field data

March, 2, 2002 ～ March, 8, 2002

Chapter 2 Geography of Survey Area

2-1 Location and access

The Zacualpan area is situated to the southwest of Mexico city, in Guerrero and Mexico states. Principal villages in the survey area are Zacualpan, Ixcateopan Ixcapuzalco and Teloloapan having population 16,000 is the largest village around the area, to the south of the survey area. Base camps for the survey have been set at Teloloapan and Zacualpan. The survey area is situated in the administrative districts of the above village names.

Access to Teloloapan from Mexico City is possible in three hours by vehicles through the highway via Iguala. To reach Zacualpan from Mexico city, it is possible to use the highway through Toluca, taking the same hours. An outline of the access is shown as follows.

	200km		65km	
Mexico city	------------	Iguala	-------------	Teloloapan
	2 hours		1 hour	

A branch paved road from Highway No.51 connects Teloloapan and Ixcapuzalco. Other paved roads from the northeast of the survey area to Zacualpan and from the east to Ixcateopan are available. There exist other gravel roads connecting each village, but it will become hard to use those roads in rainy season.

2-2 Topography, climate and vegetation

The survey area is geographically in the Sierra Madre del Sur (Raiz 1959) and included in the Balsas-Mexcara sub-province near by the Neo-volcanic axis.

The northern area is in a high altitude area and shows many steep V-shape valleys, but its altitude is getting lower toward south. The topography in the southern area shows relatively gentle low land area. The Sultepec River in the west end of the area is 700 meters in lowest altitude and Cerro Tentacion to the south of Zacualpan is 2,710 meters, highest in the area.

The drainage systems in the area are divided into three, separated by the

Cerro Tentacion. The Sultepec River system occupies about 60 percent of the whole survey area and rivers running down to the southwest from the watershed have been formed in the system area. The Los Sabinas River system occupies the southeast part of the survey area and rivers running down to the south and southeast have been formed. The San Jose River system occupies about 10 percent of the whole area at the northeast end and rivers running down to the east have been formed. These systems constitute branches of the Balsas River.

The climate in the area is of tropical to subtropical and its rainy season is from the end of June to October, dry season from November to May. The average annual rainfall is 1,100 to 1,400 millimeters and the average temperature is 18℃ in Zacualpan.

The vegetation in the area is dominated by tall weeds in the lowland area, lower than 1,800 meters in altitude. Some cornfields are partly seen there. In the highland area, pine and oak trees grow scarcely.

2-3 Infrastructures

Electricity, communication and medical facilities are satisfactory available in Teloloapan, one of our base campsite and two major bank offices are situated in the village. Three gas service stations are locate along Highway No.51. In the other villages in the area, electricity and communication facilities are available, but no bank and gas station are available. Satellite communication facilities are available in some small villages and mobile telephones are useable along almost all roads and mountain or hill ridges.

The road networks are generally well developed, but almost all roads are not paved and difficult to transit in the rainy season. It will be usual that all roads, except major ones, blocked everywhere in July and August.

Chapter 3 Outline of Geology

3-1 Outline of existing survey

Some regional geological survey programs have been conducted in the area by some investigators such as Fries (1960), De Cserna (1965 and 1978) and Campa et al., (1974) and some geological frameworks for the region have been established. Campa et al., (1974, 1978 and 1979), specially, proposed a development history model of the geological structure for an area named "Tierra Caliente" based on description of volcano-sedimentary rocks of the Ixtapan de la Sal area. Coney and Campa (1987) and Sedlok et al., (1993) proposed classifications of geological structure zones for the whole area of Mexico respectively. The survey area of this report corresponds to the boundary between the Guerrero Terrene and Mixteco Terrene, based on the classification by Coney and Campa (1987).

De Cserna and Fries (1983), Guerrero et al., (1990, 1991 and 1993), and Elias and Sanchez (1992) demonstrated a very detailed stratigraphic succession and a development history of the geological structure for the volcano-sedimentary rock area. CRM has started survey programs for massive sulfide ore deposits hosted in the volcano-sedimentary rocks in the area, as a part of "Eje Neovolcanico" project in 1979 for the Tlanilpa-Mamatla-Azulaquez area. Recently Valerie Gold Resources Ltd. was carried out mineral exploration on Mamatla property in 1994-1998.

3-2 Outline of geology

The geology of the survey area is well summarized in the geological and economic geological map quadrangle of "Teloloapan" and "Pilcaya" by Serratos et al., (1999), scaled 1 to 50,000 and some geological maps by CRM, scaled 1 to 25,000. Figure I-3-1 and Figure I-3-2 show the compiled geological map and schematic geological columnar sections.

The survey area is situated in the Teloloapan terrene constituting part of the Guerrero terrene and the Mixteco terrene in the eastern survey area, based on the regional geological structure zone classification.

The stratigraphic succession in the Teloloapan terrene side is the Tejupilco

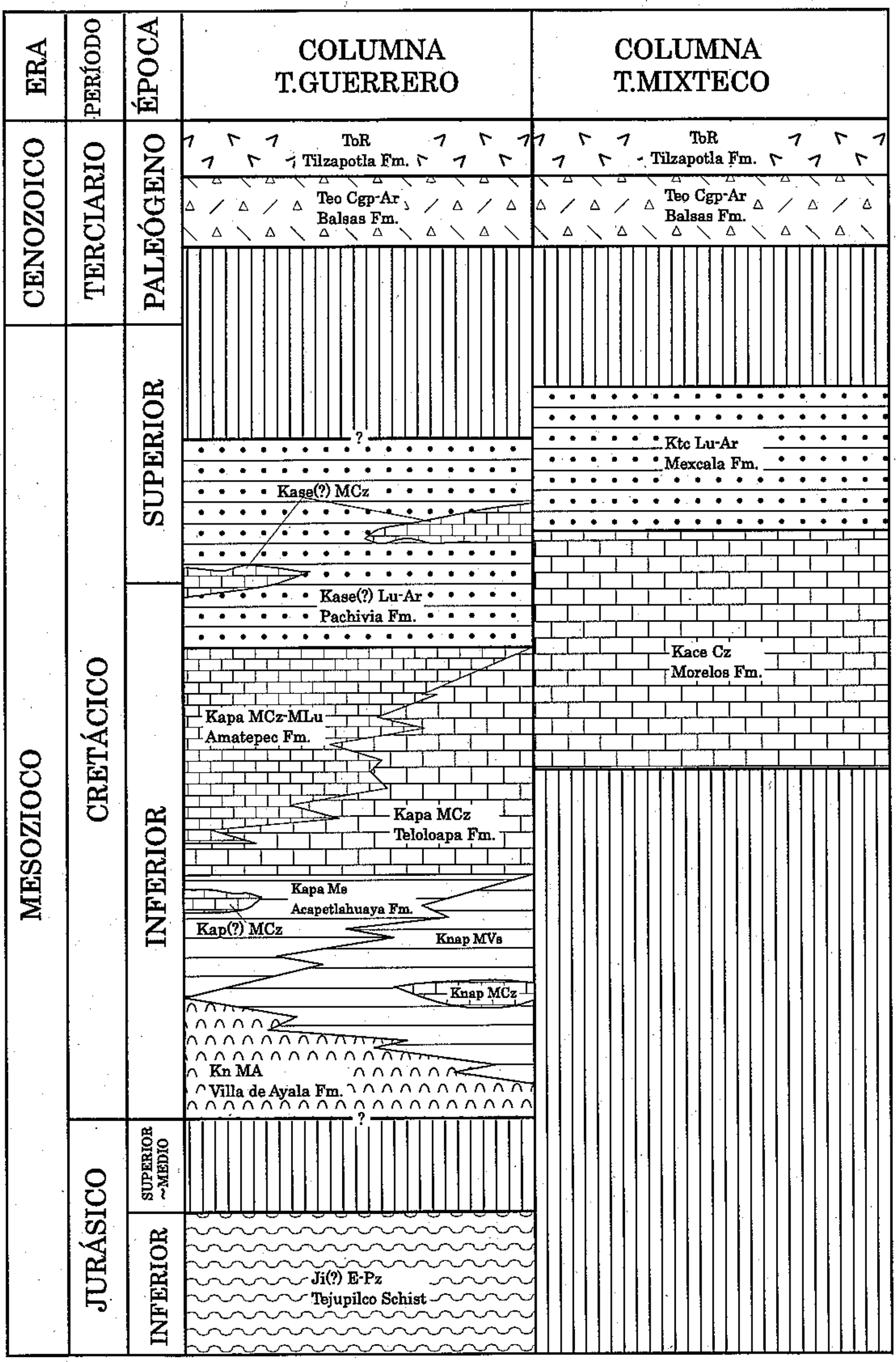

Fig. I − 3 − 1 Schematic stratigraphic column of previous works

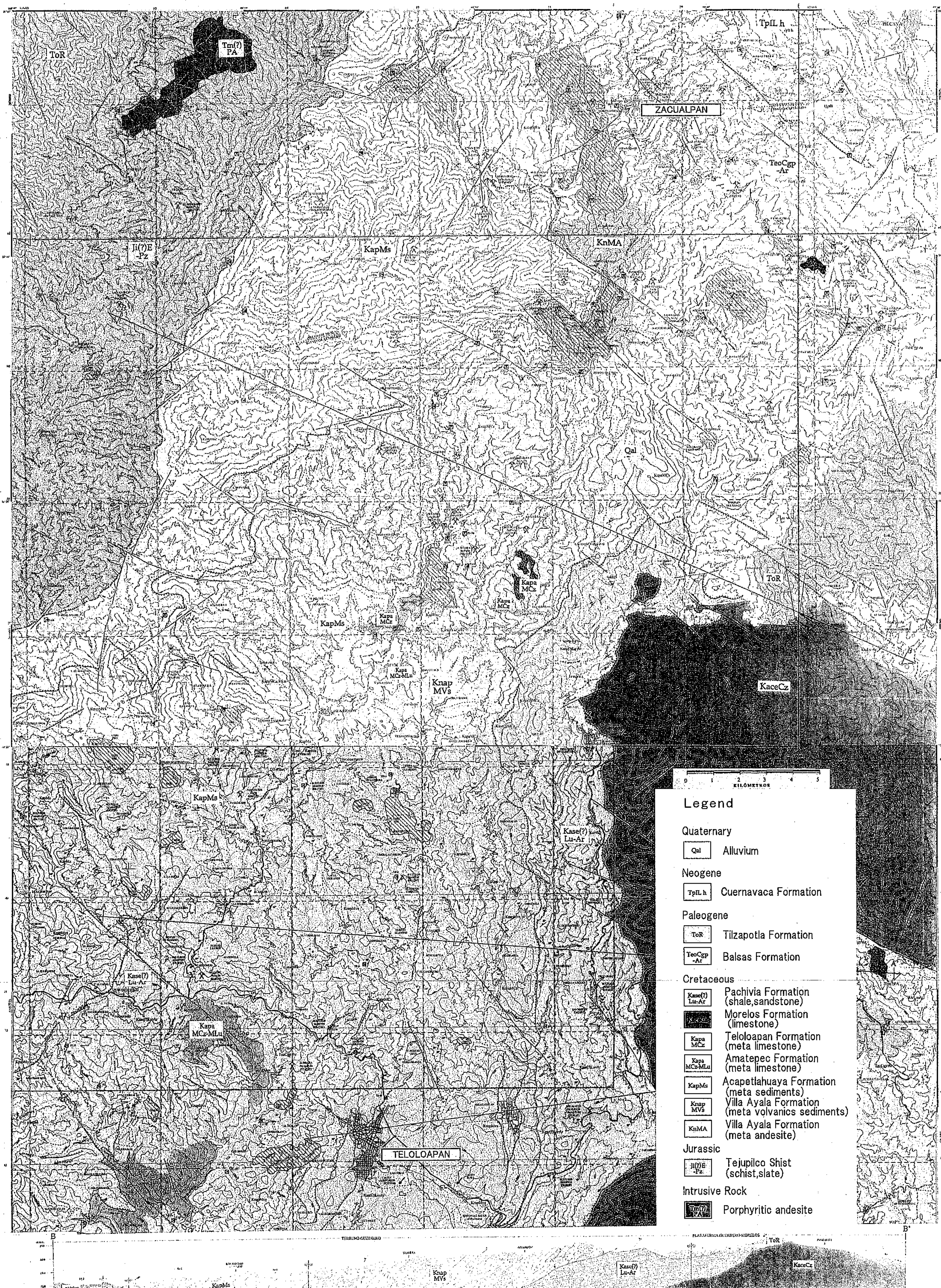

Fig. I − 3 − 2 Geological map of previous works

Schist, Villa de Ayala Formation (metavolcanic and sedimentary rocks), Acapetlahuaya Formation, Amatepec Formation (simultaneous difference phase with Acapetlahuaya) and overlying Teloloapan and Pachivia Formations, from the bottom. The Mixteco terrene is consists of the Morelos and Mexcala Formations. These Formatios are unconformablly covered by the Balsas Formation and Tilzapotla Formation of Tertiary age, Cuernavaca Formation of Pliocene and alluvial sediments.

The Tejupilco Schist was identified in the Tejupilco map by De Cserna (1983) and Amatepec map by Serratos et al., (2000) and mainly consists of pelitic and psammitic schist accompanied with green schist.

The Villa de Ayala Formation was defined by Guerrero (1990) and consists of alternation of basaltic to andesitic lava, pillow lava, autobrecciated lava and dacitic to rhyolitic pyroclastic rocks. The age of this formation is not clear in this moment, but assumed as early Cretaceous to late Jurassic time.

The Acapetlahuaya Formation was identified by Guerrero et al., (1991) as an overlying transitional facies of the Villa de Ayala Formation and is composed of alternation beds of conglomerate, pyroclastic rocks and tuffaceous mudstone.

The Amatepec Formation was defined by De Cserna (1978) and consists of calcareous sedimentary rocks accompanied with tuffaceous sedimentary rocks.

The Teloloapan Formation is composed of limestone (three meters in thickness) containing abundant fossils (Guerrero et al., 1990). The formation is of Aptian to Albian time of the Cretaceous.

The Pachivia Formation consists of muddy, calcareous, sandy, or tuffaceous sedimentary rocks derived from turbidite and its age seems to be the late Cretaceous.

The Morelos Formation in the Mixteco terrene is of Albian to Cenomanian age (Fries, 1990). The formation is composed of layered limestone accompanied with thin beds of chert in the lower part, fossiliferous limeston in the middle part and stratified limestone in the upper part.

The Mexcala Formation is of the late Cretaceous and described by Fries (1960). It mainly consists of sandstone, siltstone and calcareous mudstone, and transitionally changes from the underlying Morelos Formation.

The Balsas Formation consists of Eocene to Oligocene continental sedimentary rocks (Fries, 1960), and is composed of calcareous conglomerate, sandstone, tuffaceous siltstone and gypsum.

The Tilzapotla Formation is of the Oligocene (Fries, 1960) and consists of rhyolitic volcanic rocks.

The Cuernavaca Formation is composed of Pliocene sedimentary rocks mainly consisting of conglomerate, sandstone and siltstone.

The Guerrero terrene has undergone the Laramide orogeny in early Tertiary time (Salinas et al., 1994) and shows ductile deformation, isoclinal folding and thrust faulting extending north to south. Generally it shows an east vergence. On the contrary, the Mixteco terrene shows no ductile deformation, and it is said that the terrene has undergone compaction stress from east to west.

A fault group trending northwest to southeast appears in this area after the Laramide orogeny. It is possible that this fault group has been formed in a tension field from northeast to southwest. Vein type ore deposits nearby Zacualpan are hosted in this fault group.

3-3 History of mining in the area

A private company was aggressive for mining activity for the Azulaquez massive sulfide deposit in the area from 1915 to 1920, and it is said that the Aurora, Capire, San Francisco, Guadalupe, Cruz Blanca and San Antonio deposits were developed at that time (Ochoa et al., 1985). These mines were closed because of deletion of ore reserves.

Peñoles Company conducted a geophysical and drilling program in this district in 1975, but they withdrew from the Azulaquez district.

La Campana Company operated the Rey de Plata mine, about 10 kilometers southwest of Teloloapan, applying open-pit and underground mining methods from 1946 to 1949. The main target was silver. Afterward, Peñoles conducted a drilling and underground adit exploration program from 1975 to 1991 and confirmed around 2,000,000 tons of massive sulfide ore reserve after 24,000 meters drilling. Recently

Industria Peñoles S.A. de C.V. Dowa Mining Co., Ltd. and Sumitomo Corporation started operation of Ray de Plata mine in October 2,000 at a rate of 3,000tones per month. But it was suspended because of low price of Zn in December 2001.

In Zacualpan, many vein type ore deposits of silver, lead and zinc have been developed since the Spanish colony time, however only the Cuchara and La Alacrán mines are in 350 tons a day operation by El Provenir de Zacualpan S.A. de C.V. at present.

Chapter 4 Integrated Discussion of Survey Result

4-1 Characteristics of geological structure and mineralization

The most part of the survey area, except the eastern part, is geological structurally situated in the Guerrero terrene. The eastern survey area is in the Mixteco terrene. The Guerrero terrene consists of mainly strongly deformed marine sedimentary rocks, on the contrary the Mixteco terrene is of limestone of the Morelos Formation. These two terrenes are in thrust fault contact and overlain by Cenozoic continental sedimentary and volcanic rocks.

The marine sedimentary rocks in the Guerrero terrene are divided into three stratigraphic units by the middle, green submarine volcanic rocks of the Villa Ayala Formation, that is the lower unit consists of Tejupilco Schist containing low-grade metamorphic rocks derived from muddy and sandy rocks and the upper unit consist of Acapetlahuaya Formation and calcareous sedimentary rocks (Teloloapan and Pachivia Formations) consisting of calcareous meta-sedimentary rocks. It means that the activity of the green ocean-floor volcanic rocks of the Villa Ayala Formation changed its sedimentary environment from reductive to oxidative.

The most part of the Villa Ayala Formation is composed of basaltic and andesitic lava and its hyaloclastite. A dacitic volcanic activity occurred at the last phase of the activity and formed an alternation layer of muddy to calcareous sedimentary rocks. It is assumed that the massive sulfide mineralization rich in lead and zinc occurred at the same time. Also it is assumed that fine grained sulfide lenses in the Aurora and Capire deposits and very fine grained ores found in drilling cores have deposited or re-deposited in relatively distal position to mineralization center, judging from the lack of significant alteration zone and its sedimentary texture.

The dacitic volcanic rocks are locally distributed only in a part of the Aurora area and this phenomenon is important to conduct exploration programs.

In the Tizapa, the deposit hosted in the Guerrero terrene, rocks of rhyolitic to dacitic lava are distributed. In the Rey de Plata deposit, the ores are hosted in rhyolitic to dacitic volcanic rocks and muddy sedimentary rocks. The ore horizon of these ore deposits is situated above the green ocean floor volcanic rocks and below the calcareous sedimentary rocks.

The Tizapa and Rey de Plata deposits have undergone regional deformation in several times after their deposition and the ore bodies have been complicatedly deformed by strong folding activity. The strong folding structure is seen in the survey area, making geological structure complicated.

The Guerrero and Mixteco terrenes have been in the same environment since Tertiary time and vein type deposits have been formed. Ag-Pb-Zn vein-type deposits represented by the Taxco deposit outside of the survey area has been in operation since the Spanish colony time up to present.

It is thought that these ore deposits were formed in a northeast trending minimum stress field. Accordingly, northwest trending steep veins exist in the area, however other north to south and northeast trending veins also exist.

Same fissure filling type vein deposits are in operation in the Zacualpan area and the bonanzas are mainly hosted in the calcareous rocks.

4-2 Potential for ore

The massive sulfide ore deposits in the Guerrero terrene such as Tizapa and Rey de Plata are commonly hosted in the upper horizon of the green volcanic rocks. This trend is also recognized in the whole survey area.

The Mamatla district shows the strongest alteration effect in the green volcanic rocks, however the stratigraphic horizon of the green volcanic rocks is lower than the common ore horizon.

Alteration of the footwall in the Aurora area (including Otates, Tlanilpa, Capire, Azulaques) is not clear, however some acidic volcanic and calcareous sedimentary rocks concerning simultaneous with mineralization are distributed there. Accordingly it is judged that this area has high potential for ore. No potential is noted for surrounding areas of other massive sulfide mineral occurrences (cf. Mamatla, Manto America) distributed in the area, because of scarce hanging wall acidic volcanic rocks.

Mentioning of the vein type ore deposits, it seems that existing this type of deposits have been already mined out. Is it thought that potential for discovery of new and large vein-type ore deposit is rather low.

Chapter 5 Conclusions and Recommendation

5-1 Conclusions

The regional geological survey, total survey line 500 kilometers and geological description for the existing drilling cores, total logging length 4,000 meters, have been performed in this year's program.

The geological succession of the area is the Tejupilco Schist, Villa Ayala Formation, Acapetlahuaya Formation and calcareous sedimentary rocks of the Teloloapan and Pachivia Formations in the Guerrero terrene and the Morelos Formation of the Mixteco terrene and overlain Cenozoic Balsas and Tilzapotla Rhyolite Formations and intrusive rocks.

The Tejupilco Schist is mainly composed of weakly metamorphosed muddy to sandy rocks accompanied with a small amount of green schist. The Villa Ayala Formation consists mainly of basaltic to andesitic volcanic and pyroclastic rocks such as massive lava, pillow lava, autobrecciated lava to pillow-breccia and hyaloclastite, and its upper part contains alternation beds of a little salic andesite to dacite lava, tuff, slate, calcareous sedimentary rocks. The Acapetlahuaya Formation is composed of mainly alternation beds of well-bedded slate and sandstone and a small amount of calcareous sedimentary rocks. The calcareous sedimentary rocks are mainly composed of black phyllite and foliated slate, accompanied with sandy tuff or conglomerate and dark grayish muddy limestone, which ranges from thin beds or lenses, several centimeters in thickness, to some large rock bodies, 1 to 2 kilometers in width in some places. The Morelos Formation consists mainly of grayish black to grayish white massive limestone. It is stratified with thin beds of slate to shale, or accompanied with thin beds and lenses of chert, 1 to 20 centimeters in thickness, in some places. The Balsas Formation is mainly composed of reddish brown conglomerate. The Tilzapotla Rhyolite Formation mainly consists of rhyolitic to dacitic pyroclastic rocks. The intrusive rocks bodies are distributed in various sizes and the rocks are of rhyolite to dacite and andesite.

The rocks of Guerrero terrene consisting of Tejupilco Schist, Villa Ayala and Acapetlahuaya Formations and calcareous sedimentary rocks, has undergone the strong deformation of folding and thrust faulting due to the Laramide orogeny. This kind of deformation has not occurred in the Morelos Formation of the Mixteco terrene and Cenozoic formations.

The mineralization in the area is of the massive sulfide ore and Tertiary vein-type ore.

The massive sulfide deposits and mineral occurrences in the area are distributed in the Aurora and Mamatla districts. That of the Mamatla district is in the footwall bed of the ore horizon, seemingly in the pathway of rising hydrothermal solution. The ore horizon is situated at the uppermost part of the green volcanic rocks of the Villa Ayala Formation. It has been accordingly clarified that the ore horizon is of simultaneous deposition with the alternation beds of a little acidic volcanic rocks and muddy to calcareous sedimentary rocks.

Some vein-type ore deposits have been mined around Zacualpan, however only two mines are in small-scale operation at present. Some vein-type mineral occurrences have been seen in the existing drilling cores, however it is judged that the potential for high grade and large-scale deposits is low in the area.

5-2 Recommendation for the second year's program

The distribution of the ore horizon and the geological environment of the massive sulfide ore deposits have been revealed by the first year's program. It is geologic structurally assumed that the rocks of the ore horizon deposited in a specific environment, however the details of these still remain unknown due to several times of strong deformations by folding and thrust faulting. It is possible to assume that some kinds of chemical elements(e.g.Pb, Zn, Ba, As, etc) have been concentrated in as geochemical halos in the simultaneously deposited sedimentary rocks. Accordingly, it is possible to select high-potential zones by more detailed geological and rock-geochemical surveys for the alternation zones of the hanging wall volcanic and sedimentary rocks near the mineralization centers.

Also it is possible to reveal the detailed geology by a drilling program of a few hundred meters long within the hanging wall horizon and it will clarify especially the details of the depth of the ore horizon, the state of the mineralization and alteration of the footwall rocks. Furthermore, it will be able to perform a more reliable potential appraisal for the area by an integrated analysis combined with results of the proposed surface survey programs.

A geophysical (e.g. IP) survey program is useful to presume the sizes of the potential targets afterward.

The following surveys are recommended in order of high priority.

1. Detailed geological and geochemical surveys in the hanging wall area.
2. Survey of structural drill holes in the hanging wall area (e.g. the Aurora district).