Part II Details of the Survey

Pert II　Details of the Survey

Chapter 1 Geological Survey

1-1 Survey method

The geological survey in the field has been performed along route lines set up for the survey, after study of existing geological data. Topographic maps scaled 1:25,000 enlarged from existing maps scaled 1:50,000 have been provided for the rout map survey in the field. GPS has been utilized for the field survey. Principal subjects for the survey are to make clear geological structure and state of mineral occurrences. Mineralized zones and outcrops have been surveyed using simple survey instruments if it necessary and important zones have been sketched, 1:100 to 1:200 in scale, and taken in color photographs. Specimens for all typical rocks and rock facies have been taken with sufficient cares. Table II-1-1 shows points for all specimens as ARC-View corresponding digital data.

1-2 Survey result

Figure II-1-1 and Table II-1-2 show the geological map and section produced from the survey results. Figure II-1-3 shows points for all specimens taken.

1. Stratigraphic succession

The stratigraphic succession in the area is the Tejupilco schist, Villa Ayala Formation, Acapetlahuaya Formation, calcareous rocks (Teloloapan Formation, Pachivia Formation), Morelos Formation, Balsas Formation, Tilzapotla rhyolite Formation and intrusive rocks, from the bottom.

1) Tejupilco Schist

The name of Tejupilco schist described in Amatepec Quadrangle (Serratos et al., 2000). This is corresponded with middle to lower parts of Taxos schist defined by JICA・MMAJ(1994).

・Distribution: It is distributed from the west of Zacualpan to around Ixtazacatra, central western survey area, extending from northeast to southwest.

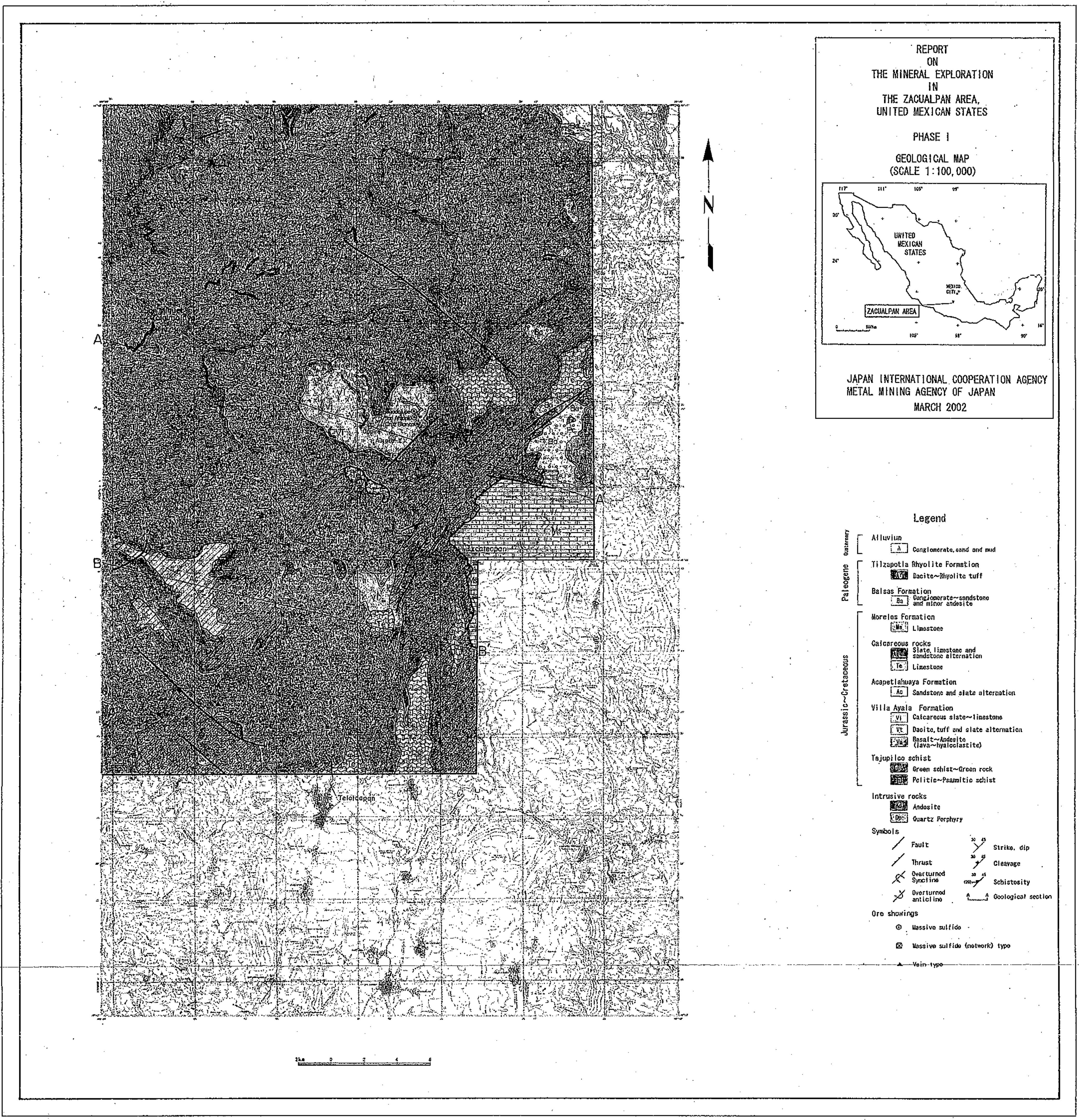
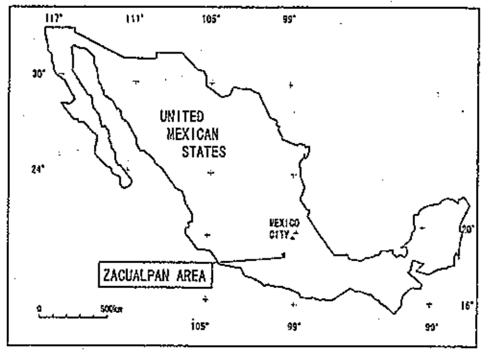


Fig. II − 1 − 1 Geological map

REPORT
ON
THE MINERAL EXPLORATION
IN
THE ZACUALPAN AREA,
UNITED MEXICAN STATES

PHASE I

GEOLOGICAL SECTION
(SCALE 1:100,000)



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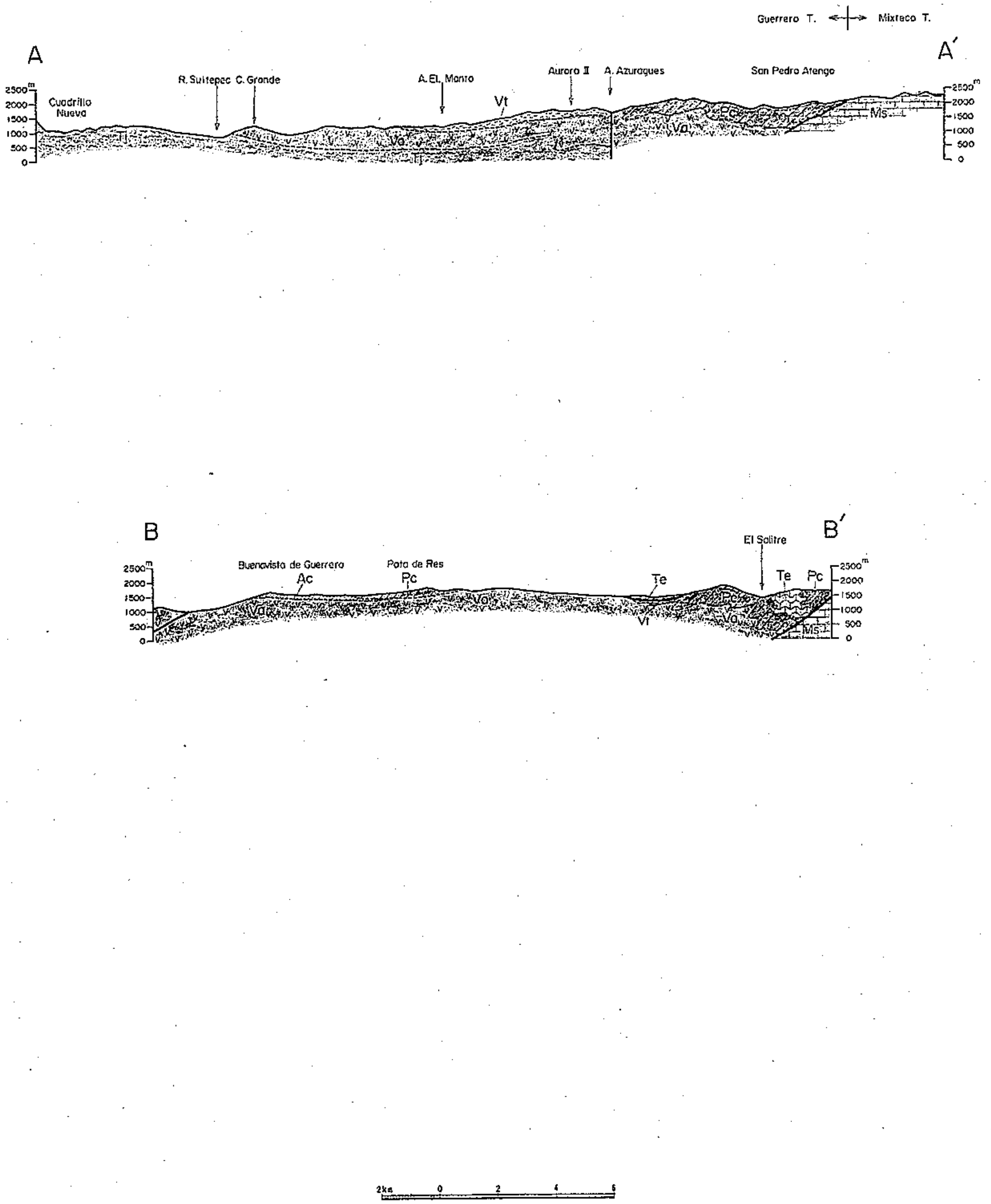


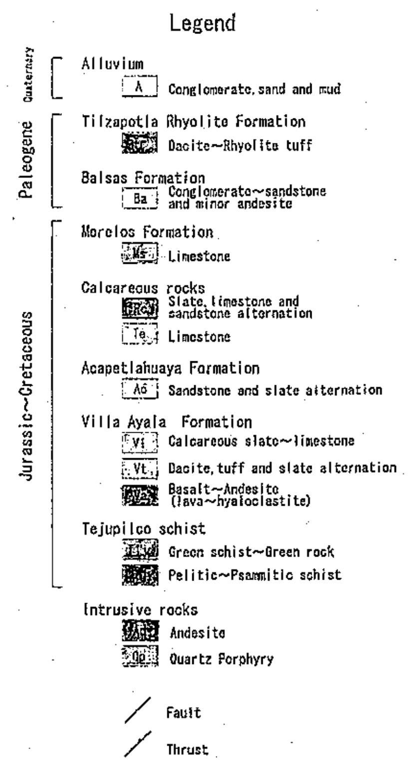
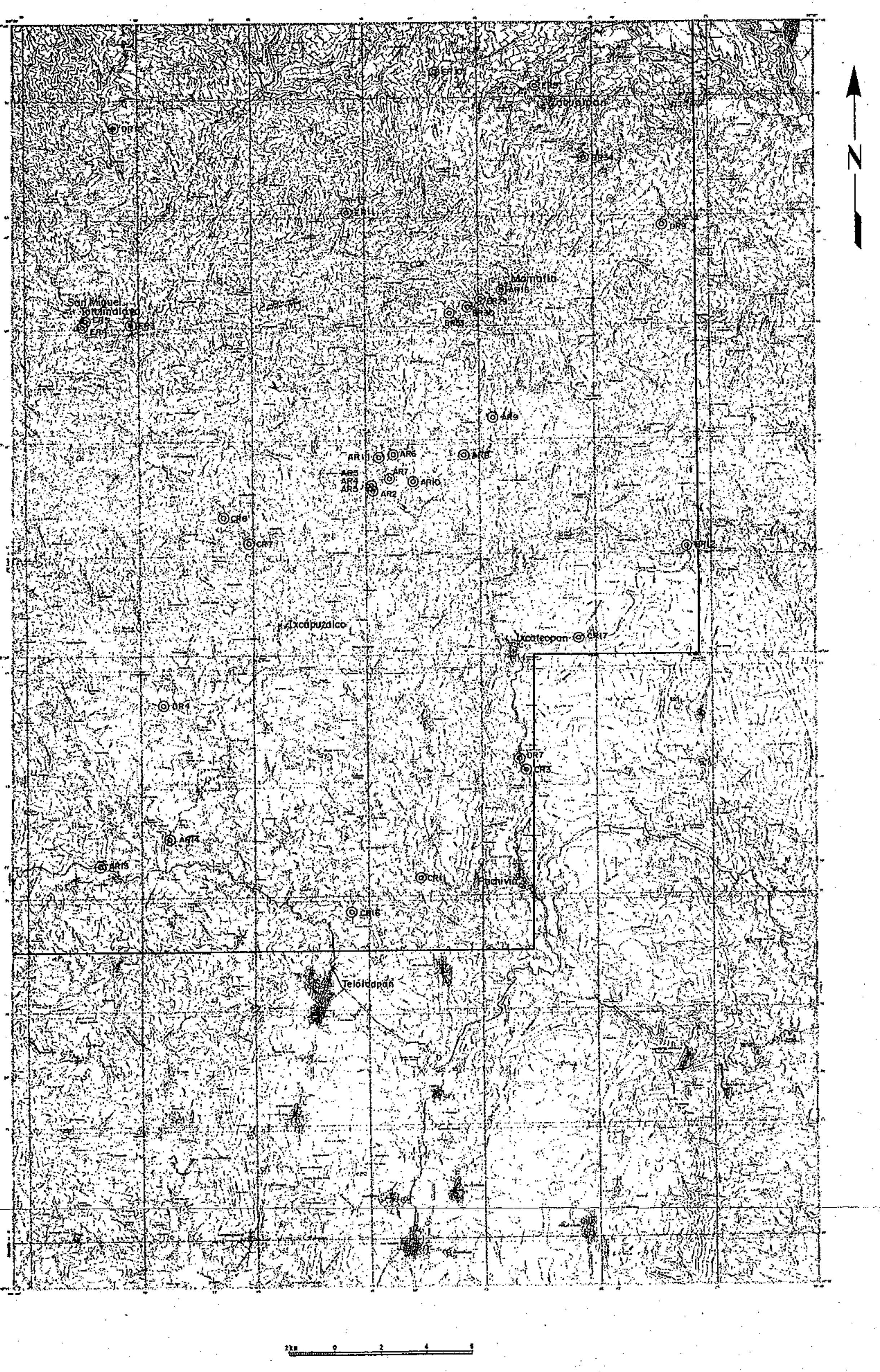


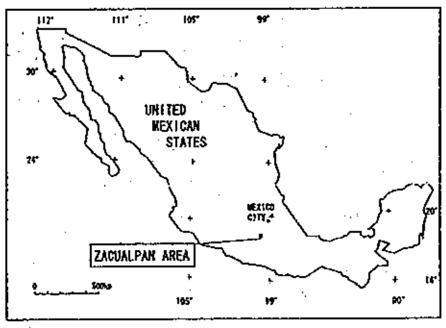
Fig. II－1－2 Geological section



REPORT
ON
THE MINERAL EXPLORATION
IN
THE ZACUALPAN AREA,
UNITED MEXICAN STATES

PHASE I

LOCATION MAP OF THE ROCK AND ORE SAMPLES
(SCALE 1:100,000)



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MARCH 2002

Legend

◎ Location of Rock and Ore sample

Zacualpan Area

Fig. II − 1 − 3 Location map of rock and ore samples

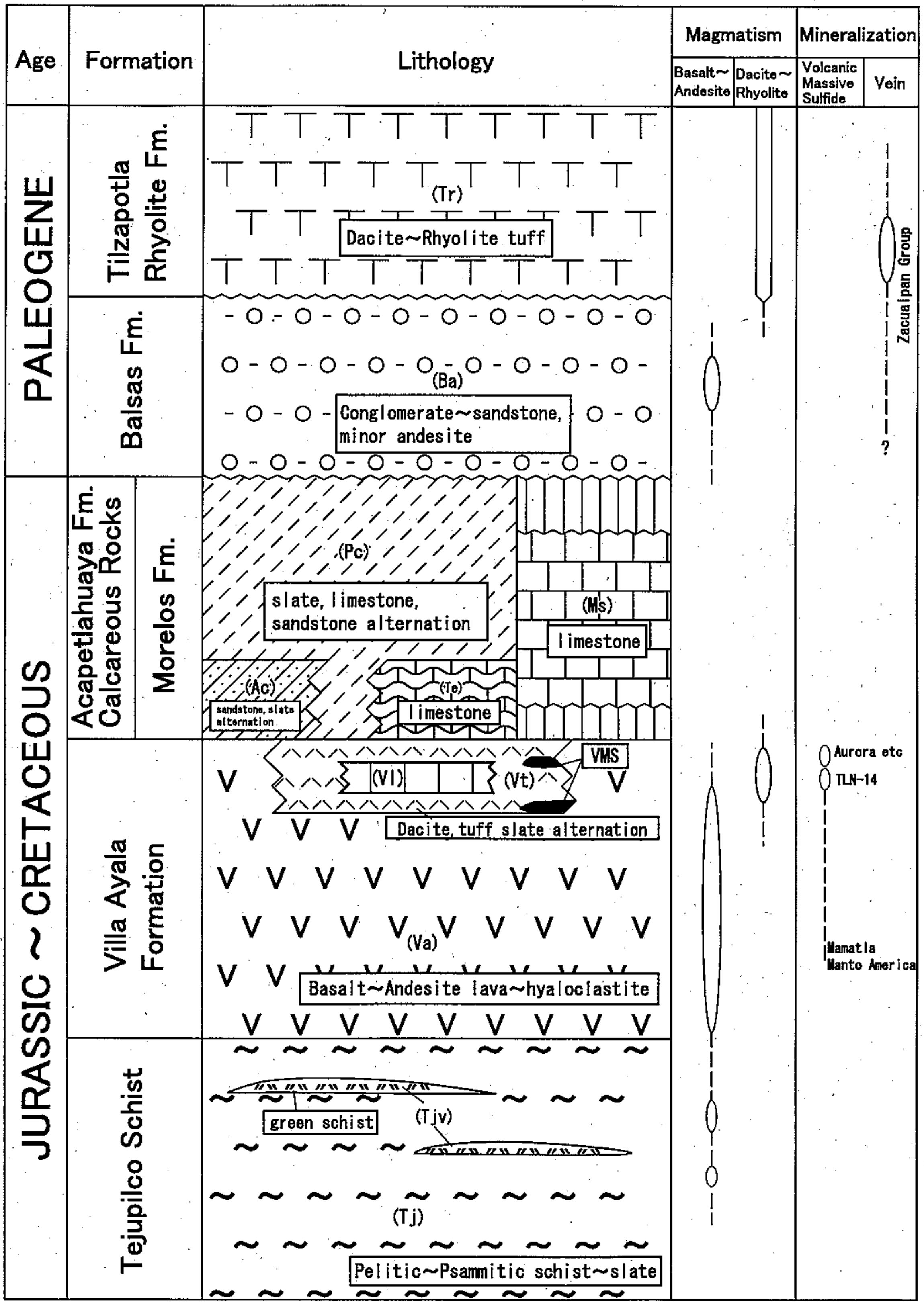


Fig. II－1－4 Schematic stratigraphic column

Table Ⅱ－1－1 List of rock and ore samples

No.	Sample Number	Rock Name	Formation	UTM(X)	UTM(Y)
1	BR30	slate	Tejupilco Schist	414580	2060950
2	ER3	slate	Tejupilco Schist	399681	2060127
3	ER5	phyllite	Tejupilco Schist	397423	2060237
4	ER4	green schist	Tejupilco Schist	397426	2060253
5	CR6	massive green rock	Villa Ayala Fm.	403700	2051850
6	ER9	massive green rock	Villa Ayala Fm.	417708	2070693
7	CR11	lapilli tuff	Villa Ayala Fm.	412250	2036087
8	CR7	schistose green rock	Villa Ayala Fm.	404717	2050850
9	AR8	hyaloclastic rock	Villa Ayala Fm.	414250	2054550
10	AR3	dacite	Villa Ayala Fm.	410275	2053100
11	AR7	tuff breccia	Villa Ayala Fm.	410975	2053550
12	AR4	slate	Villa Ayala Fm.	410275	2053100
13	DR4	slate	Acapetlahuaya Fm.	400914	2043679
14	CR16	limestone	Calcareous Rocks(Teloloapan Fm.)	408265	2034523
15	AR13	calcareous shale	Calcareous Rocks(Amatepec Fm.)	398060	2036650
16	CR17	limestone	Morelos Fm.	419222	2046456
17	CR3	calcareous shale	Calcareous Rocks(Pachivia Fm.)	416900	2040700
18	DR7	calcareous shale(altered)	Calcareous Rocks(Pachivia Fm.)	416008	2041233
19	DR9	conglomerate	Balsas Fm.	422963	2064770
20	BR12	rhyolite	Tilzapotla Rhyolite Fm.	423900	2050450
21	DR12	rhyolitic intrusive rock	Intrusive rock	398860	2069055
22	BR29	dacitic intrusive rock	Intrusive rock	415100	2061250
23	AR2	altered rock	Villa Ayala Fm.	410600	2052950
24	AR5	tuff	Villa Ayala Fm.	410275	2053100
25	AR9	limestone	Calcareous Rocks(Teloloapan Fm.)	415600	2056150
26	AR14	mineralizated altered green rock	Villa Ayala Fm.	401250	2037775
27	AR6	ore(Aurora I)	Ore	411100	2054575
28	AR10	ore(Aurora II)	Ore	412050	2053375
29	AR11	ore(Capire)	Ore	410525	2054425
30	AR16	ore(Pyrite-Mamatla)	Ore	416050	2061550
31	BR33	ore(Manto America)	Ore	413600	2060925
32	BR34	ore(Cuchara)	Ore	419500	2067750
33	ER10	siliceous ore	Ore	413145	2071307
34	ER11	siliceous ore	Ore	409259	2065236

・Rock facies: Mainly black to gray pelitic, psammitic and siliceous schist to slate, accompanied with green schist. A very thin, several millimeters to centimeters, alternation layer of sandy and siliceous schist and accompanied graphitic schist appears in the western area (lower part). It is accompanied with green schist and partly calcareous. Fine grained slate is dominant in the eastern area (upper part). Schistosity plane and cleavage are abundant in the pelitic and psammitic schist and easily breakable. Segregation quartz appears within the schistosity planes. The green schist is chloritic-sericitic-feldspathic, partly showing well schistose to massive appearance.

・Age, stratigraphic position and thickness: The formation is of the lowest in the area, but its age is not clear. The Villa Ayala Formation conformably overlies the Tejupilco schist and transitionally changes from the latter through an alternation zone of both facies. It is difficult to estimate the thickness of the formation because of strong folding, however assumingly it would be over 500 meters.

2) Villa Ayala Formation

The Villa Ayala Formation was named by Guerrero et al.,(1990). According to the Cuernavaca Quadrangle explanation book, the Villa Ayala Formation roughly corresponds to the Taxco green rocks “Rocaverde Texco Viejo” (Fries, 1960), Mesozoic metavolcanic sedimentary rocks “secuencia Mesozoica Volcanico-Sedimentaria metamorfizada” (Campa et al., 1974), or meta-volacanic sedimentary rocks “secuencia vulcanosedimentaria metamorfizada” (Campa y Ramirez, 1979).

・Distribution: The formation extends to Zacualpan and Cruz Alta in zonal shape and then changes its direction to southwest to cross the area as a wide belt.

・Rock facies: Most part of the formation is of basaltic to andesitic massive lava, pillow lava, autobrecciated lava to pillow breccia and hyaloclastite. Alternation of dacitic lava, tuff, slate, calcareous sedimentary rocks is partly seen in the upper part.

Basalt and andesite show greenish to grayish green and porphyritic with pyroxene and plagioclase phenocryst to aphyric. The rocks show pillow and autobrecciated textures in many parts, further change to hyaloclastite within several meters. Amygdaloidal texture filled with chlorite and calcite is frequently seen. Schistosity is well developed in fine grained parts, reflecting tuffaceous parts.

The upper alternation zone is distributed around the Capire and Aurora mineral occurrences in the central survey area. It is composed of vitric dacite or andesite rich in plagioclase and in some places dacitic tuff to lapilli-tuff , gray sandy tuff, slate and calcareous slate to limestone. The calcareous slate to limestone appears similar to those of the overlying calcareous rocks (Teloloapan and Pachivia Formations). The alternation layers are from several centimeters to several meters in thickness.

The change to the facie rich in plagioclase phenocryst means a change of volcanic activity, being different from the andesitic volcanic rocks in the lower part.

Small-scale distribution of similar dacitic volcanic rocks is seen in Las Hoertas situating northeast of Zacualpan, a ridge east of Cruz Alta situating east of Mamatla, around Lancho Viejo and a place to the south of El Pochote in the southwest corner of the area. The alternation of slate and tuff with intense hydrothermal alteration will be extensively distributed along the highway (No-51) to the west, out of the area.

・Age, stratigraphic position and thickness: Campa et al., (1974) reported that ammonite found at Campo Morado, outside of the survey area, was of early Cretaceous. Guerrero et al., (1990) reported that radiolarian age of the formation indicated early Cretaceous.

The formation conformably and transitionally contact with lower and upper formations and its thickness is estimated at 300 to 400 meters. It is assumed that the upper alternation zone is several tens meters in thickness.

3) Acapetlahuaya Formation, calcareous sedimentary rocks (Teloloapan and Pachivia Formations)

These formations are of almost simultaneous deposition judging from the field occurrences, therefore they will be described in this same section. The Acapetlahuaya Formation was described after Guerroro et al., (1990). De Cserna, (1981), described the Acapetlahuaya Formation as a part of the Taxco Schist (Esquisto Taxco).

・Distribution: The formation is distributed along the road nearby Buena Vista de Guerrero extending east to west in the southwestern survey area. The rock facies transitionally change to calcareous sedimentary rocks toward east. The calcareous sedimentary rocks are distributed in the northern part of (Ixcapuzalco), nearby Puente de Dios ～southwestern part of El Pochote, an area of about 10 square kilometers each. The rocks are also distributed in an area around San Pablo in the eastern area extending to the south of Ixcateopan and farther south of Pachivia continuously in a belt shape and partly nearby Teloloapan.

・Rock facies: The Acapetlahuaya Formation is mainly composed of alternation beds of well-bedded slate and sandstone, accompanied with sandy tuff or conglomerate. The sandstone and tuff have undergone weathering in many places, showing yellowish gray. The unit of alternation is of several millimeters to several tens centimeters in thickness. Schistosity is clear in the rocks and oblique to the bedding plane in many places. The bedding dips 15 - 40 degrees to the northeast and 10 - 25 degrees to the north. The schistosity strikes north-northeast and dips 15 – 40 degrees to the west.

The calcareous sedimentary rocks mainly consist of black foliated slate, accompanied with dark gray muddy limestone in some places. The limestone is of partly thin beds and lenses, several centimeters in thickness and forms rock bodies about 1 to 2 kilometers in width in some places. The limestone dominant parts were corresponded to the Teloloapan Formation in the previous map. Film-form limonite layers are seen at the lowermost slate in some places.

Small-scale folding structures having the axis of schistosity planes are generally seen together with kink-foldin and boudinage.

・Age, stratigraphic position and thickness: Guerrero et al., (1992), reported some fossils from the limestone of the Teloloapan Formation as of Aptian to Albian of the lower Cretaceous. The formation transitionally changes to the underlain Villa Ayala Formation. It is about several tens meters in thickness in some central parts of the area and it is probably several hundreds meters in the eastern part.

4) Morelos Formation

The Morelos Formation exists in the Mixteco terrene. It was named by Fries (1960) for the limestone distributed in Morelos state (Estado de Morelos).

・Distribution: It is distributed in the mountainous area to the east of Ixcateopan, in the west end of the survey area, continuously south to north.

・Rock facies: The formation is mainly composed of gray to grayish white massive limestone. It is accompanied with thin beds of phyllite～shale, showing layered structure in some places. Thin beds and lenses of chert, 1 to 20 centimeters in thickness, are contained in the formation. The limestone is of fossiliferous biomicrite to biosparite. The rocks are utilized as building materials and manufactured as so-called marble.

・Age, stratigraphic position and thickness: The formation is defined as the age between Aptian - Albian and Cenomanian, judging from their microfossil and macrofossil data.

The Morelos Formation is in thrust and strike fault contact with the Pachivia Formation of the Guerrero terrene and overlain by the Cenozoic formation.

5) Balsas Formation

The Balsas Formation was named by Fries (1960).

・Distribution: It is intermittently distributed along the eastern edge of the survey area from the northeastern corner to the south, to nearby Santo Domingo situating northeast of Ixcateopan. The center of the distribution of the formation is outside of the area.

・Rock facies: The formation is mainly composed of conglomerate with reddish brown in color. It's groundmass is medium to coarse grained sand or tuffaceous sand and contains abundant fragments of green rocks, lime stone, quartz, shale and chert etc. Fragments size vary from 1 to 20 cm in diameter and show subangular to subrounded shape. The conglomerate bed interbeded with andesitic to basaltic lava (50m thick) at the north east part of Ixcateopan. The bedding plane shows N-S strike and dipping 20° E.

・Age, stratigraphic position and thickness: The age of this formation is presumed to be Eocene to Oligocene from overlaying rhyolite formation of late Oligocene.

6) Tilzapotla Rhyolite Formation

Fries (1960), gave the name of Tilzapotla to the formation. The locality is the Tilzapotla Mountains in Morelos state.

・Distribution: The formation is locally distributed in the northwestern corner of the survey area and northeast of Ixcateopan. Its distribution center is outside of the survey area.

・Rock facies: The rock facies in the area to the northeast of Ixcateopan is grayish pink, fine-grained tuff and its bedding plane dips roughly 40 degrees to the east. The formation occupies a part of the Goreta Mountains in the northwestern area and consists mainly of dacitic pyroclastic rocks.

・Age, stratigraphic position and thickness: Fries (1960), reported 26 Ma by Pb-isotope method for the formation. The formation unconformably overlies the Tejupilco Schist in the northwestern area. It is estimated at several hundreds meters in thickness.

7) Intrusive rocks

Rhyolite to dacite and andesite appear in the area as massive blocks in some scale. Other than those, small-scale dacite bodies and andesite dykes and sheets are distributed.

Rhyolite to dacite bodies are situated in the northwestern corner of the survey area, nearby Puerto de las Majadas, trending northeast to southwest with 2 kilometers in width. The rocks are of white to grayish white quartz porphyritic, appearing fine grained non-porphyritic in the edges of the bodies. The bodies contain weak pyrite dissemination. No alteration halo is recognized in their surrounding rocks.

The andesitic bodies are distributed around Tecamachalco to the southeast of Ixcapuzalco, in an area about 2 kilometers in diameter. The rock facies is dark green porphyritic, containing some phenocrysts of chloritized mafic minerals and plagioclase.

The dacitic sheets containing some mineral occurrences are distributed to the west-southwest of Mamatla. The rocks have undergone strong silicification, sericitization and dissemination of pyrite conforming mineralized alteration zones together with the surrounding Villa Ayala Formation. Their original texture is not clear, but some plagioclase phenocrysts and scarce quartz phenocrysts are recognized.

2. Geological structure

The formations occupying most part of the Guerrero terrene, such as Tejupilco schist, Villa Ayala Formation, Acapetlahuaya Formation, calcareous rocks (Teloloapan and Pachivia Formations) have undergone strong deformation probably due to the Laramide orogeny in early Tertiary time.

The stratification planes (S0) and schistosity planes (S1) of the formations are commonly seen throughout the area, however they are frequently deleted due to coverage of the later-stage fracture cleavages (S2), caused by rearrangement and growth of minerals along the cleavages (S2). In many places, the cleavages (S2) are parallel to their primary planes of (S0) and (S1). It is possible to distinguish (S2) from others, if they are oblique each other.

The most dominant structure in the Guerrero terrene is a folding structure having the axis of the cleavages (S2). The closed shaped folding structure observable in outcrops is several centimeters to several meters in scale. It is expected that a larger scale folding system exists there judging from its drug sense.

In the field outcrop scale, an kink type folding superimposed on S2 cleavage folding and folding with wider spacing fracture cleavage (S3) are developed in part. They have been deformed by new wave-length folding activities.

Other than the above-mentioned structural elements, faulting is one of principal structural elements. The boundary of the Guerrero and Mixteco terrenes exists in between the Pachivia and Morelos Formations. It is thought that this boundary is of thrust fault, which the Pachivia Formation thrust over the Morelos Formation.

Many small-scale thrust faults and low-angle reverse faults exist in the formations in the Guerrero terrene.

After Tertiary time, northwest to southeast, northeast to southwest, north to south and east to west trending high angle fault systems have been formed in the area. Vein-type ore deposits around Zacualpan are hosted in those fault systems. Confirmed faults giving largest transposition are the normal fault trending northwest to southeast situating to the southwest of Mamatla, the lateral slip faults trending east to west and northeast to southwest situating to the northeast of Ixcateopan and the fault trending northwest to southeast situating to the southwest of Pochote.

3. Mineralization and alteration

Figure II-1-5 shows the mineral occurrences location map of the area.

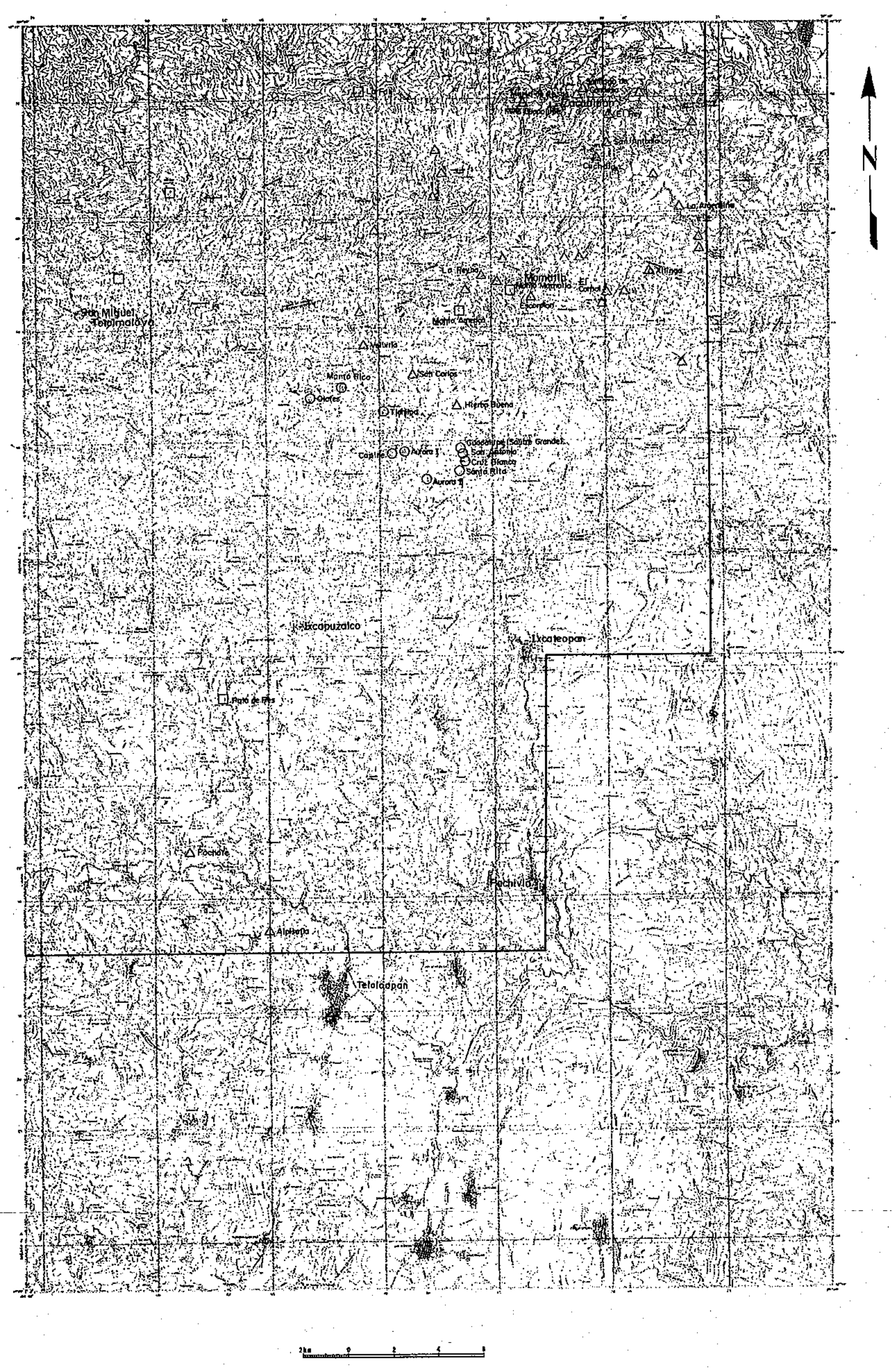
Mineralization and alteration in the area are mainly related to the massive sulfide ore and vein-type ores of Tertiary age.

1) Massive sulfide ore deposit and mineral occurrence

This type of ore deposits is distributed in the Aurora and Mamatla.

In the Aurora district, the occurrences of Aurora I and II, Capire, San Francisco, Guadalupe, Cruz Blanca, San Antonio, Tlanilpa and Manto Rico are distributed.

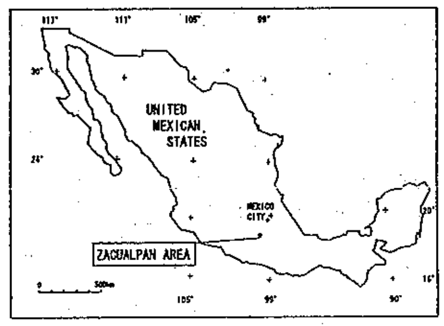
The ore deposits are lenticular bodies hosted in the acidic volcanic rocks and alternation zones of slate and calcareous sedimentary rocks of the upper Villa Ayala Formation.



REPORT
ON
THE MINERAL EXPLORATION
IN
THE ZACUALPAN AREA,
UNITED MEXICAN STATES

PHASE I

LOCATION MAP OF THE ORE SHOWINGS
(SCALE 1:100,000)



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Legend

- ○ Massive Sulfide Mineralization
- □ Massive Sulfide Type Mineralization (Network)
- △ Vein Type Mineralization
- Zacualpan Area

Fig. II − 1 − 5 Location map of ore showings

Aurora II contains sulfide lenses composed of fine-grained sphalerite and galena and hosted in an alternation zone of slate and fine-grained sandy tuff (Figure II-1-6). No significant alteration zone is accompanied with ore body. A small-scale isoclinal reverse folding structure having the axis of cleavage (S2) is seen in the host rock.

At Aurora I some ores of fine-grained sphalerite and galena stains were found in waste rocks near by an abandoned submerged adit. An outcrop of green andesite is seen on the river floor nearby the old adit. A brownish oxidized network zone with very fine-grained pyrite stains exists there. Waste rocks of calcareous black slate are abundant in the waste disposal dump. It is therefore assumed that the ore is hosted in the slate.

In Capire, a small-scale abandoned adit exists extending towards north 25 to 45 degrees east. A siliceous ore body, 10 to 20 centimeters in thickness and dipping 20 degrees to north, is hosted in black slate. The strata around there is an alternation of schistose slate and whitish tuff. Mud ball like slate fragments are contained in the tuff.

The Manto Rico ore deposit is situated on a bank of the upper stream of the El Manto River and several abandoned adits exist there. No waste has been seen there, but the geology of the area is of an alternation, several centimeters thick, of black slate and gray tuff with significant plagioclase crystals. Folding having axis of cleavage (S2) lying almost horizontal is significant there.

The assay result of ores by CRM (1986) is as follows.

Occurrences	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	Fe (%)	Ba (%)
Aurora I(W)	2.18	735	1.16	4.75	12.7	4.6	17.4
Aurora II(E)	0.8	600	0.5	4.9	14.9	5.58	5.5
Capire	0.4	445	0.55	5.42	17.3	3.24	9.95
San Francisco	0.6	240	1.04	7.49	17.3	3.37	17.07
Guadalupe	--	665	--	10.81	17.24	--	--

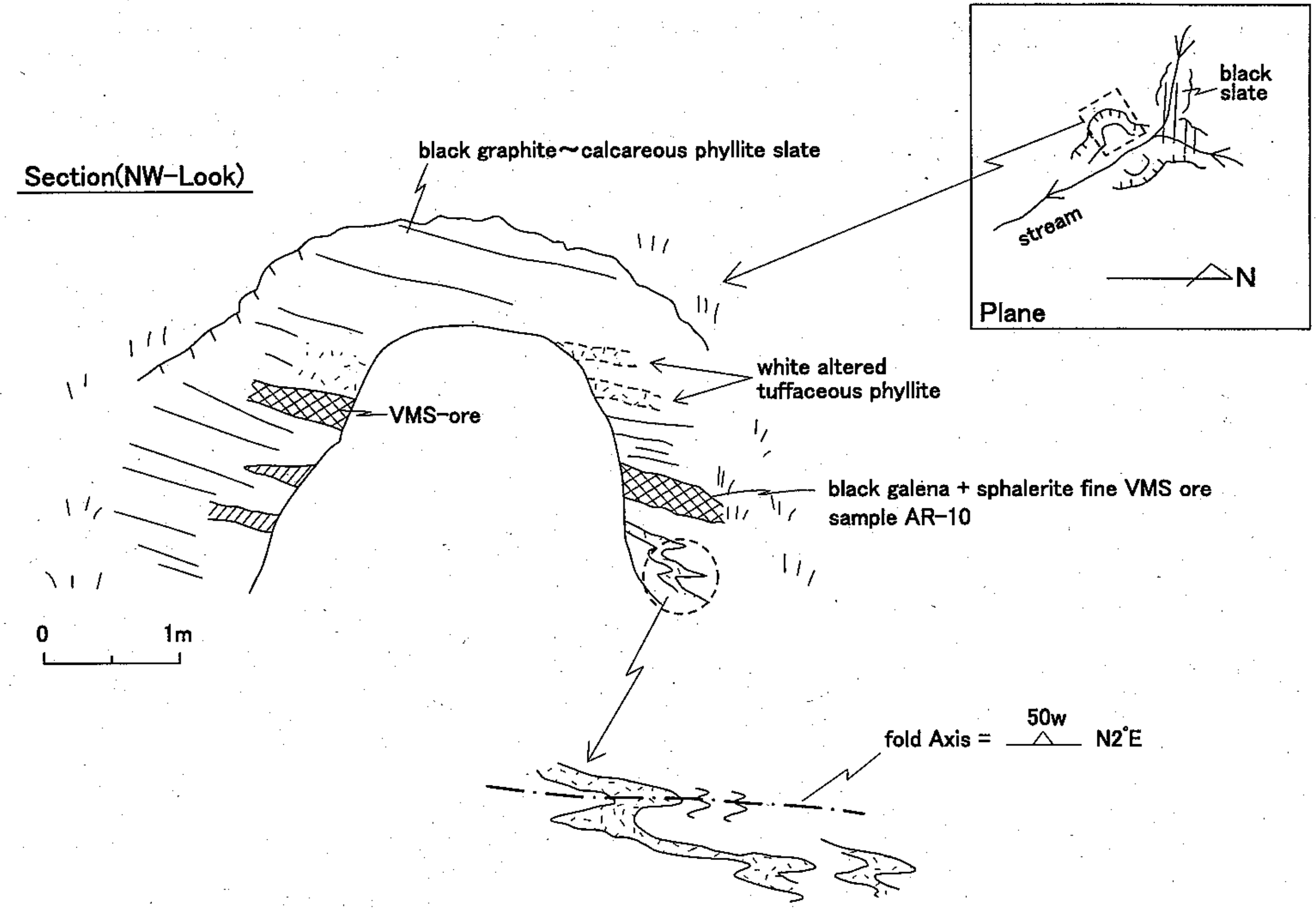

Fig. II－1－6 Sketch map of Aurora-II

The ore minerals are mainly sphalerite, galena and minor pyrite, chalcopyrite, miargyrite. Gangue minerals are quartz, barite, gypsum bornite and calcite. Secondary minerals are covelline, malachite and azurite.

Colloform and framboidal texture are usually recognized but emulsion texture of chalcopyrite in sphalerite was not observed.

The occurrences of Mamatla and Manto America are in Mamatla district.

It is said that the occurrences in the district are of the Manto type (Reyes 1990). The occurrences are distributed along the road connecting Zacualpan and Ixcapuzalco, nearby Mamatla village, extending more than 1 kilometer. The mineralized zones are of dissemination and network of pyrite, 5 to 10 meters in thickness and mainly massive pyrite hosted in the green schist of the Tejupilco Schist. The mineralization is accompanied with strong silicification and sericitization.

The highest assay result of the occurrences is 20.1 g/t Au, 622.5 g/t Ag, 0.18 % Pb and 2.00 % Zn (Reyes, 1990).

Manto America is situated 4 kilometers to the west-southwest of Mamatla village, on the north mountain slope. Three submerged adits exist there. The ore body is 1.2 meters in thick, north 80 degrees west in strike and dipping 55 degrees to the southwest (Reyes, 1990). The geology of the zone is of weakly whitish sericitic and silicified greenstone of the Tejupilco Schist. Some siliceous ores containing pyrite and sphalerite are seen in waste dumps.

2) Vein-type deposit

Many vein-type ore deposits principally containing Ag, Pb, Zn minerals are distributed nearby Zacualpan, being continuously active in operation since the Spanish colony age. The La Aracuran and Cuchala mines are in operation at present. According to mining engineers of the mines, their mining operation is 350 t/day in production, 230 g/t Ag, 5.6 % Pb, 7.4 % Zn in grade. The veins trend northwest to southeast. The deposit is of fissure filling type, consisting of galena, sphalerite, pyrite, argentite, pyrargyrite, tetrahedrite etc. Gang minerals are calcite and quartz.

It is said that general trends of the veins are north to south, northeast to southwest and northwest to southeast, and their ore grades range 0.1 to 0.6 g/t Au, 10 to 485 g/t Ag, 0.15 to 1.2 % Pb, 0.45 to 2.8 % Zn and 0.3 to 9.0 % Cu (Serratos et al., 1999). It tends to show high grade in calcareous rocks.

Other than Zacualpan, mineral occurrences are distributed in San Carlos Yerbabuena and Pochote etc.

Chapter 2 Survey of Existing Drilling Cores

2-1 Survey method

The logging has been performed for selected principal parts of the drilling cores preserved in a storehouse of the Zacualpan village office. Total 4,177 meters of cores have been geologically and mineralogically described, 1 to 200 in scale.

2-2 Survey result

Table II-2- 1 is of the list of the drill holes surveyed, Figure II-2-1 shows the location map of those and Figure II-2-2 displays the logging columnar sections of those.

Table II-2-1　List of the surveyed drill holes

District	Drill hole（m）	Logged（m）
Aurora	AU-5（201m）, AU-8（222m）, AU-9（203m）, AU-11（153m）	779m
Cruz Blanca	CB-7（252m）, CB-12（279m）	531m
Guadalupe	GL-6（201m）	201m
Capire	CP-21（142m）, CP-26（102m）, CP-38（207m） CP-41（174m）, CP-51（147m）	772m
Tlanilpa	TN-4（201m）, TN-5（111m）, TN-14（195m）	507m
Los Mantos	MT-8（174m）, MT-9（165m）	339m
San Carlos	SC-1（267m）, SC-2（300m）	567m
Yerbabuena	YB-7（280m）	280m
Velixtla	VLX-5（201m）	201m
9 districts	21 holes	Total:4,177m

The rocks confirmed in the survey are of andesite to basalt lava, hyaloclastite, dacitic tuff, slate to calcareous slate and alternation beds of tuff and slate of the Villa Ayala Formation. The geology and mineralization of each district are described as follows.

1. El Manto to Tlanilpa districts

The surface of the district is of weathered tuff, calcareous slate and alternation beds of those, appearing andesitic hyaloclastite and andesite in the lower part. Mineralized parts have been confirmed at the boundary of an andesitic hyaloclastite bed and an alternation bed of tuff and slate. A volcano-sedimentary mineralized occurrence mainly consisting of pyrite is seen in between 72 meters and 88 meters in depth of TN-14. They are massive in its lower part and form thin layers with slate and tuff in its upper part. Layered dacitic tuff containing plagioclase crystals overlie those beds. Andesitic hyaloclastite in the lower horizon contains some pyrite networks and breached parts due to silicification and sericitization, down to 130 meters deep.

In TN-4 and TN-5, a small-scale film-like pyrite mineralized zone has been encountered at the same horizon as that of TN-14.

2. Capire district

Dacitic tuff and hyaloclastite appear at the surface and alternation beds of slate and tuff underlie them. A calcareous slate layer of 50 to 60 meters thick is situated below them and dacite and massive andesite appear in the bottom. In CP-21, It is assumed that the upper part of the column would be of repeated part due to folding.

A little amount of pyrite thin-layers and films have been encountered in the bottom of the calcareous slate formation. Andesite in the bottom of CP-38 and CP-41 contains weak dissemination of pyrite in the whole body, having undergone chloritization.

3. Aurora district

Dacitic volcanic rocks and alternation beds of slate and tuff are dominant in the district. The apparent thickness of the calcareous slate is roughly 30 meters. The calcareous slate formation appears relatively thick in AU-11, but actually this would be because of repeated folding process. Clear fracture zones are seen in other drill holes and it probably indicates existence of faults or thrusts faults there. Andesite lava is not seen in the hole, different from those found in other holes.

The mineralization is of weakly disseminated pyrite. Tree points of layered pyrite occurrences have been seen in the uppermost part of the calcareous slate beds in AU-5. They are 4 to 7 centimeters in thickness.

4. Guadalupe to Cruz Blanca districts (Azulaques)

In GL-6 of the Guadalupe district, dacitic hyaloclastite has been seen in the upper part and andesite lava exists in the lower part, being separated by a thin bed of calcareous slate in the middle part. In the Cruz Blanca district, dacitic hyaloclastite and alternation beds of slate and tuff exist in the upper part and the calcareous slate of the Pachivia Formation exist in the lower part. Accordingly, the formation is exactly overturned. Clear fracture zones exist in the shallow part.

The mineralization in the district is weak and only film-like pyrite stains are scarcely distributed in alternation beds of slate and tuff.

5. Velixtla to San Carlos to Yerbabuena districts

These districts are in the vein-type ore field in the area. VLX-5 in the Velixtla district is of green rocks in the whole section, principally schistose texture dominant. SC-1 and SC-2 in the San Carlos district are composed of andesitic volcanic rocks and alternation beds of tuff and slate in the upper part and calcareous slate layers in the bottom. It is highly probable that the succession is overturned. The rocks of the Yerbabuena district are rather specific, being mainly composed of black, plagioclase rich, glassy porphyritic dacite accompanied with a small amount of andesite and hyaloclastite. A calcareous slate bed appears in the bottom. At least four fracture zones exist there, making the geological structure complicated.

The mineralization and alteration in the district are a little complicated due to overprint of different type of those, massive sulfide type and vein type. VLX-5 in the Velixtla district shows vein-type occurrences mainly consisting of pyrite and sphalerite in between 57 meters and 63.5 meter in depth. Furthermore, a network part consisting of quartz, calcite, pyrite and chalcopyrite is seen in between 87 meters and 97 meters. The portion from the surface to the network section has undergone significant chrolitization.

SC-1 and SC-2 in the San Carlos district show some calcite and quartz veins containing galena, pyrite and rarely sphalerite in andesitic volcanic rocks and tuff, however they are not economical. In addition, a fine-grained pyrite dissemination part, 5 to 10 per cent minerals, is contained in between 266.2 meters and 269 meters in depth and some sulfide films are distributed in the calcareous slate beds.

In the Yerbabuena district, some quartz and calcite veins, several centimeters in thickness, containing sphalerite and pyrite are scattered thorough out the drill hole. Some pyrite films are seen in the slate at 122 meters, 134 meters and 254 meters in depths.

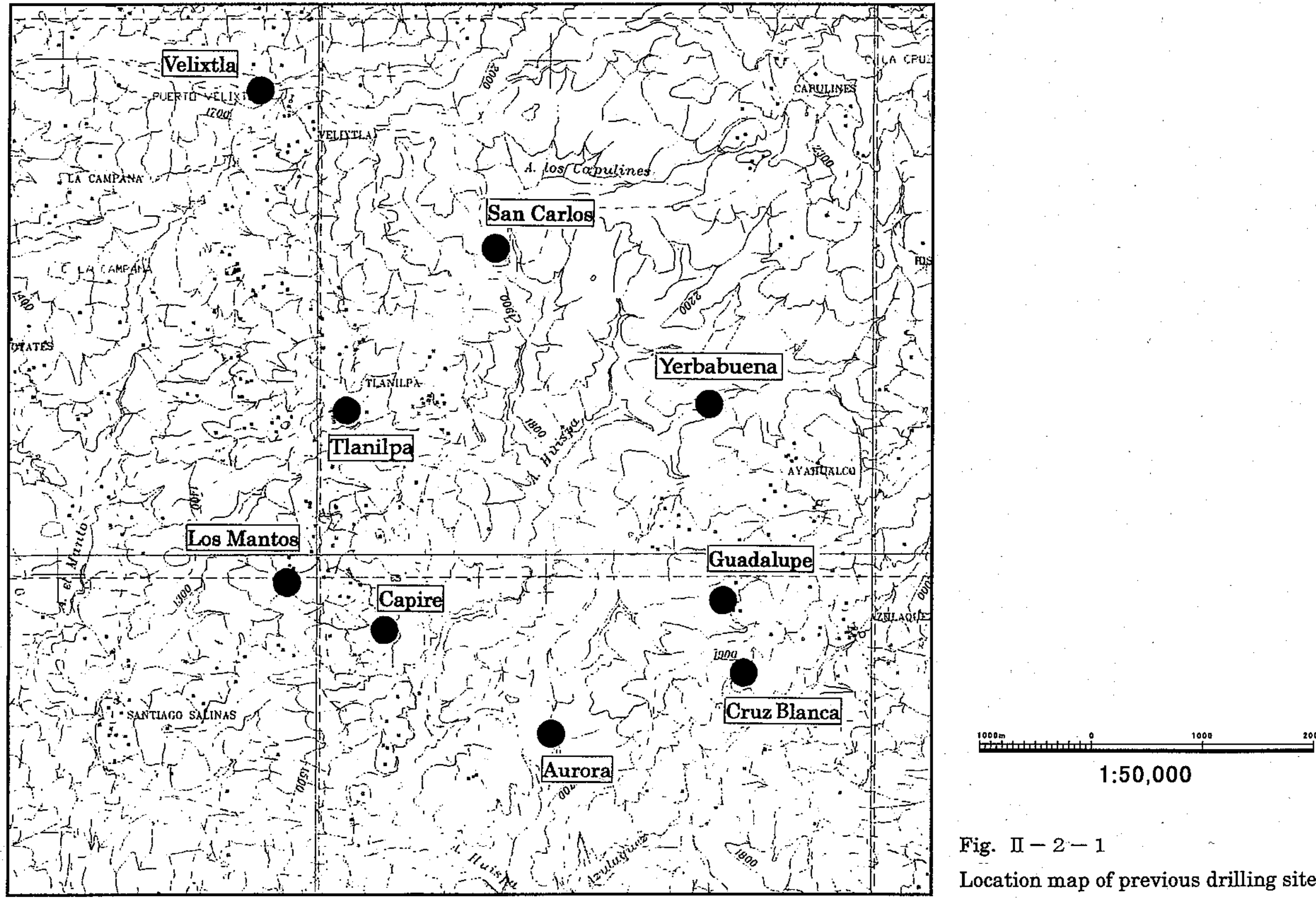

Fig. II − 2 − 1
Location map of previous drilling sites

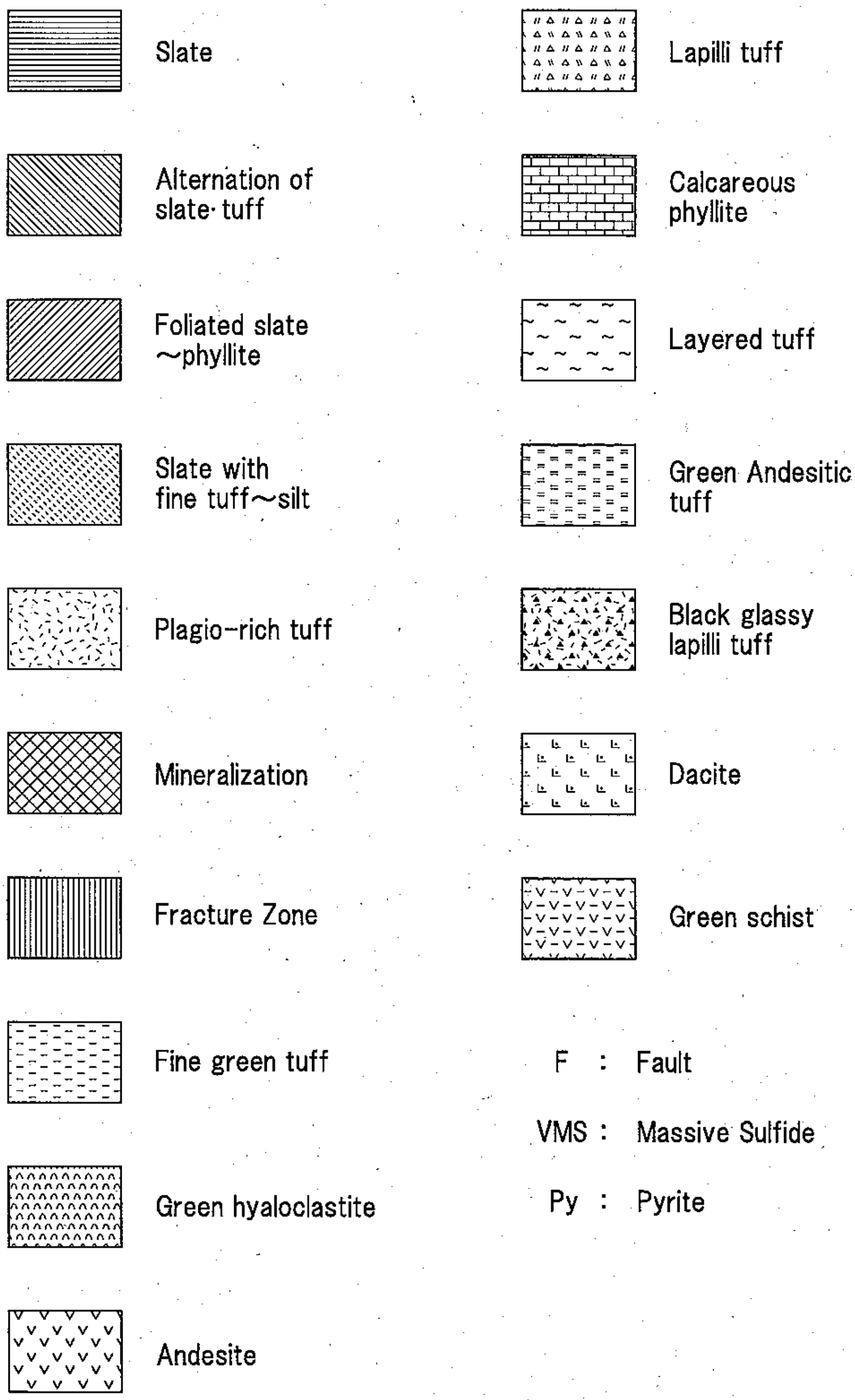

Fig. II－2－2 Legend for columnar section

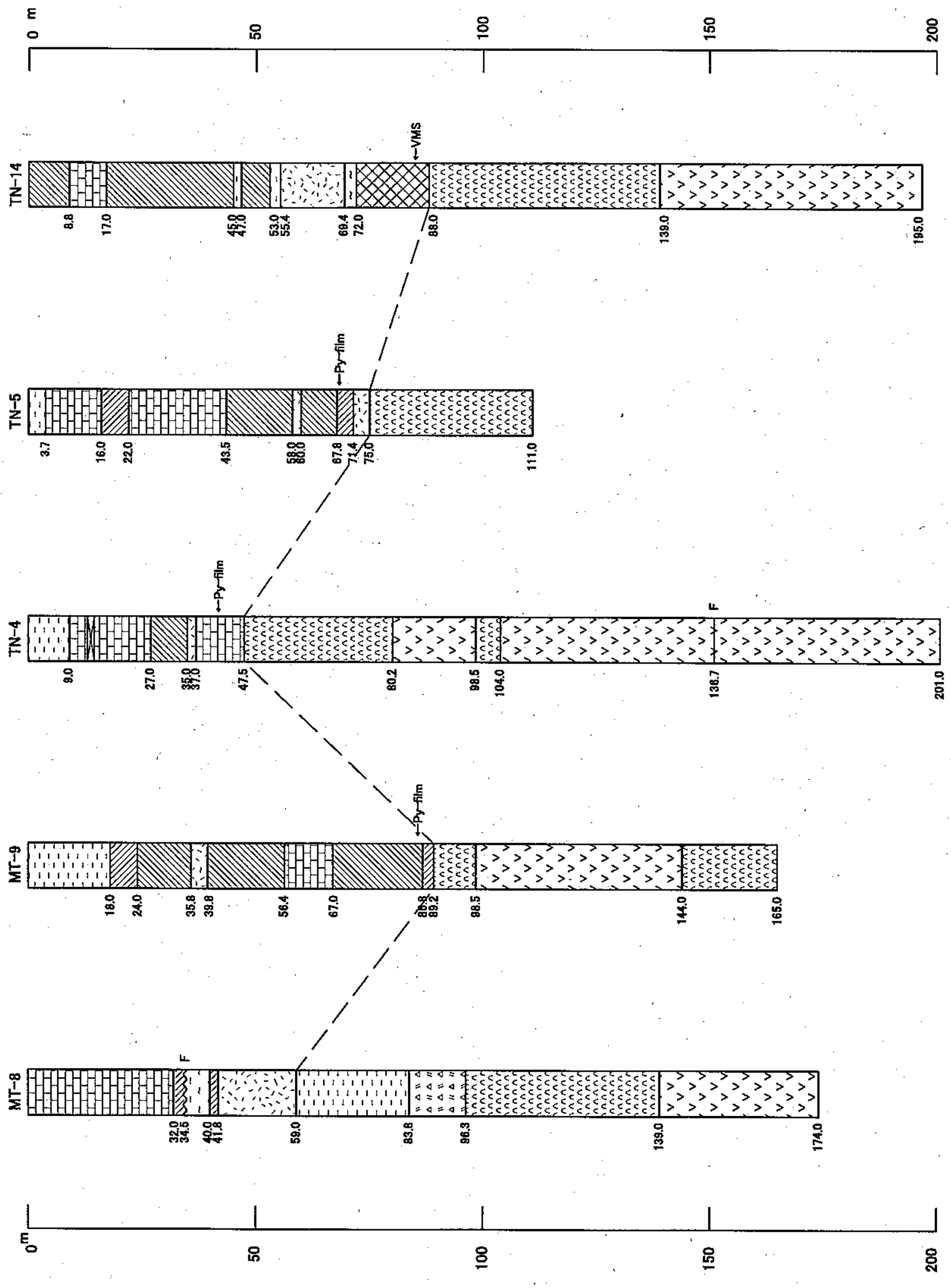

Fig. II − 2 − 3 Geological columnar section(Los Mantos~Tlanilpa)

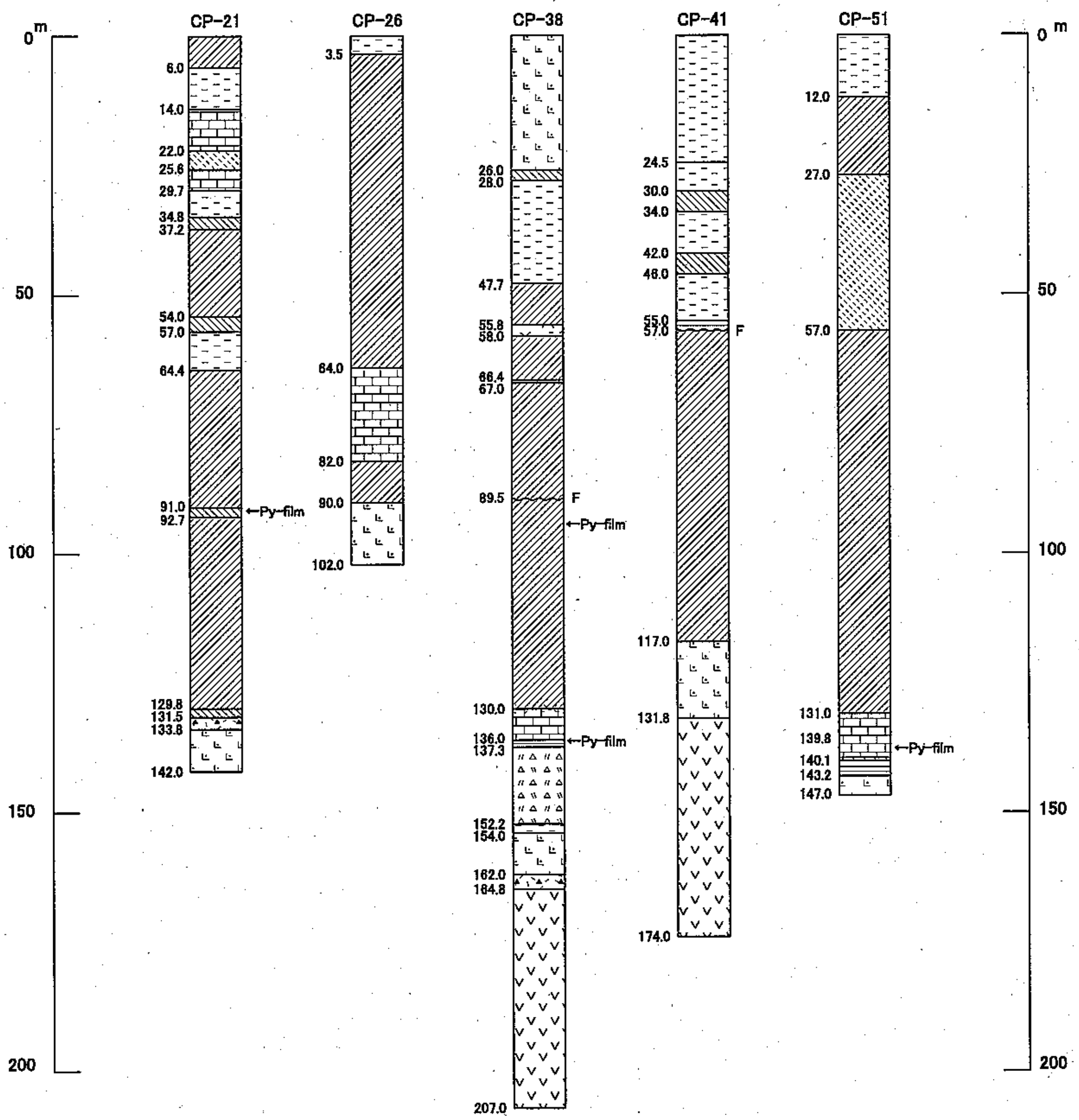

Fig. II－2－4 Geological columnar section(Capire)

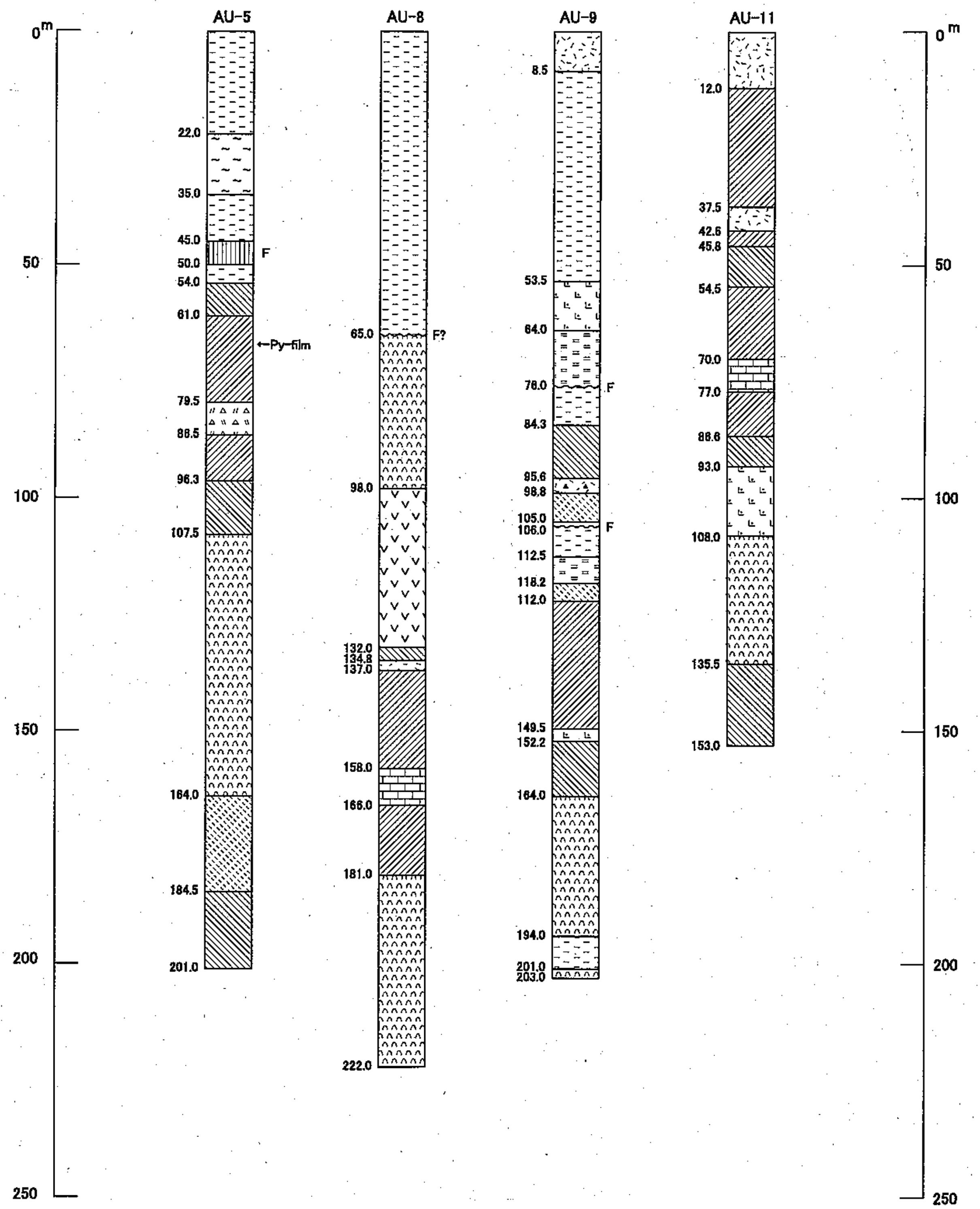

Fig. II − 2 − 5 Geological columnar section(Aurora)

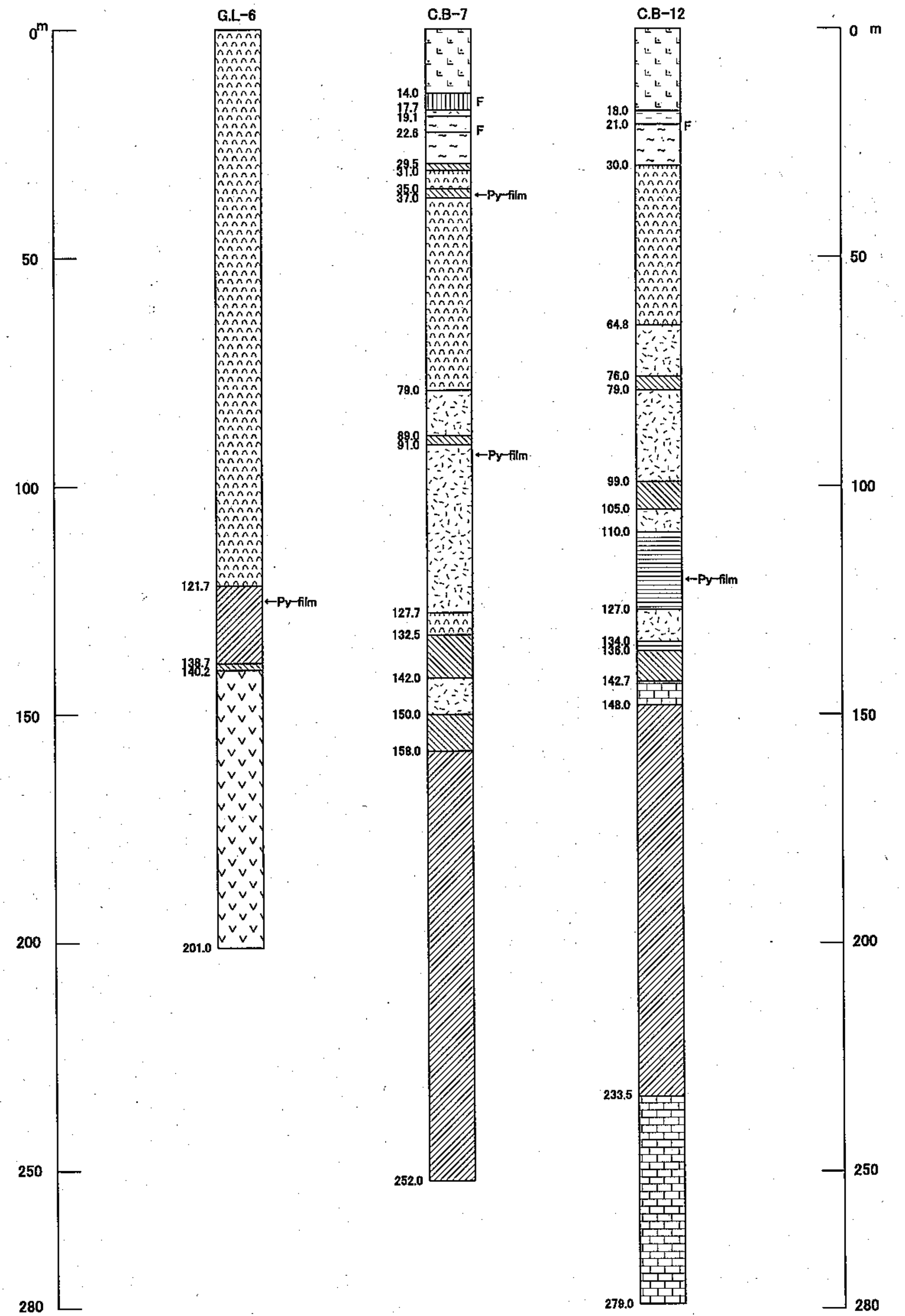

Fig. Ⅱ－2－6 Geological columnar section(Guadalupe～Cruz Blanca)

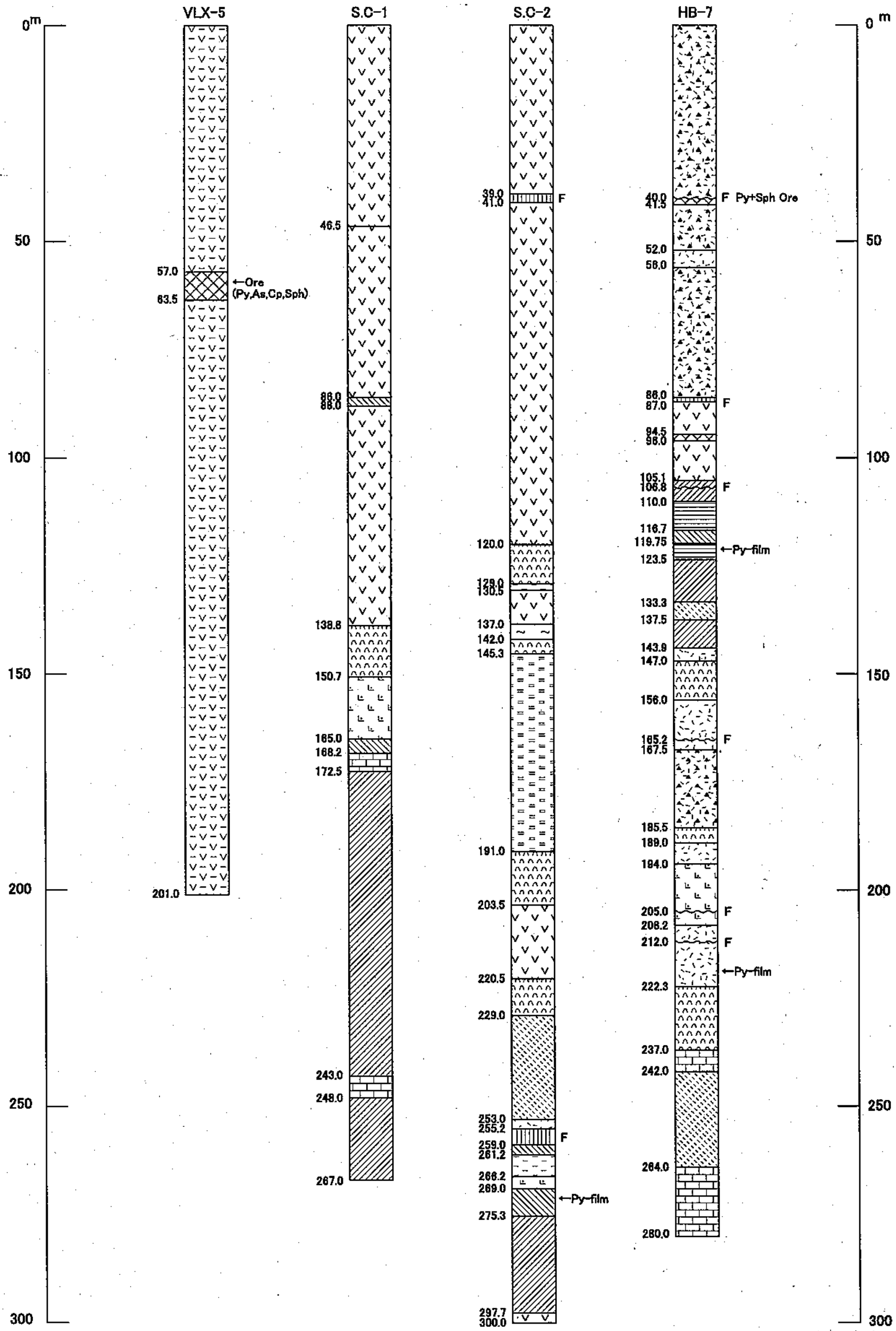

Fig. II − 2 − 7 Geological columnar section(Velixtla～San Carlos～Yerbabuena)

Chapter 3 Integrated Discussion

Figure II-3-1 shows the integrated interpretation map.

3-1 Geological structure

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 of the Mixteco terrene and overlaying Cenozoic Balsas Formation and Tilzapotla Rhyolite Formation .

The Guerrero terrene occupying the principal part of the area is also locally called the Teloloapan sub-terrene. The Tizapa, Rey de Plata and Campo Morado Deposits, similar type of massive sulfide ore deposits to the Japanese Kuroko deposits, are distributed in the terrene. These ore deposits are hosted in the uppermost horizon of the green volcanic rocks correlated to the Villa Ayala Formation.

The depositional environment for muddy rocks is dominant in the Teloloapan terrene, but the activity of the green volcanic rocks, typical in the Villa Ayala Formation, is one of these under this environment.

The green volcanic rocks well reserve their original structure and texture of basaltic to andesitic pillow lava, autobrecciated lava, massive lava and hyaloclastite. Accordingly, it is obvious that they are ocean floor products. It is thought that the activity changed to dacitic to acidic andesitic intermittent one at the final stage and alternation beds of mudstone and pyroclastic rocks were locally deposited. It is also possible that the massive sulfide ore deposits were simultaneously formed with the above-mentioned deposition. The Aurora, Capire and Tlanilpa occurrences situated in the central area are all hosted in the alternation beds of mudstone and pyroclastic rocks.

After the cease of the volcanic activity, its depositional environment was greatly changed to that of increase of calcareous sedimentary rocks portion. Calcareous material becomes partly dominant rather than muddy material. It is thought that the Pachivia and Teloloapan Formations deposited under this environment. This is not only seen in this area, but also in the whole areas of Teloloapan sub-terrene as a general trend of global environmental change.

Afterward, the sub-ocean volcanic and sedimentary rocks in the Guerrero terrene have undergone regional deformation and metamorphism and finally contacted with the limestone of the Morelos Formation in the Mixteco terrene. The deformation in the rocks of the Guerrero terrene is mainly of closed folding accompanied with fracture cleavages, several meters to several hundreds meters in wave length. Other various scale faults and thrust faults are also seen in the area.

The above-mentioned deformation is not recognized in the Morelos Formations of the Mixteco terrene and Cenozoic Formations. Only a brittle deformation type is recognized in the area since Tertiary time. Some vein-type ore deposits are accompanied with those faults trending northwest to southeast, northeast to southwest and north to south in some places.

3-2 Mineralization and alteration

The mineralized occurrences of the massive sulfide type associated with ocean floor volcanic activity and vein-type are distributed in the survey area.

The massive sulfide ore bodies are hosted in the uppermost horizon of the Villa Ayala Formation. Some lenticular ore bodies consisting of fine grained lead and zinc minerals have been observed in the alternation beds of slate and tuff in Aurora and Capire. Some pyrite occurrences simultaneously deposited with tuff and mudstone are seen in the drilling cores of TN-14 in the Tlanilpa district. The footwall side alteration is not clear in Aurora and Capire, but some weak pyrite veinlet-networks and breached parts due to silicification and sericitization are seen in TN-14. Accordingly, it is presumed that the Tlanilpa district is situated closer to the massive sulfide-type hydrothermal activity center than the Aurora and Capire districts because of its northern position.

The most significant mineralized occurrences and alteration zones at the surface are of an intermittently spotted zone extending toward west-southwest from the northeast of Mamatla to nearby Velixtla, including Manto Mamatla and Manto America. In Mamatla, significant silicified and sericitized zones are in the green rocks and some pyrite disseminated parts and networks exist together with massive parts. It is possible that the vein-type mineralization has been overprinted on the massive sulfide mineralized occurrences, however it is possible to distinguish minerals of the vein-type mineralization from those of the massive sulfide type by those courser grain size and accompanied quartz and calcite. It is judged that the mineralization and alteration of Manto Mamatla and Manto America indicate the massive sulfide type, however they are situated in the lower horizon of the standard massive sulfide zone.

The ore horizon is in the upper part of the green rocks formation and overlain by the alternation beds of tuff, slate and calcareous slate. Consequently, it is judged that potential zones for the massive sulfide ores are restricted to the Manto Rico to Santiago Salinas to Aurora to Azulaquez districts, where the alternation beds are distributed in large-scale. It is possible to think that these districts are situated in a probable caldera structure, structurally deformed specific volcanic sedimentary basin.

It is said that many vein-type ore deposits have been operated around Zacualpan in the past, however only two mines are in operation at present. Some vein-type mineral occurrences have been recognized in the existing drilling cores. VLX-5 in the Velixtla district had encountered a vein-type occurrence of pyrite and sphalerite from 57 meters to 63.5 meters in depth. It is said that high-grade veins are generally restricted in the calcareous rocks accordingly an area to the east of Zacualpan is only one for high potential.

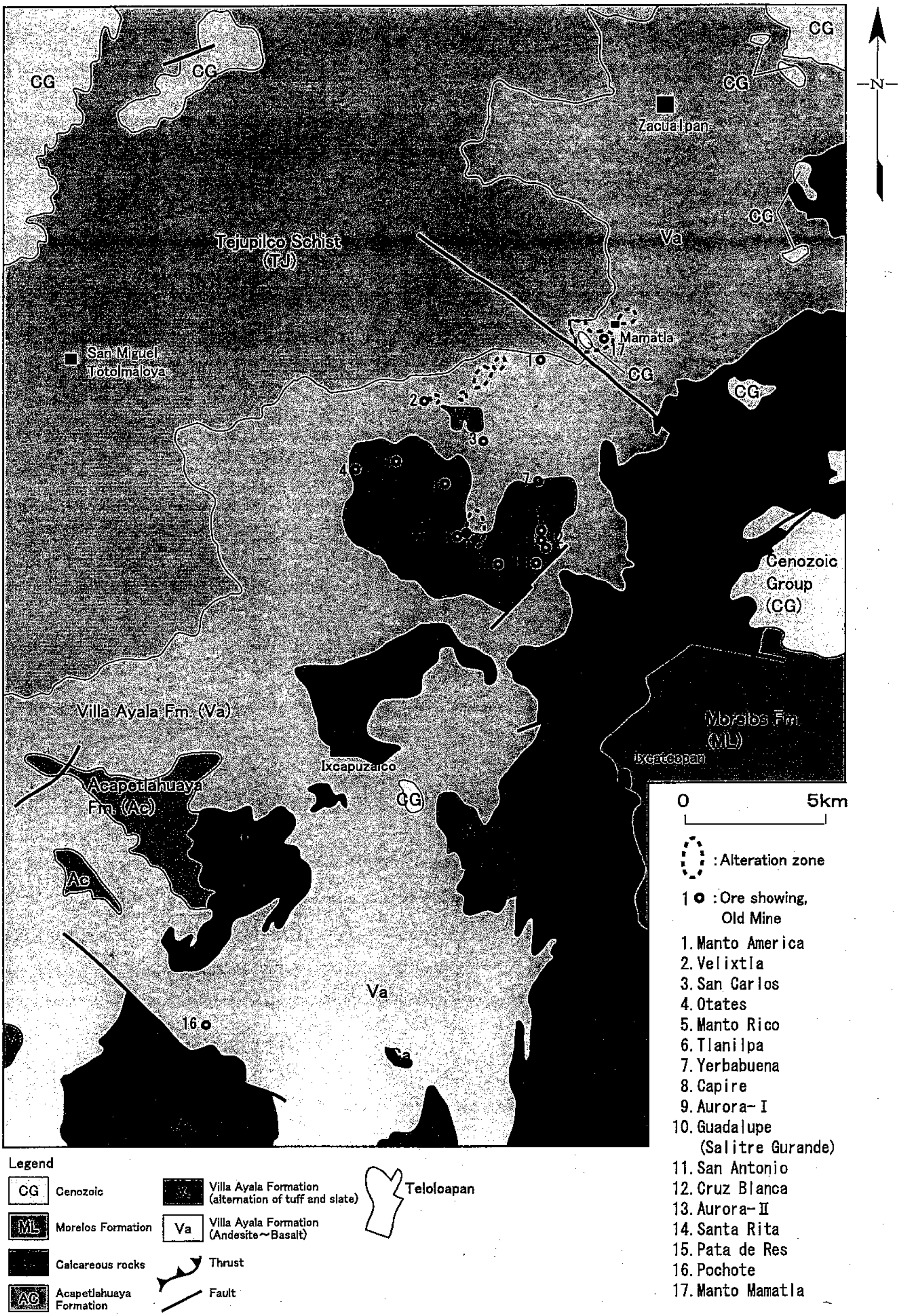

Fig. II－3－1 The integrated interpretation map