PART IV S.TUBOH AREA

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Chapter 1 Outline

The S.Tuboh area was selected from detailed survey area covered 18km^2 through the detailed geological and geochemical sueveys of the initial phase. There are three mineral indicators, S.Tuboh, S.Kering, and S.Sepan, in the detailed survey area, and the area covers S.Tuboh indicater.

The detailed survey of the initial phase has revealed that the S.Tuboh area included high grade Ag-Zn-Pb and Cu mineralized zone, and was expected to extend strike and dip sides. A drilling survey was conducted ten shallow holes(total 1,580m) to clarify horizontal extention of the mineralized zone. in the second phase survey. As a result of the survey, the S.Tuboh mineralized zone was clarified to be skarn type mineralization, consisting of several units with high grade Ag-Zn-Pb.

On the basis of the results, the drilling survey was made plan to unravel these extention horozontally and along the shoot. The drilling survey of 13 holes, 7 holes for hoizontal and 6 hole for inclined total length was 3,170m.

As a result of the survey, nine mineralized zones (units) in the S.Tuboh area, and obtained provisional ore reserves of 1,700,000 ton below surface to 300m.

The area performed drilling survey in the S.Tuboh covered 600m(NE-SW) × 400m(NW-SE) in the second phase, and additionally 900m(NNE-SW) × 500m (NW-SE).m

Chapter 2 Geology

2-1 Outline of geology

The geology of the S.Tuboh area consists of the Mersip Limestone Member(which can itself be divided into three facies) belonging to middle and upper parts of the S.Rawas Formation (Mesozoic formation : Upper Jurasic to Lower Cretaceous). In addition, sandy-muddy facies with intercalated beds of andesitic lava and tuff of Lower formation, and sandstone facies of Upper formation are distributed. The alkaline intrusive rocks (dated as 50Ma before and after) has intruded the Formation. There is also small distribution of semi-consolidated pyroclastic rock correlated to S.Minak Formation of Neogene System.

2-2 Sedimentary rocks

The Mersip Limestone Member in the S.Tuboh is distributed from Mersip (its type locality) to the part extennding southeast past Bt. Raja. In the S.Tuboh, it has undergone marmorization, and converted to marble. Both the thin intercalated beds, sandy-muddy faceis has been altered into hornfels, and tuff facies into serpentine and partly into talc. Despite this alteration, the structure and composition of the original rock has been preserved in most case. The intercalation beds of alkali-mafic tuff and lava make a useful key bed, and interprets the grological structure. Marble appearing to be part of the same strata is distributed from the S.Tuboh basin, to the lower leachs of the S.Tuboh, the S.Kering anld S.Sepang in the east, and the middle reachs of the S.Nilau in the north.

The sandy-muddy facies with intercalated beds of andesitic tuff and lava of lower formation is exposed at S.Tuboh area. The formation consists of tuffaceous sandstone, and sericite-chlorite phylite which is assumed to be of tuffaceous-argillaceous rock origin.

The upper sandstone-mudstone facies is hardly accompanied by any tuffaceous materials, and is most often formed alternated strata of sandstone and slate. It has usually undergone hornfels.

Semi-consolidated pyrocrastic rock correlated with the S.Minak Formation is narrowly exposed at west part of the S.Tuboh area. It consists of felsic pyrocrastic flow sediments, and yields petrified wood in some place.

2-3 Intrusive rocks

The intrusive rocks consists of two facies of deep and shallow of alkaline intrusive rocks. Both show that they intruded closely into the place under geological structure control, and both large and small scale intrusive rocks have a tendency to trend NE-SW.

The alkaline intrusive rock (deep facies) have been intruded as two fairly large rock body trending NE-SW at the southeast and northwest of S.Tuboh mineralized zone. Although they are apparently a single intrusive rock, they are composed of many lithologic rocks in detail. Studies of thin sections and whole rock assay reveals that the intrusive rocks are made up quartz monzonite, quartz monzonite porphyry, tonalite, alkaline gabbro, quartz diorite and diorite.

The alkaline intrusive rocks (shallow facies or volcanic facies) consists of trachy andesite, basaltic trackyte, basaltic tracky andesite, alkaline basalt, tracky dolerite, and occur usually as small intrusion. The rock occasionally coexists with mineralized zone, and rocks have often undergone skarnitization. Similarly to the alkaline rock(deep facies), they show a tendency to trend NE-SW and dip shaply to SE.

Chapter 3 Geological structure

In the S.Tuboh area, a fault system running NNW-SSE or N-S is extensively distributed which is virtually perpendicular to the general strike of the strata, and makes the geological structure very complex. The strata generally dip gently, and the trend is in predominant contrast with the area in the north of the S.Rawas. Namely there is a NW-SE trend in the north of the S.Rawas, while there is a NE-SW trend in the S.Tuboh area.

Fronm the fact that in the S.Tuboh, the alkaline intrusive rocks also trend NE-SW, it appears that the NE-SW strike of the strata match with the direction of a deep fracures wich controlled the emplacement of the intrusive rocks. Accordingly, although the dominant NE-SW direction of the geological structure in the S.Tuboh area can be seen as a localized structure in terms of the general structure of the whole South Sumatra area, it is regarded as one of intrinsic structure.

The mable stratum of main part in the S.Tuboh which have been marmortized by metamorphosis of the Mersip Limestone Member delineates a anticlinal structure trending ENE-WSW and plunging gently SW by intercalated alkaline mafic lava at north east part, while homoclinal structure at southwest part and a synclinal structure trending NE-SW and plunging NE from central part to southwest part. The NE trend anticlinal structure is cut by a fault running N10° W ～N10° E across the center part of this area.

The initial phase described that two systems of faults, a NW-SE system and a MW-SE to N-S system, occur extensively in the detailed survey area including the S.Tuboh area. However faults of N-S system is conspicuous in the geological map compiled by the survey. The reason for this is that the faults of N-S system are the youngest structure in the S.Tuboh area, and run across perpendicularly to the old structure, and their presence is easy to detect. On the other hand, the faults of NE-SW system are a strike-srip fault. They are older faults and were attributed to emplace the intrusive rocks. Therefor the faults are unclear due to same strike with the strata and the intrusive rocks.

However, from the general structure of the south sumatra area point of view, the relationship of 2 fault systems of NW-SE and N-S (NW-SE) are both the old faults, and they presumably repeated their moving up to present. Consequently, relationship of the both faults rather reverse, comparing to

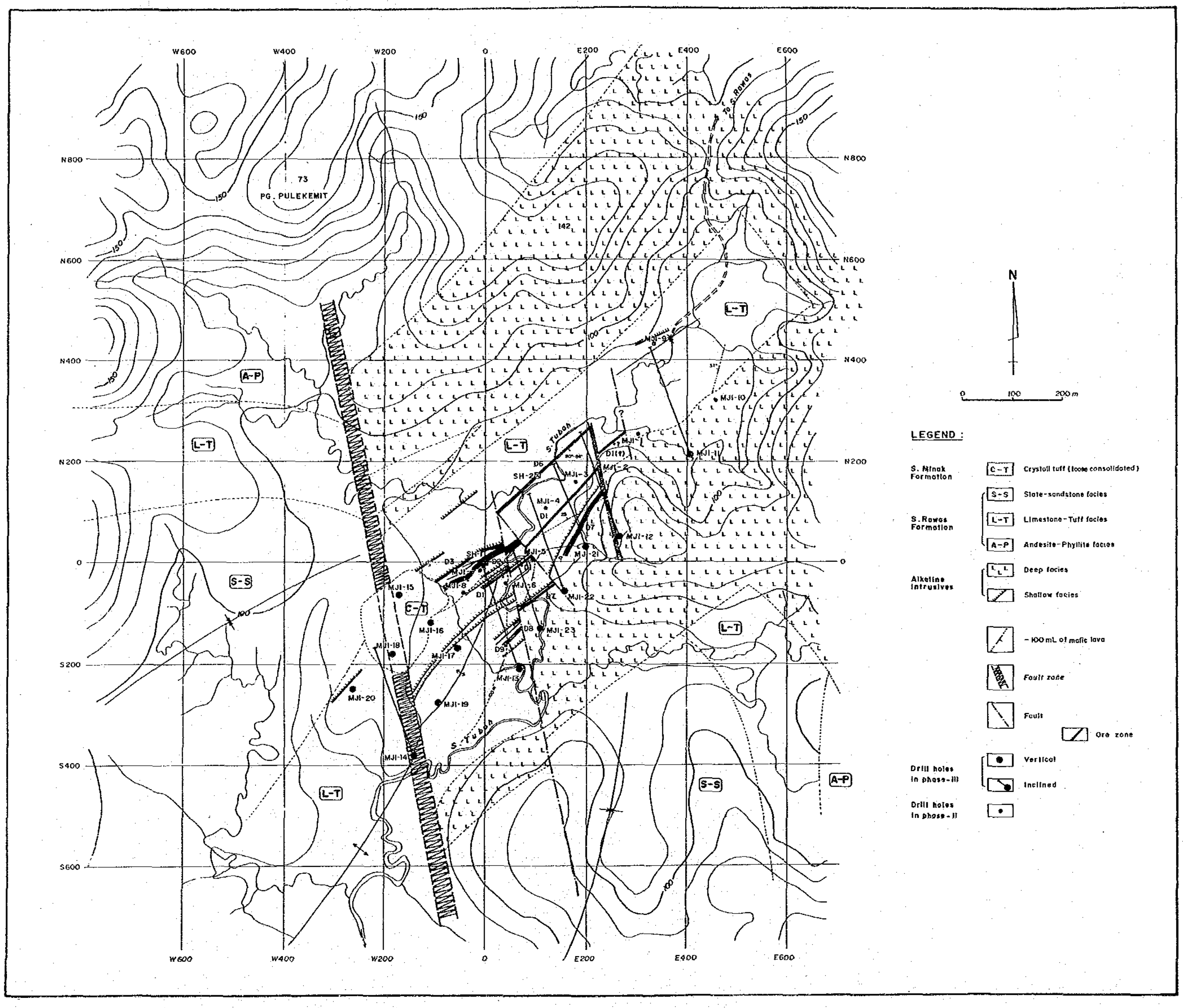

Fig. 14 Geological map of the S.Tuboh area

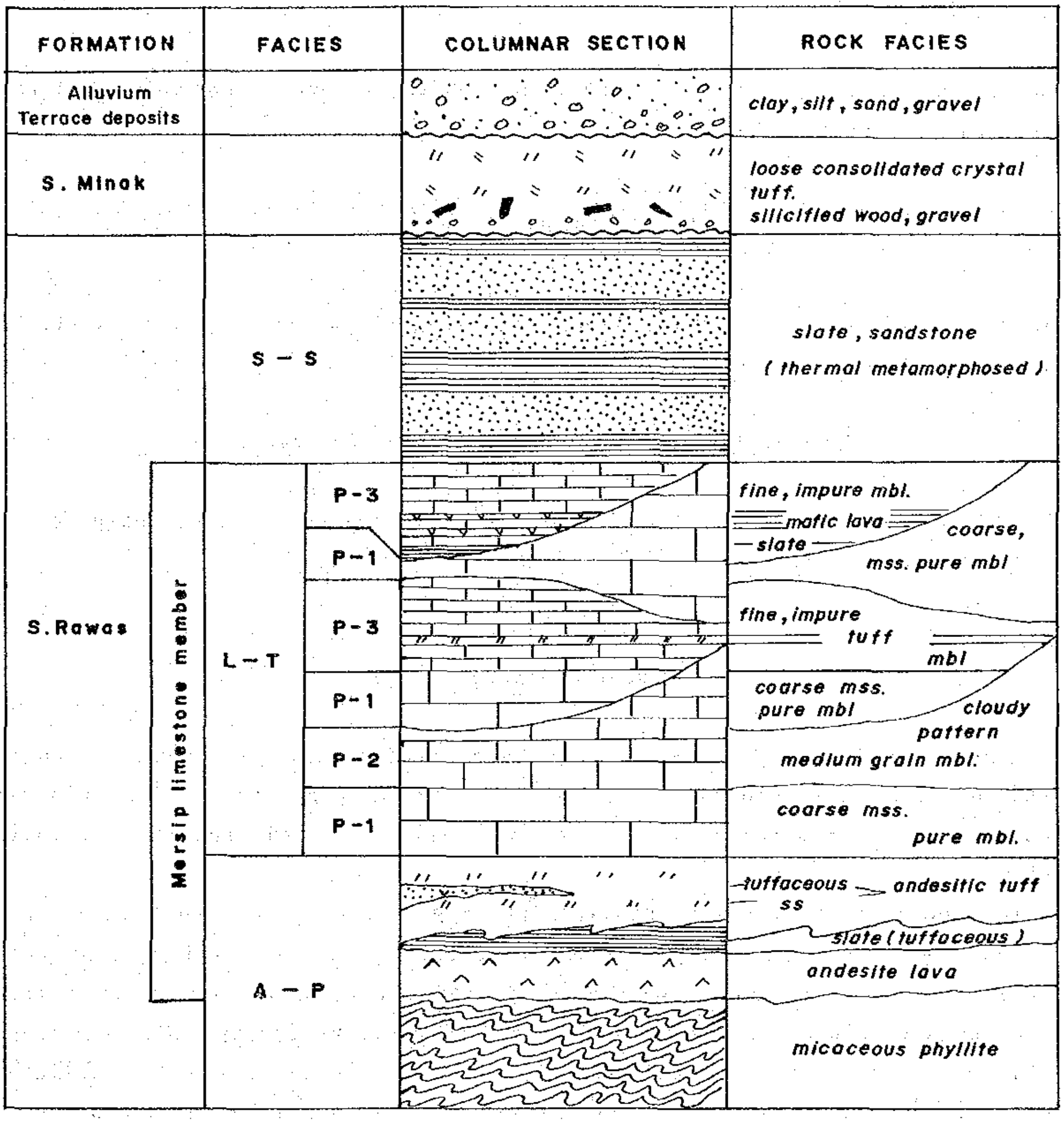

Fig. 15 Schematic geologic column of the S.Tuboh area

that of S.Tuboh area. Then the relation of the 2 fault systems in the S.Tuboh area, namely N-S system is younger than NE-SW system, is accepted within the S.Tuboh area.

The concept on the geological structure in the S.Tuboh area is summarised as follows ;

NE-SW trend folding structure formed through the techtonic movement in late Jurassic ~ early Paleogene

⇩

Formation of NE-SW faults from period of folding movement(NW-SE faults also formed, but faded later due to the movement)

⇩

Intrusion activity of the alkaline rock along NE-SW fault system as strike faults and deep fracture.

⇩

Mineralization and formation of mineralized zone

⇩

Formation of NW-SE to N-S faults in Pliocene - Pleistocene(probably reopening of old fissures)

Chapter 4 Mineralization

Nine mineralized zones(units) have been found in the S.Tuboh area up to the present. The mineralized zones are skarn type from thier mineral composition, but seem to be paralel vein type or bedded deposit from their shape.

In view of its variation dipward, the mineralization of the S.Tuboh area cannot be strata-bound deposit(bedded sulfide). Despite this, Sr/Sr data indicates that the source materials of the mineralized zone derived from sedimentary origin(the second phase), and also sulfur isotope analysis shows that ore sulfur forming the mineralized zone is of sea water salfate. Namely, this suggests that the mineralization in the S.Tuboh area was due to movement, reorganization and redeposition of existing sulfur in the S.Rawas Formation under the physical condition which produce skarnitization. On the other hand, the evidence of existence of a large amount of quartz(rock-crystal), silisification and decorouring(sericite and kaoline), no coarse gangue mineral shows that the mineralization is slightly differnce occurence from skarn type deposit. The Tuboh mineralization signifies to be peculiar.

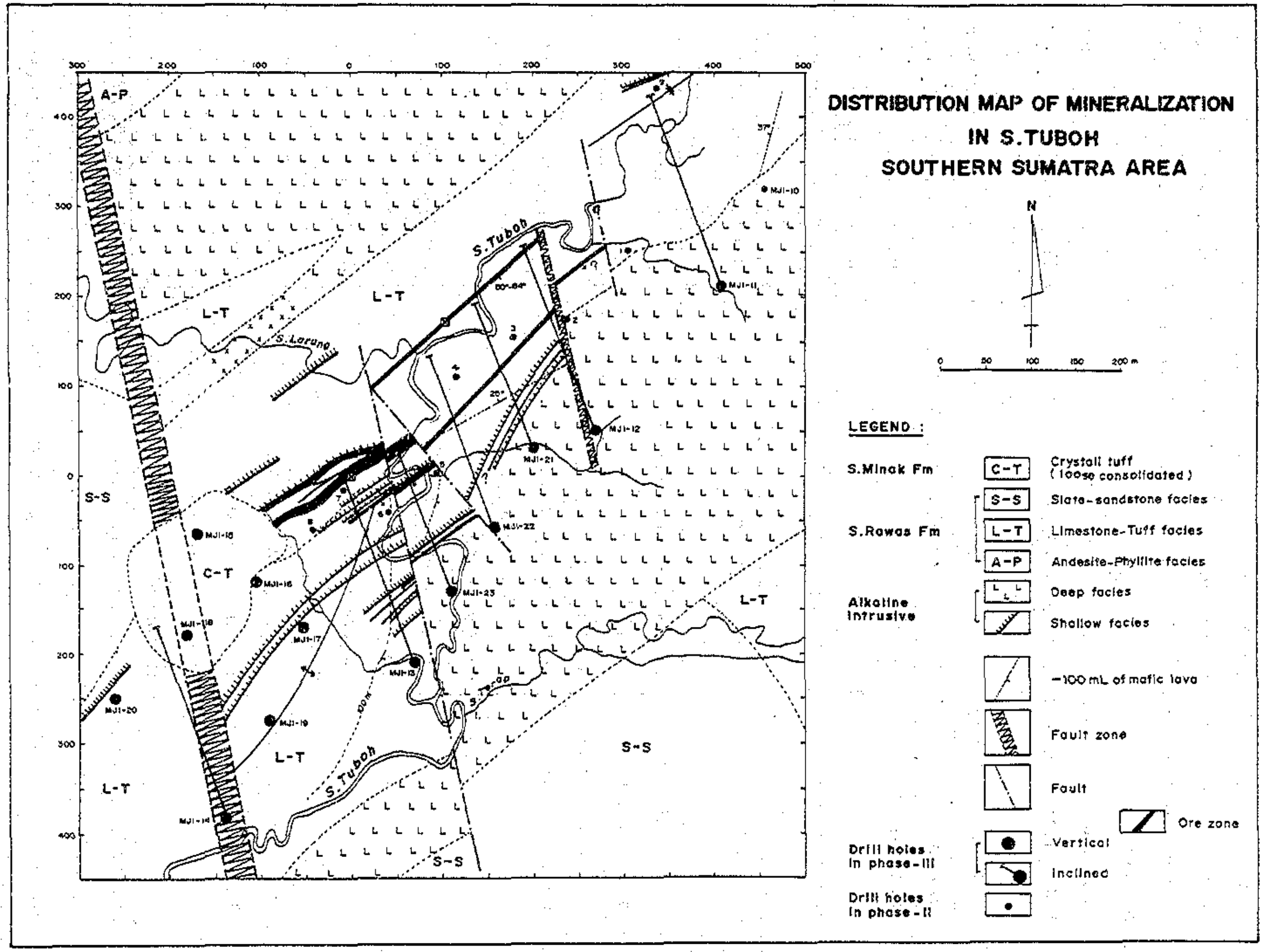

Fig. 16 Distribution map of the mineral indications in the S.Tuboh area

Data that supports the case for skarnitization as the form of the S.Tuboh area is the existence of gustavatite(silver mineral $Ag_2S\text{-}Bi_2S_3\text{-}PbS$) as report in the second phase survey, and temperature by geothermometer from sulfur isotope. Occurence of the gustavite resembles that in the Nakadatshu mine, well known for its skarn type ore deposit, and an average isotope geo temperature(430℃) obtained from sulfur isotope matchs well with the measurements for most skarn deposit. Furthermore, a metasomatic texture seen at the contact part of the mineralized zone is usually observable in skarn mineralization.

The ore minerals and gangue minerals are summarized in Table 11, and all factors relating to the mineralization are also shown in Table 17.

Table 11 Ore and Gangue Minerals in the mineralized Zones, the S.Tuboh

amount	Ore Mineral	Gangue Mineral
a large amount	sphalerite	quartz,andradite hedenbergite,calcite
a large～middle amount,common	chalcopyrite,galena,hematite	chlorite,epidote
a small amount common	chalcopyrite,pyrrhotite	kaoline,sericite mixed layer mineral
rare or usually a small amount	marcacite,magnetite, molybdenite	hornblende,talc
very fine mineral	Gustavite	
ore paragenesis	Sp-Gn-Cp-Py-(Gv) Sp-Gn-Cp-Py-Asp Cp-Sp-Gn-Po-Py Cp-Gn-Sp-Py-Mt Cp-Gn-Py-Sp Sp-Hm-Py-Gn Sp-Gn-Mb	(accompanied ore) Qt,Cc,Ad,Hd,Ep,Ch,Se (skarn zone) QWt-Ad Qt-Ad-Hd Qt-Cc-Ad-Ep
common paregenesis through necked eye	Sp-Gn-Qt-Hd-Ad-Ep Sp-Gn-Cc-Ad-Qt Sp-Gn-Cc-Ad-Po Sp-Gn-Hd	

Sp:Sphalerite, Gn:Galena, Cp:Chalcopyrite, Po:Pyrrhotite, Py:Pyrite, Mt:Magnetite, Hm:Hematite, Mb:Molybdenite, Cv:Gustavite, Qt:Quartz, Ad:Andradite, Hd:Hedenbergite, Cc:Calcite, Ep:Epidote, Ch:Chlorite, Se:Sericite

In the S.Tuboh area, a barrene skarn zone accompanied by a minimum number

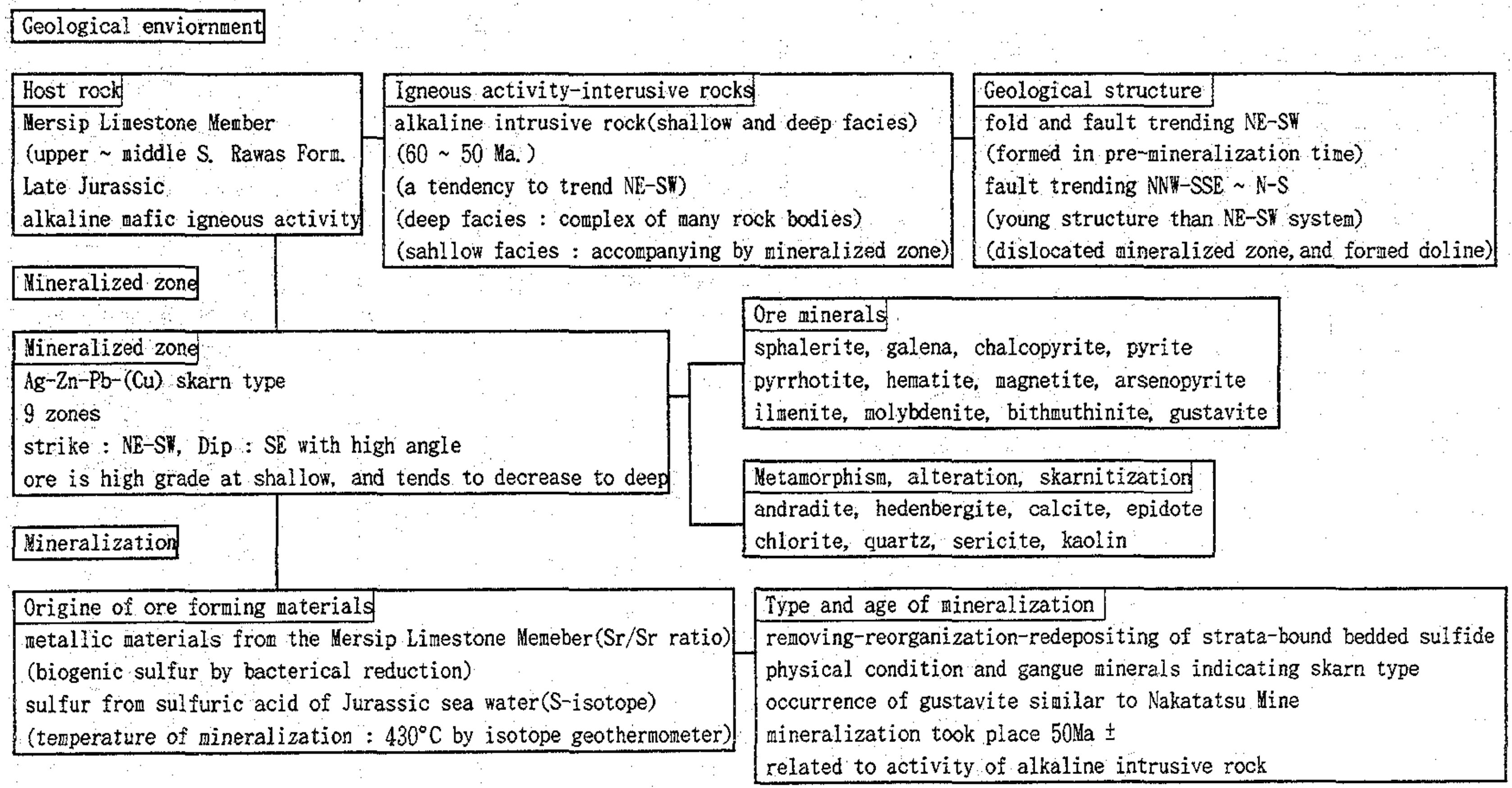

Fig. 17 Overall characteristics of mineralization in yhe S.Tuboh area

of pyrrhotite occurs at boundarty between northwest margin of alkaline intrusive rock, locating at southeast the mineralized zone, and the marble. It is composed of grossular, vesuvianite, quartz, potassic feldspar, diopside, and it is also known the existence of aegirine, olivine, magnetite, pyrrhotite, chromite of a composition mineral of mafic alkaline rock. The later alkaline intrusive rock (deep facies) replaced the early alkaline intrusive rock (deep facies) and the calcareous rock, and the barrene skarn was produced by this metasomatism.

Chapter 5 Provisional calculation of ore reserves

A total of 9 mineralized zone(unit) were discovered by drilling survey of 23 holes (a total length : 4,680m) implemented in the S.Tuboh area over 2 years in second and third phases. Among them, 7 mmineralized zones were calculated provisional ore reserves on the basis of the condition mentions below. The amount of the provisional ore reserves is shown in Table 12. The longituginal section of the zones is shown in Fig. 18-1～3. The plan parallels along to N50° E-S50° W of the mineralized zone.

The ore reserves differs from the minable ore reserves, namely considering no mining method and no condision. The ore reserves might be tentatively calcurated only existing amount of ore to know its potential from geology and ore deposite point of view. Then cosidering the first step of the exploration, following calculation condition is provided :

【Condition of ore eserves calculation】

① A ore block is delineated the area confirmed at least two holes, or estimate considerable strike and ore shoot, even though it is estimated by a hole.

② The calculation ore width should be more 1 meter in drilled width, or value of grade×drilled width should be satisfied over the cut of limit memtioned in ④

③ Culculation depth differs for each zone, but it shuld be up to a muxmum of -300m level, as the base level(om level) is set at surface of MJI-7

④ The calculated components are Ag,Cu,Pb,and Zn. These cut-off limit grades are shown as follow, and a ore block is calculated provided at least a component in average satidfies over the cut-of grade .

Au≧0.5g/t, Ag≧5g/t, Cu≧0.5%, Pb≧1%, Zn≧1%.

⑤ A specific gravity of rock and skarn used is estimated as $3.5g/cm^3$.

The specific gravity of the ore normally changes with the amount of metal content(grade), so the value should be used depending on the grade. however, all that required here is an approximate estimnate, so these value are adequate.

Among these zones, D_2 (D-2) is the most valuable zone, in terms of both ore reserves and grade, the main mineralized zone in S.Tuboh area. D_7 (D-7) has good grade, and D_6 (D-6) has very good continuity.

Table 12 Provisional ore reserves calculated

Unit	Area	Wd	Volume	SP	Ton	Grade				
						Au	Ag	Cu	Pb	Zn
	m²	m	m³		t	g/t	g/t	%	%	%
D_1	126,575	0.90	113,917	3.5	398.709	0.09	105.2	1.10	1.69	8.05
D_2	50,400	4.43	223,272	3.5	781.452	0.13	117.7	0.78	0.90	8.58
D_3	25,200	0.54	13,608	3.5	47.628	0.07	441.2	0.76	14.58	18.58
D_6	84,000	0.90	75,600	3.5	264.600	0.11	26.3	0.47	0.07	6.29
D_7	96,350	0.68	65,518	3.5	229.313	0.07	187.9	0.60	0.84	18.47
D_8	13,000	0.35	4,550	3.5	15.925	0.14	378.0	3.20	4.20	14.50
D_9	13,000	0.35	3,640	3.5	12.740	0.20	1220.0	0.79	5.42	36.40
D_{10}	7,000	0.50	3,500	3.5	12.250	0.11	263.2	1.09	11.72	15.76
total		1.21			1,762,617	0.11	.130.4	0.80	1.45	9.98

Metal content

Metal	content
Au	192.1kg
Ag	229.768.1kg
Cu	14,084t
Pb	25,622t
Zn	175,868t

On the basis of amount of metal content provisionaly calculated, the economic amount is estimated as us$156,000,000, provided total recovery (total of existing rate, mining, mineral dressing, and smelting recoveries) is estimates 60%. The value is simply summed up each recoverble metal amount times metal price, and metal prices used are as follows :

Gold : 450$/oz
Silver 700¢/oz
copper 1,700$/t
Lead 600$/t
Zinc 830$/t

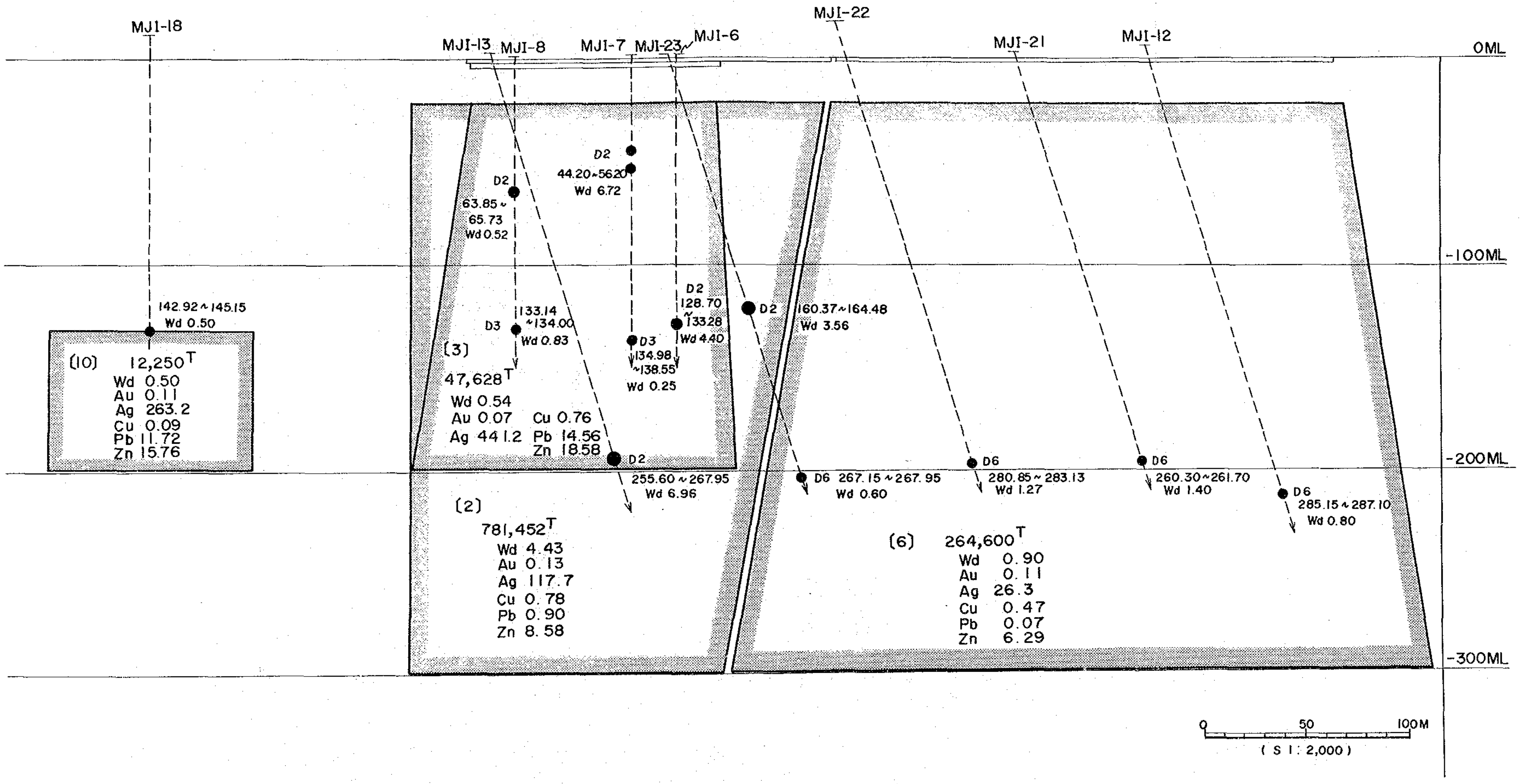

Fig. 18 Crose section for ore reserves (1)

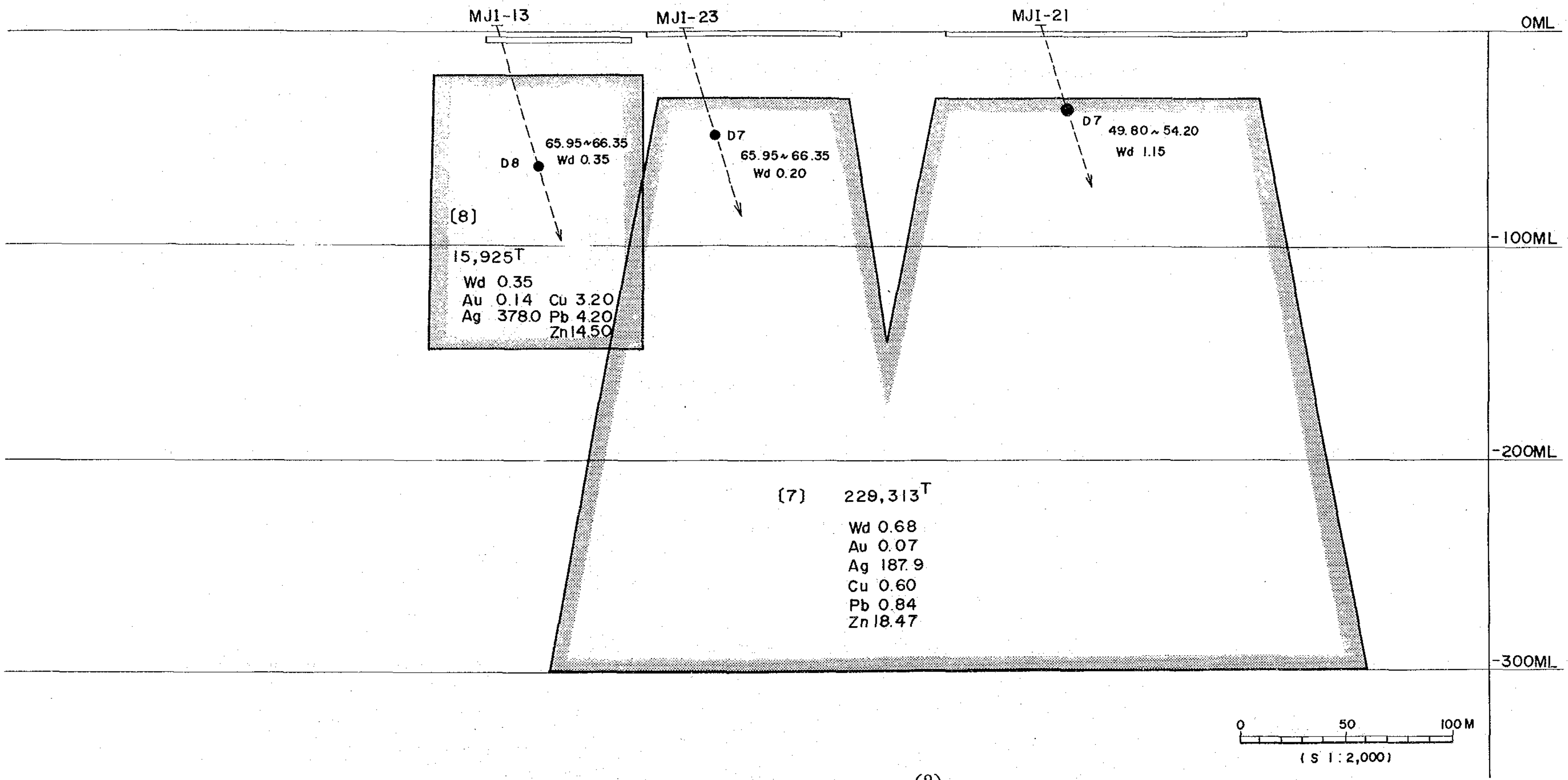

Fig. 18 Crose section for ore reserves (2)

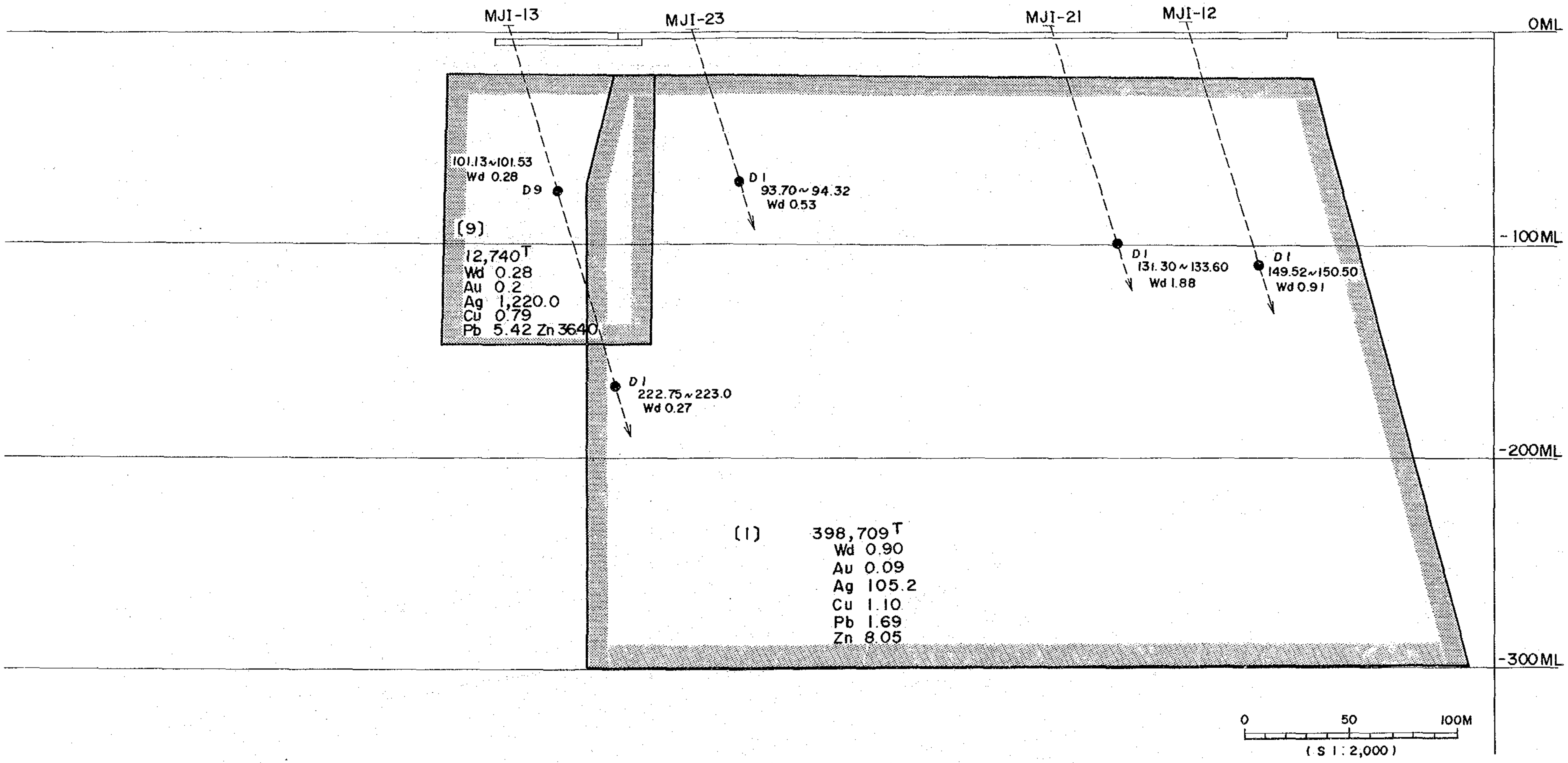

Fig. 18 Crose section for ore reserves (3)

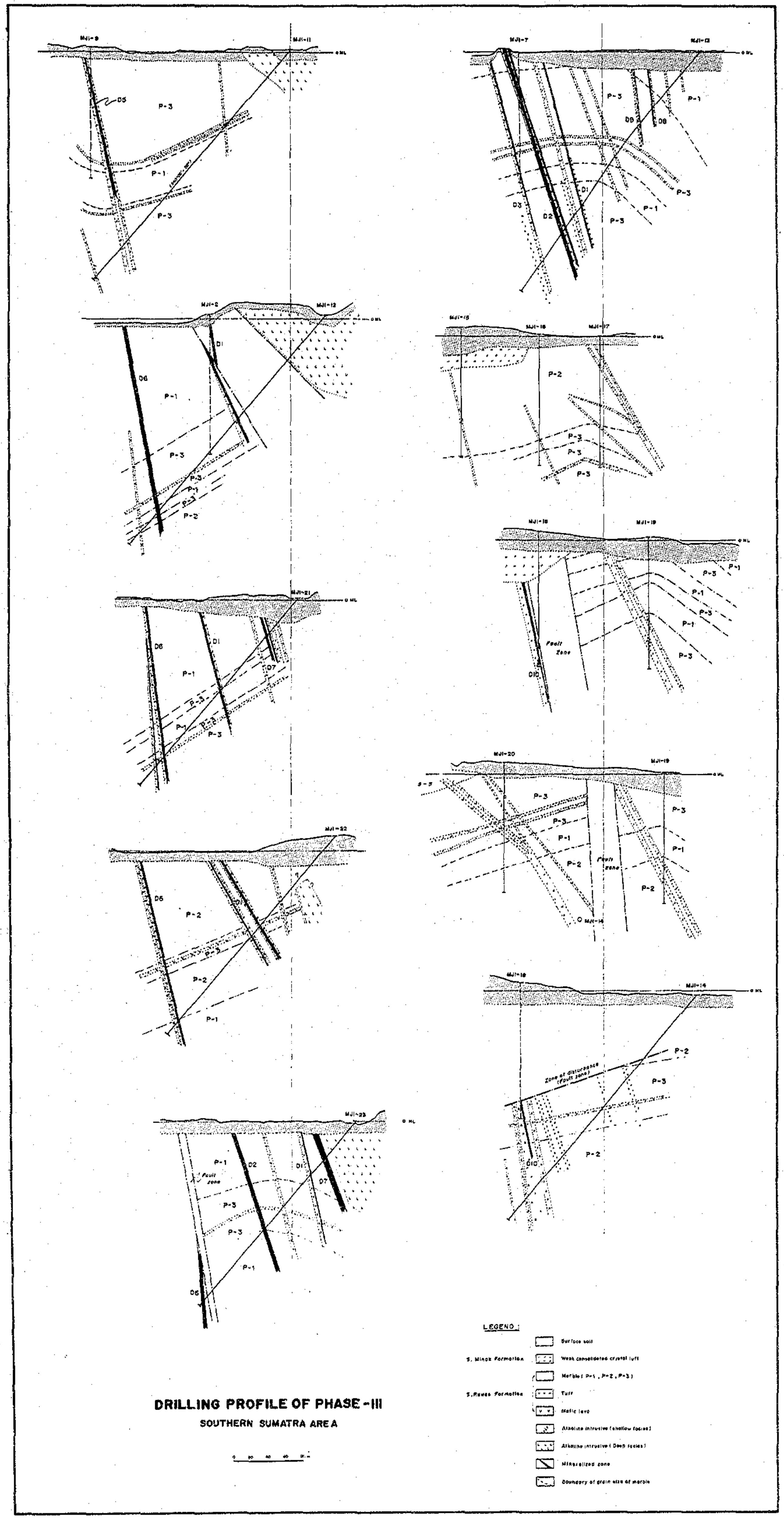

Fig. 19 Geologic profile by geologic column of drills

How to handle these calcuration of ore reserves is a future assignment in the S.Tuboh area. The ore reserves is not enough to evaluate the result of this survey, and further exploration surveys are needed to increase the precision of these provisional calcuration. Around the mineralized zones of S.Tuboh area, the other mineral indications, such as S.Kuring and S.Sepang indications, are still remained as promising and prospecting area. In addition, the marble area at the northwest S.Nilao is interesting area for skarn type mineralization. It is recommended that after the exploration survey is performed in the area including these indications closing each other to unravel potentiality of the metallic mineral resources, future exploitation plan is to be synthetically investigate.

Chapter 6 Drilling survey

6-1 Extent of drilling survey

The extent of the drilling survey conduct in the S.Tuboh, as shown in Table 13, was 23 holes, and a total of 4,680.90m. At the same time, 278 specimens of core were tested and analyzed. ore grade analysis was performed on 132 of those specimens, with a total elements of 714.

6-2 Drilling works

The drilling survey works in the second phase was performed by a drilling machine, operated by one team. and in the third phase,two drilling machines and two teams were used. The drilling work was generally performed on a three-shift system.

Geologically, there were no accidents in the hole due to wall collapsing, because the main rock is marble, and it's quality was good. Then the drilling survey maintained very steady working. Caves(doline) occaisionally occuring in the marble produced some circulation loss and spouting, casing the hole to deviate,and there was also some wear on the drilling tools(bits,drill rod casings).

The equipment was landed at Palembang and transported 540km by truck to village of Surulangun at the entrance to the Southern Sumatra area. Because there were no road, and it was unreasonable to cut roads through the rubber tree, the equipment was transpoeted from there to the drilling site(S.Tuboh area) by helicopter. A crane carrier with caterpilar track was used for carrying the equipment between drilling points at the site, because there were swanps in parts.

Table 13 Overall results of drilling survey

Total holes performed	23holes	Working hour(drilling)	2.603° 10′
total length of drilling	4,680.90m	〃 (other)	778° 40′
Core length	3,963.50m	(recovery working)	162° 10′
Core recovery(total)	84.6%	total	3,544° 00′
〃 (excluded surface)	92.1%	(moving in area)	762° 00′
Totol drilling shift	431shift	(road construction)	590° 00′
The total workers	612shift		
〃 (Engineer)	1,480person		
〃 (labour)	4,485person	The total	4,896° 00′

Bit record

size	Number used	Drilling length	Bit life
NQ	37	1,302.80m	35.2m/bit
BQ	59	2,791.10m	47.3m/bit

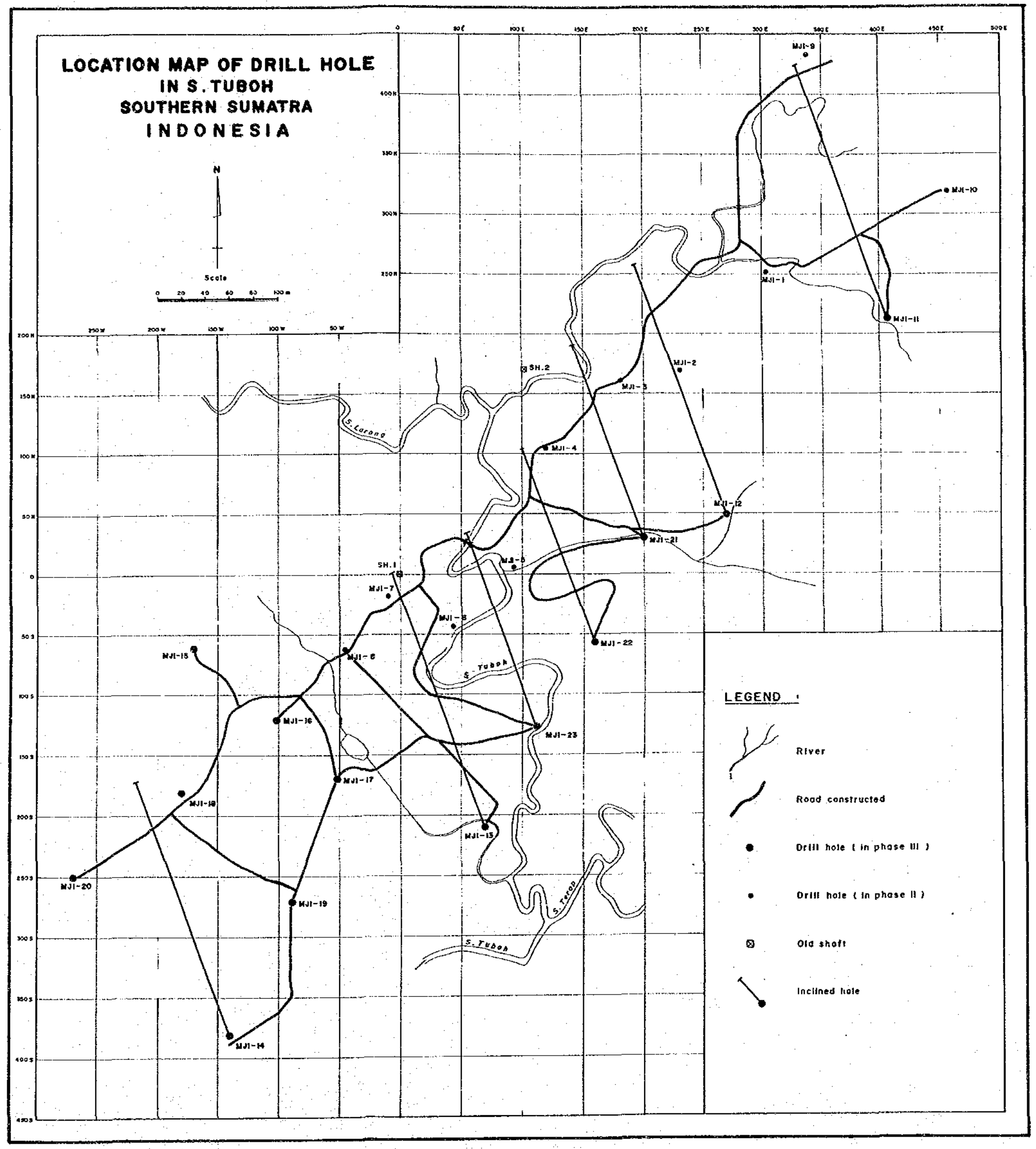

Fig. 20 Location map of drill hole

Part V Conclusions and Recommendation for the future

Part V Conclusions and Recommendations for the future

Chapter 1 Conclusions

The past three years of surveys have revealed the existence of skarn type mineralization in the S. Tuboh area and its surroundings, porphyry copper type, skarn type and pyrite disseminated type mineralization in the Bt. Raja area, and pyrite dessiminated type mineralization in the lower of River Kuwis.

Of these, it has become clear that skarn type mineralization has a substantial distribution in the S. Tuboh area, where 9 mineralized zones have been discovered.

There have also been able to infer the existence of metamorphic-segregated type gold mineralization distributed in the Mesozoic disribution areas, and epithermal type gold mineralization in the Neogene (Hulusimpang Formation) distribution areas with a high probability.

These different types of mineralization can be summarized as follows.

* S. Tuboh area skarn type mineralization : Formed by Ag-Zn-Pb skarn type mineralization. Takes the form of a grouping of mineralized zones, and is the most important mineralization in the Southern Sumatra area.
* Bt. Raja area porphyry copper type mineralization : Forms network quatrz veins with Mo-(Pb-Zn-Co-Au-Ag), but on a small scale and with low grade.
* Bt. Raja area skarn type mineralization : Forms massive deposits of Fe-oxide (magnetite or/and hematite), but is on a small scale.
* Bt. Raja area pyrite disseminated type mineralization : Forms pyrite disseminated silicified zones but the grades are low and the scale is small.
* Lower River Kuwis pyrite disseminated type mineralization : Forms pyrite disseminated sicified zones but the grades are low.
* Epithermal type gold mineralization in Neogene disribution areas : Mineralization resembling the Piio-Pleistocene gold-quatrz vein deposits found all over Indonesia. Presence inferred from anomalies discovered by geochemical survey in the Neogene (Hulusimpang Formation) distribution areas.
* Metamorphic-segregated type gold mineralization in Mesozoic distribution

areas : Concentrations of gold assumed to be produced by metamorphosis of argillaceous facies of the S. Rawas Formation. Thought to be the source of alluvial gold collected in the River Rawas.

Of the 9 mineralized zones discovered in the S. Tuboh area, the 7 with the the good groupings were used to caluculate the ore reserves as shown in the table below.

Provisional culculation of S. Tuboh area mineralized zone ore reserves

Ore	Grade					Content				
Reserves	Au	Ag	Cu	Pb	Zn	Au	Ag	Cu	Pb	Zn
(x 10^3 t)	(g/t)	(g/t)	(%)	(%)	(%)	(kg)	(kg)	(t)	(t)	(t)
1,726	0.1	130	0.8	1.5	10	192	229,760	14,000	25,600	176,000

These provisional calculation of ore reserves include some uncertain elements as the calculation elements because they only represent the calculations for the initial stages of an exploration. These figures signify that development is a possibility if an economical enviornment can be provided by increasing the amount of reserves. There are many parts (areas) in the S. Tuboh area which have yet to be surveyed, including the parts around the confirmed mineralized zones in the S. Tuboh area and the part from the two S. Kering and S. Sepan indications to the middle reaches River Nilau. It is therefore necessary for surveying to progress to these parts with the object of finding more ore reserves.

Epithermal gold mineralization is an important type of mineralization which can form the economical concentrations (deposits) of gold in the area of distribution of the Neogene (Hulusimpang Formation) may determine the presence of gold mineralized zones.

Other underground resources in the Southern Sumatra area are limestone (several billion tons) around Bt. Bulang in the north and marble (several hundred thousand tons within 50 m deep from the surface) in the S. Tuboh area. Chemical analysis of the limestone around Bt. Bulang in the north gives the following results. Its quality means that it can be used as a raw material for carbide, lime/soda ash, glass, flux for steel and copper refineries, as well as for cement.

Grade from analysis of limestone around Bt. Bulang

SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	LOI
0.60	0.28	0.13	0.03	0.32	54.21	0.03	0.01	0.03	0.04	42.75
1.64	0.79	0.19	0.06	0.45	53.00	0.04	0.11	0.04	0.05	42.12

Develpoment of the S. Tuboh area for its marble and rocks around the mineralized zones may help to promote development of the S. Tuboh area mineralized zones. This depends on acquiring mining technology, clarification of the occurrences of the mineralized zones, and sales income from the "marble" (marble itself and rocks).

Chapter 2 Recommendation for the future

a) S. Tuboh area

More accurate information is need about the quantities and grades of reserves in the S. Tuboh area itself, and the amount of confirmed reserves needs to be increased by prospecting in the as yet unsurveyed areas (parts) around the mineralized zones which are already known.

To obtain more accurate information on the quantities and grades of reserves, the occurences of the mineralized zones need to be considered, ideally using underground prospecting including tunnels and short drillings.

The following locations are suggested for the unsurveyed areas around the mineralized zones which are already known.

1) Between MJI-13 and MJI-14
2) Foot wall part of D_6
3) Parts to SW and NE of D_5 (D-4 by MJI-9)
4) Between MJI-12 and MJI-11
5) Around MJI-18
6) Foot wall parts of D_2 and D_3
7) Deeper part more than 300 m from the surface

These parts can be explored by drillings from the surface.

Apart from these areas in the S. Tuboh area, it is also desirable to survey the area of marble distribution from the S. Kering and S. Sepang indications to the middle reaches S. Nilau, with the aim of increasing the ore reserves.

It is desirable that feasibility study are conducted, based on the results of these surveys, to evaluate the total resource potential of the area centered around the S. Tuboh area.

In addition to dealing with the technical aspects of development, a feasibility study should cover a wide range of areas, including scale of development and production, estimates of income from sales and mine life, capital investment, running cost, capital cost, raising capital, tax law and tax benefits, labor, transport, harbors, sales, energy supplies, water supply and discharge, and envionmental controls. This investigation should ideally be conducted by setting up a project team include the experts required to be able to deal with these areas. It is important to investigate fully what sort of impact the mining development would have on the local area.

The possibility of mud flows should be investigeted for both the S. Kering and S. Sepan indications, and if they are found to be the result of mud flows, the source of the mud flow needs to be traced down.

These surrounding areas should ideally be surveyed by a combination of detailed soil geochemical surveys, electirical geophysical exploration and 100 m deep drilliong surveys in addition to detailed geological surveys.

b) Neogene (Hulusimpang Formation) distribution area

The area including the geochemical anomaly discovered in the Neogene (Hulusimpang Formation) distribution area should be surveyed in detail for epithermal gold mineralization.

The most of surveying used should initially be to confirm the extent of the mineralization by detailed geological surveying, detailed geochemical exploration of rock and soil, and alteration zone surveys.

c) Other recommendation

The quantity of limestone around Bt. Bulang in the north needs to be confirmed, and the quality of marble and rocks around the mineralized zones in the S. Tuboh area needs to be investigated.

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