2.2.6 Pangaribuan

2.2.6.1 Summary of geological features

As the geological map (Figure 2-25) shows, the area around Lake Toba in northern Sumatra, where the Pangaribuan Mine lies, consists of a Paleozoic phase, penetrated by plutonic rock and overlaid by a layer of volcanic rock. The volcanic rock phase extends to a width of about 150km and a length of about 250km, surrounding Lake Toba. Further to the west of that part of the volcanic belt which extends from the western edge of Lake Toba, a belt of Paleozoic phase runs south-eastwards from the northern edge of the island of Sumatra, while another Paleozoic belt, about 50km wide and about 100km long, lies to the south-east of Lake Toba in the middle of the volcanic belt. It is through these belts of Paleozoic phase that belts of plutonic rock can be seen penetrating. Pangaribuan is located on the western edges of the Paleozoic belt which lies to the south-east of Lake Toba, and it is presumed that the Pangaribuan feldspar ore deposits were formed from the granite which pierced through the Paleozoic stratum and the feldspar which would have crystallized within it at the time the rock was formed.

2.2.6.2 Conditions at and around the location

The Pangaribuan feldspar mine is situated about 180km south-east of the major north Sumatra city of Medan, in the northern part of the prefecture of Tapanuli (Kabpaten Tapanuli Utera) (Figure 2-26). A three-hour drive southwards from Medan, along the main paved highway, brings you to the western edge of Lake Toba. Another 2-1/2 hour journey southwards, through the lake side resort town of Prapat, brings you to Tarutung.

In Tarutung is the Tapanuli Prefecture, Tarutung branch of the Industry Ministry, under whose jurisdiction the mine lies. In this office, samples of 35 kinds of locally produced ceramic raw material are on display, along with locally-made unglazed jars, fired using rice husks, from which display it is apparent that a great deal of effort is put into promoting the ceramics industry. Twenty-five km to the east of Tarutung, if you follow an occasionally bumpy mountain road for about two hours, you enter the village of Pangaribuan. The stockyard is in the village and then, if you continue from there, climbing up a now extremely bumpy mountain road for about an hour, for a distance of 10km, you reach the quarrying site itself. The road from the village to the quarrying site is a little over 3m wide, but because of its serious state of disrepair it is barely passable for a six-ton vehicle. In particular, under present conditions, it is impossible to take a vehicle along the final 2km.

2.2.6.3 Nature of the resource deposits

The Pangaribuan mine extends over the summit of a 300m high mountain, falling sharply on both sides to a deep valley. At the top of a ridge formed by a line of small hillocks, an area of mainly reddish-brown weathered granite (known as 'country rock') about 300m long, 10 to 30m wide, and extending 20 to 50m down the sloping sides towards the valley, can be seen. There are four quarrying faces in the 300m length along this ridge (Figure 2-27), and to judge from the condition of the furthest site, and also from the ore remaining in the nearest one, which has already been quarried almost to exhaustion, the nature of the feldspar configuration at this mine is such that most of it was not laid down in large masses but rather was distributed in very thin layers across the granite. The superior quality pegmatite feldspar held by BBK was probably configured in the form of large lumps lying very close to the surface.

Concerning the volume of ore in the mine, there are no detailed survey results either in the MTRDC/BBK database or in the DSM report. However, since it has been confirmed, according to local people involved, that feldspar exists to a depth of 50m at this mine it can be calculated that some 400,000 tons of feldspar remain in it. However, looking down from the summit towards the valley, much of the slope area has been stripped away, although there are no signs of rocks or of rocky rubble at the bottom of these old excavations. Furthermore, over much of the slope there are a number of 1-2m wide ditches, which look as if people have gouged them out with their fingernails, running vertically in a fin shape, and these are places where the superior quality feldspar has already been dug up. With these quarrying remains now at a stage where a few white lumps of clay are becoming visible, and with no good quality feldspar visible on the surface, these places are now fully exhausted. The current quarrying site is 10ha in area, but with similar feldspar-rich mountains both 5km south, and 10km north of this mine, giving a total mining area of 100ha, the quantity of ore is presumed large.

2.2.6.4 Quarrying, beneficiation, and use

The company which owns the Pangaribuan feldspar mine is PT. Mica Nic Maduma. Having gained the consent of a few of the landowners, the company's managers obtained mining rights from the prefectural government, but the mine has remained unworked for a year. According to the local people, the reason for the suspension of operations is that, having been requested by the users to supply them with fine 200-300 mesh powder, the company began investigating pulverizing equipment with its Taiwanese partners but, having failed to make any progress, that is still where things stand at the present time. It is only a conjecture, but it may be that the production quantity was so low that even if they had brought in the equipment the operation would not have been cost-effective.

The area at the top of the mountain, where the old quarrying remains are, is more or less devoid of trees, while all around it the ground slopes down into a deep valley. While it appears that, for about 50m, the downward slope was excavated by hand, it seems that because the slope to be quarried is so steep, and the access route is so narrow, no machinery of any kind was used. There are 4 quarrying faces, spaced at 50-60m intervals along the ridge, running in a line towards the interior of the mountains. The first site is located at the innermost point and, with a length of 30m and a quarrying face some 20m high, it is in the form of a small hillock raised about 5m above the level of the road. On one of its southern slopes an old quarrying trench for the previously mentioned high quality pegmatite feldspar remains. 1-2m in depth, 1-2m width, and 10-15m length, these quarrying remains are still fresh and it appears that they were being worked right up until the whole operation was suspended. For a distance of 10m along the 5-6m high apex of the site the rock has been shaved down, but this is not very far advanced and there is still potential for further excavation.

Next, the second quarrying face lies just before the entrance to the approach road, on the eastern side. Measuring 20 x 20m, the top part of a mound 4m high has been quarried. A reddish-brown powdery ore, which looks like well-weathered granite, has been left in a large pile here, as if in a temporary storage place. (Samples have been taken for analysis. As [FP-2].)

The third quarrying face is located in the central part of the mine. On an eminence 30m long by 20m wide, a large piece of multi-layered granite (which the local people call 'country rock') of 2-3m in height has formed and has largely survived. If you take a shaving of this 'country rock' and, by way of a preliminary test, wash it in water, it turns out to be 40 per cent kaolin and 60 per cent silica-rich feldspar. Analysis of this silica-rich feldspar showed it to be 75 per cent silica and 25 per cent feldspar, the feldspar thus making up a mere 15 per cent of the ore. (For a sample of this, as [FP-3].)

The fourth quarrying face is located facing the entrance to the approach road. 30m long, 2-5m across the top, and about as high as the road surface, its sloping face has been shaved away to a distance of 50m down from the level of the road. There is evidence that, these old workings having been dug out some time ago, the site was then used for grading the ore by sieve or as a temporary storage place. Some articles made of coarse-grained feldspar have been left at this storage point, and these have proved to be of superior quality feldspar with a ratio of less than 5 per cent silica mixed into it. (Samples of this have been taken for analysis and these are shown at [FP-4].)

2.2.6.5 Quality

Because this mine is generally in an advanced state of weathering and it is therefore easy to separate the silica and the feldspar, it is possible to sieve it by hand at the quarrying site itself and readily sort the ore according to its granularity or to remove the silica. It can be surmised, therefore, that it was possible, by grading the ore, to quarry the high quality feldspar. The granite at this old extraction site being in an advanced stage of weathering, the feldspar has almost all turned into kaolin and there is very little feldspar remaining. Given that the weathered granite is rich in kaolin, and that moreover, being brittle, the rocks are easily rendered into a powdered ore form, there would be ample scope for its use as a raw material if, in the near future, something like a tile factory were to be set up and ways of quarrying and beneficiation it were to be devised.

2.2.6.6 Transportation

In the past the production quantity, with about 50 workers, was 2 tons a day, giving a yearly rate of about 600 tons. Because the ore was in very thin layers, and the weathering process was very advanced, it was possible to quarry it by hand, but in comparison with other feldspar mines the production quantity was low for the number of workers and so the cost was probably quite high (the exact costs are unknown).

The stockyard is located 10km away from the quarrying site, among the rows of private houses in the village of Pangaribuan, at the foot of the mountain. The site is 40m x 40m, giving a total area of 1,600m^2, while the building is a single-story construction with a frontage of 20m and a depth of 10m, very solidly built. As the entrance was locked, it was not possible to inspect the interior. According to people connected with the yard, the feldspar is held inside the building and shipped out when required.

2.2.6.7 Developing the site: Issues to be addressed.

(1) Configuration of the deposits and their quality.

The Pangaribuan feldspar which has been shipped thus far having been feldspar of the pegmatite variety, the quality is said to have been good. However, the superior quality feldspar has already been exhausted and only the weathered granite (country rock) remains. It is possible that some superior quality feldspar does lie in the lower part of a number of veins, but as the veins are only 1-2m in width no great quantity can be expected. With the remaining granite being composed of silica, fine-grained and brittle feldspar, and kaolin, it is possible - if these are separated out by washing with water or sieving so that the proportion of feldspar content is raised and an uniformity of quality established - that this feldspar can be utilized as a raw material in medium class goods such as tiles. At present, however, no large scale tile factory exists in northern Sumatra, and even if, in the future, a tile factory were to be established it would be necessary, if weathered granite were to be used as a raw material, to have a separating and beneficiating facility. As that would inevitably lead to increased costs, it remains to be determined whether or not the development of this mine could be made into an economically viable endeavor.

(2) Modernization of quarrying methods and the provision of infrastructure

As the rock at this mine is brittle and easily rendered into powder form, technically speaking the quarrying and beneficiation operations are simple. From a topographical point of view, it is possible both to use heavy quarrying machinery and also to be sure of a dumping ground for the waste earth. To resume the development of this mine in the future a considerable amount of investment is going to be necessary, both in ways to secure consistency of quality, such as through rationalizing the operation by mechanizing the quarrying and carrying out research into methods of beneficiating 'country rock' and building the necessary facilities, and in infrastructure provision such as putting in a road. Furthermore, if a market cannot be established for the silica which is a by-product of the separating and beneficiation process, it will become that much harder to run the operation profitably.

In addition to these cost-raising factors, the fact that it is located in the inland part of northern Sumatra is the other major disadvantage for this quarrying operation. From here, it is a long way to the biggest source of demand in Indonesia, the island of Java, and there are too many problems both with the overland route and with the sea route. In terms of harbor facilities, there is Bara harbor at Medan, and Tanjungbalai, which also faces the Andaman Sea, but both of these are too far away (the latter is closer than Bara but the harbor is for the sole use of private businesses and only authorized users can take advantage of it). On the Indian Ocean side there is Sibolga harbor, but this is only a small fishing port and in its current state it would be very difficult for large vessels to dock at it. Even if the harbor were to be enlarged, the rough waves of the Indian Ocean would create serious problems for the ships used to transport the ore, which are smaller than 1,000 tons.

For the above reasons, given that the feldspar is of prime quality and the volume of production is not high, it does not seem likely to be economically viable to seek a market for Pangaribuan feldspar in the island of Java. Bearing in mind these adverse conditions, therefore, there would seem to be very little possibility of a resumption of quarrying operations, an increase in output, or of any expansion of demand.

2.2.7 Narawita feldspar

2.2.7.1 General topographic and geological features

According to the geological map (Figure 2-9), Narawita ore mine is located at in the center, slightly to the west from the center, of the quaternary undifferentiated volcanic products zone that spreads to the south- east of Bandung over an area of approx. 150km from east to west and approx. 50km from south to north. To the west lies the Gabbro peridotite phases of 15km in width. In this Narawita ore mine, the part of rhyolite in the undifferentiated volcanic products zone that contains a large amount of alkaline substances and only a small amount of iron is exploited as feldspar.

Narawita feldspar mine is located approx. 40km to the east of Bandung, and its address is Kp. Cicadas, Desa Narawita, Kec. Cicalengka (Figures 2-4 and 2-28). Cicalengka can be reached within 50 minutes' ride by car from Bandung via the paved trunk road. Passing through the downtown of Cicalengka, and turning to a small alley directed toward the south at the end of the town, you will come across an unpaved country road , and then, come to the mountain road merely paved with large stones. As your car shakes up and down, left and right, as the road is so bumpy, you cannot speed up the car you drive. In approx. 2 hours' time after leaving Bandung, you will arrive at an elevated part of the land, Narawita Hill. The road used for carrying out the ores is about 15 minutes' ride, but the breadth of the road is extremely narrow and the gradient is large, therefore, trucks as large as 5 ton-trucks can narrowly pass the road. The configuration of the ground there is that the flat land changes into mountainous area, and small mountains that are not so high rise and fall, and furthermore, the floras of palm trees and bananas are seen. At the quarrying site, backhoe is introduced when required. A new face is being made, shaving off the upper part of the mountain.

2.2.7.2 Reserves

Narawita Hill consists of the feldspar mine of 20ha and silica mine of 20ha that are linked together. This is the Narawita region, and is the only mine approved by the government.

According to the information obtained at the actual site, in the part of feldspar mine where feldspar exists, that is taking the shape of standing folds (pleats) of 30m in height, feldspar veins spread over an extensive area of 2km to the north from the center of the quarrying site, 2km to the south, 2km to the east and 2km to the west. As for the depth of the ore deposit stratum, it is already checked by boring upto 40m underneath the bottom of the current quarrying site.

At the digging face (vertical section), many faults are observed crossing with one another in vertical, horizontal and inclined directions. Also, as shown in Figure 2-29, the appearance of the mine here exhibits complex features partly with a variety of layers, that is, brown layer containing a large amount of crops (plate-type ferric oxide), white - pale gray layer containing high quality feldspar and pale brown layer in the middle, and in addition, the layers with pinkish, grayish and purplish colors, mixing altogether. The ores here, as a whole, is soft, and easy to exploit, and can be crushed with a bulb of a finger. It is approx. 7 years since the exploitation of this mine was commenced, and already the mine has been cut approx. 60-70m deep into the mountain.

2.2.7.3 Quarrying, beneficiation and utilization

In the mine field currently being exploited, its surface soil of, more or less, 2m deep has been already removed, and about half of the small mountain has been cut or shaved off with open-mining. Judging from the appearance, the field consists of the slightly purplish part close to the mountain peak and the layer where many brownish veins attributable to their iron content mingled together, which occupies 60% of the quarrying section, and the layer where the white portion and slightly brownish portion are intermingled. Workers of less than 10 in number have been cutting into the mining holes located at 11 places, using square spades, etc. as if to dig a pocket wise pod.

In this mine, 2 kinds of materials, that is feldspar and quartz, are produced. Of all feldspar, the material shipped as the high quality feldspar has mainly been dug manually from the best quality portions that exist taking the shape of a pocket included in the portion that appears to be white or the potion closer to it. In the actual site, the materials are classified into 2 kinds, that is, feldspar of a high quality and the colored portion (waste soil). The ratio of the two is said to be 20 : 80. However, it is considered that the feldspar of a high quality constitutes from 5% to 10%, at the maximum, according to the observation of the digging surface.

As for the quality of the feldspar, through an visual observation, the feldspar here is very soft and therefore, is crushed into powder when pushed with a bulb of a finger. In addition, black colored fine particles that seemed to be mica, with a small quantity, though, are dispersed minutely in the powdery part. It is quite difficult to remove these impurities. The materials other than those of a high quality are in part shipped to be used for roof tiles, but most of them are piled up as the waste soil. Therefore, if the same situation continues, there is a large possibility that the disposal of the waste soil would come to a standstill. To prevent this from happening, it is necessary to evaluate the quality of the waste soil and study the possibility of further utilization in the future.

In addition, the portion rich in silica that exists near the summit of the mountain is separately packed in a bag and shipped for the usage as glaze. The amount of shipment for this application, however, has decreased a great deal recently. A horizontal hole has been newly dug just before the stock yard near the entrance of the exploitation site. Feldspar rich in silica is produced from here. The potion rich in silica was created when the surface layer was washed away with water leaving silica. Therefore, it will not be possible to produce it constantly in the future.

As for the carrying out after digging, 5-6 workers, putting the product in the two baskets at both edges of a carrying pole, carry it to the stock pile, with a roof, located within the exploitation site, and after weighing, the product is unloaded and piled up. At the temporary stock pile, 5 ton- truck can park at its side, and the workers of about 10 or more, in turn, load the product on the truck using shovels, and then, the truck carries the load down to the stock pile located 5km below the site at the foot of the mountain. This stock pile at the foot of the mountain is located in the residential district of Kp. Cilulumpang Rt2/Rw2, Ds. Cikasungka Kec. Cikaneung Kab. Bandung 40390, and has a roof covering it and surrounded by a concrete wall (215m^3 (5.5 x 13m x 1.5mH x 2 locations)). Approx. 300 tons of feldspar can be accommodated. 60 tons /day(5 ton-truck x 12 times) of ore is carried in from the quarrying site in the mountain. Compared with the amount carried in, the stock pile is falling short of the appropriate size, and can only play a role as the transit spot. The road for transportation from the stock pile to the destination of the shipment is paved, and the location of the site is quite favorable in the sense that the distance to the trunk road is not very far.

The destination to be shipped and the amount to be shipped are as follows :

PT. Raja Keramik	:	75 tons/day (1,500 tons/month for 20 days/month)
PT. Asahimas	:	less than 100 tons/month
PT. Abadi	:	less than 100 tons/month

The destinations to be shipped are limited to the above 3 firms. The delivery to PT. Raja (tile manufacturer) occupies a major part. To PT. Abadi (roof tile manufacturer), the high quality feldspar is mixed with the waste soil and delivered. The waste soil is crushed into particles of 100 mesh-sieve passing size, and used as the raw material for roofing tiles and unfired bricks (pataco). Formerly, silica was shipped at about 25 tons/day, but silica has been rarely shipped in recent years.

The prices of the products are as follows:

Feldspar	:	Rp.42/kg
Waste soil	:	Rp.0.2/kg (Rp. 1,000 for a full load of 5 ton-truck)
High quality feldspar	:	Rp.70/kg (crushed feldspar with the particle size that can pass through 100 mesh-sieve, put in a 50 kg bag)

Feldspar of a good quality that is selected with a specific sieve is stored at the stock pile at the foot of the mountain. When the request is made by the customers, 18 tons/one time of feldspar is delivered to the customers loaded on the truck sent by them. Destinations in this case are mostly Jakarta and its surrounding area[8].

2.2.7.4 Important considerations in development

As for the exploitation, it is recommended that we should begin to dig from a scratch, reducing the digging level (height), from the valley closer to the mine, at an early possible date in the future, because the proportion of feldspar that can be utilized is low and also because a problem exist with the water drainage during the rainy seasons, despite that feldspar is said to exist upto 40m deep from the bottom of the current digging site. Currently, feldspar is separated from the waste soil when digging is done, but the proportion of feldspar is only 5% to 10% at the maximum. The feldspar is a so called friable stone (weak stone) which is in the process of transformation to the clay, and is not hard, and when a force is applied it will be crumbled to powdery existence.

Narawita feldspar is the feldspar of volcanic products origin, and its particle is small, easy to absorb water. Compared to the feldspar of pegmatite origin, the removal of iron by acid is considered to be easy. As a consequence of performing the preparatory test in this study, it is considered that removal of iron by hydrochloric acid is possible[9].

However, removal of iron through the treatment by the acid leaves many problems that needs to be resolved, such as the problem with water, environmental issues attributable to acid rinsing water and the problem with equipment, etc. In addition, the Narawita feldspar has not only a problem of iron contamination but also a problem that the quality becomes unstable depending on the change in the mixing proportion of silica. It is necessary to take some measures to make the quality uniform or stabilize the quality, as it

8 Further, away 500m from this feldspar quarrying site, there exists a kaolin mine, which was operated by use of a treatment (crushing) facility but digged up and has been abandoned.

9 Two kinds of Narawita feldspar, white and reddish in appearance were fired and, due to the influence of ferrous, the former became dark gray, and, the latter, dark brown. The same feldspar were dipped in 20% Hcl solution for 14 days, and a lamp of the ore after such treatment was melted. The color of melted ore was not less than that of feldspar used by Japanese top-rank porcelain manufacturer. This shows that the ferrous in Narawita feldspar can be removed sufficiently by hydrochloric treatment.

is hard to check the silica mixing proportion.

In Java island, feldspar of volcanic products origin that is similar to the one of Narawita ore mine is abundant. If it becomes possible to obtain feldspar of a good and stable quality, the shortage of high quality feldspar, the largest problem with the ceramic raw materials in Indonesia, will be resolved.

2.2.8 Lampung feldspar

2.2.8.1 General topographic and geologic conditions

According to a geological map (Figure 2-25), southern Sumatra where the Lampung feldspar mine is located geologically founds upon the early Tertiary formation consisting of Cenozoic and Mesozoic layers and granites, which are covered by sedimentary and volcanic rocks of the Tertiary and Quaternary periods. Top soil has whitish color peculiar to granite areas, making a sharp contrast to that found on Java, a reddish color indicating a high iron content.

In Lampung, feldspar mines are located near a ferry port (Kec. Penengahan[10]) connected to Java on the south, around the Seputi, Pubian, and Sulan rivers (Kec. Padangratu[11]) northeast of Bandar Lampung City (Figure 2-30). The former is situated in a mountain behind settlements along a main road and is not extensively explored by a mining company. The latter is mined by PT. Ferindo Perkasa which operates two quarrying sites. Locations of the two mines are as follows:

Kalimati Mine:	Kp. Kalimati, Ds. Nyukanghardjo, Kec. Padangrato, Kab. Lampung
Trenggalok Mine:	Kp. Trenggalok, Ds. Nyukanghardjo, Kec. Padangrato, Kab. Lampung

These mines can be reached by driving 30km on a main road northward from the Bandar Lampung Airport, and after passing Gunung Sugih, driving further 50km westward. From the main road, an additional 3km drive on a side road will lead to the mine sites. The site road is unpaved and rough in some sections where even a jeep can drive at 10km/h. Nevertheless the road generally runs on flat terrain and is 7-8m wide, thus allowing 20-ton trucks to be used for transportation of mined ores.

Traditionally, as there is no high-grade feldspar mine near western Java where the ceramic industry is concentrated (JABOTABEK), feldspar produced in Lodoyo, eastern

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[10] A small sample was collected by BBK staff.

[11] A small sample was collected by team members who visited with BBK staff.

Java has usually been transported by truck over a distance of more than 1,000km. The Lampung mine is relatively close to Java. Its high-quality feldspar with small contents of colored impurities such as iron is suitable for production of medium-grade ceramics, attracting attention of tile manufacturers in recent years.

The following sections give detailed description of the mines owned by PT. Ferindo Perkasa, on the basis of observation made by the study team.

2.2.8.2 Reserves

The mine and its vicinities are generally covered by granite, e.g., weathered granite can be observed in an area other than the mine and feldspar is seen at the bottom of a nearby river. The mine has land area of 30ha, and feldspar resources extends 1km before and beyond the mine, with approximately 30m in depth. According to DSM's report, feldspar reserves in the entire area are very large, amounting to approximately 12.5 million m^3.

Feldspar found in the area is weathered granite. Note that the degree of granite weathering differs between the upper and lower layers of the mine. The upper part consists of sandy stone or soft stone that is easily crushable by hand, containing a relatively large amount of quartz. The lower part is made of rocky stone and forms a layer with a relatively high feldspar content. Stone becomes harder as depth increases and feldspar quality improves. It contains cohesive minerals such as muscovite and mica, which are expected to adversely affect coloration of stone after firing.

2.2.8.3 Current state of quarrying, beneficiation, and utilization

(1) Kalimati mine

See Picture 2-4. At the entrance to the mine, located 10m above the road and along a gently sloped road, is a building which accommodates a site office and a rest room for workers. Quarrying is carried out in a manner shown in Figures 2-31 (1) and (2). A small, 70-80m high mountain on the front was removed by excavation and three-stage faces are constructed, with each face being 15-20m high. Note that face B in Figure 2-31 (1) is at the same level as the mine entrance. The area in front was strip mined and drainage is provided to prevent puddles during the rainy season. Quarrying is carried out manually, and the uniform ore bed enables excavation of the entire face, rather than spot mining. Judging from topography, heavy equipment such as a backhoe and a power shovel can be easily introduced for operation. At present, excavated ores are packed in bags and are stored in an open space created by mining. Since feldspar quality (hardness and feldspar content) varies from one face to another, ores are classified according to quality grade and stored.

On the left side of faces A and B on front is another working face that surrounds the two faces. The deposit in the face contains ores with more feldspar and less mica than weathered granite in faces A and B, and pegmatite-based feldspar in which smaller crystals are intermingled with quartz crystals. This high quality feldspar, although separated from sandy materials, packed with quartz produced from crushing and shipped.

(2) Trenggalok mine

See Picture 2-5. The mine is 3km from the Kalimati mine on road and 1km over straight distance. The road to the mine is narrower than that to the Kalimati mine and surface conditions are poor, making it difficult for 5-ton or more trucks to drive along. At the mine entrance, a hut is maintained as a rest room for workers. The mine site is shown in Figures 2-32 (1) and (2). The mine is slightly smaller than Kalimati, while stone quality shows little difference on appearance. The quarrying face on the left side is soft and flaky. Also the face forms a steep slope and makes quarrying operation difficult during the rainy seasons due to the danger of landslide. As a result, another face on the right side, which is made of hard rock, is mainly quarried during the rainy season.

Land ownership for the mines belongs to residents of two villages. Each village office, on behalf of villagers, concluded a concession agreement with PT. Ferindo, who received the quarrying right from the prefectural government.

Monthly production in total amounts to 3,000 tons. PT. Ferindo owns 20 fifteen-ton trucks which are operated 8-9 times per month. Massive feldspar-rich ores account for 30% of total shipments and sandy quartz-rich ores 70%. The former is mainly used for floor tiles and the latter for stoneware.

The ex-mine price is Rp.25/kg. Ores are mainly shipped to West Java and Jakarta. The ferry cost to Java is Rp.35/kg. The price including transportation to Gunungputri, Bogor, is Rp.95/kg. According to PT. Ferindo personnel who guided the study team through the quarrying sites, the price of feldspar imported from Thailand is US$60/ton (approx. Rp.130/kg). Thus, if quality is more or less the same, feldspar produced from the mines has an obvious cost advantage over imported products.

Major customers include PT. Cikarang Indah, PT. Indopenta Sakti Teguh (IMOLA), and PT. Muliakeramik Indahraya. PT Cikarang used the Kamado feldspar produced in Japan until 1988 and switched to the Lampung feldspar because the Kamado feldspar was expensive. PT. Muliakeramik started to use the Lampung product in 1996. In addition, PT. Angsa Daya (IKAD), one of the Kedaung group company is planning to use it from this year. PT. Ferindo is now promoting its product to three floor tile manufacturers and one stoneware company in Cibinon, Bogor. Finally, it is reported that PT. Sari Koyotoki, a tableware maker in Bogor, started to use the Lampung feldspar but terminated the use due to large quality variation. However, the product was not supplied from PT. Ferindo's mines.

PT. Ferindo is exporting feldspar from its mines to the U.S. and the U.K. It also shipped samples to a Korean company upon request, and it has received an inquiry on hard feldspar-rich ores.

2.2.8.4 Major considerations in development

Development of the mine has the following advantages:

1) The access road to the mine is in relatively good conditions and is close to the main road (paved), so that transportation of products by large trucks does not present a problem.
2) The mine itself is located on the foot of a gentle hill within a flat plain, and is easy to excavate and accessible by heavy equipment for more efficient mining.
3) Reserves are relatively rich and deposits have simple structure suitable for large-scale development.
4) The site is relatively near West Java where the ceramic industry concentrates and offers transport advantages over other mines.

On the other hand, evaluation by ceramic manufacturers on quality of ores produced in the area, although varied, indicates the need for improvement in the following two areas:

1) At present, excavated ores are packed at site without classification. Product quality can be maintained by classifying them according to quality and quarrying location and storing them in large quantities to allow the mixture of different ores to ensure uniform quality.
2) Since feldspar produced in the area is relatively crushable, so that crushing classification may result in high-grade products.

2.2.9 Belitung

Belitung Island is a major kaolin producing area in Indonesia, emulating Bangka Island in terms of prospective reserves and quality. There are 9 kaolin mines (companies) in Belitung Island. Production is 70,000 tons annually at the most productive mine (PT. Alter Abadi), with the average of 40,000 tons per mine and the annual total of 360,000 tons. Five mines operate latest beneficiation equipment such as water cyclone systems, and four still use old equipment.

2.2.9.1 General topographic and geological features

Belitung Island is made up of plutonic rock and sedimentary rock formed in Paleozoic and Mesozoic epock, and has relatively simple form as geological structure (Figure 2-25). It mainly has flat land, a majority of which is covered by forest. Thus, it is relatively easy to develop a new mine. Surface soil generally has whitish color, while forest and farmland are covered with blackish soil due to inclusion of organic matters. Faults in clay mines and other locations, as observed by the study team, did not show red clay that contains color impurities (iron content) as seen in Java. Thus, iron content in surface soil is not likely to permeate into lower productive mineral layers, and uniform and high-grade mineral reserves are expected. In addition, top soil is very shallow and can easily be removed for quarrying.

2.2.9.2 Reserves

According to MTRDC's and BBK's data bases, kaolin reserves in Belitung Island are estimated at 7 million tons. On the other hand, DSM conducted field investigation at seven quarrying sites, and estimated reserves in two mines at 7.5 million tons and 12.3 million tons.

Of 9 mines (companies) operating in the island, PT. Aneka Kaolin Utama's mine covers land area of 25ha, with excavation depth of 20m. In the mine, an area of 150m x 40m is excavated to 20m below ground level. While surface soil has some discoloration, the ore bed is generally uniform and extends more or less horizontally, indicating large reserves of high-grade kaolin. On the opposite side of the river, across from the flat quarrying area, a quarrying site for white clay having different quality from kaolin extends. In total, the entire quarrying site amounts to 70ha.

2.2.9.3 Quarrying, beneficiation and utilization

The mine of PT. Aneka Kaolin Utama started operation 1952, and at present, approximately 100 workers extract 31,200 tons of kaolin annually. The mine has reserves sufficient to continue extraction in the next 20 years. As shown in Figure 2-33, the mine has been developed by excavating flat land extensively. 2 backhoes are used for the purpose (shared with clay quarrying work discussed above). A haul road runs parallel to the excavated pit, 50m away. Extracted ores are first carried out by using a slope road, located on the right hand side of the figure, to a treatment plant for beneficiation. Beneficiation kaolin are packed in container bags and shipped. Beneficiation is done by using water cyclones to separate kaolin and silica sand as shown in Figure 2-34. The elutriation processes consumes 400m^3/hr of river or well water, which is recycled as far as possible. Waste water treatment is done by gravity sedimentation and does not present any problem.

Yield of kaolin ranges between 30% and 40%, which are better than generally observed yield levels. Silica sand, accounting for remaining 60-70%, is stored for sales within the quarrying site, but it is not sold well compared to kaolin. For quality control of kaolin, samples are taken from the final stage (crushed after beneficiation and drying) every hour. They are kept in bags, with record of sampling date and time, and are later tested according to standard criteria. Testing items are chemical analysis, particle size, whiteness, water content, and abrasion. Chemical analysis is conducted by a testing company in Jakarta, SUCOFINDO, and other tests are conducted by the company's own laboratory that has necessary equipment.

Kaolin is shipped to major domestic tile manufacturers, Roman, KIA, and Asia. It is also sold to paint manufacturers and is exported to paper companies in Japan.

2.2.10 Pacitan

2.2.10.1 General topographic and geological features

According to a geological map, Pacitan region where the site is located is made up of sedimentary layers formed in the Miocene epoch of the Tertiary period, which extend 100km from east to west and 50km from south to north. It is bordered by volcanic rock formed in the Quartenary period on the north, and limestone formed in the Miocene epoch of the Tertiary period on the south (sea side). Overall, the area is described as relatively simple geological formation (see Figure 2-35). Thus, homogeneous and extensive mineral veins are expected.

Toseki deposits in Pacitan are located in Pacitan prefecture (Kabupaten Pacitan) of East Java. From Yogyakarta City, it takes approximately 3 hours and 40 minutes by car (running distance of 200km) eastward via Surakarta (Solo) City. The site is situated approximately 2km south of Nawangan, near a mountain road on the way from Purwantoro in Wonogiri prefecture to Arjosari in Pacitan prefecture (address: Kampung Mlokomanis, Desa Karanggade, Kecamatan Arjosari) (see Figures 2-36 and 37). The road, paved for light traffic, has rough conditions due to surface damage and is narrow that two passenger cars can barely pass each other. Also, it has steep grade in many sections. As a result, the road is difficult for 5-ton or larger vehicles to run on the road. The site is accessible from Purwantoro on the north or Arjosari on the south. The latter route is better in road condition, while it is longer in distance from Solo City.

The deposits are located in the middle of mountains elevating 500 - 600m above sea level. The road runs along ridge lines of these mountains, and houses are settled near the road. Mountains are mostly cultivated up to their heights. Clay in top soil remains on steep slopes, suggesting high solid viscosity.

2.2.10.2 Reserves

The quarrying site extends from one side of the road running near the mountain top to a valley (see Figure 2-38). Digging seems to have started on a steep mountainside and tailings are discharged to the valley. The excavation face has already reached a level close to a vertical line from the top of the mountain, creating a risk of landslide. Surface soil near the top is around 1m deep, while the excavation face and outcrops are all rock. Surface soil slide has been seen in various places.

The site mainly produces agalmatolite, and Toseki was found in a steeper valley 50m away. Test excavation was made for an outcrop that has exposed as surface soil was washed away by rain.

Judging from the excavation face, the ore bed appears to be relatively uniform. Also the vertical distance from the mountain top where agalmatolite is extracted to the outcrop of Toseki, 50m, suggests that the ore bed is fairly deep.

The area has been investigated by a private survey company under contract with the East Java government to estimate mineral reserves. In an area of 1km long east and west and 500m long north and south, test pits were drilled at an interval of 40m - 60m, and extensive presence of pyrophyllite was confirmed (see Figure 2-39). Also, the Directorate of Mineral Resources under the Ministry of Mines and Energy studied the area and verified reserves of 5,180,800m^3 (Bahan Galian Industri di Indonesia)

Although there is no detailed information on Toseki in the area, samples obtained from the outcrop did not look like agalmatolite - agreed with information furnished by the mine owner - and the result of analysis, as discussed later, confirmed that they were in fact Toseki.

2.2.10.3 Quarrying, beneficiation and utilization

In the area, agalmatolite is commercially quarried by around 10 individuals who operate as private business, and there is no company to produce ceramic raw materials. The mine we visited is owned by a person who has the longest history of mineral extraction business in the area. He owns 3 - 4ha of land and is the only one in the area who operates under license of the East Java government. According to him, other miners do not have license. Recently, a large tile manufacturer in Surabaya has applied for the mining license covering 40 - 50ha of land nearby, which has still to be issued.

The following data and information and data are about the mine obtained from the owner.

(1) Type of product, production, and market

At present, only agalmatolite is produced. The quarrying operation started in 1979, and current production is 50 tons per month. Pyrophyllite produced is all shipped to a refractory maker in Jakarta. During the peak period between 1984 and 1987, 6,000 tons were extracted monthly from the site and were shipped to two large tile manufacturers in Gresik and the ceramic industry in Trung Agung. The shipment declined sharply because the contract with the tile manufacturers was terminated, as the owner could not meet requirements from the manufacturers in terms of price and quality and they started to use other ceramic raw materials.

As for Toseki, 5-6 truckloads of samples have been shipped. Since then, the owner receive the request for supply every month, but he is unable to provide regular supply due to the shortage of financial resources and the lack of marketing ability (he does not have a direct communication route with customers or factories). While the owner intends to develop Toseki resources in future, he does not have feedback from his customers. Thus, there is little communication between suppliers and users to exchange detailed information on product quality.

(2) Quarrying method and stockpile

At present, the mine is excavated manually by around 10 workers. Since the excavation face is relatively uniform in mineral content, it has been evenly dug out, compared to other mines where only high-grade portions are extracted to leave potholes all around. However, the deposit is located on the steep slope where landslide occurs in various places, so that excavation is carried out in relatively safe locations.

Excavated ores are dumped and kept in several places along the access road to the mine and the main road, which are not stockpiles. Once a stockpile reaches an amount filling a 5-ton truckload. A truck is borrowed for shipment. There is no truck operator to carry mineral products in the area.

(3) Beneficiation

Pyrophyllite ores shipped are manually crushed (not using a crushing machine) at a crushing plant in Solo and then shipped to refractory manufacturing plants. During the peak period, the mine owner shipped beneficiated products by using a ball mill in addition to original rocks.

(4) Quality control

Excavated agalmatolite ores mainly contain wax-like portions and can be classified into the following four types on the basis of their appearance:

1) A bluish white part that is about to soften;
2) A dense part that is relatively hard, with some portions only breakable by hammer;
3) A part that contains some pores and has mixed colors from brown to light pink; and
4) Anywhere between the above three.

These parts are assumed to have the same quality and thus are not separated before beneficiation. Instead, they are classified into hard and soft ones in consideration to crushability, and are mixed again after the crushing process. No quality check is performed in the quarrying site.

In the extraction process, portions near the ground surface, which have high iron content and do not have wax-like appearance, such as thin iron oxed layer, are discarded to the valley.

As pointed out earlier, the lack of communication between users and suppliers to inform quality requirements hinders the supply of raw materials with stable quality and better quality control.

(5) Product prices and transportation costs

Agalmatolite produced in the area is sold at the examine price of Rp.9/kg, and Toseki at Rp.18 - 20/kg. Note that the price of Toseki, more than twice that of agalmatolite, was set for sample shipment. Transportation costs are Rp.22/kg up to Solo City, Rp.27/kg to Surabaya, and Rp.11/kg to Ponorogo. On the other hand, information on transportation costs between Yogyakarta and Jakarta (wood) indicates Rp. 100,000 for a 5-ton truck (doubled for a 10-ton truck), or Rp.20/kg. Based on these data, the agalmatolite price when shipped to Jakarta will be Rp.51/kg (according to the mine owner, the price delivered at Jakarta during the peak period was Rp.50/kg) and Toseki will be priced at Rp.60-62/kg. Thus, prices of ceramic materials produced in Pacitan are dominated by transportation costs that far exceed production costs.

2.2.10.4 Important considerations in development

(1) Estimation of Toseki reserves

Mineral ore reserves available in Pacitan have been the subject of extensive investigation by the DSM and the East Java government. However, no detailed survey has been conducted for agalmatolite and Toseki separately. Preliminary surveys have mainly been concerned with agalmatolite, and reserves of Toseki have not been estimated in detail. Agalmatolite is mainly used for refractory, but it is not highly valued by its large user, tile manufacturers. On the other hand, there is strong demand for Toseki from manufacturers of tiles, sanitary ware and table ware (in fact, it is used as a raw material serving as a basic element of green body). Since the area is expected to become one of a few major producing areas, reserves of Toseki needs to be accurately estimated in developing the Pacitan mine.

(2) Transportation of raw material

Since Pacitan is located in East Java and Jakarta is assumed to be the major market, transportation costs will take up major portions of product prices, making them less competitive in the market. Pacitan, although facing the sea, does not have a port facility equipped to ship mineral products, so that road transport must be relied on. Considering the major disadvantage related to transportation cost, it is recommended to assume Surabaya as the primary market because of its relative proximity. On the other hand, if West Java is to be the target market, a port facility must be constructed to lower transportation costs. In this case, the project will not be economically feasible unless there is large demand, and port construction must be considered within the framework of the regional development plan including the development of other industries and resources.

(3) Site conditions

As described earlier, the site is located within the rugged mountain region. Furthermore, excavation will take place on a steep slope on the mountainside and have to be done manually. Inability to use machinery will affect productivity. Also, the site the study team visited is located in the valley near the road running near the mountain top, and quarried materials are manually carried to the road or the access road to the site.

According to the study team's observation, the ore bed is relatively large and appears to be uniform in quality. In light of the fact that the main road runs near the top, it seems to be feasible to mechanize the excavation work by removing top soil from the mountain top to secure access. Nevertheless, the change in quarrying method, relocation of roads, and other preparation work require various preconditions to be fulfilled, i.e., there must be demand for products to ensure project viability, and the project must be continued for a certain period of time. In addition, further research and study is needed to determine reserves accurately (in particular, Toseki), estimate potential demand, and consider possible application markets for agalmatolite.

2.2.11 Others

2.2.11.1 Jepara

No information on Jepara feldspar is available in MTRDC/BBK's data base nor DSM's study reports. Thus, no detailed information including the current state of mining operation, reserves, and quality is not known. However, the largest sanitary ware manufacturers in Indonesia, PT. Indo American Ceramic (KIA Group), is using the Jepara feldspar in combination with the Malaysian feldspar, suggesting that it is a promising material in terms of quality.

2.2.11.2 Bangka

In Bangka Island, 8 companies including PT. Putra Kusuma Abadi are quarrying kaolin. The largest production by one company amounts to 60,000 tons annually. Total production in the island, including beneficiated kaolin and ore, reaches 300,000 tons. 3 companies have new beneficiating equipment imported from the U.K. or Taiwan. The largest producer uses a water cyclone made in Taiwan, and testing equipment and a rotary dryer made in the U.K. The company plans to add one line next year. Beneficiating operation in the island was started only four years ago. Before then, ores having high kaolin content were extracted and exported to Japan. Now, beneficiated kaolin is exported in powder, instead of cake (filter pressed and dried), as demanded by customers.

Kaolin produced in Bangka has a higher kaolin content than that in Belitung, but its quality is varying. It is therefore used according to kaolin content and characteristics derived from it. Samples of Bangka kaolin are brought into Japan, but its varying quality raises concern among Japanese companies.

Table 2-1 Ceramic Raw Material its Location Quantity and Quality (1/5)

Kind of Raw Material	Location	Occurrence	Estimation of Reserve	Chemical Analysis									Mineral Composition
				SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	K_2O	Na_2O	ILO	
1. Kaolin	Belitung Island	· Sedimentary residual · Host rock granite	+7,000,000 t.	47.14	35.47	0.44	0.26	0.19	0.04	1.18	0.26	13.13	Kaolinite, Quartz, Sericite, Gibbsite
2. Kaolin	Bangka Island	· Sedimentary residual · Host rock granite	+6 billion t.	44.23	37.70	0.64	0.52	0.06	0.19	0.67	–	14.44	Kaolinite, Quartz, Sericite, Gibbsite
3. Kaolin	Pajintan West Kalimantan	· Hydrothermal · Host rock granite	+2,400,000 t.	72.38	17.94	0.80	0.07	0.14	–	1.39	0.65	7.14	Kaolinite, Quartz,
4. Kaolin	Bandarpulan North Sumatra	Hydrothermal of volcanic tuff	+60,000 t.	42.92	36.72	0.49	0.59	0.21	0.07	0.20	0.33	17.14	Halloysite, Quartz Gibbsite
5. Kaolin	Bonjol West Sumatra		Million t.	64.46	23.13	0.75	0.81	0.17	0.17	2.41	–	7.94	Kaolinite, Quartz
6. Kaolin	Karaha West Java	Post volcanic activity (hydrothermal andesitic rock)	+7,000,000 t.	47.14	35.47	0.44	0.26	0.19	0.04	1.18	0.26	13.13	Kaolinite, Tridymite Plagioclase
7. Kaolin	Cikadu West Java	Hydrothermal of andesitic rock	+67,500 t.	58.69 65.24	20.84 33.91	0.10 1.27	–	–	–	–	–	–	Tridymite Plagioclase
8. Kaolin	Bintahan South Kalimantan	Sedimentary deposit rock	+3,168,000 t.	72.96	24.61	1.76	–	0.64	0.86	1.80	–	9.86	
9. Kaolin	Argasari Kebumen Central Java	Hydrothermal of andesitic rock	+100 ha	45.79	36.81	0.60	–	0.23	0.63	0.05	–	14.13	
10. Kaolin	Tatakan South Kalimantan	Sedimentary deposit	+150,000 t.	62.17	35.75	1.46	–	0.56	0.22	0.32	–	12.60	

Table 2-1 Ceramic Raw Material its Location Quantity and Quality (2/5)

Kind of Raw Material	Location	Occurrence	Estimation of Reserve	Chemical Analysis									Mineral Composition
				SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	K_2O	Na_2O	ILO	
11. Clay	Wonotirto East Java	Hydrothermal activity on volcanic tuff	?	74.26	15.32	1.12	0.60	0.39	–	1.93	–	7.18	Quartz, Plagioclase Sericite, Halloysite Montmorillonite
12. Clay	Cipeundeuy West Java	Post volcanic activity	?	45.22	30.15	1.84	1.36	0.17	0.33	0.11	0.14	20.66	Halloysite, Cristobalite Tridymite, Quartz
13. Ball Clay	Belitung Island	Sedimentary Kaolin	?	54.00	28.79	0.80	0.63	0.10	–	0.23	–	14.89	Halloysite
14. Ball Clay	Parungpanjang West Java	Weathering of acid volcanic tuff	+96,000,000 M	49.75	29.73	1.46	0.69	0.45	–	2.42	–	12.81	Kaolinite, Sericite, Quartz, Plagioclase Montmorillonite
15. Ball Clay	Gunung Guruh West Java	Sedimentary deposit	+96,000,000 M	66.52	17.24	2.33	0.90	1.50	0.82	1.38	0.20	8.24	Quartz, Halloysite Sericite, Feldspar
16. Ball Clay*)	Monterado West Kalimantan	–	–	52.59	33.73	0.38	0.94	0.29	0.07	0.78	1.25	9.16	
17. Silica	Bojong West Java	Weathering of volcanic tuff	+400 ha	71.49	17.03	0.57	0.07	0.10	0.77	2.27	1.10	5.09	Halloysite, Tridymite Plagioclase
18. Sand (Quartz)	Narawita West Java	Weathering of liparitic tuff	+75 ha	93.03	3.83	0.12	0.02	0.84	0.14	0.33	0.46	0.55	Tridymite, Plagioclase
19. Quartz Sand Stone	Ngepon Tuban Central Java	Sanddune (reworked deposit)	+124 t.	95.70	1.05	1.68	0.05	–	–	–	–	–	
20. Quartz Sand Stone	Gedongmeneng South Sumatra	Sedimentary rock	n.a.	99.54	0.13	0.07	0.08	–	–	–	–	–	

Table 2-1 Ceramic Raw Material its Location Quantity and Quality (3/5)

Kind of Raw Material	Location	Occurrence	Estimation of Reserve	Chemical Analysis									Mineral Composition
				SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	K_2O	Na_2O	ILO	
21. Quartz Sand Stone	Gunung Pasir East Kalimantan	Sedimentary rock	Million t.	99.20	0.27	0.20	-	-	-	-	-	-	
22. Quartz Sand	Belitung Island	Sedimentary rock	Million t.	99.50	0.27	0.15	-	-	-	-	-	-	
23. Feldspar	Lodoyo East Java	Weathering of liparitic tuff	+40,000 t.	78.37	10.90	0.25	0.34	0.13	-	7.75	-	0.88	Quartz, Orthoclase Plagioclase, Kaolinite
24. Feldspar	Lampung	· Dike in granite bodies · Pegmatite	?	64.91	19.45	0.17	0.03	0.21	-	11.91	3.86	-	Orthoclase Plagioclase, Quartz
25. Feldspar	Bonti West Kalimantan	· Dike in granite bodies · Pegmatite bodies	?	65.90	19.44	0.15	0.03	0.25	0.44	10.99	0.44	-	Microcline Plagioclase, Quartz
26. Feldspar*)	Pangaribuan North Sumatra	-	-	62.57	21.58	0.34	-	1.12	-	13.82	1.00	0.40	Orthoclase, Alpha Quartz
27. Feldspar	Banjarnegara Central Java	Meta sediment (arcosic rock) Melange	+642,000 t.	77.83	12.29	0.33	0.08	0.09	0.07	4.74	4.34	0.86	Quartz, Potassium feldspar, Sodium feldspar, Sericite
28. Sanidine	East Coast of North Sumatra	Weathered of liparitic rock	Million t.	86.00	8.74	0.16	0.04	0.67	0.31	3.14	1.45	-	Quartz, Sanidine Biotite, Aragonite
29. Feldspar Saparua	Saparua Moleceas	Pegmatite(?)	n.a.	76.28	14.25	0.48	-	1.19	0.47	3.28	3.48	-	Orthoclase, Plagioclase Quartz
30. Pyrophyllite	Pacitan East Java			84.58	12.614	0.11	0.56	0.10	-	0.21	0.28	3.01	Quartz, Pyrophillite Kaolinite

Table 2-1 Ceramic Raw Material its Location Quantity and Quality (4/5)

Kind of Raw Material	Location	Occurrence	Estimation of Reserve	Chemical Analysis									Mineral Composition
				SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	K_2O	Na_2O	ILO	
31. Pyrophyllite	Nglebo Trenggalek East Java	Hydrothermal of dacitic rock	n.a.	56.07	31.274	0.89						9.69	
32. Dolomite	Sekapuk, Gresik East Java	Replacement process of limestone	+50,000,000 M		0.00– 0.59	0.22– 0.74	– 47.10	29.50 20.84	7.08 20.84	–	–	46.20 50.40	
33. Dolomite	Gummg Kaklak Gresik East Java	Replacement process of limestone	+70,000,000 M		0.10– 1.40	0.20		31.40	9.07–			45.70 47.50	
34. Limestone	Cipanas West Java	Coral reef (Biohern)		0.28		0.33		53.94	0.85			42.97	P_2O_5=0.02 Fe_2O_3=13.0–14.0 H_2O (110℃)=0.27
35. Limestone	Cibinong West Java	Coral reef (Biohern)	Hundred Million t.			0.06– 0.10		51.00	0.90	–	–	41.00 43.00	
36. Limestone	Tagogapu West Java	Coral reef (Biohern)	Ten Million t.			0.13		56.94	–			43.36	H_2O (110℃)=0.20
37. Limestone	Bongas/Palimanan West Java	Coral reef (Biohern)		2.30	10.48	0.39		53.37	1.00			43.42	
38. Limestone	Karangbolong Central Java	Coral reef (Biohern)	Hundred Million t.	0.20	0.03	0.22		54.70	0.20			43.72	H_2O (110℃)=0.20
39. Limestone	Pamotan Central Java	Coral reef (Biohern)	85 Million t.	1.04	0.77	0.34		52.64	0.93			42.93	
40. Limestone	Wuryantoro & Watukale Central Java	Coral reef (Biohern)	Ten Million t.			0.60		52.64	0.93			42.93	H_2O (110℃)=0.20

Table 2-1 Ceramic Raw Material its Location Quantity and Quality (5/5)

Kind of Raw Material	Location	Occurrence	Estimation of Reserve	Chemical Analysis									Mineral Composition
				SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	K_2O	Na_2O	ILO	
41. Limestone	Tuban East Java	Coral reef (Biohem)		0.33* 2.12	1.00	1.00		44.80 55.30	0.10* 7.40			42.30 45.50	P_2O_5=0.10 SO_3=0.10
42. Limestone	Gunung Kidul Central Java	Coral reef (Biohem)			1.10	0.07		54.17	0.41			43.36	P_2O_5=0.119=0.20 H_2O=0.27
43. Bauxite	Bintan Island Riau	Weathering of shale	+14,000,000 t.	54.90	54.90	10.20	0.80	–	–	–	–	–	
44. Bauxite	Kijang Island Riau	Weathering of shale	+100,000 t.	3.44	61.59	1.94	2.12	–	–	–	–	–	
45. Magnesite	Padamarang Island	Pocket in ultra basic rock	+2,000 t.	11.10	–	0.76	–	trace	43.08	–	–	–	
46. Magnesite	Labuan Dalam Riau	Pocket in ultra basic rock	+1,000 t.	9.86	–	1.76	–	–	40.42	–	–	–	
47. Chromite	Pleihari Kalimantan	Residual deposit of ultra basic rock	+10,000 t.			13.00*							Cr_2O_3=31.0–32.0 Fe_2O_3=13.0–14.0
48. Chromite	Latan Sulawesimantan	Beach sand	+3,000 t.										Cr_2O_3=50.0–32.0

Note: *) Additional information of BBK

Table 2-2 Data of Ceramic Raw Material Deposits (1/2)

Location	Estimated Areas/Reserves	Number of Company	Production Cap	Users	Land Ownership	Others
1. Feldspar						
(1) Ds. Kalitengah Kec. Purwanegara Kab. Banjarnegara Prop. Java Tengah (Central Java)	4,950,000 m^2 Thickness: 60 m	5	15 - 20 t/d	PT. Queen Ceramics (Semarang) PT. KIA (Bekasi) PT. Super Itali	Private	The calculation is based on: - Surface distribution of feldspar out crop - Test pit/channel
(2) Ds. Kebon Dalem Kec. Purwanegara Kab. Banjarnegara Prop. Java Tengah (Central Java)	19,200,000 m^2 Average Thickness: 50 m	3	20 - 25 t/d	Ditto	Private	False correction = 30% Impurity materials = 20%
(3) Ds. Kebutuh Jurang Kec. Purwanegara Kab. Banjarnegara Prop. Java Tengah (Central Java)		2	20 t/d	Ditto	Private	
(4) Cicadas Ds. Narawita Kec. Cicalengka Kab. Bandung Prop. Java Barat (West Java)	+ 35 Ha Thickness + 30 m + 10,500,000 m^2 (27,300,000 ton)	1 CV. Pusaka Jaya	+ 50 t/d	PT. Raja Keramik Indah		
(5) Penengahan Ds. Muara Bakau Ds. Harapan & Ds. Hatta Kec. Penengahan Kab. Prop. Lampung	+ 50 Ha + 12,500,000 m^3		100 t/d	Based on order for building materials	Individual ownership	

Table 2-2 Data of Ceramic Raw Material Deposits (2/2)

Location	Estimated Areas/Reserves	Number of Company	Production Cap	Users	Land Ownership	Others
2. Ball Clay						
(1) Cileketan Ds. Gorowong Kec. Parungpanjang Kab. Bogor Prop. Java Barat (West Java)	+ 40 Ha Thickness + 45 m	1	+ 200 t/d	PT. Bermis PT. IKAD PT. KIA PT. Indoporlen	Mr. H. Makmur	Estimated areas and reserves is according to the owners
(2) Padaraang Ds. Sirnaresmi Kec. Cisaat/Gunung Guruh Kab. Sukabumi Prop. Java Barat (West Java)	+ 500 Ha Thickness + 20 m	1	+ 100 t/d	PT. Masterina PT. Roman PT. Super Itali PT. IKAD PT. KIA	Local government	Estimated areas and reserves is according to the chief of local government
3. Refractory Clay						
(1) Cipeundeuy Ds. Cikarang Kec. Malangbong Kab. Garut Prop. Java Barat (West Java)	+ 27 Ha Thickness + 18 m + 4,860,000 m^3 (12,150,000 ton)	1 CV. Bumi Kita	50 t/d	PT. Indoporlen	Mr. H. Ono	Estimated areas and reserves is according to the owners

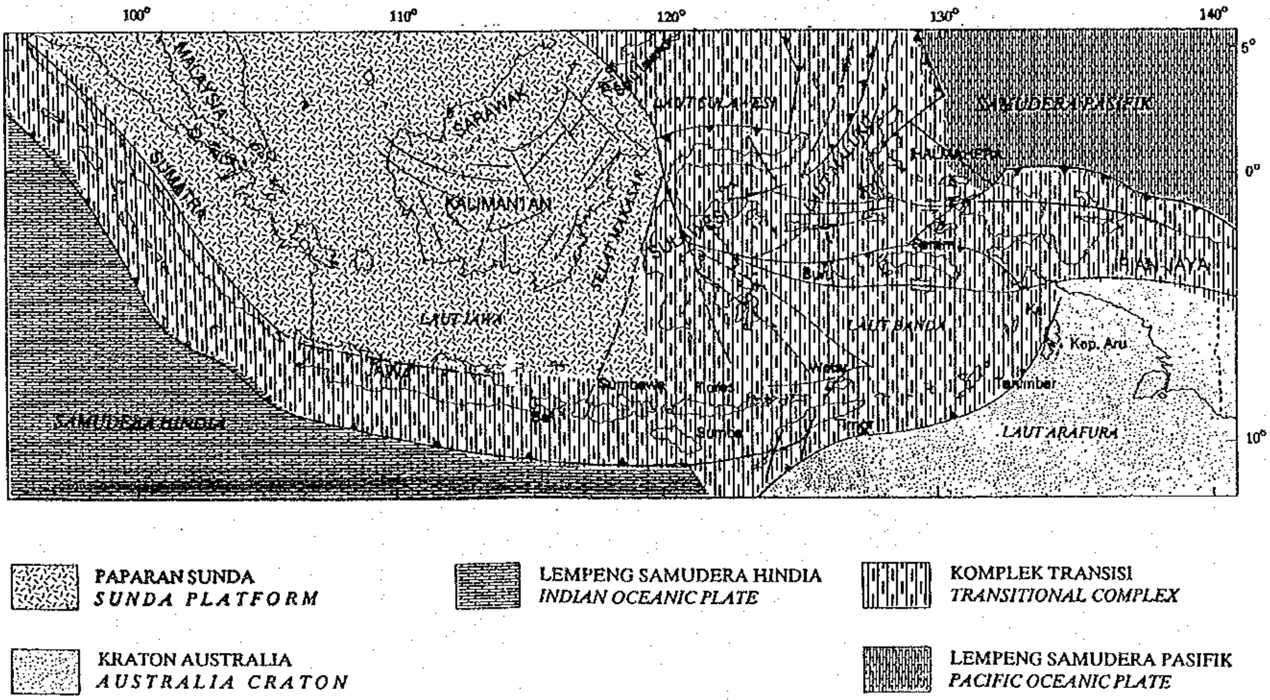
Note: Ds.- Desa (Village), Kec.- Kecamatan (District), Kab.- Kabupaten (Prefecture), Prop.- Propinsi (Province)

Table 2-3 Clay Deposit in West Kalimantan

No.	Name	Location			Areal Ha
		Desa	Kecamatan	Kabupaten	
1	A		Pajintan	Ketapang	502.15
2	B	Mandor	Sungai Raya	Sambas	600.00
3	C		Pajintan	Ketapang	260.00
4	D	Mandor	Sungai Raya	Sambas	122.50
5	E	Sagu	Teluk Kramat	Sambas	1,000.00
6	F	Sagu	Teluk Kramat	Sambas	975.00
7	D	Mandor	Sungai Raya	Sambas	1,000.00
8	D	Pangkalan Pauh	Sungai Pinyuh	Pontianak	1,000.00
9	G	Bangkal Serai / Bentawan	Kendawangan	Ketapang	25.00
10	H	Sagu	Teluk Kramat	Sambas	25.00
11	D	Mandor	Sungai Raya	Sambas	24.00
12	B	Pengkalan Makmur	Sungai Raya	Sambas	25.00
13	I	Pewangi / Mandor	Sungai Raya	Sambas	25.00
14	J	Pewangi / Mandor	Sungai Raya	Sambas	25.00

Note: No. 9–14: License by provincial government

Figure 2-1   Tectonic and Crustal Elements of Indonesian Region



Peta dasar dibuat oleh Seksi Kartografi. Pusat Penelitian dan Pengembangan Geologi (PPPG) dari Peta U. S. Geological Survey, 1978 (Hamilton, 1978) Sekala 1:5.000.000.

Base map Compiled by Cartography Section, Geological Research and Development Centre (GRDC) from U. S. Geological Survey, 1978 (Hamilton, 1978) Scale 1:5.000.000.

Figure 2-2 Geological Map of Indonesia

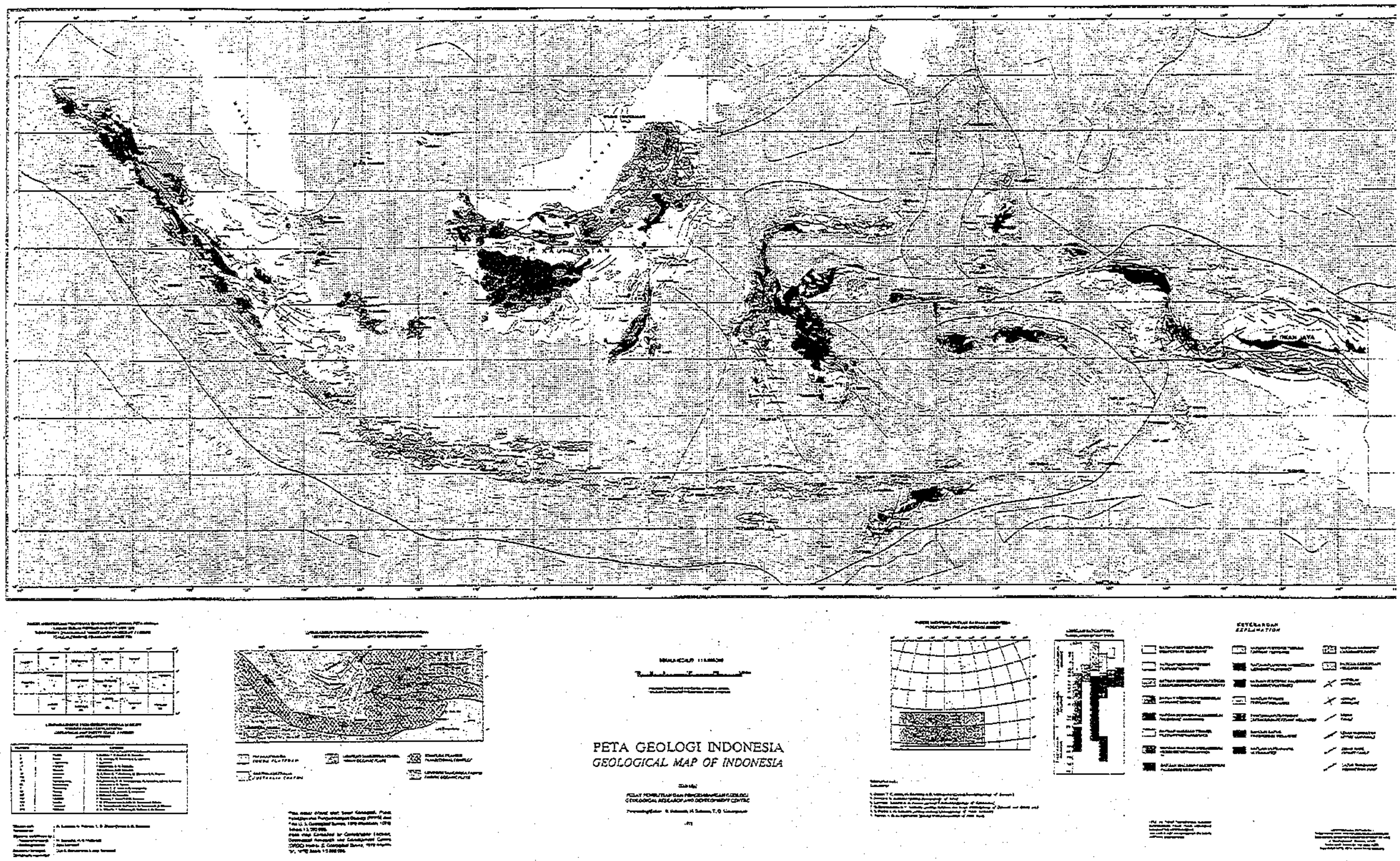


Figure 2-3 Geological Map around Parungpanjang and Sukabumi

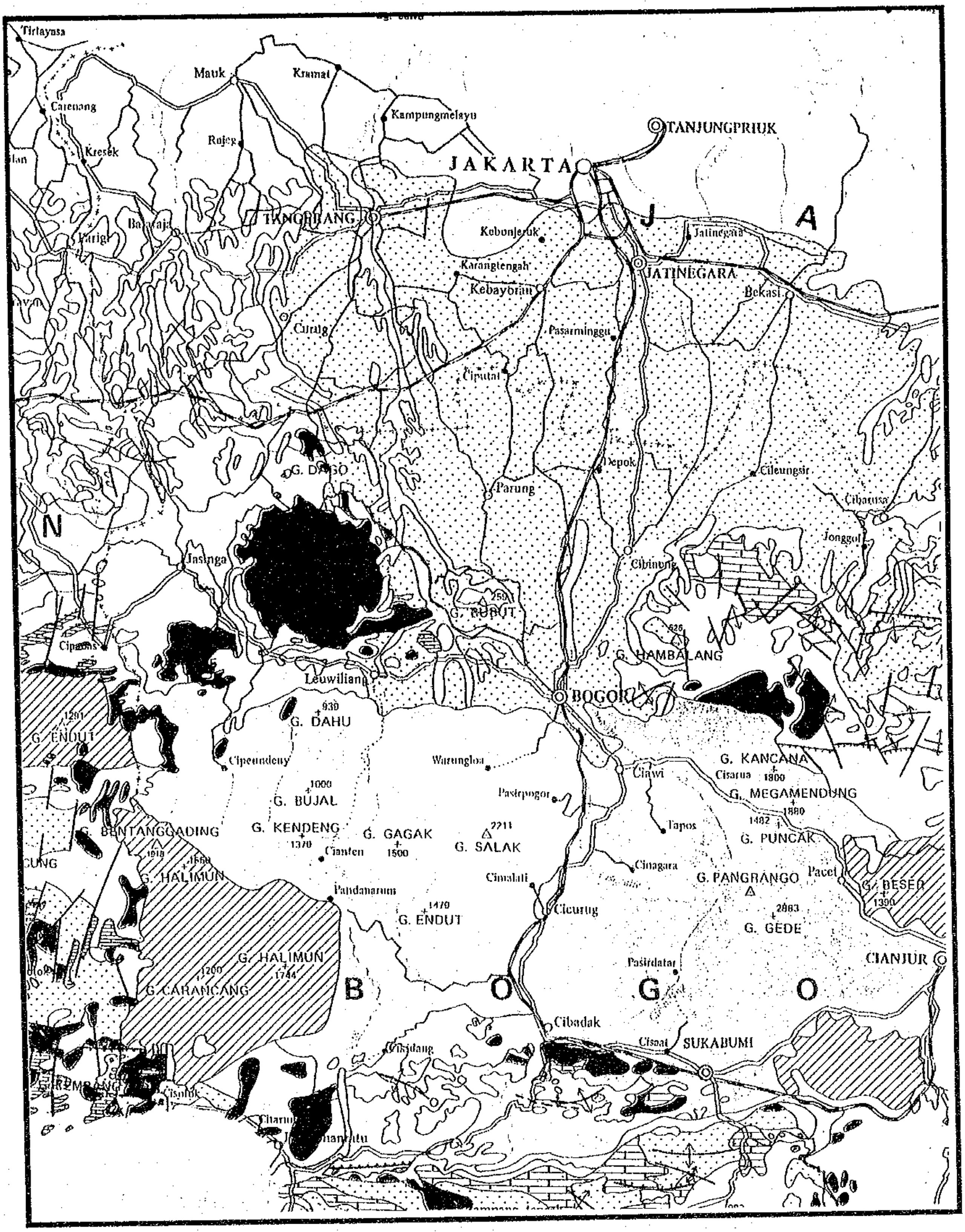


Figure 2-4 Geographical Map around Sukabumi, Narawita and Cipeundeuy (1:650,000)

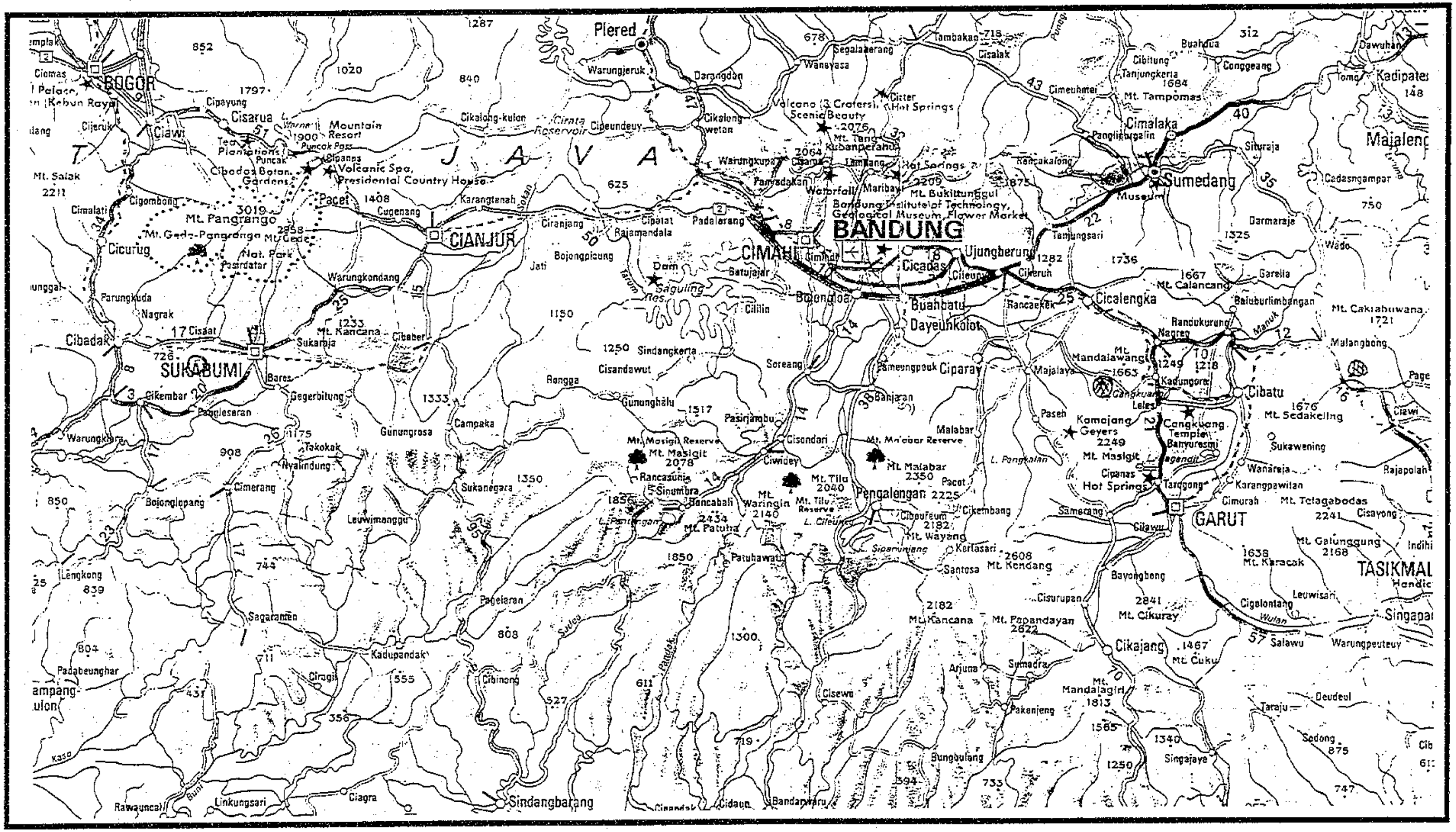


Figure 2-5 Topographical Map of Sukabumi (1:71,400)

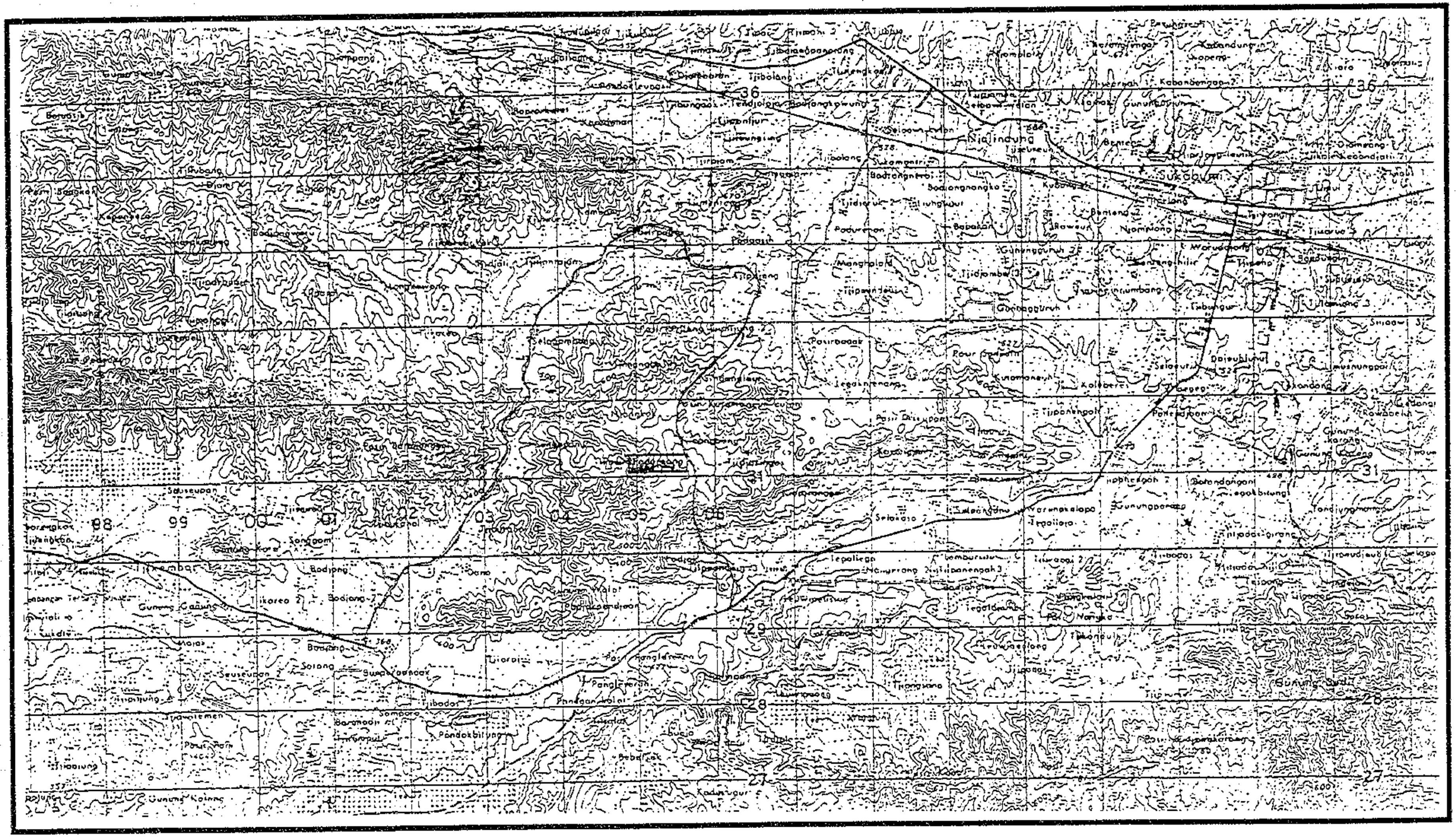


Figure 2-6 Geographical Map of Parungpanjang (1:650,000)

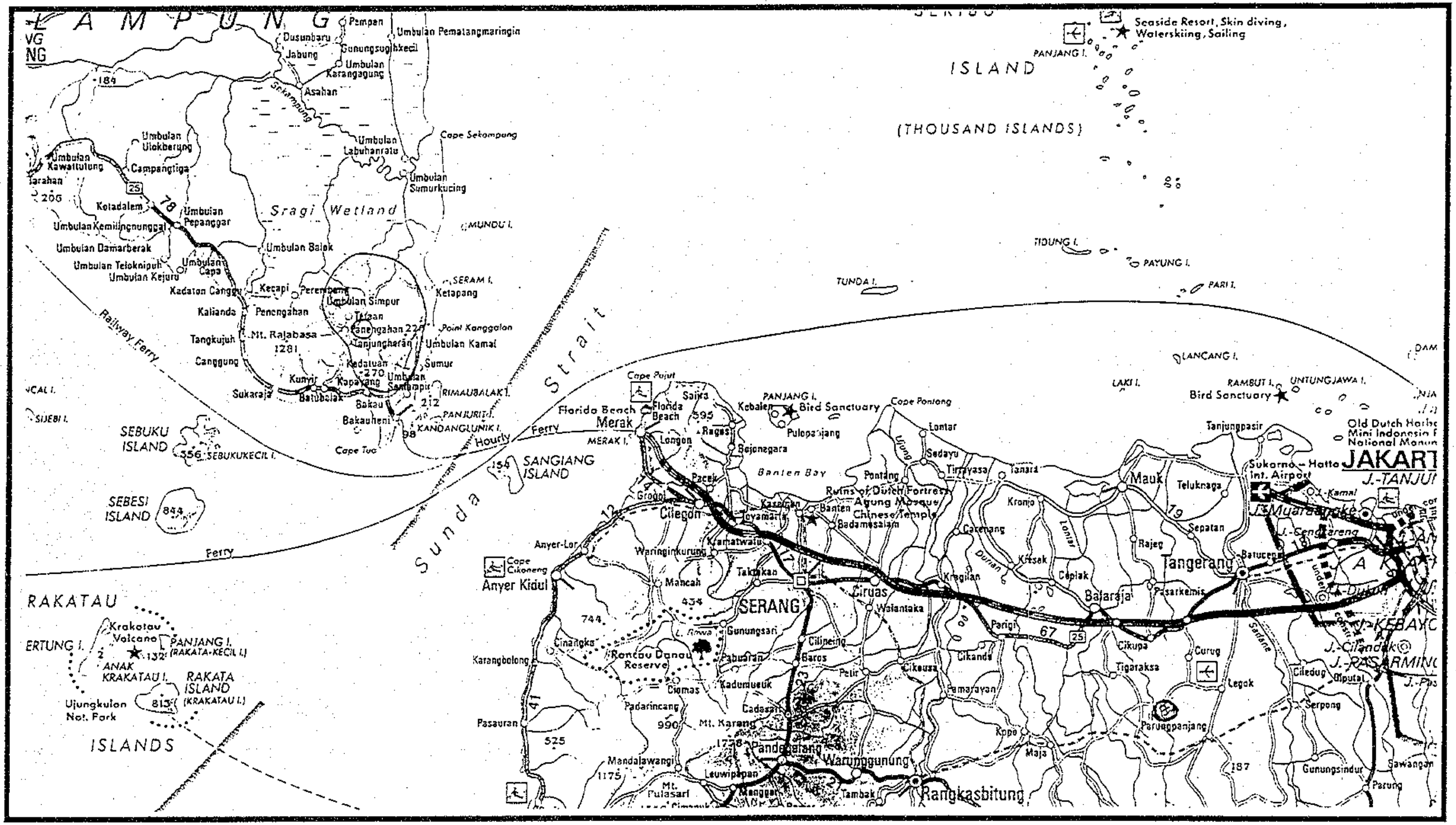
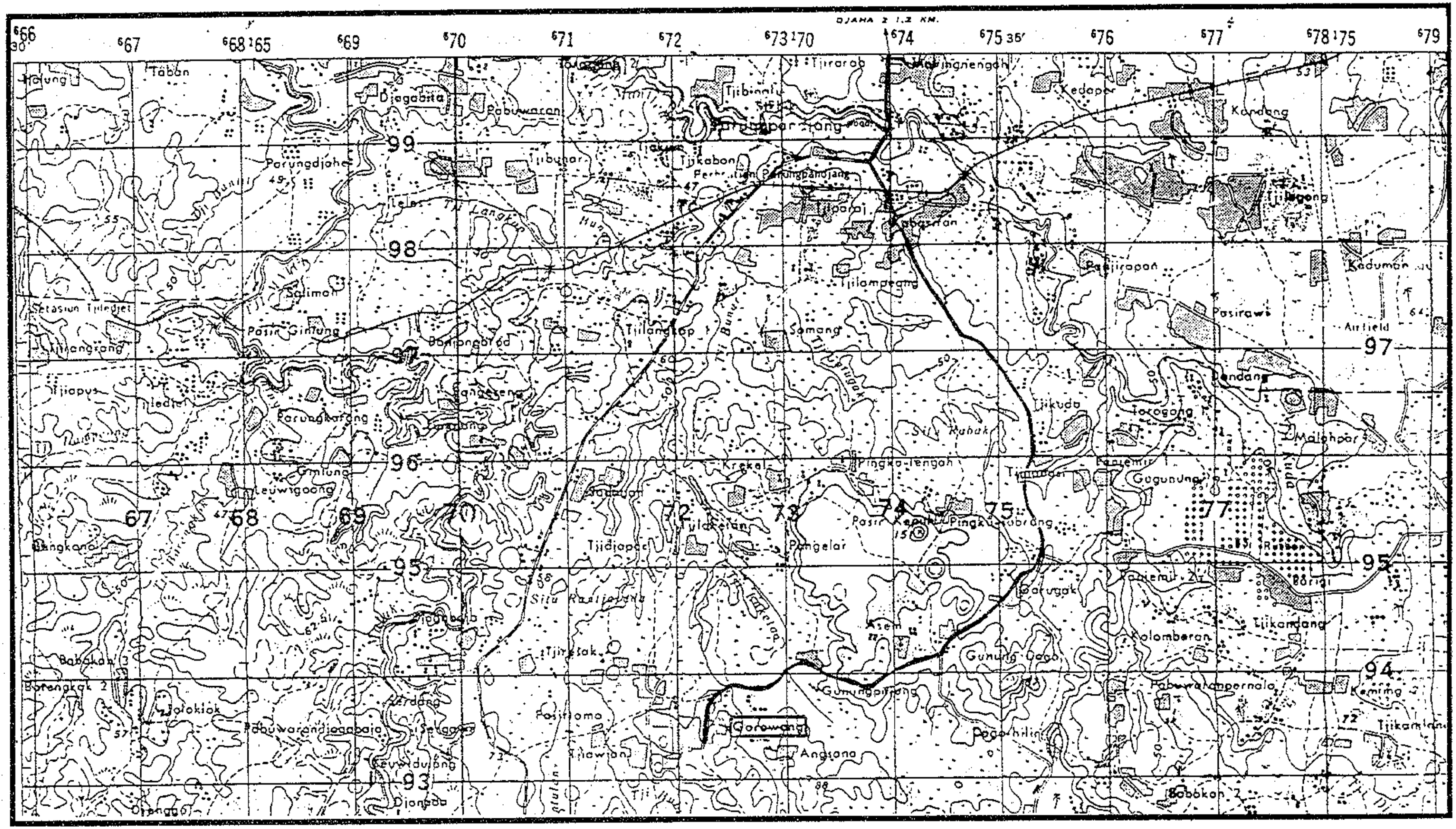


Figure 2-7 Topographical Map of Parungpanjang (1:500,000)



JAVA 1:50,000

Figure 2-8 Topographical Map of Parungpandjang (1:35,700)

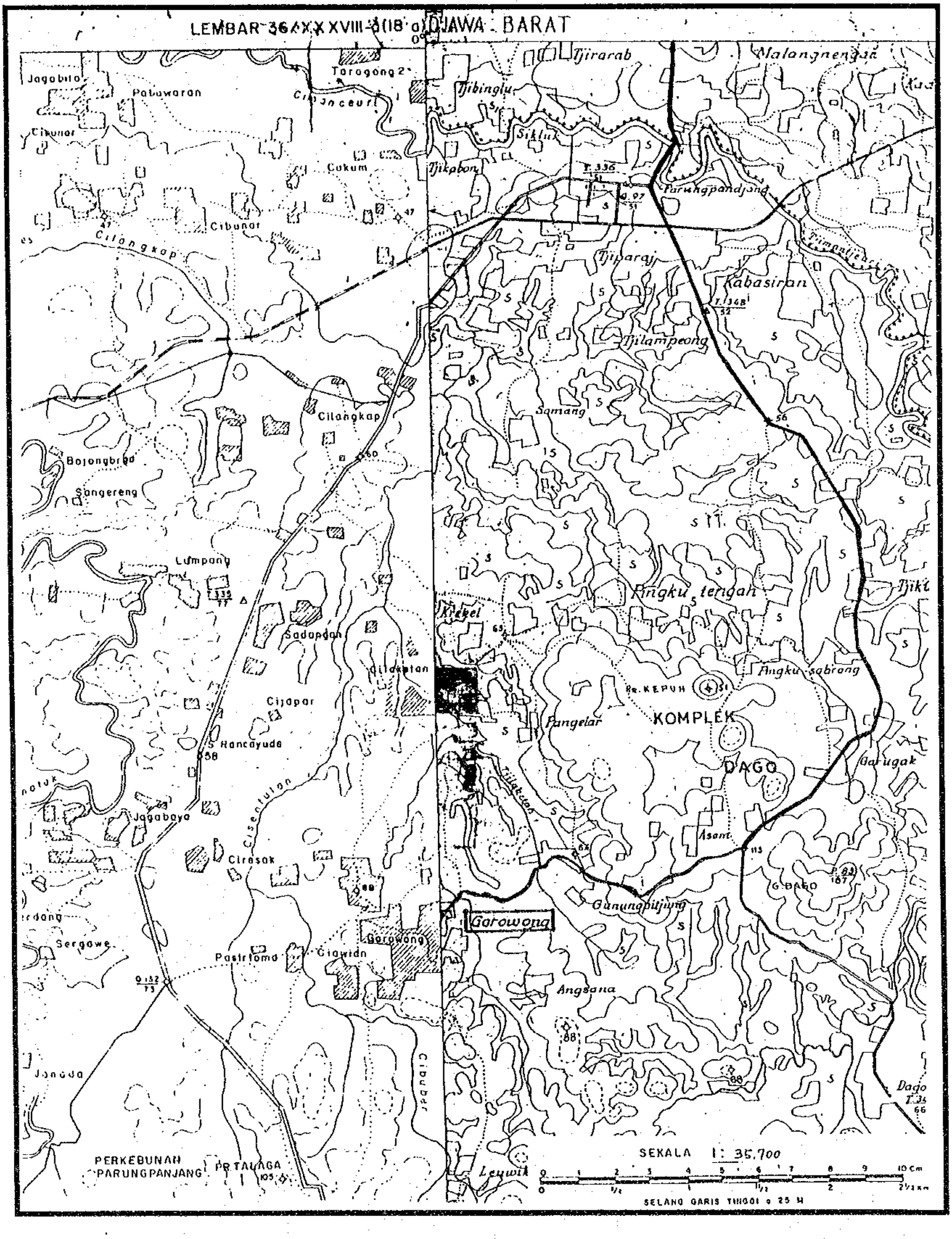


Figure 2-9 Geological Map around Narawita and Cipeundeuy

Figure 2-10 Topographical Map around Cipeundeuy (1:50,000)