(2) Kinangoni Area

(A) Location, Access and Topography

(i) Location and Access

The Kinangoni area is situated approximately 25 km north-west of Mombasa.

The area is accessible from Mombasa by motor driving on the Nairobi-Mombasa all-weather road to Mazeras, then turn northward into the Mazeras-Kaloleni road to reach to Mikomani for about 20 km, and then proceed easterly via Mubungoni School (about a half kilometre) to ore showings, namely the Kinangoni Ore Deposit for about 1 kilometre.

(ii) Topography

The Kinangoni area is situated in the eastern margin of the "Coastal Range" explicated by Gregory J.W. (1896) and Caswell, P.V. (1956), where the general topography is frequently undulated. Kinangoni Hill (approx. 900 ft or 270 m above sea-level) is situated in central part of the area, Kia Hill (approx. 1,030 ft or 310 m above sea-level) is located northeast of Kinangoni Hill. A hilly land turns off from the above hills northeasterly-southwesterly.

The eastern part of this hilly land occupies the western part of "Foot Plateaux" explicated by Gregory, J.W. (1896), where the general topography is evenly gentle, 300 to 400 ft or 90 to 120 m above sea-level. An obvious boundary of the above topographical disparity is clearly made by a fault configuration. The northwestern part of the area with gentle relief, 500 to 700 ft or 150 to 210 m above sea-level, is located on the northwestern slope of this hilly land.

(B) Existing Geological Studies in the area and Current Situations

(i) Existing geological studies in the area

The initial geological report on the ore showings in the area was made by Gregory, J.W. (1921). The author mainly geologically reported on occurrences of gossan of outcrops. After that, Parsons, E. (1928), Mckinnon-Wood (1930) and Busk, H.G. (1939) also made some geological reports. However, the first comprehensive geological studies, composed of providing air photos in the area, topographical maps of 1 to 50,000 scale and surface geological mapping were implemented by Geological Survey of Kenya (1942). Results of those studies have been refered hereinafter.

Two geological sheets: Kilifi-Mazeras Area of 1 to 125,000 scale by Caswell, P.V. (1956) and Mazeras of 1 to 50,000 scale by Geological Survey of Kenya (1981), were ever published.

Geochemical exploration, composed of stream sediment sampling and examinations for lead, zinc, copper, barium, manganese, molybdenum and vanadium was implemented by British Technical Cooperation Project (1977-1980).

Ore prospects in the area have been strenuously activated since late 1960s to introduce diamond drill exploration. The above activities have successfully resulted in an inauguration of the Kinangoni mine. The mine has been intermittently operated and is currently operated in small scale. Historical progress of the mine operations is shown below:

1965-1966	: Mloszewski, M.J. and Macdonald, A.S. implemented detailed geological mapping, geochemical research and trench prospects for geochemical anomalies.
1967-1969	: Mines and Geological Department implemented diamond drills, 28 holes totalling approx. 3,600 m. Clarke, M.C.G. (1970) calculated ore reserves. Ore reserves : 929,000 tons Crude ore grade : 8.96% Pb, 0.58% Zn, 4.23 oz/t
1970	: GEOMIN (Romanian State Mining Corporation) was permitted Special License to establish Kenya Mining Industries Ltd. (ICDC 51%, GEOMIN 49%). Commenced additional exploration drills.
1971	: Commenced exploration drifting.
1973	: Commenced underground mining operation. Ores were mined from 170 mL (metre above sea level), 120 mL and a part of 70 mL. Capacity of ore dressing plant was 250 tons per day.
1975	: Suspended mining operation.
1983	: Kenya Lead Mining Co., Ltd. commenced open cast mining operation.
1990	: Commenced preparations of underground mining.

(ii) Current situation

Open cast mining is currently being operated in the Kinangoni mine. Pit bottom has reached on 131 mL to retain a 10 m spare against the 120 mL of old workings. Also the slope of the pit wall has been gradualy steepend. The mining conditions have been, consequently, disadvantaged to execute old drifts clearance at 170 and 120 mL and to change the present open cast mining techniques to an underground mining method. Mining operation and current situation of the Kinangoni mine, as of October 1990, are as follows:

- Output : Produce 110 to 120 tons of lead concentrate per month.
- Concentrate grade : 60 to 70 % Pb.

- Ore minerals : Galena and anglesite.
- Mining method : Open cast mining.
  Ores are hand-picked by man power. Wastes are removed by bulldozers. Old drifts clearance on 120 mL and 170 mL is currently operated to restart underground mining operation in 1990.
- Workers : Approx. 150 (open cast 60, underground 40, plant 40, office 6 and others).
- Buyor : Associated Battery Manufactures (EA) Ltd.
- Operator : Kenya Lead Mining Co., Ltd.

(C) General Geology and Mineralization

Geological map and cross sections in the area are shown in Figure II-2-3-2 (1), Sketches of open cast mining pit are in Figure II-2-3-2 (2), sketches of walls of pit benches and cross section of the pit are in Figures II-2-3-2 (3) and (4).

(i) General geology

General geology in the area consists of lower, middle and upper members of the Maliakani Formation, middle and upper members of the Mazeras Formation and the Kambe Formation in ascending order and is overlain by lower member of the Mtomkuu Formation.

The lower member of the Maliakani Formation majorly consist of medium-grained sandstone, which is characterized by having well-developed mottles and is intercalated by thin beddings of siltstone or shale rarely. The middle member of the formation majorly consist of medium-grained sandstone, which is characterized by having cross bedding. The upper member of the formation mainly consist of yellowish brown-brown medium- to coarse-grained sandstone and yields carbonized plant fossils in upper part. A whole of the Maliakani Formation is considered to have been formed under the deltaic environment and is correlated to the Middle Triassic age. The middle member of the Mazeras Formation mainly consists of medium- to coarse-grained arkose sandstone and is characterized by showing a cyclic variation of grain size, to be coarser upward in the Kinangoni mine environs. This member casually yields silicified wood in lower part. These members of the Mazeras Formation are correlated to Lower Jurassic age. The Kambe Formation mainly consists of limestone which yields fossils of clinoids, gastropods, ammonites, coral and etc. and is correlated to Middle Jurassic age. The uppermost bed of lower member of the Mtomkuu Formation is properly observed in the southeastern part of the area, and mainly consists of an alternation of siltstone and shale intercalated by sandstone and limestone rarely. This member is correlated to Upper Triassic age. Reddish brown lateritic soil, which is characterized by carrying iron, alumina and manganese etc. and sandstone pebbles that are replaced by iron oxide are widely observed on ground surface. So-called "gossan" is observed in the vicinity of ore body. In-situ gossan, to be distributed directly above the ore body outcrop, is hardly observed in the vicinity of the Kinangoni mine. Transported gossans, associated with a large volume of barite pebbles, occupy an area of 200 m by 150 m, estimatedly 5 to 10 m thick, 200 m apart from the ore body outcrop, are observed in the foot of eastern slope.

(ii) Mineralization

Mineralization in the area is observed in a brecciated zone in sandstone-siltstone beds of the Mazeras Formation along the demarcation by two normal faults. The mineralized zone is formed by a stockwork of quartz fine veins associated with galena, rich in silver, and a small amount of sphalerite and pyrite. Secondary minerals, such as sulphate and carbonate minerals altered from sulfide minerals, are observed in the zone, caused by an intense oxidation toward deeper portion of ore body.

The ore body is summerized as follow based on results of the current work and existing informations:

· Outcrop of ore body

Strikes NE 15° to 20° and dips SW 70° to 80°. 1.5 to 1.8 m wide at an elevation of 270 m above sea-level.

Sparsely limonitized brecciated zone, that is heavily leached, is observed.

· Mineralized zone and ore zone

Mineralized zone : Strikes NE 10° to 30°, dips SE 50° to 80°.
Width; Less than 60 m on plan.
20 to 60 m wide on elevations 170 m high and 70 m high above sea-level, respectively.
Extension on strike : Approx. 1500 m
Extension downward : More than 120 m
Fault zones at hanging and foot walls, having identical strikes to mineralized zone, 10 m wide respectively, are observed.

Ore zone : Observed in brecciated zone along the demarcation of the above two faults.
Strikes NE 10° to 30°, dips SE 50° to 80°.
Width; Less than 50 m on plan.

4 to 45 m wide on elevations 156 m high and 120 m high above sea-level, respectively.

Extension on strike ; Approx. 800 m

Extension downward ; Unknown

It is formed flaggy, lenticular. Associated with fine ore veins, small scale.

· Mineral components :

Primary minerals	; (Abundant)	galena, quartz
	(Minor)	sphalerite, marcasite, barite
	(Sparse)	chalcopyrite, pyrite, arsenopyrite, argentite, stromeyerite, tetrahedrite, jalpaite, mackinstryite
Secondary minerals	; (Abundant)	anglesite
	(Minor, Sparse)	cerussite, pyromorphite, beudantite, plumbojarosite, smithsonite, covellite, malachite, goethite, jarosite, hematite, gypsum

· Wall Rock Alteration:

Weak silicification and weak argillization properly.

· Oxidized zone :

Distribution ; Extends 30 degrees easterly to cover a whole area of ore body.

Thickness ; 10 to more than 100 m in maximum.
To be wider downward on hill slope by Clark, M.C.G. (1970).

The lead age dating values of galena by three specimen, collected from the working in open pit and in underground on 120 and 170 metre-levels, show 231.9 Ma, 239.7 Ma and 240.7 Ma, respectively, which are estimatedly correlated to Middle Triassic age (Appendix-VI).

(D) Examination

Silver-bearing sulphide minerals, such as argentite, tetrahedrite, stromeyerite, jalpaite, mackynstryite, are identified by microscopic observation of and electron probe microanalysis of polished sections as shown in Appendixes-III and IV. A microscopic occurrence of silver in which is one of characteristics argenriferous galena of the Kinangoni ores is also identified by this work. An occurrence of silver-bearing beudantite has been reported by Clarke, M.C.G. (1970) and Bugg, S.F., (1980).

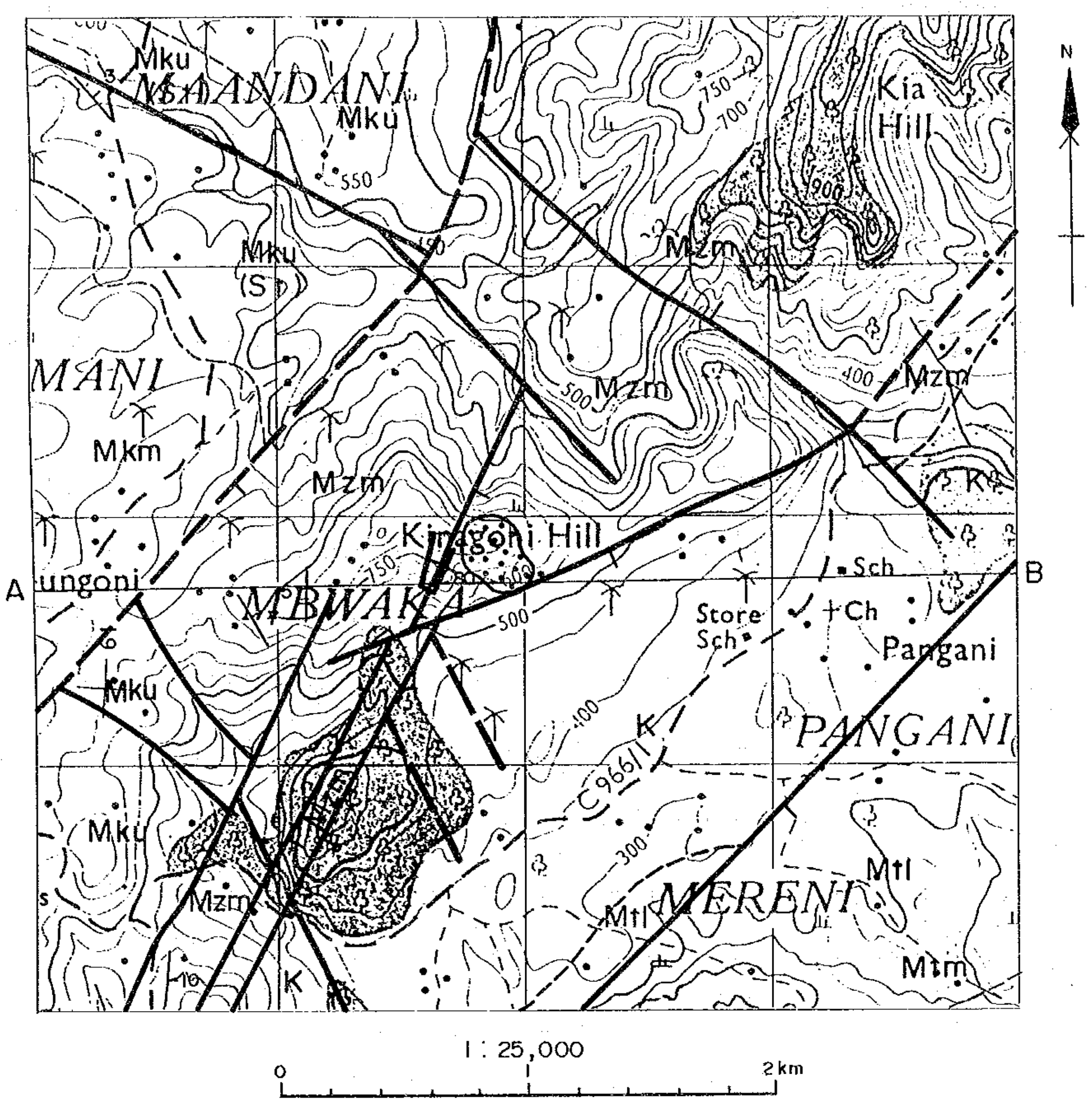
Genesis and geological environment of the Kinangoni ore deposits have been geological studied by Clark, M.C.G. (1970), Micu, C. (1976) and Bugg, S.F. (1980 and 1982). According to their studies, formation temperature of the ore bodies are estimated to be low because of widespread occurrences of barite associated with ore bodies, lack of noticeable hydrothermal alteration and ore mineral pargenesis.

The Kinangoi ore bodies are estimated to have been formed in brecciated fracture zones in the vicinity of Karroo-Jurassic Boundary Fault and subject to intense oxidation in the course of weathering to form gossans as seen on the present surface. The oxidation appears to have reached a great depth to form Pb-sulphates and Pb-carbonates after galena or other sulphides containing Pb.

The Kinangoni mine is the only operating mine for lead in the Coast Provine. There may be still possibility to find new ore deposits of a similar type to the Kinangoni in the vicinity.

Accordingly, it will be worthwhile to re-assess mineral potential of the general area in the vicinity of the Kinangoni by constructing a suitable model for this type of ore deposits.

Geophysical techniques, electrical methods in particular, will be effective tools to explore this type of ore deposits, as well as geological and geochemical prospecting.



LEGEND

JURASSIC	Mtm	Middle Member	MTOMKUU FORMATION (Mt)	Shales, subordinate sandstones, s
	Mtl	Lower Member		Shales/siltstones/sandstones Sandstone, s; limestones, l
	K		KANBE FORMATION	Limestones, (coral-rich, c; oolitic/pisolitic, o) Subordinate shales/sandstones
	Mzu	Upper Member	MAZERAS FORMATION (Mz)	Sandstones, arkoses
? ?	Mzm (St)	Middle Member		Sandstones, arkoses
TRIASSIC	Mku (St)	Upper Member	MARIAKANI FORMATION (Mk)	Sandstones (Shales/siltstones/sandstones, St)
	Mkm (St)	Middle Member		Sandstones
	Mkl	Lower Member		Sandstones

- Geological boundary (known and approximate)
- Photo-lineament
- Fault, existing and inferred
- Mineralized vein
- Transported gossan
- Bedding, dip and strike
- Bedding by air-photo interpretation
- Lp Intrusive rock (Lamprophyric dyke)
- A——B Line of section

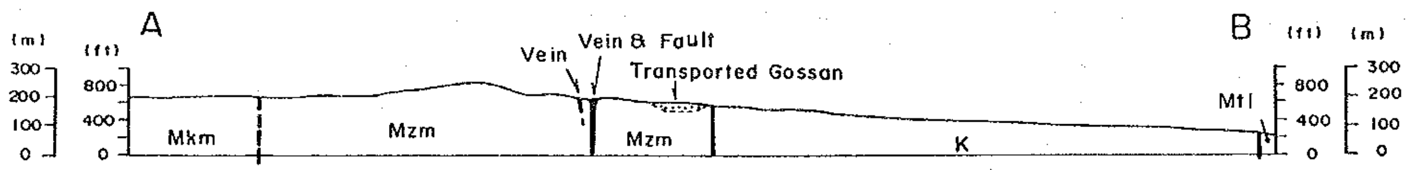


Figure II-2-3-2 (1) Geological Map of the Kinangoni Area

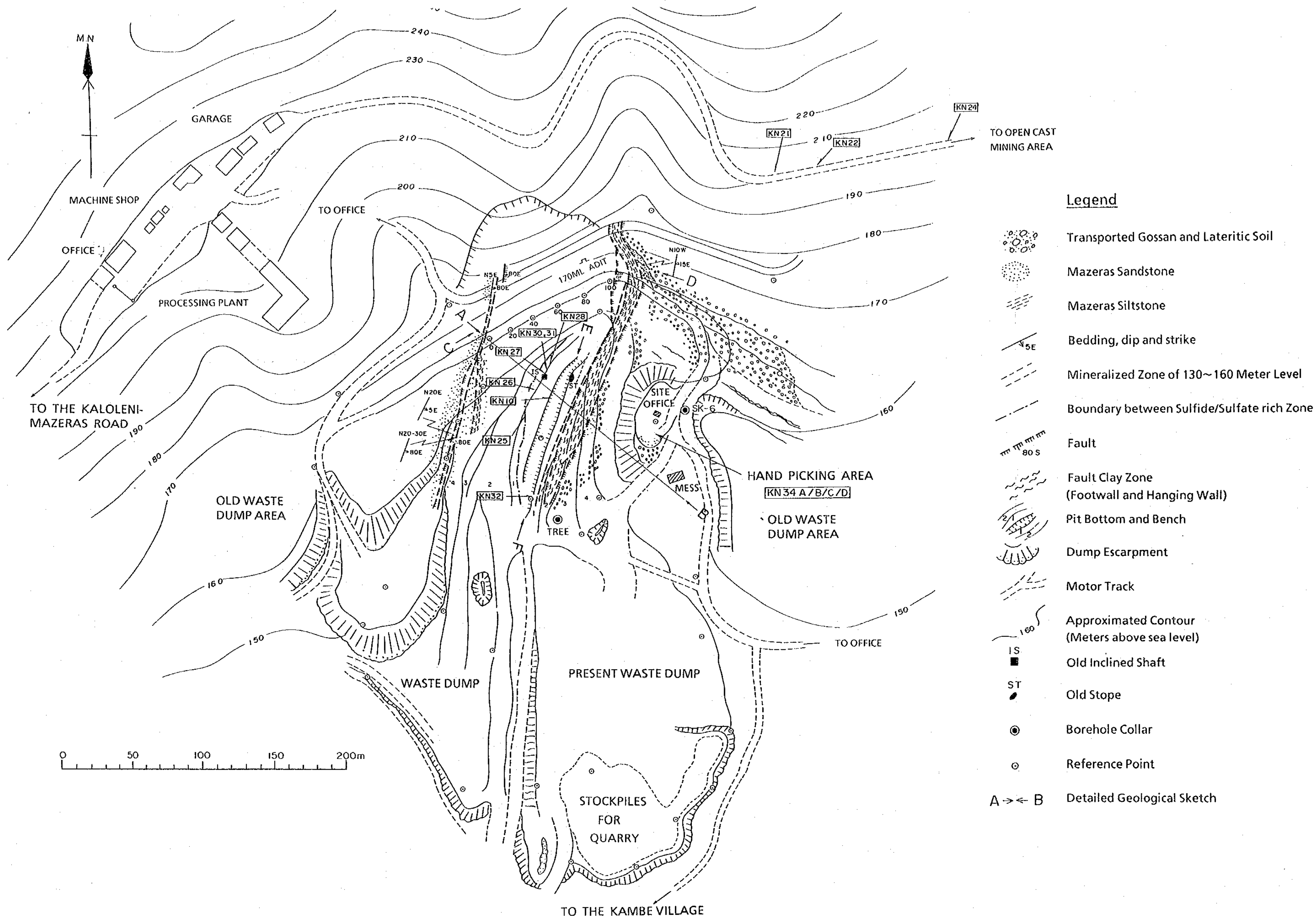


Figure II-2-3-2 (2) Geological Sketch Map of the Kinangoni Open Cast Mine

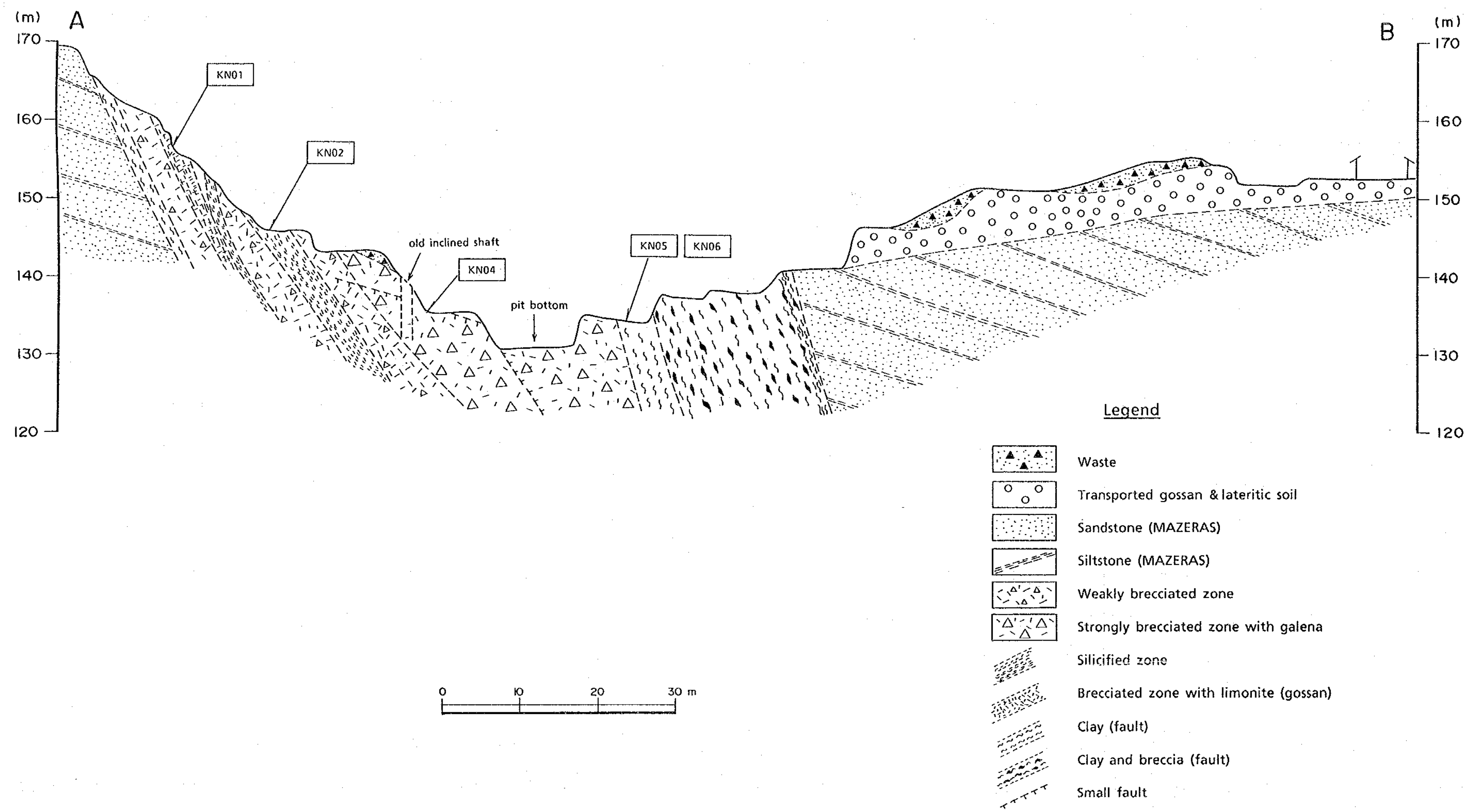
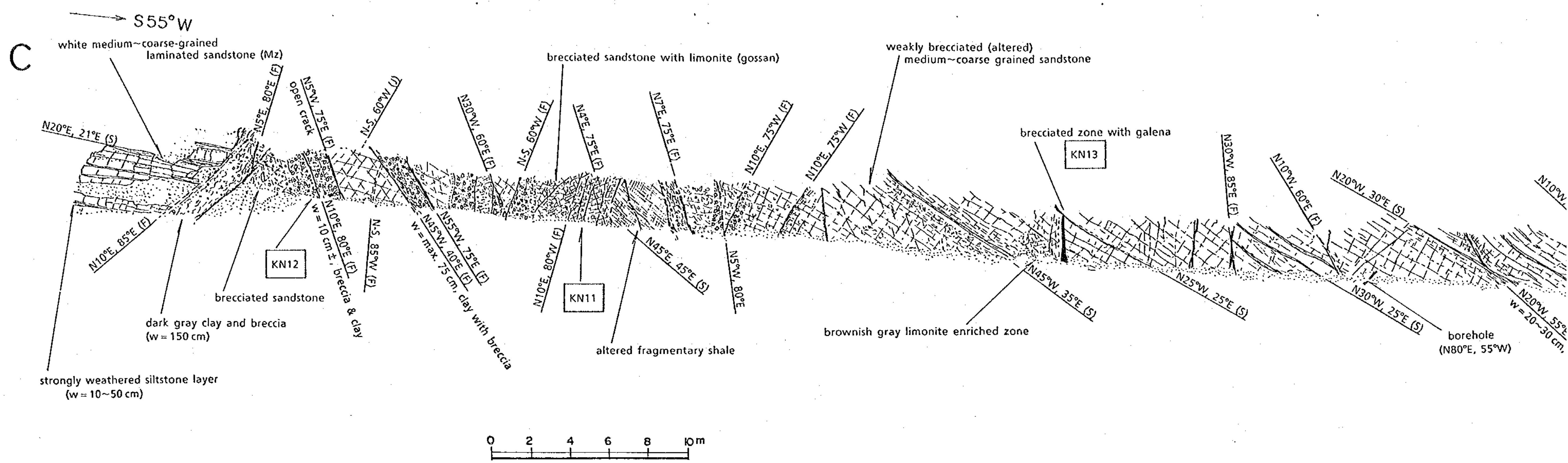


Figure II-2-3-2 (3) Geological Sketch of Pit Section



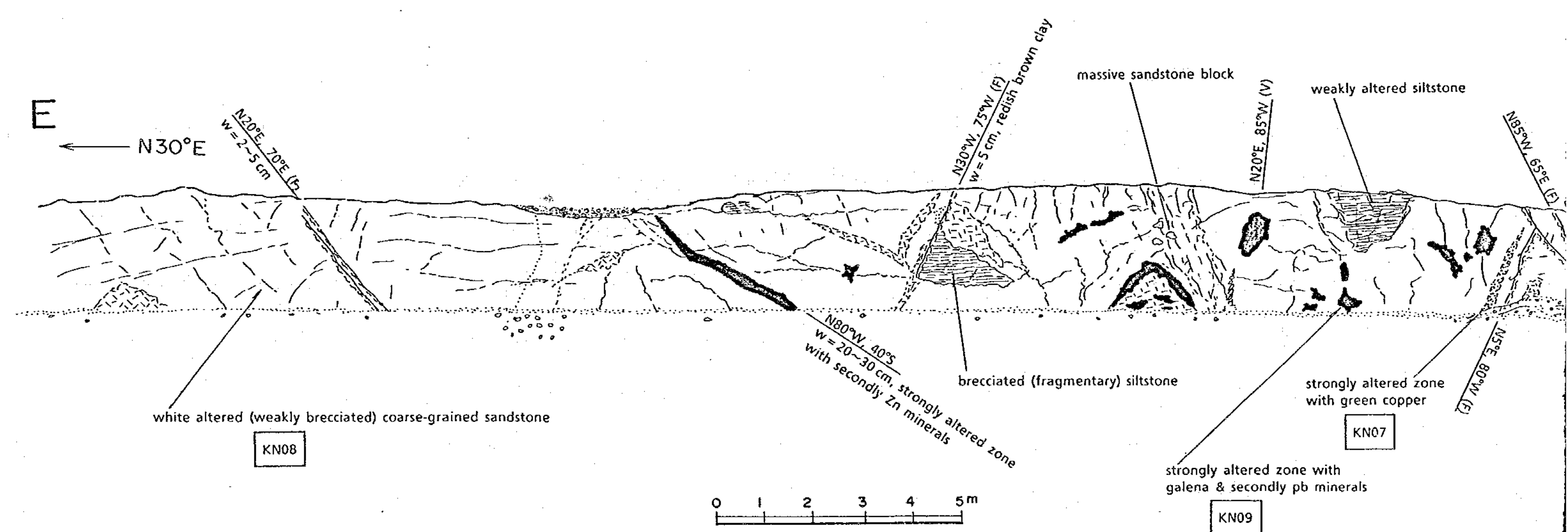
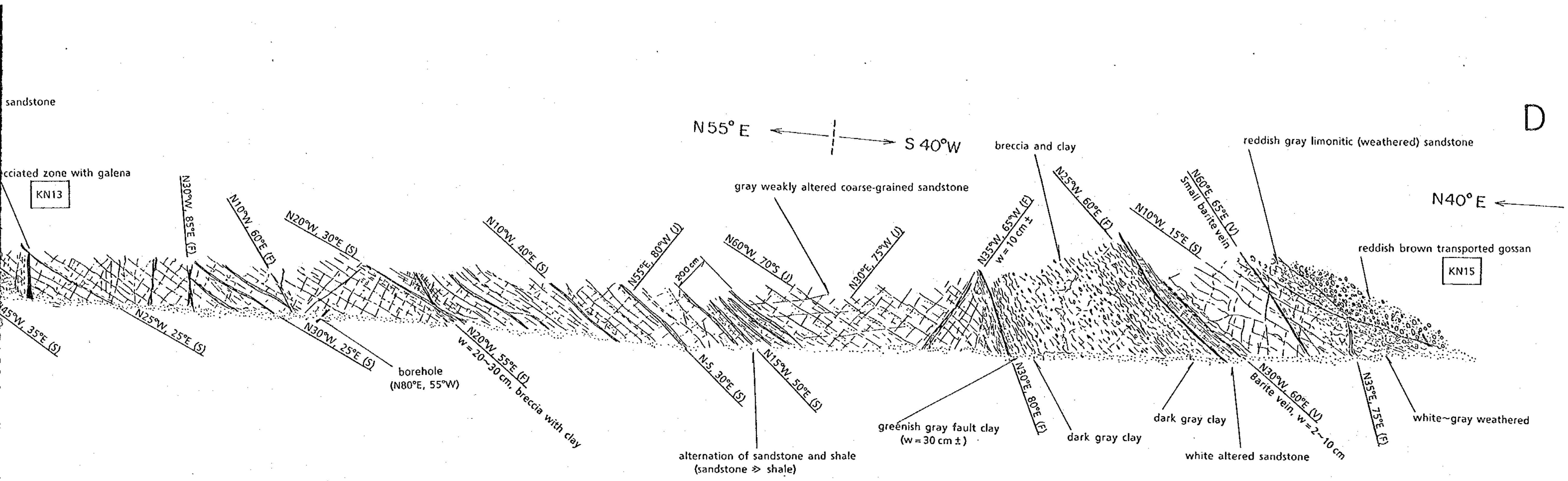


Figure II-2-3-2 (4) Geological Sketches of Upper Bench Wall and Pit Bottom



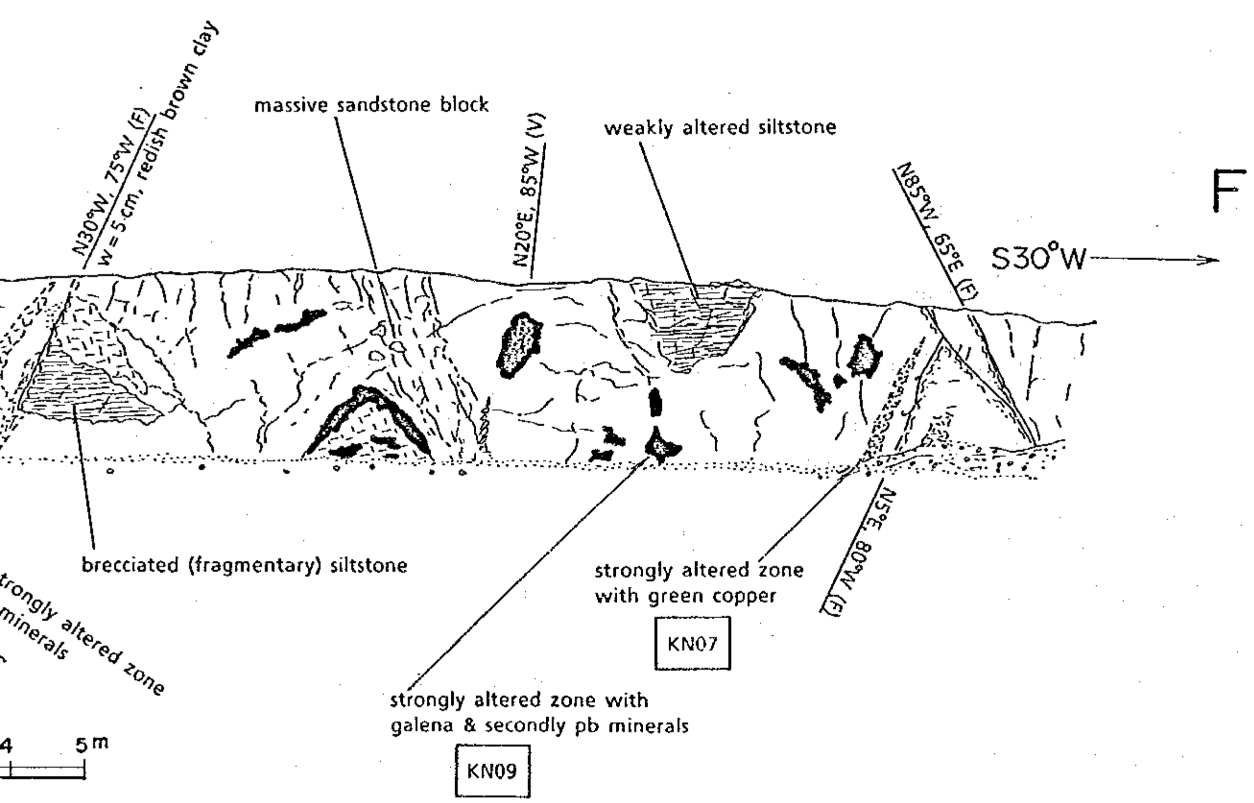


Figure II-2-3-2 (4) Geological Sketches of Upper Bench Wall and Pit Bottom

Legend

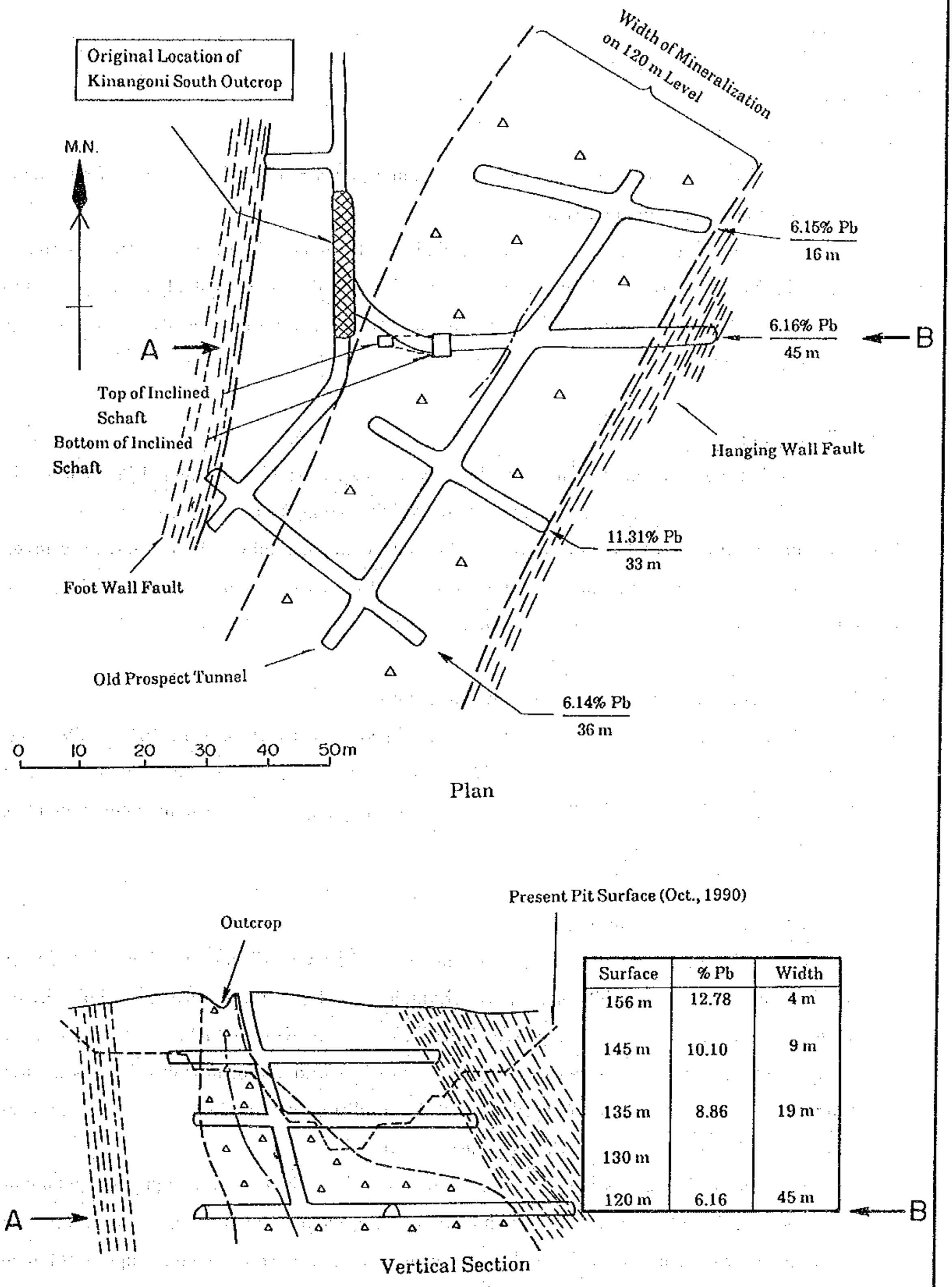
- Transported gossan
- Siltstone
- Sandstone
- Silicified zone
- Brecciated zone with limonite (gossan)
- Dark gray clay (fault)
- Dark gray clay with brecciated sandstone (fault)
- Small fault
- Joint (crack)
- Strongly brecciated zone with galena
- Strongly altered zone with green copper

(S) Strike and dip of strata

(V) Strike and dip of vein

(F) Strike and dip of fault

(J) Strike and dip of joint



Surface	% Pb	Width
156 m	12.78	4 m
145 m	10.10	9 m
135 m	8.86	19 m
130 m		
120 m	6.16	45 m

Figure II-2-3-2 (5) Plan and Vertical Section of Mineralization and Underground Exploration at Kinangoni Mine

(3) Vitengeni Area

(A) Location, Access and Topography

(i) Location and Access

The Vitengeni area is situated at the location approximately 70 km north of Mombasa or approximately 33 km northwest of Kilifi.

From Mombasa to the area, it is accessible by motor driving northerly on the Mombasa-Malindi all-weather road to Kilifi, then from Kilifi via Dida north-westerly for about 13 km to reach to Vitengeni Village, then further about 1.2 kilometres westerly, to the ore showings and old working of the Vitengeni mine.

(ii) Topography

The Vitengeni area is located in the "Nyika" explicated by Gregory J.W. (1896). In the southern part, Kavuluni River flows down southeasterly to form a river basin to be of a low land, having an altitude of approx. 300 to 350 ft (approx. 90 to 105 m) above sea level. Remaining parts in the area show very gentle relief with varying elevations of approx. 400 to 500 ft (approx. 120 to 150 m) above sea level.

(B) Existing Geological Studies and Current Situations

Mineralization in the area was initially discovered by Hobbly in 1919. The first pegging was implemented in 1922. Mining operation of galena was commenced in late 1920s to be continued until 1930s. Mining operation, mainly for barite has been continued since 1950s until the end of 1980s.

(i) Existing geological studies

General geological informations in the area publicly available are Geological Sheet: Malindi Area, 1 to 125,000 scale, by Thompson, A.O. (1956) and Geological Sheet: Vitengeni, 1 to 50,000 scale, by Gelogical Survey of Kenya (1981). Geochemical exploration, composed of stream sediment sampling and examinations for lead, zinc, copper, barium, manganese, molybdenum and vanadium, was implemented in the area by British Technical Cooperation Project (1977-1980).

Pulfrey, M. (1942) carried out a detailed research on the ore showings and ore body to establish a calculation of ore reserves of lead, zinc, copper, barium, silver ores and etc. Geological and economic geological examinations in the area were also implemented by Barnerd, B.C. (1950), Thompson, A.O. (1956) and Bugg, S.F. (1980 and 1982).

(ii) Current situations

Mining operation of barite in the area has been suspended in late 1980 due to a paucity of remaining ore reserves. More than ten old workings of open cast mining activities, aligned roughly in north-south direction for about 1.5 kilometres, are observed.

Currently, milling of barite ores, which were mined and stockpiled in the past, are being operated. The current Vitengeni mine produces powdered barites and the products are shipped as the material for use in mud water for petroleum drilling and in manufacturing porcelain. Current situations of the mine operation are as follows:

- barite ores : 500-600 tons of stockpiled ore and 300 tons of milled ore.
- production capacity : one ton per hour
- specification of products : barite concentrations; minus 200 meshes, grade; approximately 90% $BaSO_4$
- workers : approx. 20
- operator : Mineral Mining Corporation Ltd.

(C) General Geology and Mineralization

Geological map and geological cross sections in the area are shown in Figure II-2-3-3 (1), geological sketch map and vein pattern map in Figure II-2-3-3 (2) and geological sketches of old mining pits in Figure II-2-3-3 (3).

(i) General geology

General geology in the area mainly consists of middle member of the Mazeras Formation which comprises arkose sandstone intercalated by thin siltstone beds. The Formation is correlated to Lower Jurassic age. The Formation gently inclines in general and is disturbed in the vicinity of the ore body.

By interpretations of aerophotos, two distinguishable lineaments, running in directions of NNE-SSW and NW-SE are observed. The former approximately corresponds with strikes of major ore veins.

Geology, close to the ore bodies, mainly consists of an alternation of sandstone and siltstone. Siltstones close to ore veins are intensely brecciated.

(ii) Mineralization

Mineralization in the area is mainly represented by vein type ore deposits of barite, associated with minor amount of quartz and sulphide minerals, such as galena, sphalerite and etc. More than 20 veins in echelon distribution had ever been mined (Figure II-2-3-3 (2)).

By geological mapping of old mining pits (Figure II-2-3-3 (2)), and laboratory tests and analysis, ore deposits in the area are estimated to be as follows.

· Veins:

strike, dip	: NE 5° to 20°, SE 70° to 85°
width	: 0.2-0.5 m, 1.5 m in maximum (estimated)
strike extension	: 10 to more than 50 m
downward extension	: 10 to more than 100 m (The figures were estimated by existing informations, scales of old workings and comments by mine workers)

· Minerals:

Primary minerals	: (Abundant) galena, barite (Minor) sphalerite, chalcopyrite, pyrite, marcasite, quartz
Secondary minerals	: anglesite, cerussite, smithsonite, chalcocite, malachite, azurite, covellite, goethite, iron oxide.

· Alternation of wall rocks

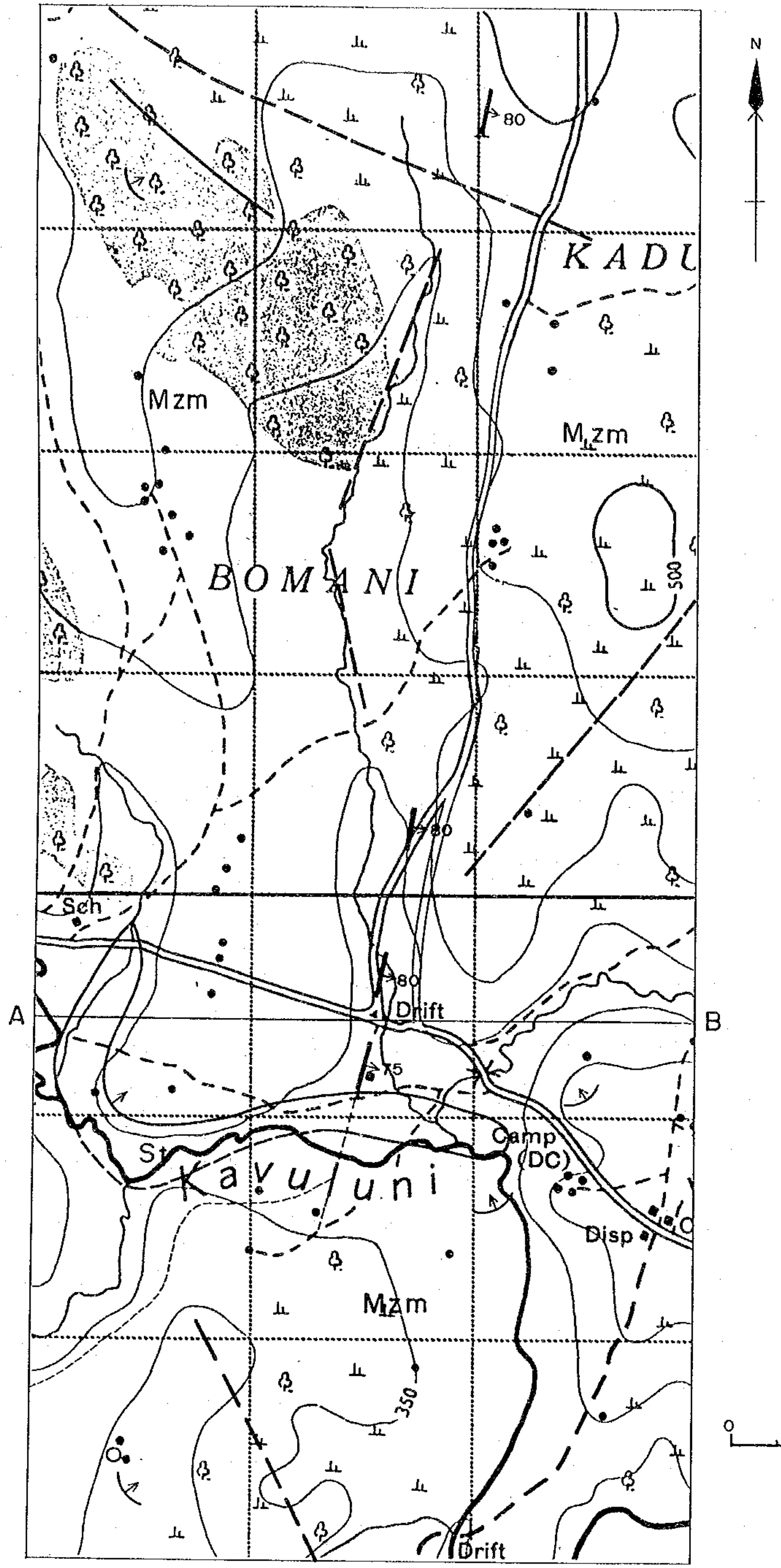
argillization	: sericitization, chloritization, kaolinization (secondary?)
silicification	: particularly in wall rock close to veins.

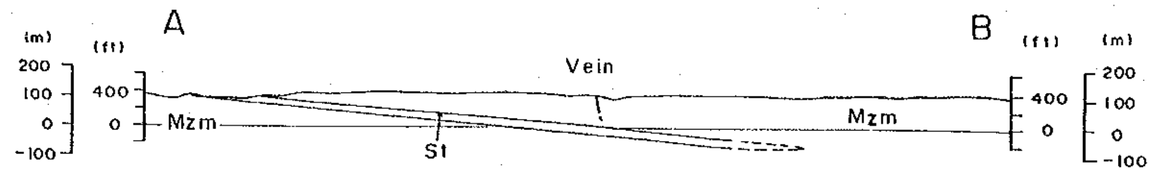
Galena, most abundant among the sulphide minerals, is generally observed in barite frequently in the form of aggregates of single crystals, 3 to 5 cm long. Sphalerite is generally limited in occurrences and usually in white granular or drusy quartz. Barite mainly occurs in the form of aggregates of large single crystals, mostly vuggy and sometimes porous and spongy. Its color varies, transparent, white, pink, yellow, brown and etc. Veinlets of barite are generally fibrous.

The lead age dating values of galena by three specimen in the area show 213.2 Ma, 231.9 Ma and 237.4 Ma, respectively, which are to be estimatedly correlated to Middle to Upper Triassic age (Appendix-VI).

(D) Examination

The fissure zone in the area, where the ore bodies occur in, has ever been investigated for an extension of 1.5 km north-southerly. A limited mineral exploration work has been implemented for a further extension of the fissure zone north-southerly, where Mangea-Kwa Dadu area is situated to the north. An implementation of ground surface geophysics, for example an electric geophysical survey, is to be warranted in future to elucidate a mineral potential in the above extension area.





LEGEND

JURASSIC — Mzm / St — Middle Member — MAZERAS FORMATION (Mz) — Sandstones, arkoses (Shales/siltstones/sandstones, St)

- Geological boundary (known and approximate)
- Photo-lineament
- Fault, existing and inferred
- Mineralized vein
- Mineralized float
- Bedding, dip and strike
- Bedding by air-photo interpretation
- Lp — Intrusive rock (Lamprophyric dyke)
- A —— B Line of section

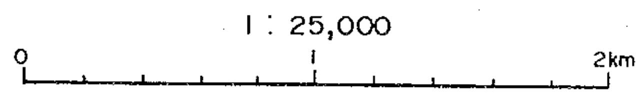


Figure II-2-3-3 (1) Geological Map of the Vitengeni Area

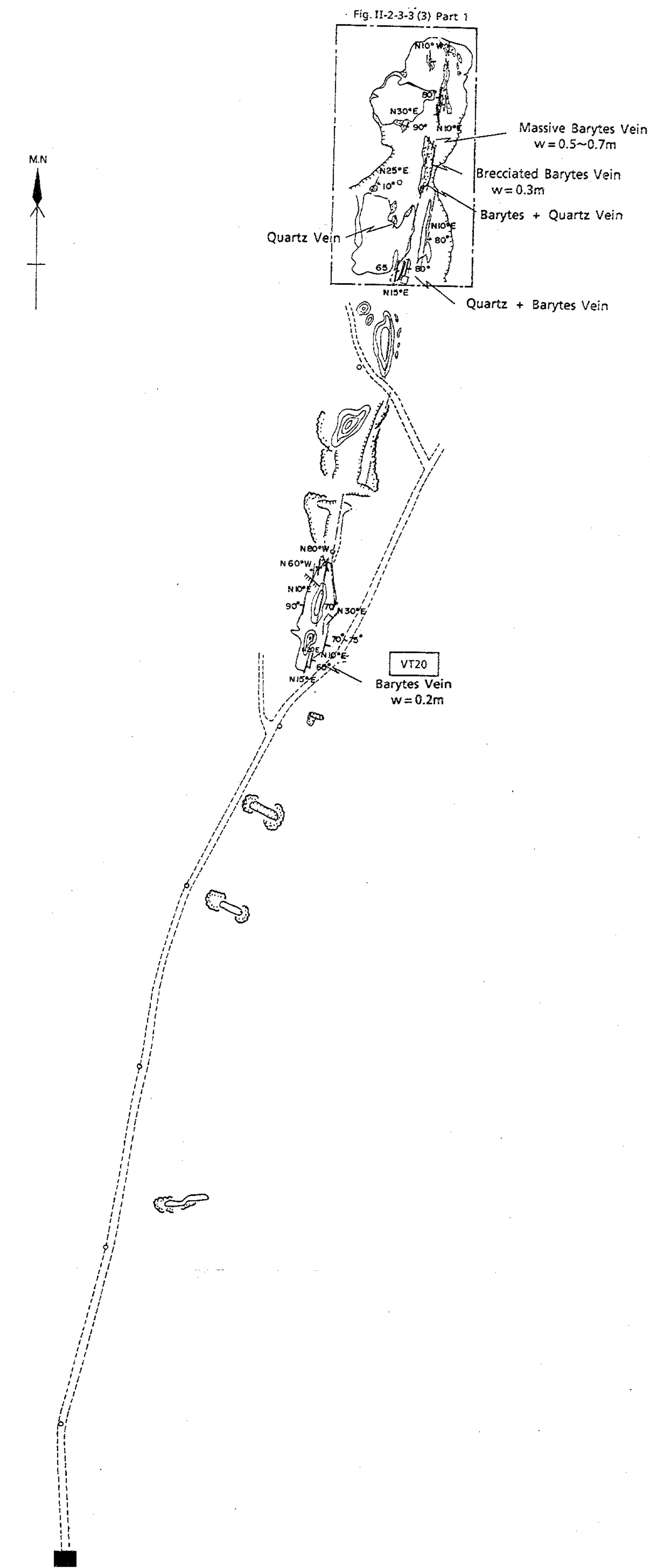
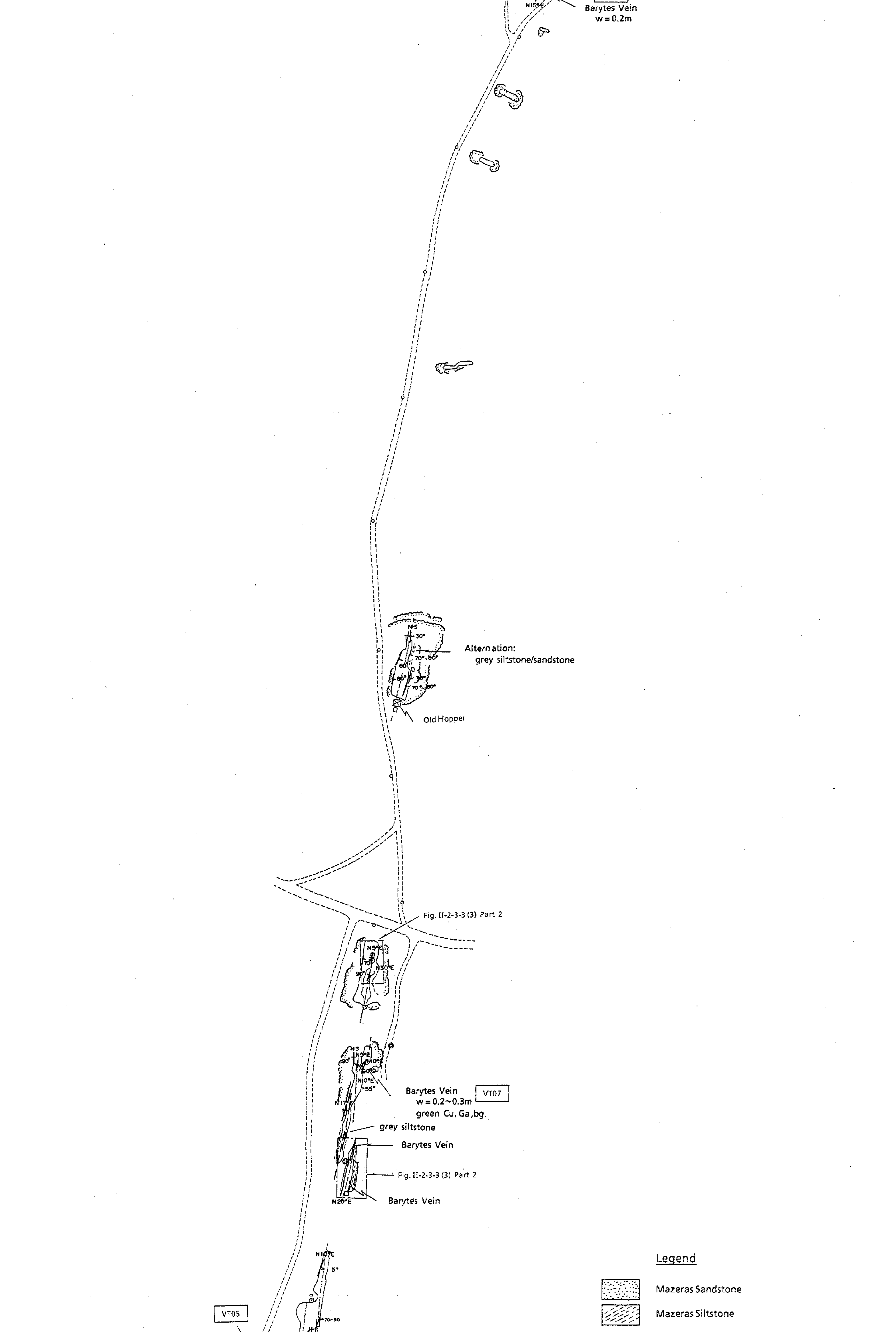


Fig. II-2-3-3 (3) Part 1
M.N
N10°W
80°
N30°E
90°
N10°E
Massive Barytes Vein
w=0.5~0.7m
N25°E
10°
Brecciated Barytes Vein
w=0.3m
Barytes + Quartz Vein
Quartz Vein
N10°E
80°
65
80°
N15°E
Quartz + Barytes Vein
N80°W
N60°W
N10°E
90°
70
N30°E
70°~75°
N10°E
65°
N15°E
VT20
Barytes Vein
w=0.2m


Barytes Vein
w = 0.2m
N15°E
Alternation:
grey siltstone/sandstone
Old Hopper
Fig. II-2-3-3 (3) Part 2
Barytes Vein
w = 0.2~0.3m
green Cu, Ga, bg.
VT07
grey siltstone
Barytes Vein
Fig. II-2-3-3 (3) Part 2
Barytes Vein
N20°E
VT05
Legend
Mazeras Sandstone
Mazeras Siltstone

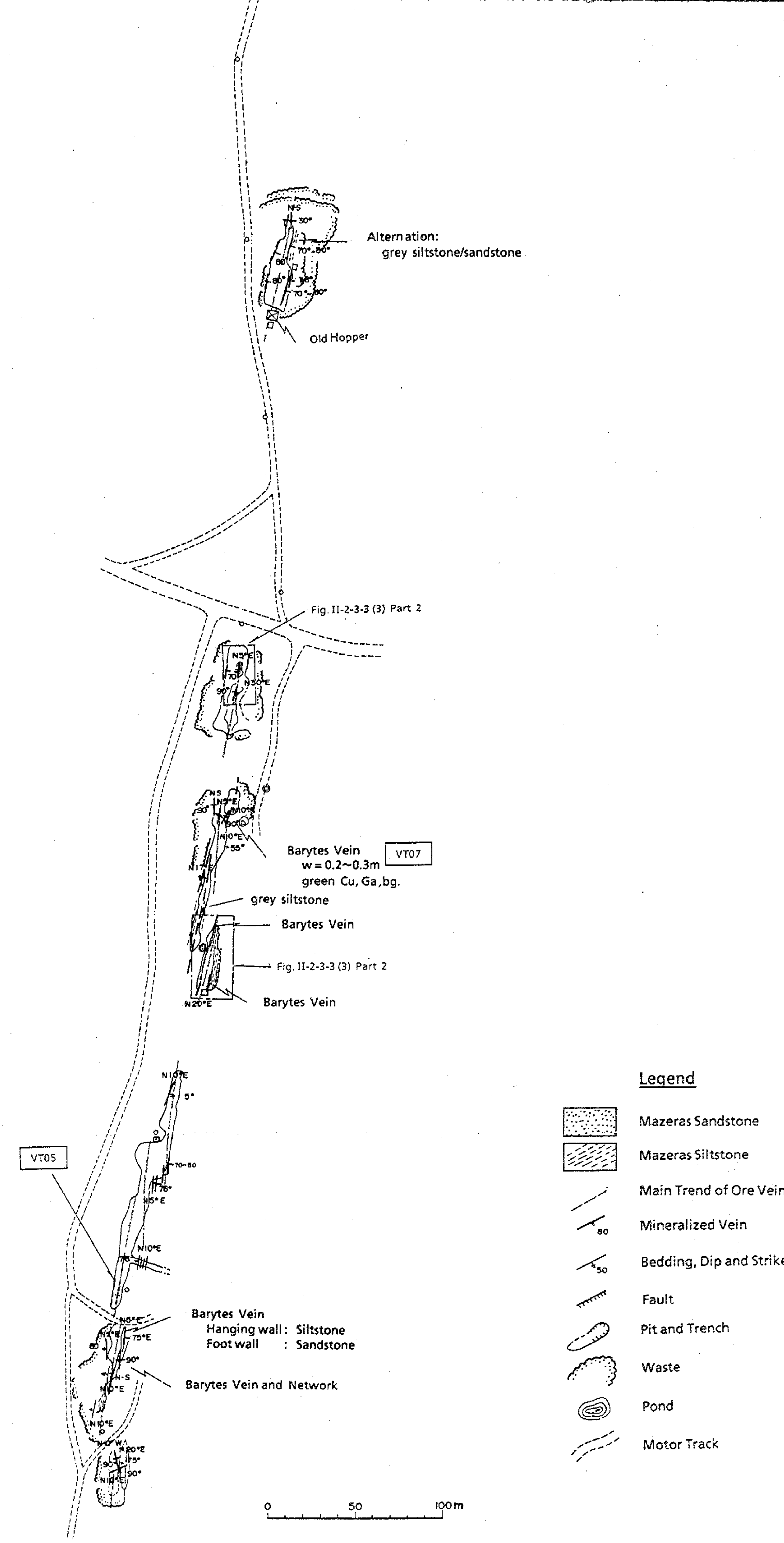


Figure II-2-3-3 (2) Geological Sketch Map and Interpreted Vein Pattern in the Vitengeni Area

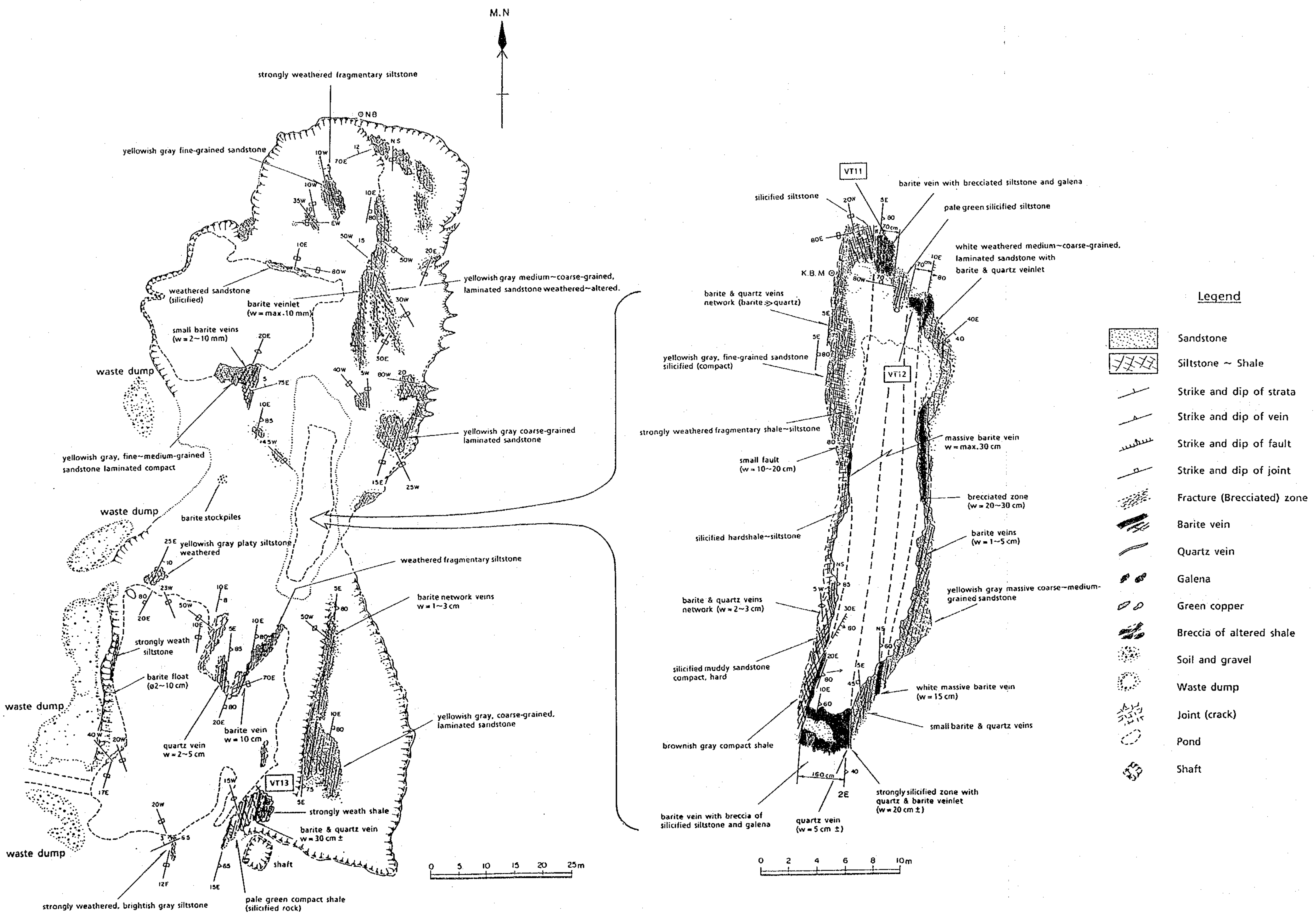


Figure II-2-3-3 (3) Geological Sketches of Mineral Showings in the Old Mining Pits (Part 1)

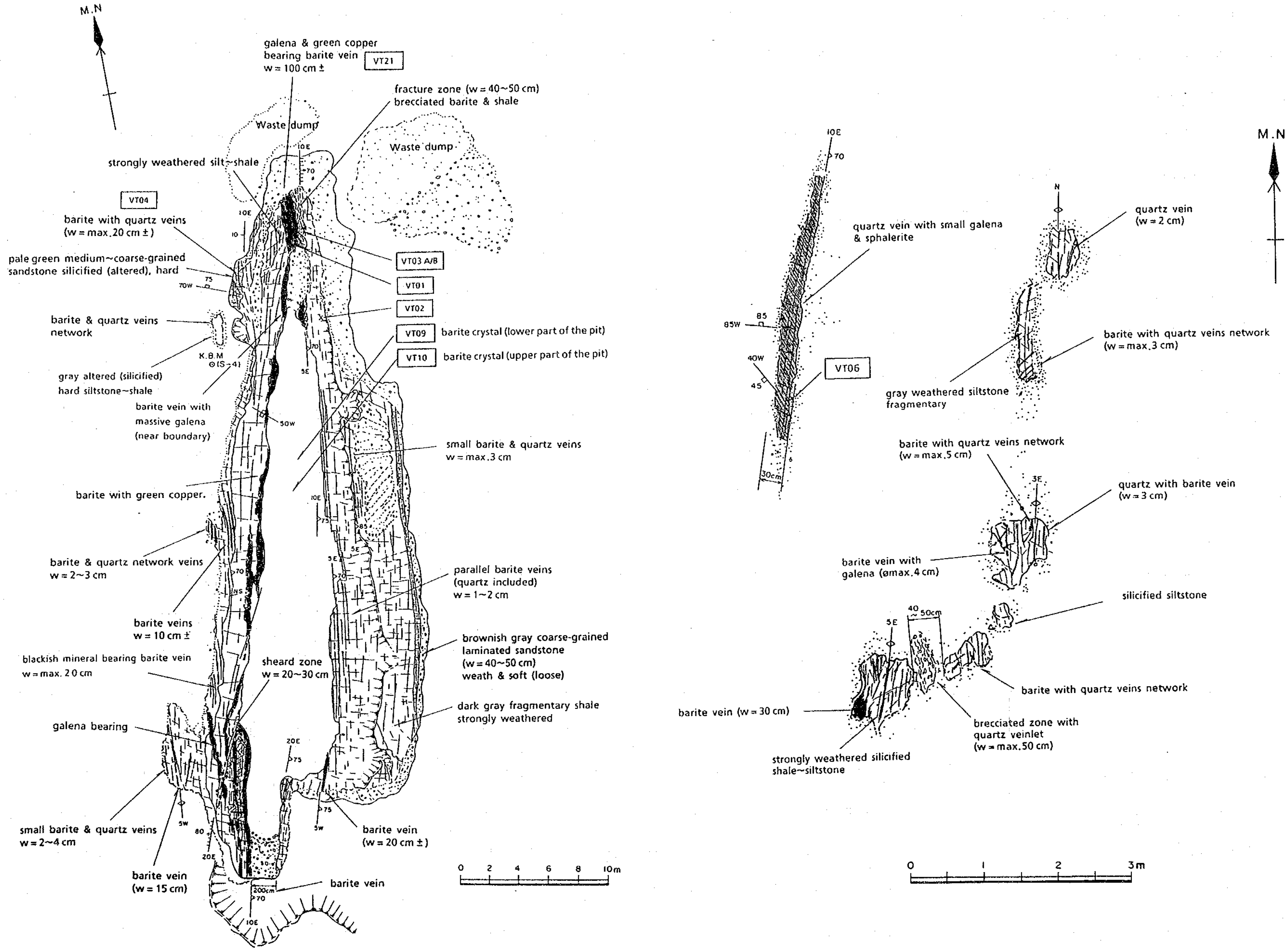


Figure II-2-3-3 (3) Geological Sketches of Mineral Showings in the Old Mining Pits (Part 2)

(4) Jaribuni Area

(A) Location, Access and Topography

(i) Location and Access

The Jaribuni area is situated at approx. 48 km north-northeast of Mombasa or approx. 12 km west of Kilifi.

The area is accessible from Mombasa by driving, on the Nairobi-Mombasa all weather road to Mazeras, northward from Mazeras to Kaloleni at the terminal of the Mazeras-Kaloleni, and then northeastward on Kaloleni-Kilifi road to Dzitsoni Village for some twenty kilometres. Ore showings in the area are about 9 km north of the village.

(ii) Topography

The Jaribuni area is located at the eastern margin of the "Coastal Range" defined by Gregory, J.W. (1896). A hilly land of limestone plateau, extending north-southerly at an altitude of approx. 500 to 550 ft (approx. 150 to 165 m) high above sea level, is located in the central part of the area. The northwestern and northeastern parts are deeply disected by the Ndzovuni River whose banks form steep cliffs.

The eastern to southeastern parts, being located in western end of the "Foot Plateaux" (Gregory, J.W. (1896)), show very gentle relief. Ore showings in the area are observed in the northern end of the crest of this hilly land.

(B) Existing Geological Studies and Current Situations

(i) Existing geological studies

Existing geological informations publicly available are; Geological Sheet: Kilifi-Mazaras Area, 1 to 125,000 scale, by Caswell, P.V. (1956) and Geological Sheet: Bamba, 1 to 50,000 scale, by Gelogical Survey of Kenya (1981).

Geochemical exploration, composed of stream sediment sampling and examination of geochemical anomalies for lead, zinc, copper, barium, manganese and etc., was implemented by British Technical Cooperation Project (1977-1980).

No information is available to data in regard to any geology or economic geology of the area.

(ii) Current situations

Man-powered hand-digging open pit mining is being operated in the Jaribuni Working in the area. Iron oxide ore body, occurring in surficial soil of limestone bed, is being mined. The current situation of the workings is shown below:

- Output : 180 to 220 tons of ore per day
- Ore grade : more than 25 percent iron in hematite ore
- Workers : 400 to 500
- Buyer : Bamburi Portland Cement Co., Ltd.
- Operator : Anwarali & Brothers Ltd.

(C) General Geology and Mineralization

A geological map and geological cross sections in the area are shown in Figure II-2-3-4 (1), and a plan of the Jaribuni workings is in Figure II-2-3-4 (2), sketches of ore body in Figure II-2-3-4 (3).

(i) General geology

General geology in the area consists of the Kambe Formation, and lower and middle members of the Mtomkuu Formation in ascending order.

The Kambe Formation mainly consists of limestone, and is seldom intercalated by shale or siltstone. The formation is correlated to Middle Jurassic age since it bears of yielding ammonitoid fossils.

Lower member of Mtomkuu Formation consists of an alternation of shale, siltstone, sandstone and limestone, while middle member of the formation consists of greenish grey shale. Both of the members are correlated to Upper Jurassic age.

The surficial part of the Kambe Formation shows a karst landform. Iron oxide ore bodies are formed in widespread dark brown soil filling depressions in the karst landform.

(ii) Mineralization

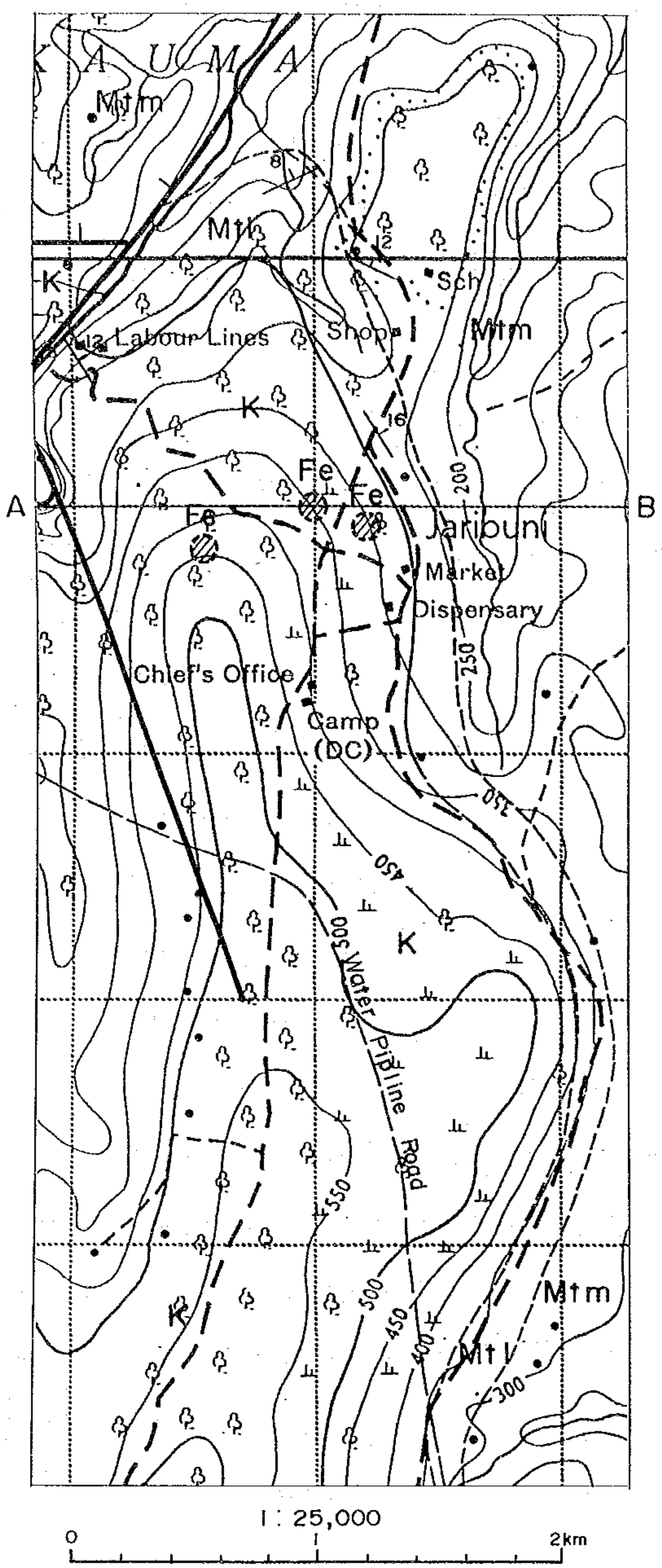
The ore deposits are of eluvial origin and formed by concentration of iron oxide minerals of residual soils which are derived from the limestone of the Kambe Formation and fill the karst landform near surface. A schematic cross section of an ore body is shown in Figure II-2-3-4 (4).

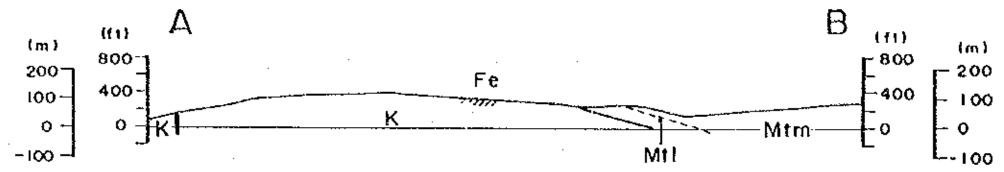
The surface in the Jaribuni Working area is covered by homogeneous dark reddish brown soil containing abundant organic materials, with thicknesses of 0.3 to 0.5 m thick. Nodules of iron oxide ores occur in the uppermost part of the karst beneath the soil cover. Grain sizes of nodules of iron oxide ore are generally fine in shallow depths, ranging from 0.5 to 0.3 mm in diameter and become coarser with depth, ranging from 3 to 5 cm in diameter at 5 to 7 metres depth where they tend to be closely clusted. At the depths deeper than this, nodules, becoming far larger in sizes, form pipes, lenses and masses of various shapes. The bottom of the depressions of the karst landform reaches 12 to 15 m deep at the deepest parts, where iron oxide ore nodules are highly glomerated and densely concentrated in form of large, compact masses with diameters of 0.3 to 0.7 m where iron contents of ore deposits become maximum of ore reserves.

Patchy pyrite disseminations are frequently observed in massive and dense iron oxide ore bodies at some 10 metres depth, from which depth onward, reduction environment may possibly be kept on.

(D) Examination

The iron ore bodies in the Jaribuni area are small in sizes and situated in surficial covers of limestone beds showing a karst landform with complex surface relief. With this situation, the ore bodies are unsuitable for a large scale, mechanized mining method and rather suitatble for a small scale, man-powered mining method. Accordingly, it would be recommended to apply a simple and in expensive exploration technique for this type of ore deposits, if necessary.





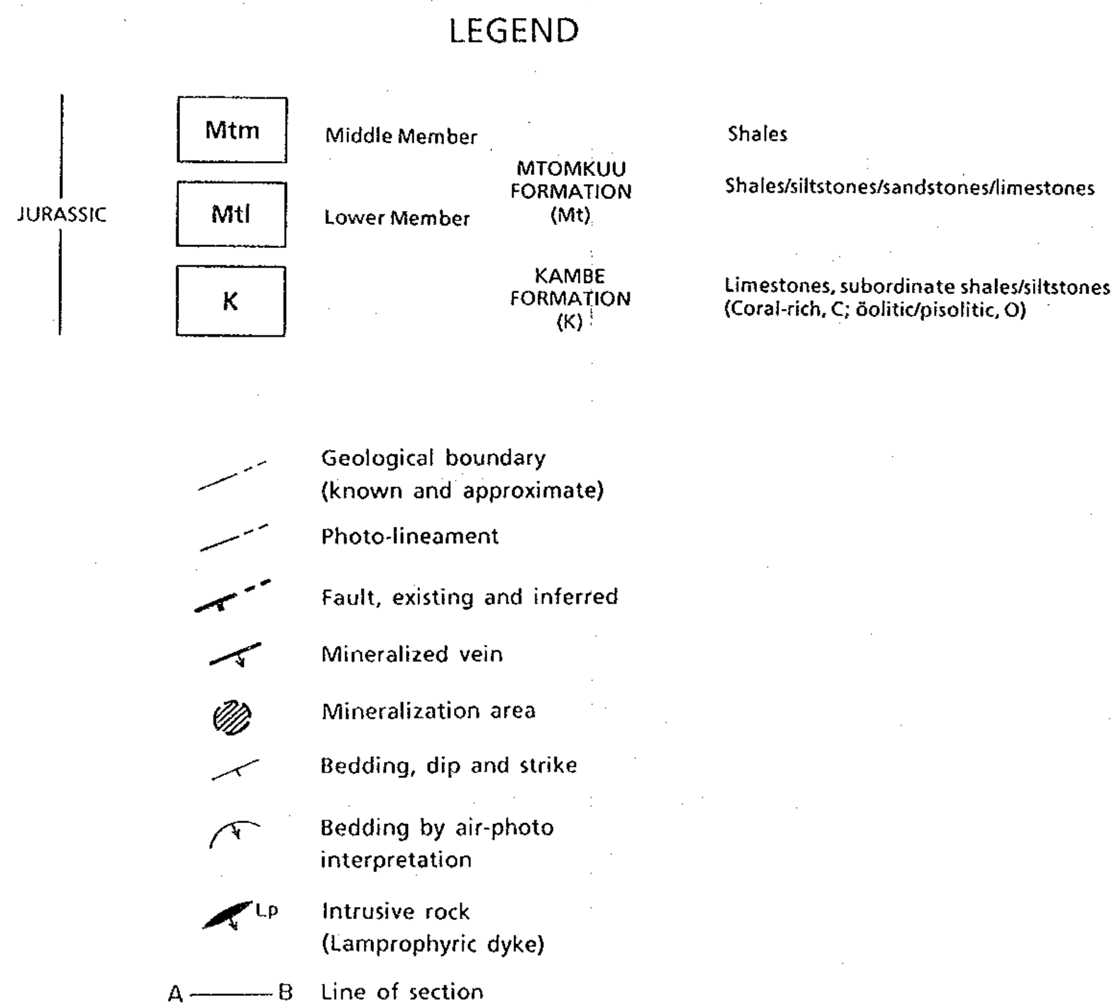


Figure II-2-3-4 (1) Geological Map of the Jaribuni Area

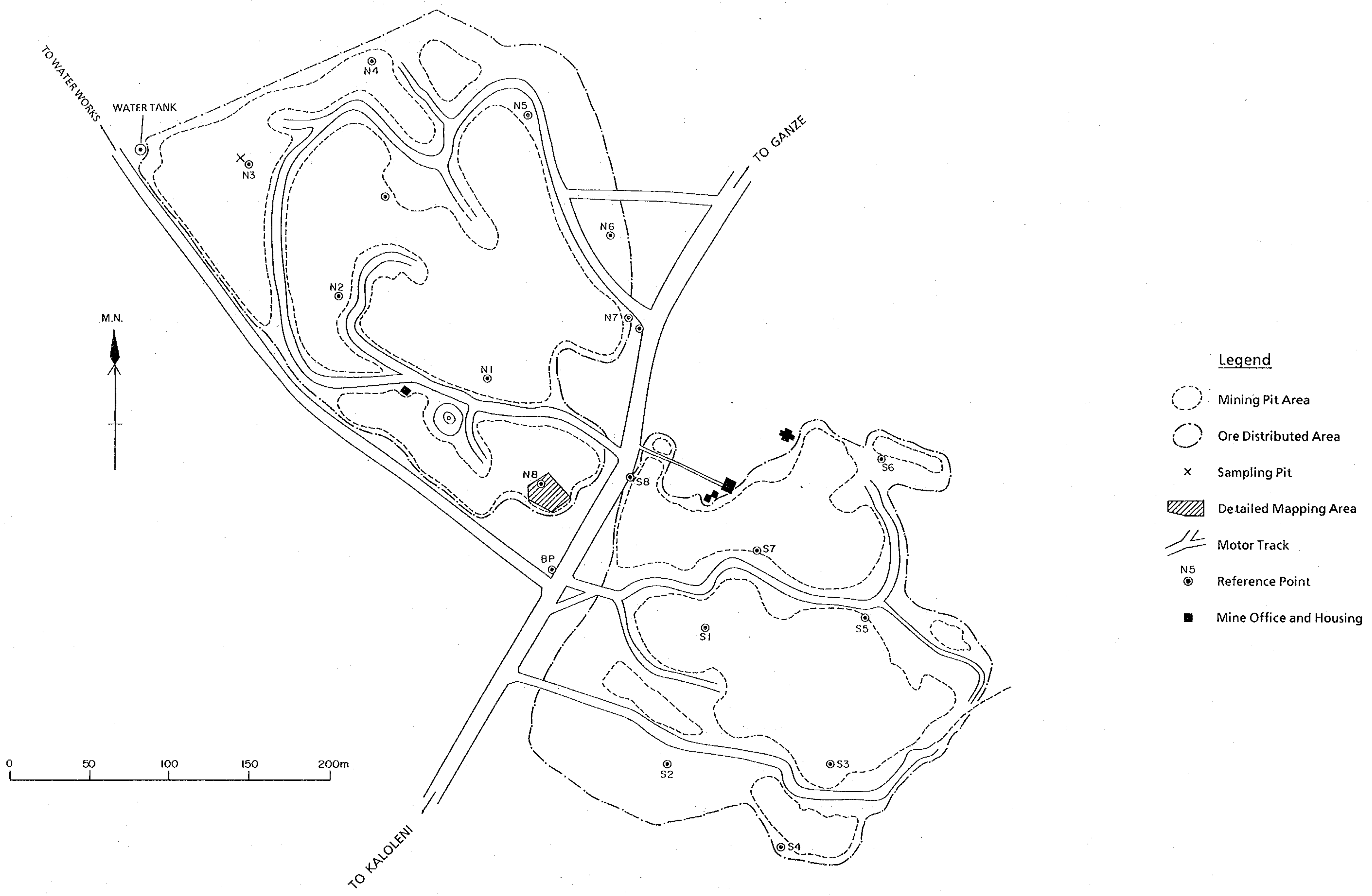


Figure II-2-3-4 (2) Plan of the Jaribuni Workings

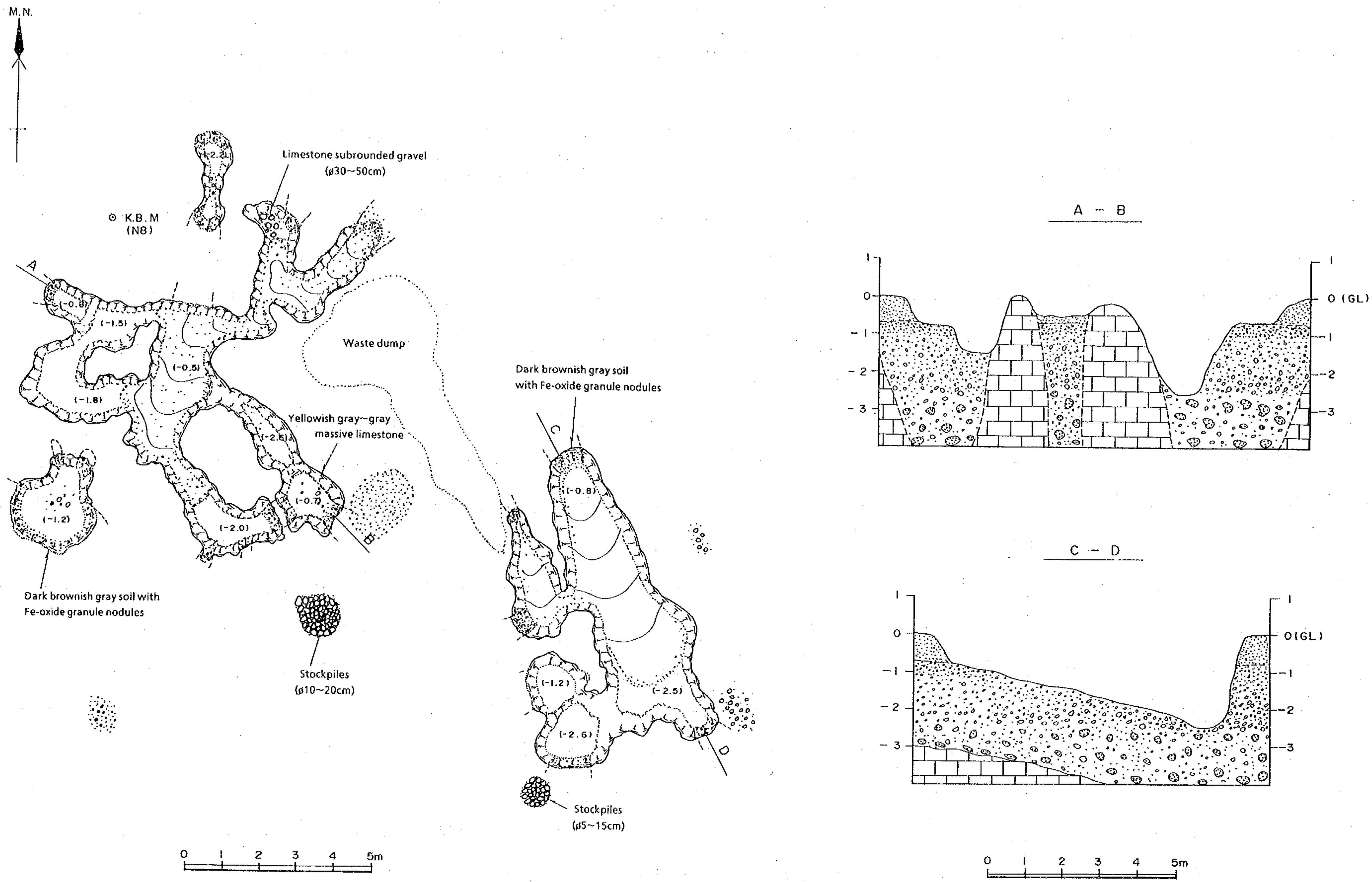


Figure II-2-3-4 (3) Geological Sketches of Fe-Oxide Occurrences in the Jaribuni Workings

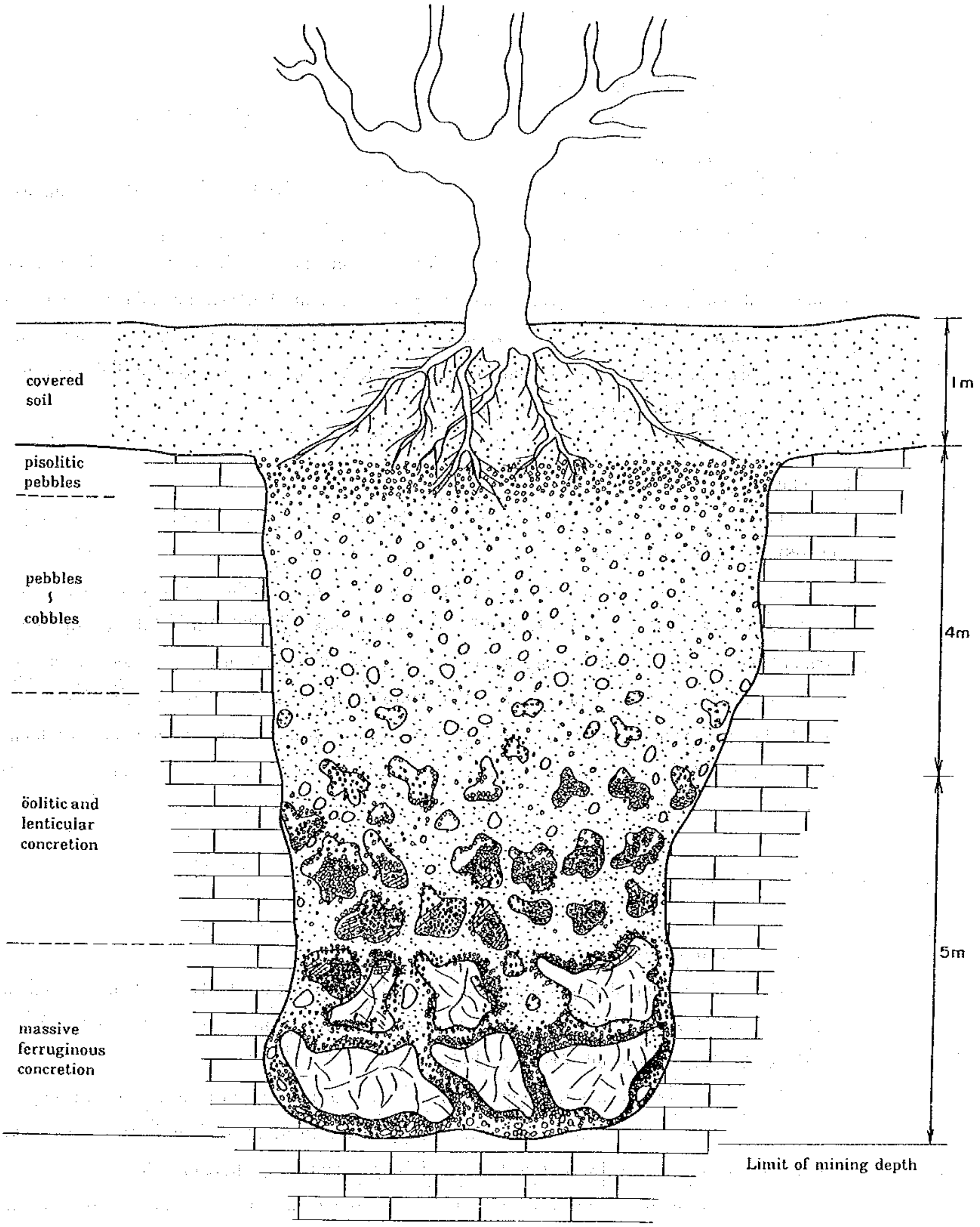


Figure II-2-3-4 (4) Schematic Ore Profile for Jaribuni Iron Deposit

(5) Kiwara Hill Area

(A) Location, Access and Topography

(i) Location and Access

The Kiwara Hill area is situated approx. 40 km north of Mombasa or approx. 12 kilometres southwest of Kilifi.

The area is accessible by driving from Mombasa on the Nairobi-Mombasa all-weather road to Mazeras, northward from Mazeras to Kaloleni at the terminal of the Mazeras-Kaloleni road and then north-westward on the Kaloleni-Kilifi road to Dzitsoni for some 20 km. Ore showings in the area are located about 4.8 km from the Dzitsoni Village via Dzitsoni School, 800 m north of the village.

(ii) Topography

The Kiwara Hill area is located in the "Coastal Range" explicated by Gregory, J.W. (1896) and Caswell, P.V. (1953).

The altitude at the top of Kiwara Hill is 1,080 ft (approx. 324 m) above sea-level, and forms a hilly land trending north northeast-south southwest. The hilly land occupies an area of the western to northwestern part of the area. The eastern to northeastern part of the area forms a gentle slope, approx. 300~800 ft (approx. 120 to 240 m) high above sea-level. The southern to south-eastern part of the area is situated on the northern extension of the Bangu Hill, which forms a hilly land, approx. 800 to 950 ft (approx. 240 to 285 m) high above sea level.

(B) Existing Geological Studies

(i) Existing geological studies

Existing geological information, available for the Kiwara Hill area are; Geological Sheet: Kilifi-Mazeras Area, 1 to 125,000 scale, and Geological Sheet: Bamba, 1 to 50,000 scale, by Geological Survey of Kenya (1981).

Geochemical exploration, composed of stream sediment sampling and examinations of geochemical anomalies for lead, zinc, copper barium, manganese and etc., was implemented in the area by British Technical Cooperation Project (1977~1980).

The ore showings in the area were initially reported by Caswell, P.V. (1956). Mason, J.E. (1968) reported for occurrences of the residual-type manganese ore deposits in the area based on geological information by diamond drills.

Mines and Geological Department implemented diamond drilling exploration (1963-

1964), and pit prospecting (1966). Mason, J.E. (1968) presented a summary report on the results of this exploration in a form of ore reserves estimation.

(C) General Geology and Mineralization

A geological map and geological cross sections are shown in Figure II-2-3-5 (1), a geological sketch map in Figure II-2-3-5 (2), and geological sketches of outcrops in Figures II-2-3-5 (3) and (4).

(i) General geology

General geology in the area mainly conists of sandstone, middle member of the Mazeras Formation. The sandstone is white to yellowish white, coarse-grained and massive, and yields silicified wood fossils. The Formation, correlated to Lower Jurassic age, is covered by brown to reddish brown soil having manganese oxide nodules. The sandstone beds, occupying a whole of the Kiwara Hill, generally strikes in north-south direction and dipping 4 to 10° to the east. The soil cover is limited in distribution to the top of the Kiwara Hill.

There are 2 trends of faults; one trend is parallel to the trend of the Kiwara Hill in the direction of north northwest. South southeast, and the other runs in the direction of northeast-southwest. The faults are distinctly recognized in air photographs in the form of lineaments.

(ii) Mineralization

The mineralization is represented by occurrences of manganese oxide ore bodies which replace sandstone beds of Mazeras Formation and have been enriched by weathering.

Manganese ore in the area is classified in the following 3 types.

- Dissemination type : Manganese oxide minerals disseminate in matrix of coarse-grained sandstone or filling joints and cracks in sandstone.
- Replacement type : Manganese oxide minerals replacing coarse-grained sandstone, usually, altered to be black. Quartz and feldspar are retained in sedimentary textures.
- Massive type or Nodule type : Massive or nodule-like, having metallic luster.

The massive or nodule type ores occur in surficial soil cover, the replacement type ores in outcrop close to surface soil or in massive sandstone of relatively large sizes and the dissemination type ores in sandstones in general (Figures III-2-3-5 (2) and (3)).

An ore deposit of the nodule type, which has ever been explored by drilling for an ore reserve estimation, is located in the surficial soil cover and estimated at 335,000 t with an average grade of 24.3% MnO_2 for an average thickness of 2.3 ft (approx. 0.8 m) (Mason, J.E. (1968)).

(D) Examination

Pyrolusite, cryptomelane, hollandite and todorokite are identified by electron probe microanalysis, microscopic ovservation of polished sections and X-ray powder diffractmetry in the course of the current works. A silver bearing manganese mineral, possibly aurorite, may be contained.

The managansese ore bodies in the area is of sedimentary origin and is distributed only in the vicinity of the current ground surface. They are very thin in thickness and small in scale. Accordingly, their commercial values are very low.

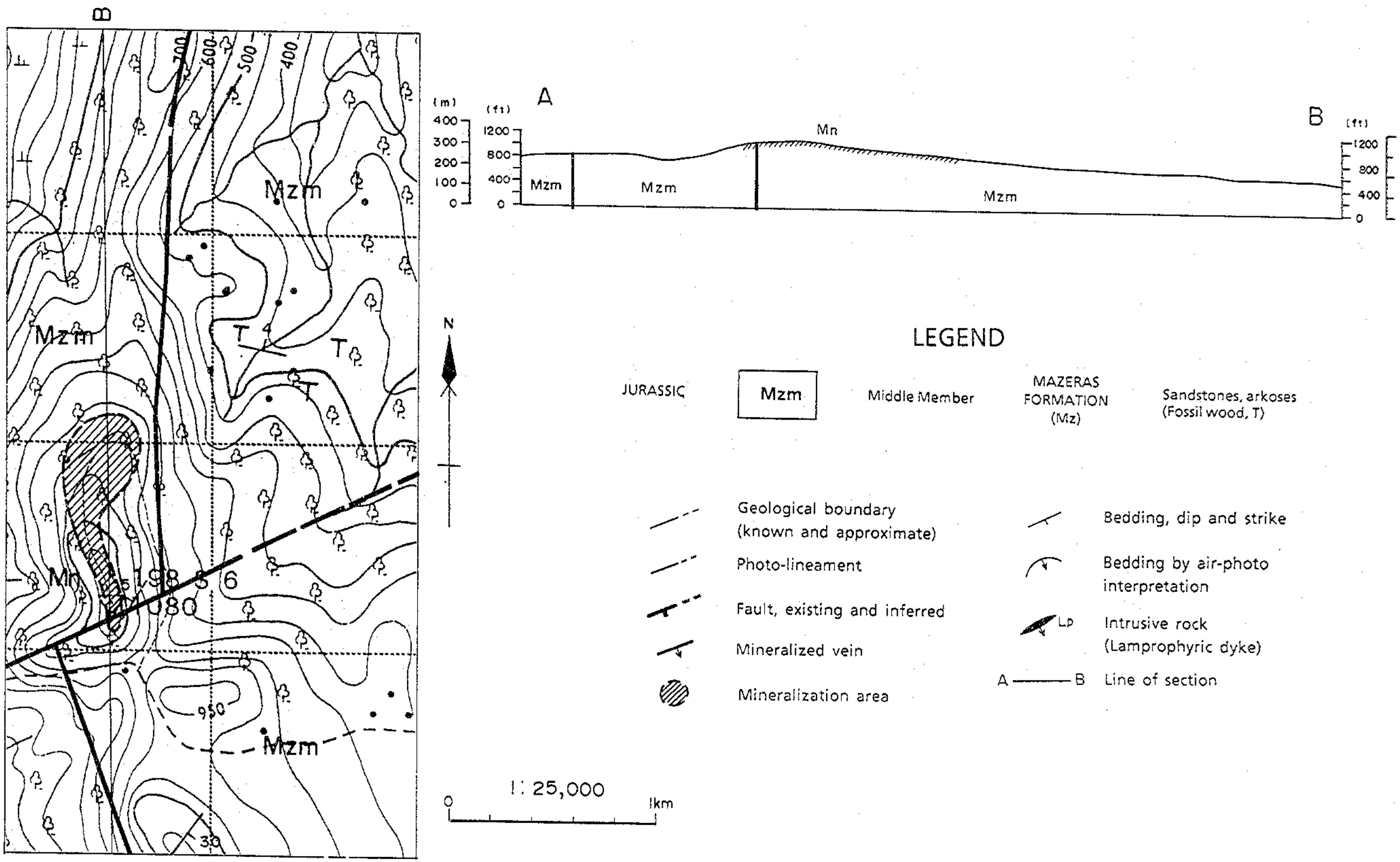


Figure II-2-3-5 (1) Geological Map of the Kiwara Hill Area

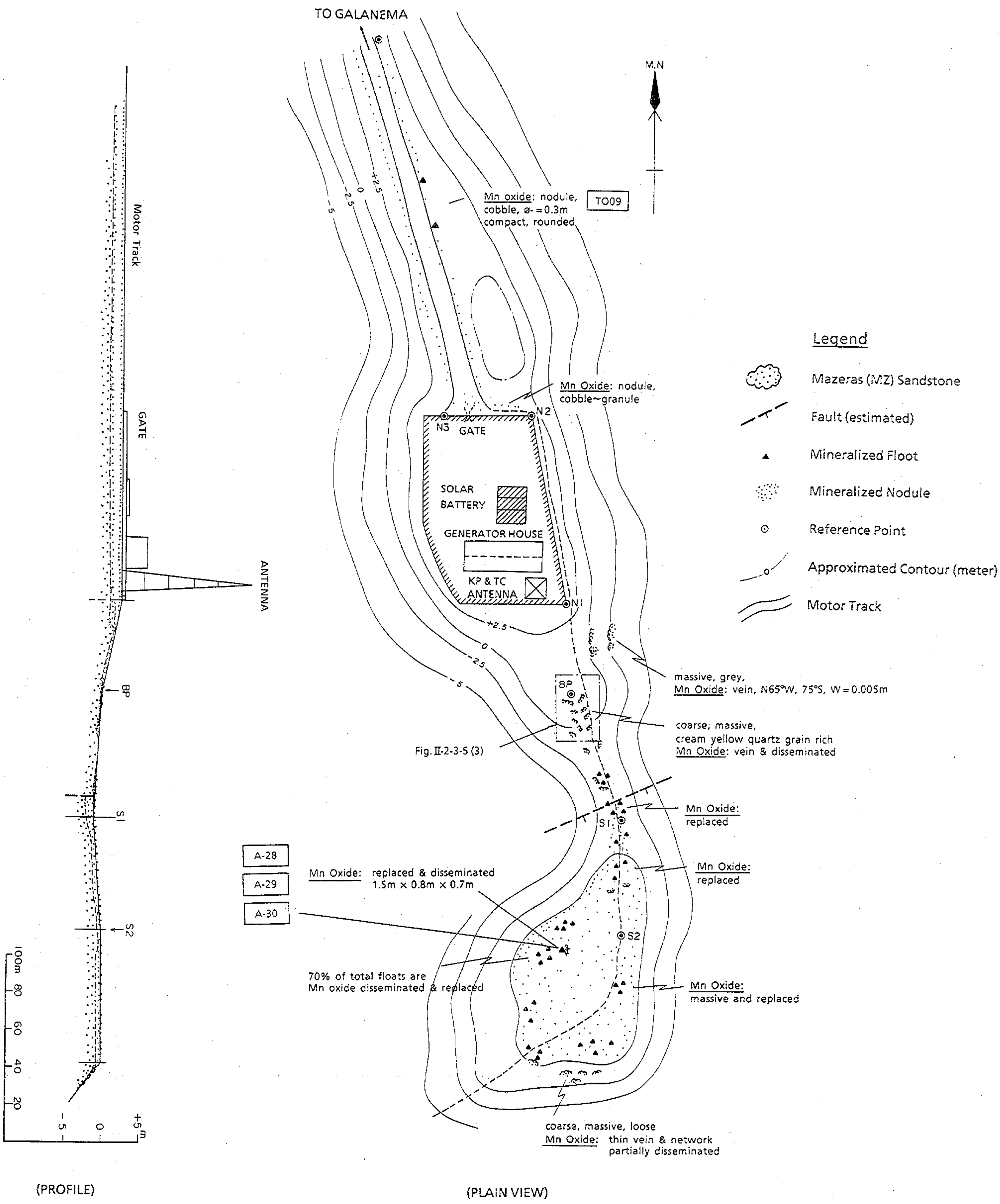


Figure II-2-3-5 (2) Geological Sketch Map and Profile of the Kiwara Hill South

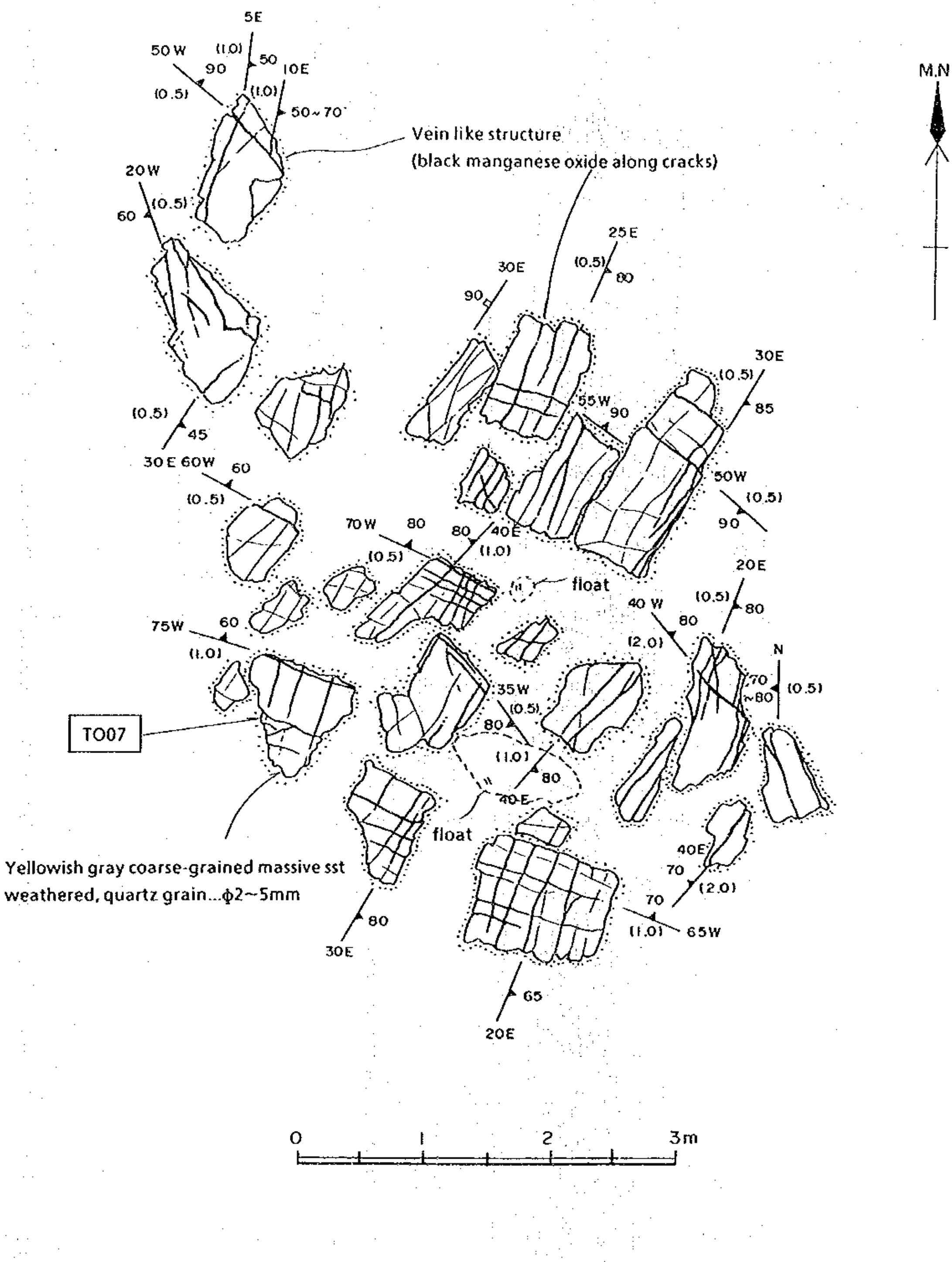


Figure II-2-3-5 (3) Geological Sketch of Mn-OxideOccurrences on the Kiwara Hill South

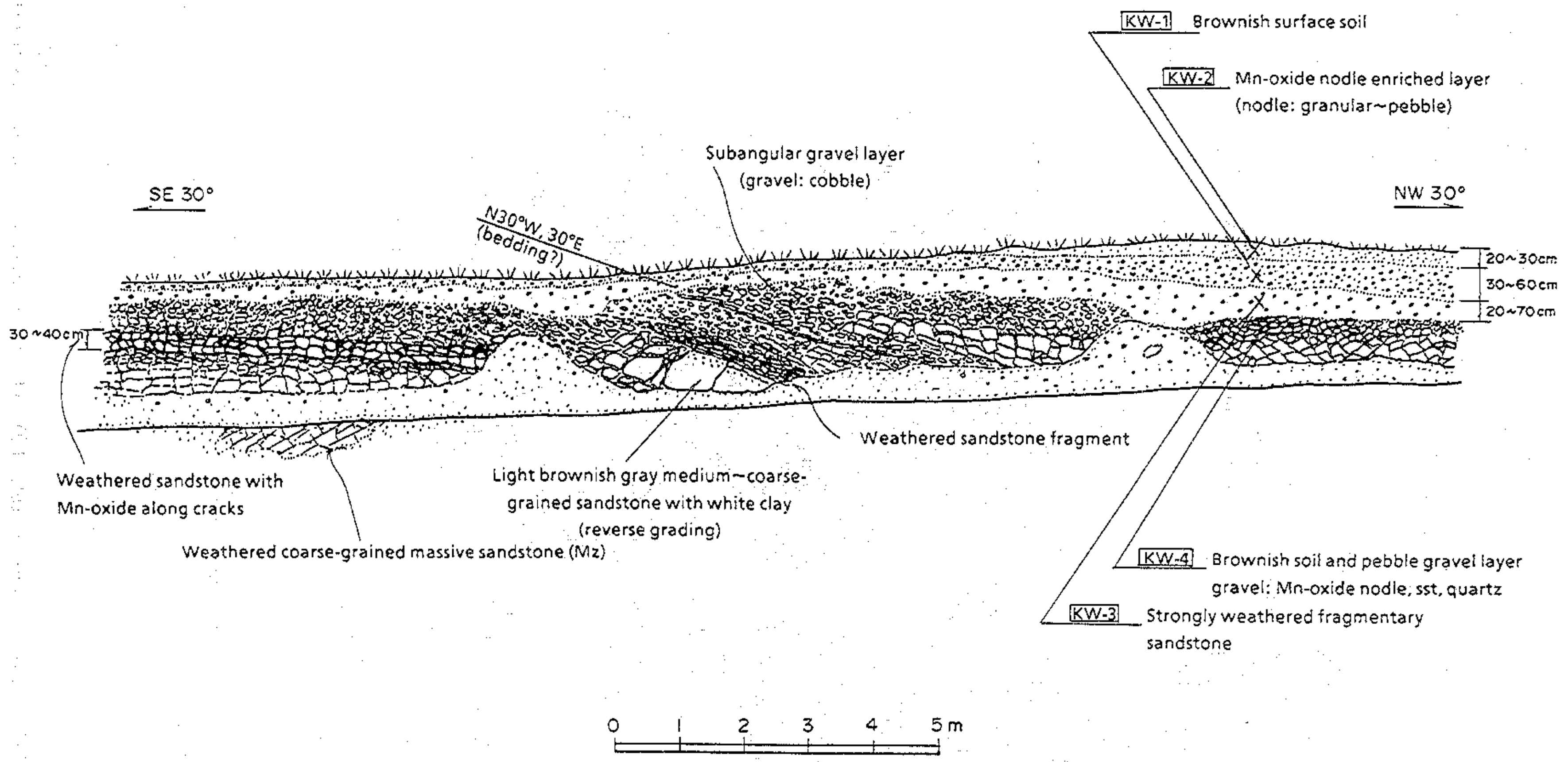


Figure II-2-3-5 (4) Geological Sketch of Mn-Oxide Occurrences on the Kiwara Hill North (Along the Motor Track)

(6) Goshi Area

(A) Location, Access and Topography

(i) Location and Access

The Goshi area is situated about 70 km north-northwest of Mombasa or about 50 km west-northwest of Kilifi.

The Goshi area is accessible from Mombasa by driving on the all weather road Nairobi-Mombasa to Mariakani, and northward from Mariakani on the Mariakani-Bamba road to Bamba for about 40 km. A gravel road leads to ore showing from Bamba northwesterly for a distance of about 20 km.

(ii) Topography

The Goshi area is located in the "Nyika" explicated by Gregory, J.W. (1896). General topography in the area is mostly featureless. The Kisusu Hill, which has a relative height of approx. 100 ft (approx. 30 m) from the bottom of the Hill and is approx. 300 m in diameter at its bottom, is located in the northwestern part of the area. Low lands are developed along the Goshi River which flows across the northwestern part of the area.

(B) Existing Geological Studies and Current Situations

(i) Existing geological studies

Existing geological informations, available are; Geological Sheet: Mid-Galena Area, 1 to 125,000 scale, by Sanders, L.D. (1959) and Geological Sheet: Mapotea 1 to 50,000 scale, by Gelogical Survey of Kenya (1981).

Geochemical research works, composed of soil sampling and examination of geochemical anomalies for lead, zinc, copper, barium, manganese and etc, were implemented in the area by British Technical Cooperation Project (1979-1982).

Geological and mineralogical information of the ore showings and ore bodies in are so far hardly available.

(ii) Current situations

A barite ore body in the area is currently being operated by open pit mining using man-powered hand digging. The barite ore body for mining is of an eluvial type formed by weathering of barite ore veins.

(C) General Geology and Mineralization

A geological map and geological cross-sections are shown in Figure II-2-3-6 (1), a geological sketch map in Figure II-2-3-6 (2), and sketches of ore showings in Figure II-2-3-6 (3).

(i) General geology

General geology in the area consists of lower member of the Maji ya Chumvi Formation, correlated to Upper Permian age, and middle member of the Maji ya Chumvi Formation, correlated to Lower Triassic age.

The lower member of the Maji ya Chumvi Formation mainly consists of an alternation of sandstone, siltstone and shale, intercalated by thin beds of limestone and limestone pebbles. This limestone is only observed in the Kisusu Hill in the northwestern end of the area. The overlying middle member of the Maji ya Chumvi Formation majorly consists of an alternation of shale and siltstone intercalated by thin sandstone beds. Fossils of fishes and nodules are contained shale beds at the lowermost middle member.

No significant lineaments or fault structures have been recognized in the area.

(ii) Mineralization

The mineralization is represented by occurrences of barite ore bodies, vein type, in shale and siltstone. Detail geology of old working pits is hard to be recognized because most of the old workings are now burried or collapsed. However, it appears that the ore veins ever mined generally strike N 57° to 60° E, dipping 75° to 80° to NW are, around 0.8 m wide in average and, composed of milky white barite as shown in Figure II-2-3-6 (3). Mode of wall rock alteration shows weak to middle silicification and weak argillization. Wall rocks are heavily fractured. A sample of black to brownish black, fine quartz veins, associated with barite ore bodies, yielded less than 0.5 g/t Ag, 0.59% Ba, 0.03% Pb, 0.07% Zn, 15.10% Fe and 10.50 % S.

(D) Examination

A barite ore deposit of eluvial type, directly overlying the surface exposure of the primary ore bodies, is currently being mined by man-powered hand-digging (Figure II-2-3-6 (3)). A barite veins, of about 1 m wide, may have been remained underneath the current workings. An implementation of techno-economical evaluation for the primary barite ore body in future may be warranted.

The above mineralization is located 35 km west of the major mineralization zone along the so-called Karroo-Jurassic Boundary Fault.

The results of the chemical analysis and the microscopic observation of thin sections of quartz-barite ore samples indicated that associated iron oxide minerals might have been derived from metallic sulphides.

There may be a possibility that additional mineralized zone which is to the known mineralized zone along the Karroo-Jurassic Boundary Fault.

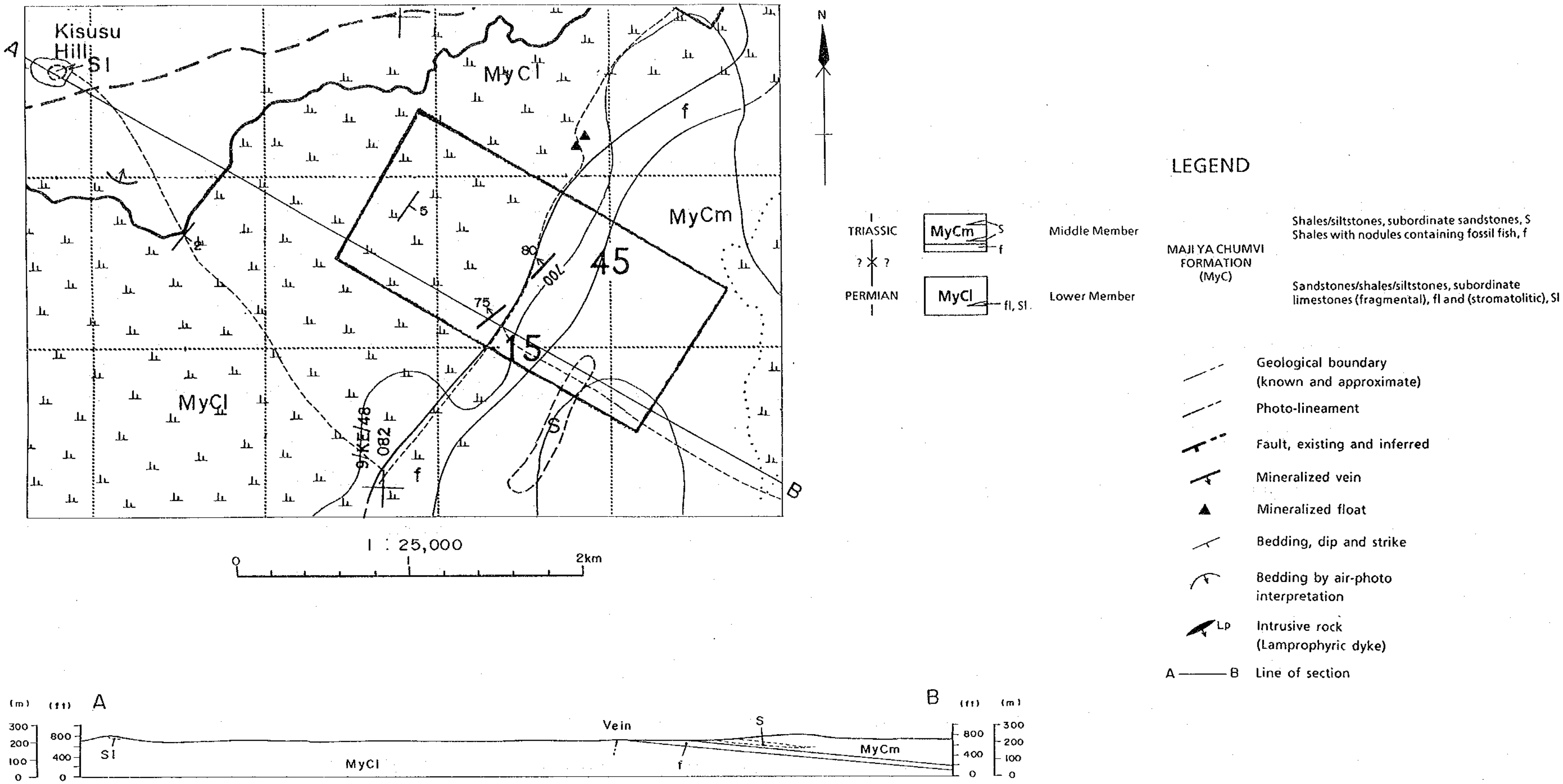


Figure II-2-3-6 (1) Geological Map of the Goshi Area

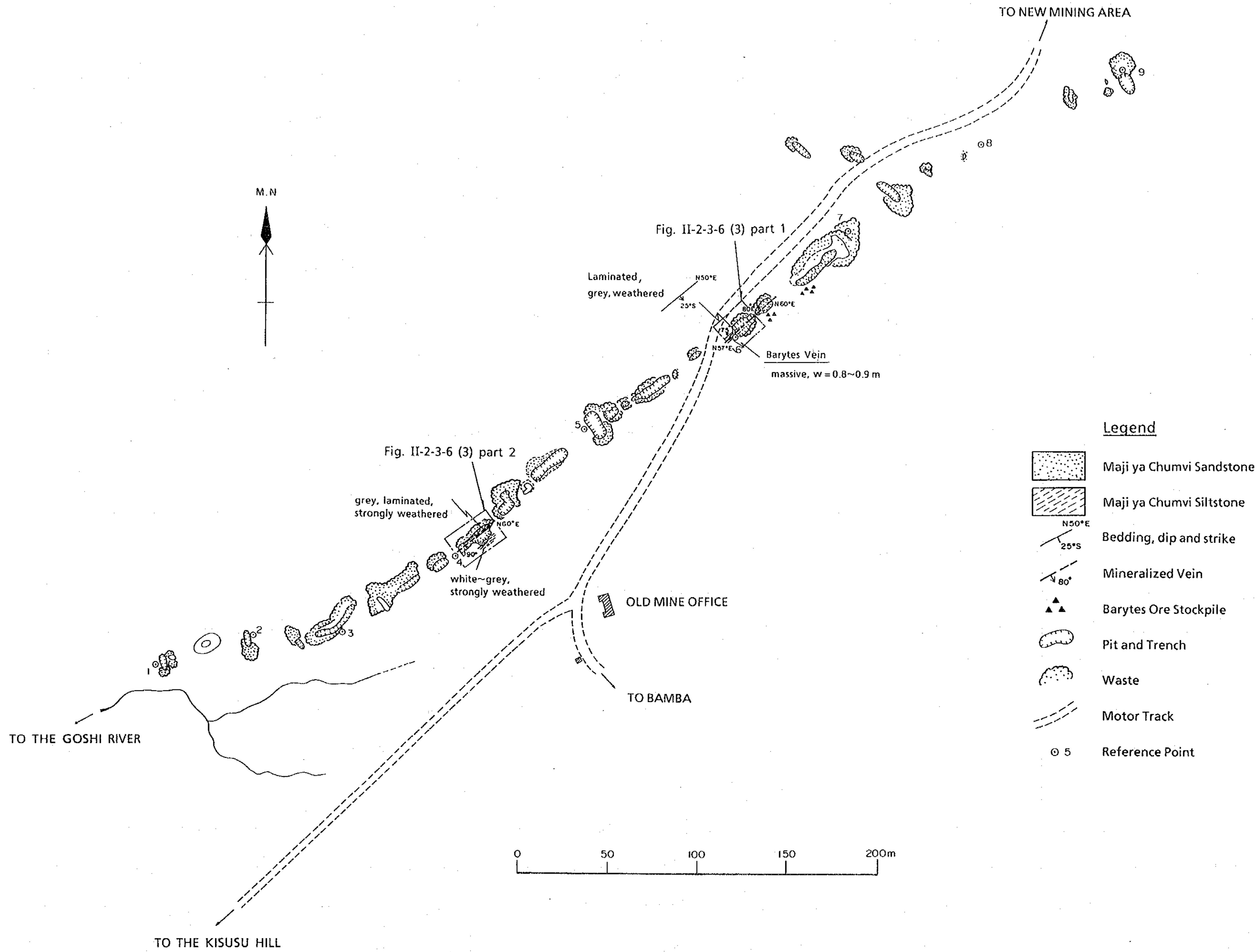


Figure II-2-3-6 (2) Geological Sketch Map of the Goshi Area

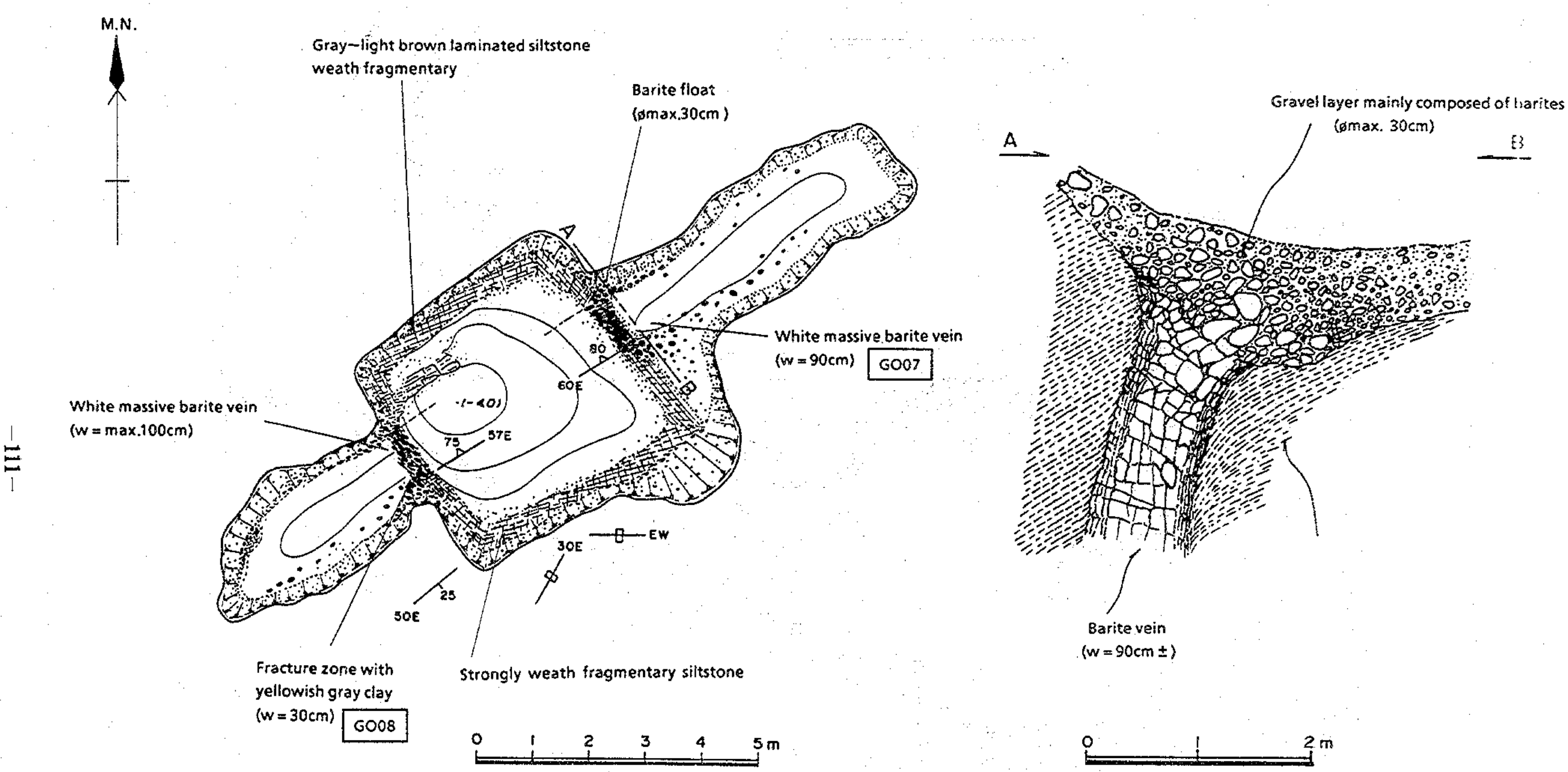


Figure II-2-3-6 (3) Geological Sketches of the Eluvial Barytes Deposit and Old Mining Pits (Part 1)

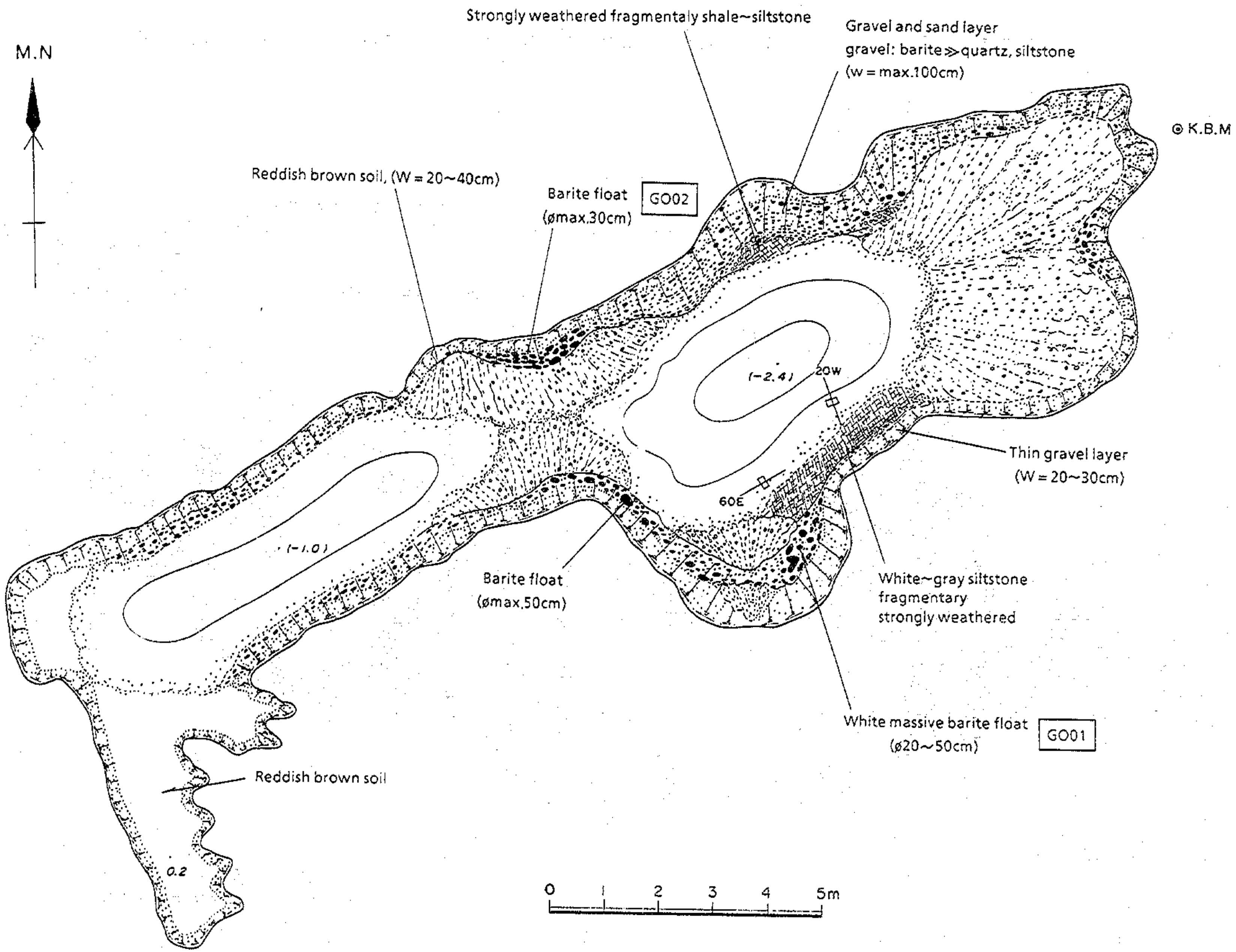


Figure II-2-3-6 (3) Geological Sketches of the Eluvial Barytes Deposit and Old Mining Pits (Part 2)

(7) Chang'ombe Area

(A) Location, Access and Topography

(i) Location and Access

The Chang'ombe area is situated approx. 15 km north-northwest of Mombasa. This area is accessible from Mombasa by driving westward to Mazeras on Nairobi-Mombasa all weather road for 18 km and northward from Mazeras to Chony Village on Kaloleni-Mazeras road for 8 km. Ore showings of Chang'ombe North, is located 3 km away from Chony Village via Batani Village. 2 km south southwest of Chony south-southwesterly.

(ii) Topography

The Chang'ombe area is located in the "Coastal Range" explicated by Gregory, J.W. (1896) and Caswell, P.V. (1953) and shows relatively an undulated topography. The Beguro river and its tributaries flow in the central to southeastern parts of the area to form a flat low land, meanwhile, a mountainous or high land is developed in the northern to western parts of the area. Altitude difference between the high and low lands reaches approx. 400 ft (approx. 120 metres). The ore showings, Chang'ombe North, is located on a relatively steep slope from the high land to low land, and extends in the direction of roughly north-south.

(B) Existing Geological Studies

Existing geological informations available for the Chang'ombe area are; Geological Sheet: Kilifi-Mazeras Area, 1 to 125,000 scale, by Caswell, P.V. (1956) and Geological Sheet: Mazeras 1 to 50,000 scale, by Geological Survey of Kenya (1981).

Rainey, T.P. (1970) and Clarke (1970) examined local geology and geological structures.

Geochemical exploration works in the area were implemented in 1967 by Dodhia, S.A. and three anomalous zones of lead-zinc were specified (Macdonald, A.S. (1967)). British Technical Cooperation Project (1977-1980) implemented geochemical exploration, composed of stream sediment sampling and examination of geochemical anomalies for lead, zinc, copper, barium, manganese, molybdenum and vanadium.

Caswell, P.V. (1956) reported occurrences of mineralized showings in non-metamorphosed sediments including at 15° dip toward the sea-shore. Clarke M.C.G. (1969, 1970) and Rainey, T.P. (1970) reported a comprehensive research results of the ore bodies in the area and examined the relations between ore deposits and geochemical anomalies.

Diamond drilling exploration for the ore showings and geochemical anomalies in the area were implemented in 1968-1970. Veins and networks of quartz, accompanying sphalerite and galena in sandstone beds of the Mazera Formation, and also disseminated stratiform mineralization, were specified by the works.

(C) General Geology and Mineralization

Geological map and geological cross sections in the area are shown in Figure II-2-3-7 (1).

(i) General geology

General geology in the area consists of the middle and the upper members of the Mariakani Formation, the middle and the upper members of the Mazeras Formation, the lower and the middle members of the Kambe and the Mtomkuu Formations in ascending order.

The middle member of the Mariakani Formation generally consists of medium-grained sandstone with relatively large-scaled cross-beddings, carries a thin shale or siltstone bed at the base and is correlated to Middle Triassic age. Upper member of the Mariakani Formation mainly consists of yellowish brown to brown sandstone, medium- to coarse-grained and is correlated to Upper Triassic age.

The middle member of the Mazeras Formation mainly consists of loose, coarse-grained and grayish white, and well-cross-bedded sandstone. The upper member of the Mazeras Formation mainly consists of relatively flaggy, medium-grained and grayish white sandstone. The middle and upper members of the Mazeras Formation are correlated to Lower Jurassic age.

The Kambe Formation, correlated to Middle Jurassic age mainly consists of limestone with öolitic texture and small pebbles 0.3 to 3 cm in diameter.

The Mtomkuu Formation, the uppermost layer in the area, majorly consists of an alternation of shale, siltstone and sandstone with an abundant number of limestone-sandstone pebbles at the base. The middle member of Mtomkuu Formation correlated to upper Jurassic age mainly consists of shale.

Rock exposures are very limited in the area. Strikes of beddings appear to run in the direction of NW-SW, with dips about 5° to NE, in general.

There are 2 trends of fault structures; one trends in the direction of NE-SW, older than the other, trending in the direction of E-W. A lead-zinc mineral occurrence, which has been outlined by the geochemical prospecting and followed up by occurrence diamond drilling, is considered to be closely related to the brecciated zone associated with a NNW trending fault.

(ii) Mineralizationn

The ore showings in the area are observed at 2 locations, Chang'ombe North and Chang'ombe South (Figure II-2-3-7 (1)). Because outcrops of the showings are extremely limited on the surface, geological characteristics of the mineralization have to be estimated by observation of ore floats and soil as well as the results of diamond drilling. The area of the showings are composed of sandstone beds of the Mazeras Formation, which are coarse-grained, reddish brown to yellowish white, and intensely fractured by fault activities.

The ore showings are of vein type, composed of quartz veins or vein stockworks, associated with mainly hematite and goethite and minor calcite and barite (Rainey, T.P. (1970)). Their wall rocks, coarse-grained sandstone beds of the Mazeras Formation, are intensely fractured and brecciated in parts, and silicified and argillized to some extent.

The results of chemical analysis for 3 samples collected from quartz fine veins in Chang'ombe North in silicified sandstone, grayish white and associated with a small amount of montmorillonite, indicated the maximum values of 0.05% Pb, 0.01% Zn and 17.5 to 43.5 g/t Ag.

In the Chang'ombe South prospect, where geochemically anomalous zones are located in reddish brown to brown soils, the result, of chemical analysis of soil samples are 1 g/t Ag, 0.20% Pb, 0.04% Zn, 720 ppm Ba, 4.54% Fe, 3,100 ppm Mn and 8.53% Al in average.

In addition to the above mineralization, it has been reported that a past diamond drilling exploration encountered disseminated stratiform mineralization of sphalerite-galena-quartz (Rainey, T.P. (1970)). This type of mineralization, if any, may well cause a wide spread geochemical anomaly.

There has been observed no evidence of igneous activities obviously related to the mineralization.

(D) Examination

Two types of mineralization, vein type and stratiform type, have been specified in the Chang'ombe area by the previous diamond drilling and by the current works. Any of the ore bodies apear to be attractive in sizes and grades for future exploitation. However, may be worthwhile to note that similar type of mineralization is known in the neighbouring Mwachi River (Tributary) area.

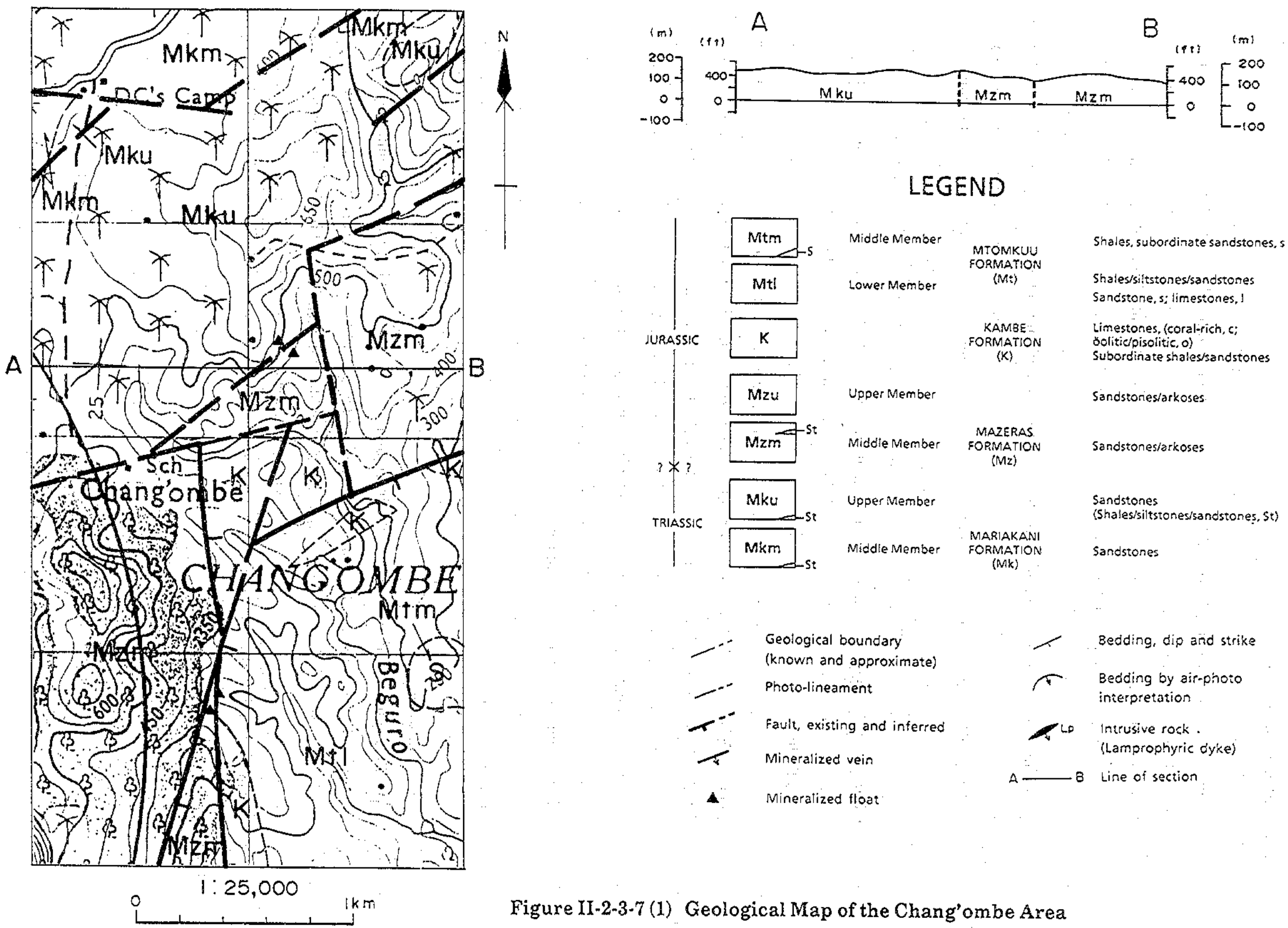


Figure II-2-3-7 (1) Geological Map of the Chang'ombe Area

(8) Mwachi River (Tributary) Area

(A) Location, Access and Topography

(i) Location and Access

The Mwachi River area is situated approx. 15 km northwest of Mombasa. The area is accessible by driving from Mombasa on Nairobi-Mombasa all-weather road for 13 km to Mazeras Water Pipeline Station. The ore showings in the area are about 2 km apart from the staffs residence of Kenya Railways 800 metres off the pipe line station.

(ii) Topography

The Mwachi River area is situated in the "Coastal Range" explicated by Gregory, J.W. (1896) and Caswell, P.V. (1953). General topography in the area is frequently undulated, caused by many tributaries of the Mwachi River particularly an escarpment up to 30 m high, is formed due to erosion by the Mwachi River. The altitude in the area ranges between 250 and 650 ft or 75 to 195 m above sea level. Hilly lands are widely developed in the northern to northeastern part of the area, while low lands in the southern to southwestern part. All the ore showings in the area are observed on the relatively flat river bottom.

(B) Existing Geological Studies

Existing geological informations publicly available are; Geological Sheet: Kilifi-Mazeras Area, 1 to 125,000 scale, by Caswell, P.V. (1956), and Geological Sheet: Mazeras, 1 to 50,000 scale, by Geological Survey of Kenya (1981). Detailed geological studies by Mloszewski M.J. in 1960s with maps, 1 to 5,000 scale, in which the interpretations of fault-fissure systems are elucidated, is also available.

Geochemical research works were initially carried out in the area by Mloszewski, M.J. in 1960s to examine highly anomalous zones of lead and zinc. The works were followed by the British Technical Cooperation Project (1977-1980) by stream sediment geochemistry to examine anomalous zones for lead, zinc, copper, barium, manganese, molybdenum and etc.

Ore showings in the area were initially specified by Caswell, P.V. (1952). It has been reported by Mloszewski, M.J. (1966) that lead-zinc mineralizations in the area are under the structure control by fault fracture zone in the direction of northeast-southwest, and a single vein of ore body is some one feet (0.3 metre) thick with roughly vertical dip.

Diamond drilling for geochemical anomalous zones in the area was implemented in 1967-1970 to elucidate that the mineralizations occur in coarse-grained sandstone-siltstone beds of the Mazeras Formation, and are composed of veins and stockworks of sphalerite, galena and calcite, meanwhile, mineralizations of dissemination-stratiform types are separately observed (Rainey, T.D. (1971)).

(C) General Geology and Mineralization

Geological map and geological cross section are shown in Figure II-2-3-8 (1), geological sketch map is in Figure II-2-3-8 (2) and geological sketches of ore showings are Figure II-2-3-8 (3).

(i) General geology

General geology in the area consists of the lower, middle and upper members of the Mariakani Formation, the middle member of the Mazeras Formation and the Kambe Formation in ascending order.

The middle and upper members of the Mariakani Formation are correlated to Upper Triassic age. The lower member of the Mariakani Formation consists of medium-grained sandstone with well-developed mottle. The middle member of the Mariakani Formation consists of medium- to coarse-grained sandstone, well-cross-bedded, meanwhile, upper member of the Mariakani Formation consists of medium- to coarse-grained sandstone, brown to yellowish brown.

The middle member of the Mazeras Formation consists of massive and loose sandstone, coarse-grained and yellowish white to grayish white, has a horizon where it yields silicified wood fossils and is correlated to Lower Jurassic age.

Kambe Formation mainly consists of limestone, partially intercalated by thin beds of calcareous sandstone and shale, and is correlated, by yielding ammonitoid fossils in limestone bed, to Bajocian to Bathonian stage of Middle Jurassic age.

(ii) Mineralization

Mineralization in the Mwachi River (Tributary) area is specified by showing of vein type and fine veins stockwork type, mainly composed of calcite and minor quartz accompanying sphalerite, galena, minor chalcopyrite, pyrite and marcasite. Wall rocks are composed of brecciated siltstone and sandstone, grayish green, and have been subjected to weak to middle silicification.

A considerable lateral extension of disseminated sphalerite and minor galena, occurring in coarse-grained sandstone of the Mazeras Formation, was specified by the previous diamond drill works (Rainey, T.P. (1971)). However, this type of mineralization is hardly discernible on current ground surface.

Four outcrops of ore veins and fine vein stockworks are observed in the tributary area of the Mwachi River as shown in Figure II-2-3-8 (2). The outcrop of an ore vein in the uppermost stream strikes NE 30° and dips vertically dipped, and has a width ranging 1 to

5 cm wide. Several numbers of veins of galena-sphalerite-calcite are observed, associated with yellowish brown limonite - mixed clay with widths of 0.2 to 0.8 m in brecciated sandstone-siltstone bed (Figure II-2-3-8 (3)). A sample of the former vein yielded assay results of 90 g/t Ag, 18.00% Pb in total (14.9% non-sulfide Pb), 0.04% Zn in total (0.02% non-sulfide Zn) and 3.79% S. The assay results of a sample of the latter ore veins, indicated 340 g/t Ag, 21.8% Pb in total (19.1% non-sulfide Pb), 10.6% Zn in total (3.25% non-sulfide Zn) and 7.45% S.

An ore vein from the outcrop of the downstream area, composed of galena-sphalerite-calcite, 5 cm wide, indicated assay results of 52 g/t Ag, 11.50% Pb in total (0.63% non-sulfide Pb) and 6.45% Zn in total (0.10% non-sulfide Zn).

The mineralization in the Mwachi River (Tributary) area is summerized to be of zinc-lead-silver ore body, vein and/or dissemination types, composed of sphalerite and silver-bearing galena.

The lead age dating values of galena by two specimen, collected from the ore outcrop in uppermost part of a tributary of the Mwachi River, show 214.3 Ma and 229.7 Ma, respectively, which are to be estimatedly correlated to Upper Triassic age (Appendix-Ⅵ).

(D) Examination

Geochemical anomalous zones, shown by zinc and lead, were initially specified by the previous geochemical research works, which were followed by diamond drill works to intersect zinc-lead-silver mineralization of stratiform type underneath the anomalous zones in the Mwachi River (Tributary) area.

Contemporarily with the above achievement, a similar type of mineralization to that in the Mwachi River (Tributary) area was also specified in the neighbouring Chang'ombe area. Howerver any geological follow-up research work has never been done because the mineralization in Chang'ombe area has not been appreciated in its possibility for economical exploitation.

The mineralization in the Mwachi River (Tributary) area has ever been insufficiently explored laterally and downward to date. An implementation of a ground geophysical research, e.g. an electrical method, together with detailed geological mapping and geochemistry, may be warranted in future for this area and the Chang'ombe area.

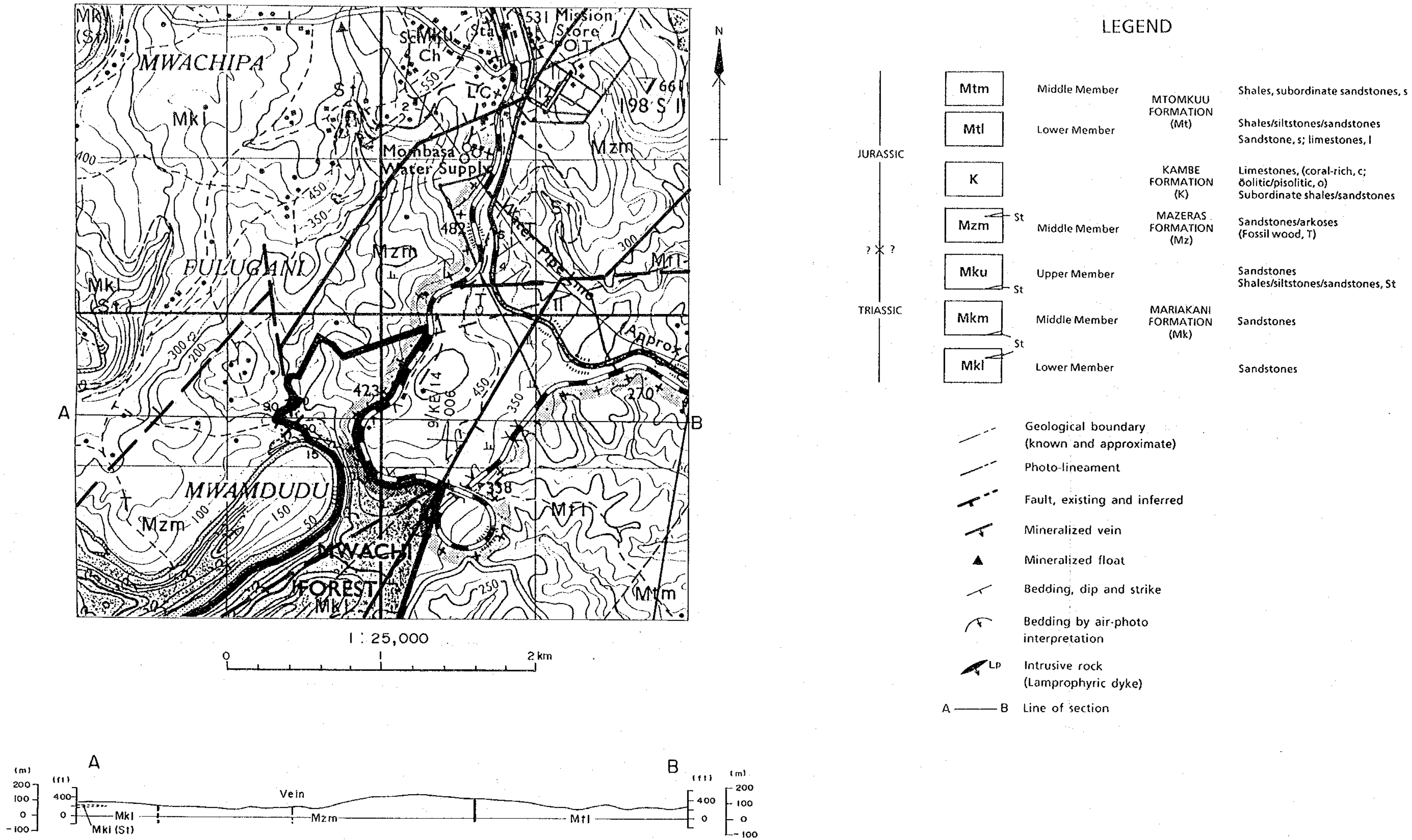


Figure II-2-3-8 (1) Geological Map of the Mwachi River (Tributary) Area

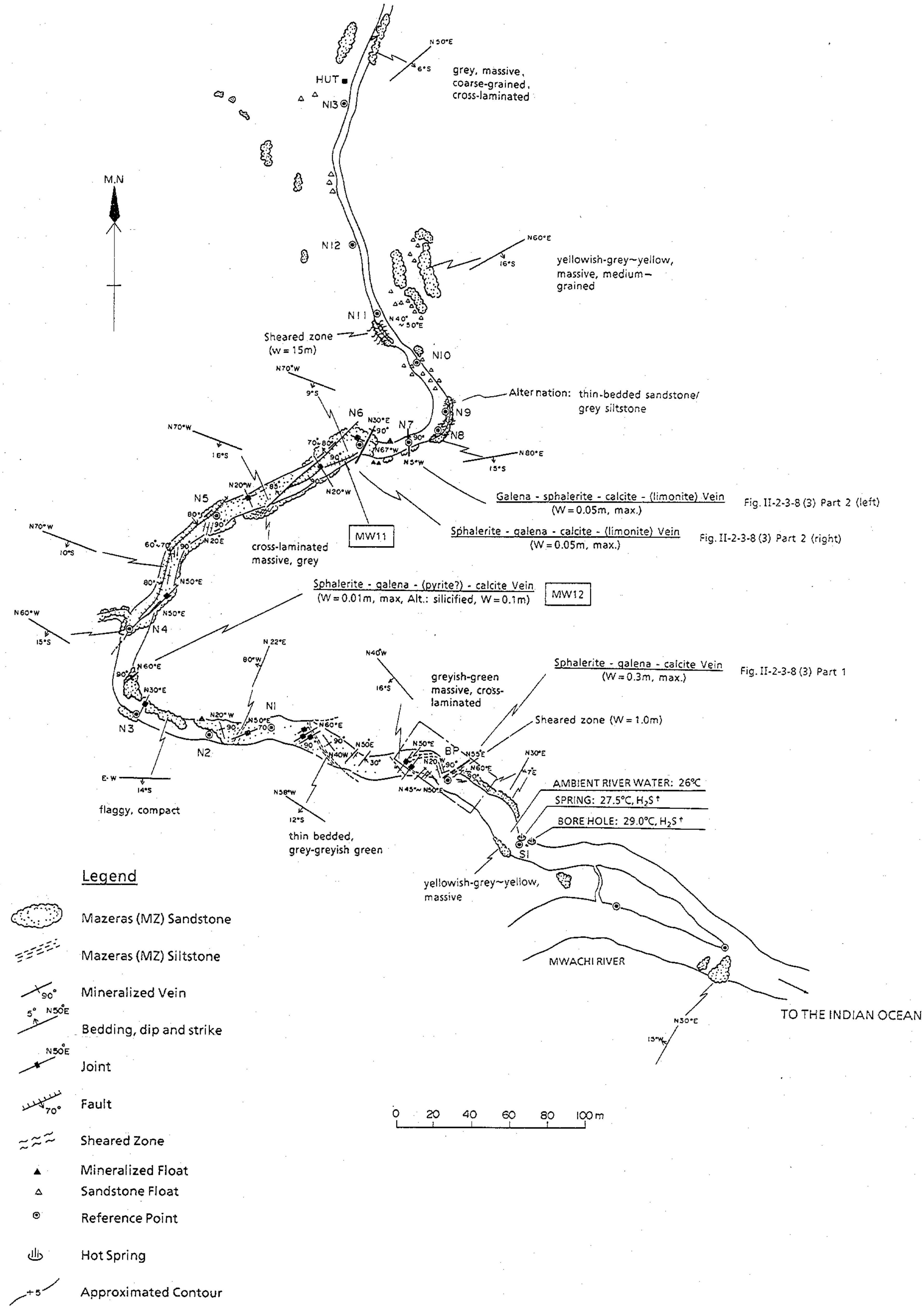


Figure II-2-3-8 (2) Geological Sketch Map of the Mwachi River (Tributary) Area

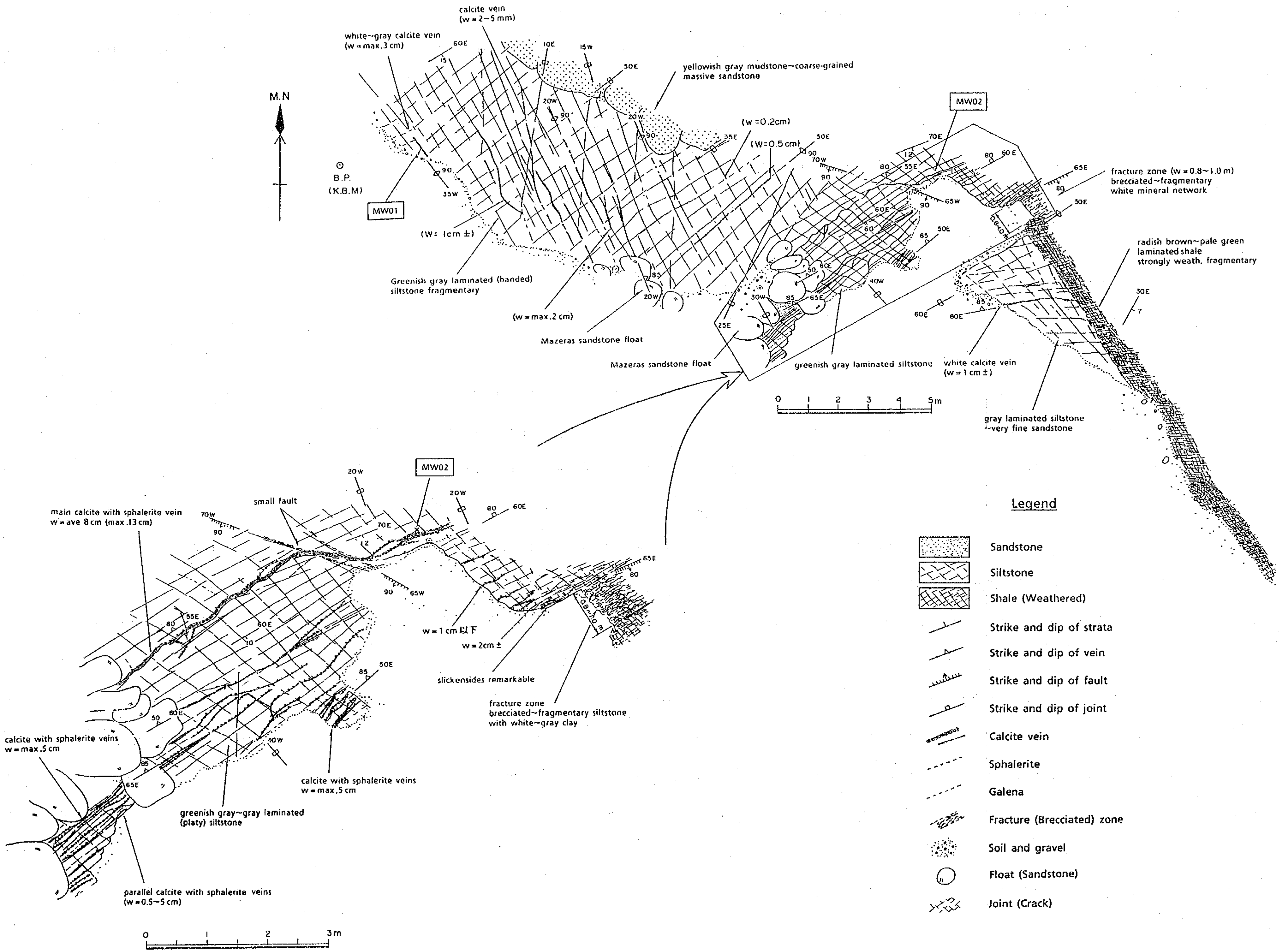
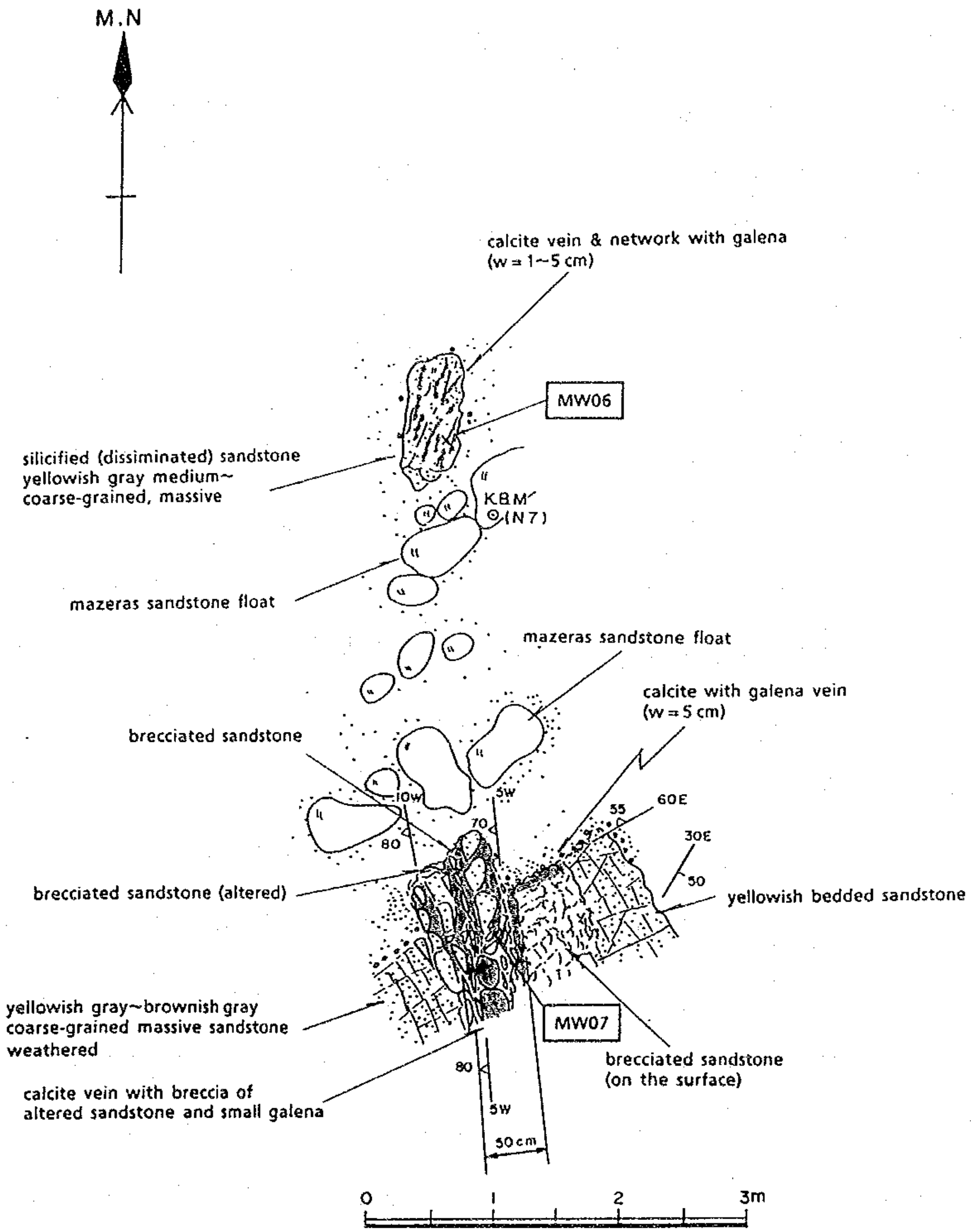


Figure II-2-3-8 (3) Geological Sketches of Mineral Showings along the Mwachi River (Tributary) Area (Part 1)



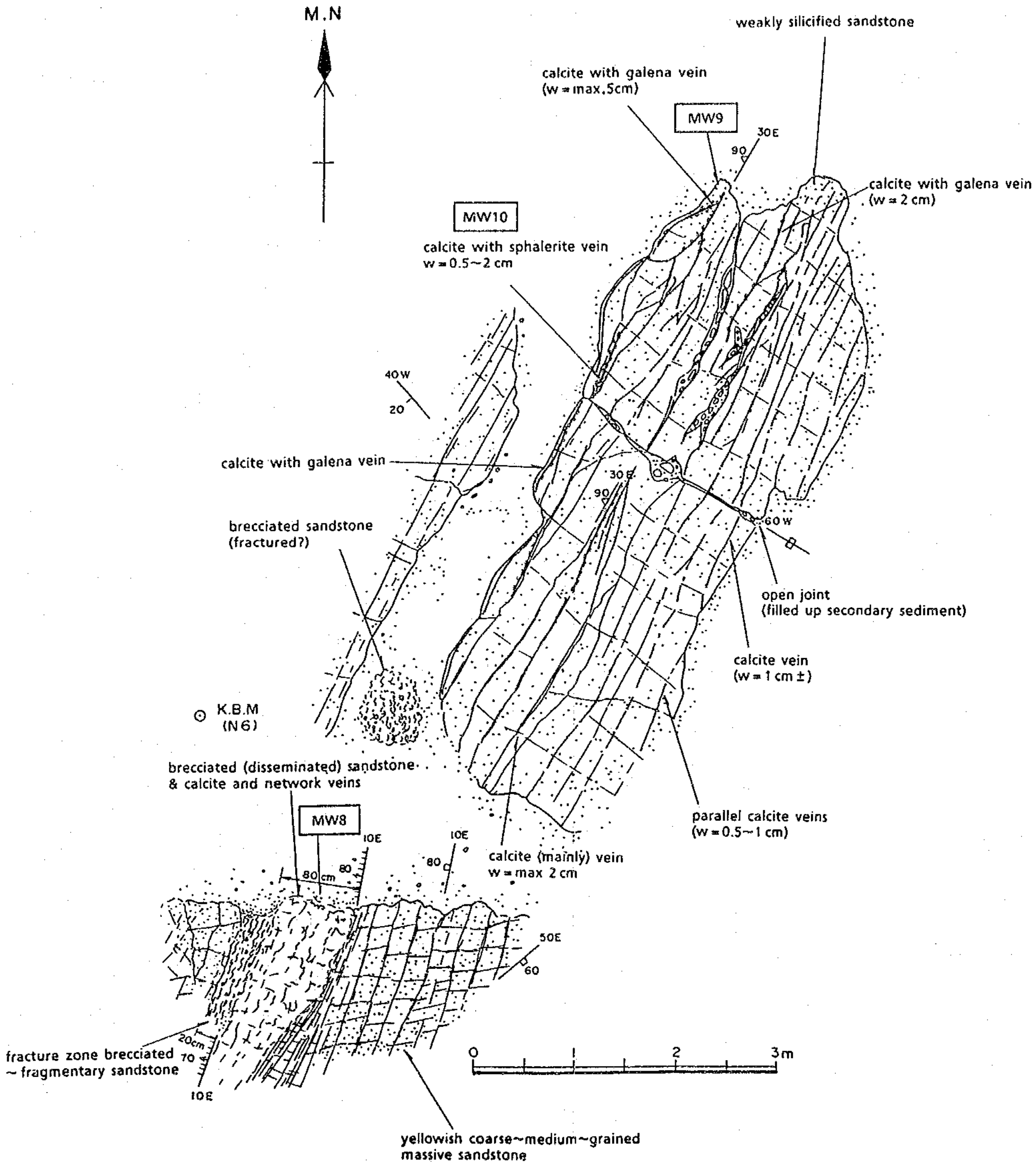


Figure II-2-3-8 (3) Geological Sketches of Mineral Showings along the Mwachi River (Tributary) Area (Part2)

(9) Mkundi Area

(A) Location, Access and Topography

(i) Location and Access

The Mkundi Area is situated approx. 60 km southwest of Mombasa, and 30 km west-northwest of Msambweni. The area is accessible by driving southward from Mombasa on the all-weather road Mombasa = Lunga Lunga to Msambweni, from Msambweni to Nguluk on the Msambweni-Nguluku road for 12 km. The ore mineral showings, Mkundi North, are reached by driving from Nguluku southwestward across the Choro Choro River for 2.5 km, via Kichakashimba and Lukore.

(ii) Topography

The Mkundi area is situated in the "Nyika" explicated by Gregory, J.W. (1896).

The Ramsi River along which low lands are developed, flows down easterly in the central part of the area. Hilly lands are formed in the northern and southern parts.

The ore mineral showings are located in two basins (200~250 m in diameter) in the northern bank of the Ramsi River and called Mkundi North and Mkundi South, which are 0.6 km apart from each other and align in the NNE-SSW direction. Several numbers of similar basins are observed in the southern bank of the Ramsi River as well.

(B) Existing Geological Studies

Existing geological informations publicly available are; Geological Sheet: Mombasa-Kiwara Area, 1 to 125,000 scale, by Caswell, P.V. (1953), and Geological Sheets Msambweni and Ndavaya 1 to 50,000 scale by Geological Survey of Kenya (1985). Geological Map, 1 to 25,000 and 1 to 50,000 scales, by Kenya-Austria Mineral Exploration Project (1977~1987) is also publicly available.

Geochemical research works by stream sediments in the area were implemented by the above Kenya-Austria Mineral Exploration Project (1973-1977) and geochemical anomalous zones for lead, copper, zinc, barium, silver, mercury, chromium, nickel and etc., were examined.

Geological summaries of the ore showings in the area are reported in the reprt by Kenya-Austria Mineral Exploration Project (1977~1978).

(C) General Geology and Mineralization

A geological map and geological cross-sections in the Mkundi area are shown in Figure II-2-3-9 (1), gelogical sketch map is in Figure II-2-3-9 (2) and geological sketches of ore showings are in Figures II-2-3-9 (3) and (4).

(i) General geology

General geology in the Mkundi area mainly consists of the upper member of the Maji ya Chumvi Formation of Lower Triassic age, the lower member of the Mariakani Formation of Middle Triassic age and the middle member of the Mazeras Formation of Lower Jurassic age in ascending order. Intrusive alkaline rock dykes are also observed.

The upper member of the Maji ya Chumvi Formation consists of yellowish brown flaggy sandstone.

The lower member of the Mariakani Formation consists of medium-grained, yellowish white sandstone beds with well-developed mottles, intercalated by thin beds of siltstone and shale.

The middle member of the Mazeras Formation consists of arkose sandstone.

Alkaline intrusive rocks, specified to be of lamprophyric dykes, are observed in some ten localities in the area. The dykes are 0.5 to 3 m wide and are extended north-northeasterly to south-southwesterly along the fissures.

Lineaments and faults, in the north-northeast to south-southwest, the northeast-southwest and the northwest-southeast directions, are dominantly observed in the area on air photographs interpretations and verified by ground truth in the course of this year's campain. Active hot springs are associated with both the ore showing groups aligning in the NNE-SSW direction. There are more than 20 active hot springs which are gushing hot water of high temperature (upto 76°C) along fissures in the NNE-SSW direction. There are 4 piles of yellowish white, yellowish brown clayey travertine with hights of 3 to 4 m and diameters of 20 to 40 m in the Mkundi South basin where activity of the hot springs are very intense.

(ii) Mineralization

There are 2 groups of ore showings in the area, Mkundi North and Mkundi South.

The ore showings in Mkundi North is specified by having 2 types of mineralization as follows:

- Type 1 : quartz vein and fine veins stockwork, associated with galena, pyrite and minor cerussite as ore minerals and with some amount of barite and clay mineral as gangue minerals.
- Type 2 : quartz vein, 5 to 30 cm wide, and fine veins stockwork in silicified zone, associated with chalcopyrite, malachite and pyrite as ore minerals.

The former type is observed along the southern bank of a creek crossing the Mkundi North ore showing area and in the form of a stockwork pocket of quartz veinlets which is some 4 m wide, strikes northeast 5° to 10° and dips vertically as shown in Figures II-2-3-9 (2) and II-2-3-9 (3). However, it seems to be unlikely that this mineralization would extend further to the north or to the south.

The latter type occurs in a stockwork of quartz veinlets in a silicified zone developed along a fault which intersects and dislocates a NNE-SSW trending lamprophyric dike. The silicified zone is upto 5 m wide and traceable for more than 50 m in the northeastern part of Mkundi North ore showing area.

The ore showings in Mkundi South are associated with silicified zones accompanying stockworks of quartz veinlets. This type of mineralizatin has a similar feature to that of the 2nd type in Mkundi North, haviang a strike of NE 20° a width of 1 m, in a form of intrusion into lamprophyric dyke, striking northeast 30° as shown in Figure II-2-3-9 (4).

Euhedral pyrite, that are being formed by currently active hot spring water, are observed in the area. Hot spring water is weakly brackish with hydrogen sulfide gas stench, and is with 76°C in maximum (Figure II-2-3-9 (2)). A sample of white banded travertine in the Mkundi South yielded assay of 0.56% Ba, more than 1% Sr, 1.55% Mg and 18.90% Ca. This chemical character of hot water, being rich in alkali elements, might pose an implication of particular geological conditions of fluid passage.

The lead age dating value of galena specimen, collected from the galena-pyrite-quartz vein in Mkundi North, sample-numbered MK-17, shows 170.1 Ma, which is to be estimatedly correlated to Middle Jurassic age (Appendix-VI).

(D) Examination

The mineralization in this area occurs in association with geothermal spots currently active and consists of quartz veins or alteration zones accompanying copper and lead minerals of which were identified by microscopic observation and electron probe microanalysis during this year's study. There may be a very little possibility of gold-silver quartz mineralization because the maximum gold content was 6 ppb in a quartz vein and silver content, being usually proportional to lead content in galena, was 1 g/ton at its maximum in a quartz vein.

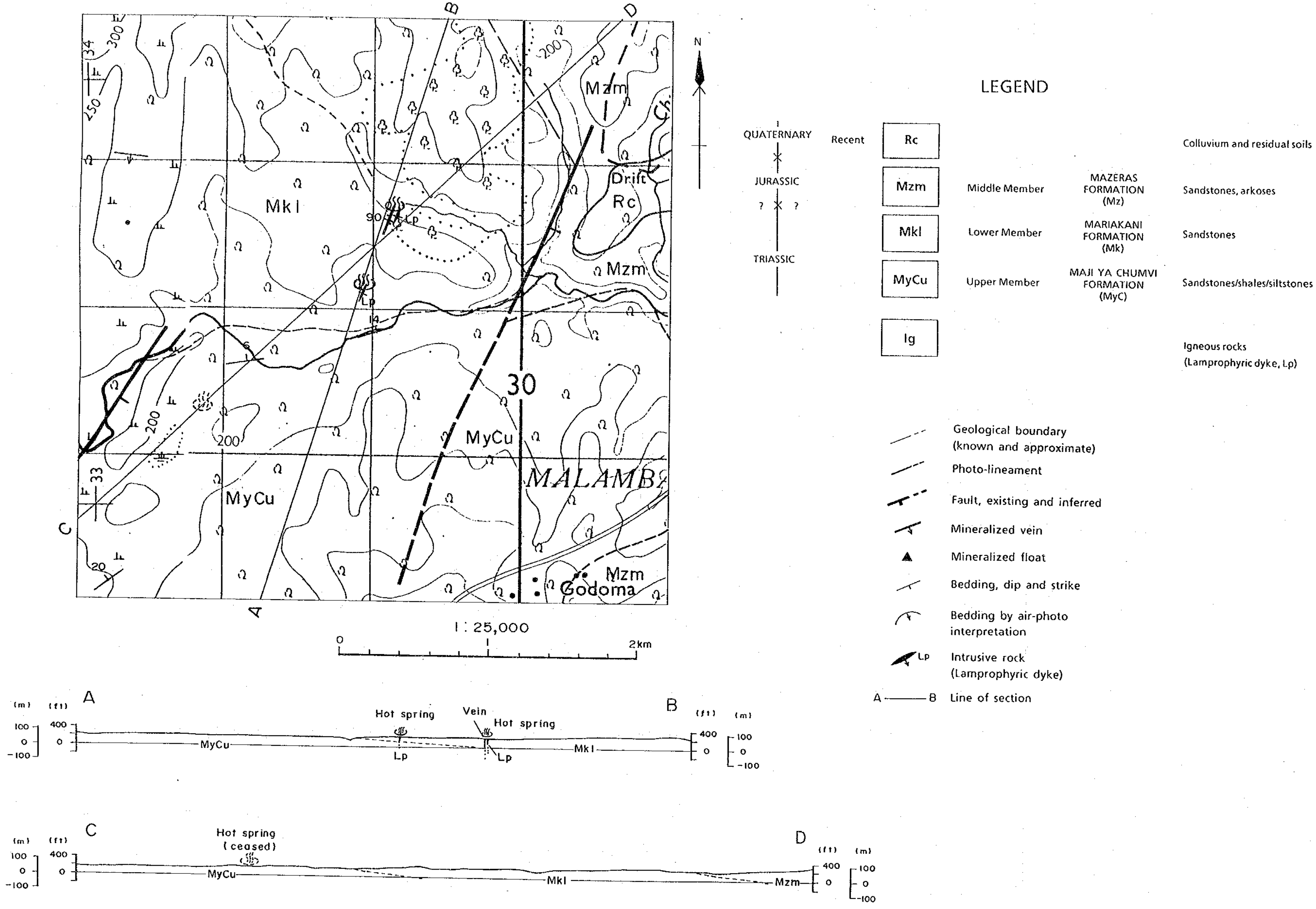
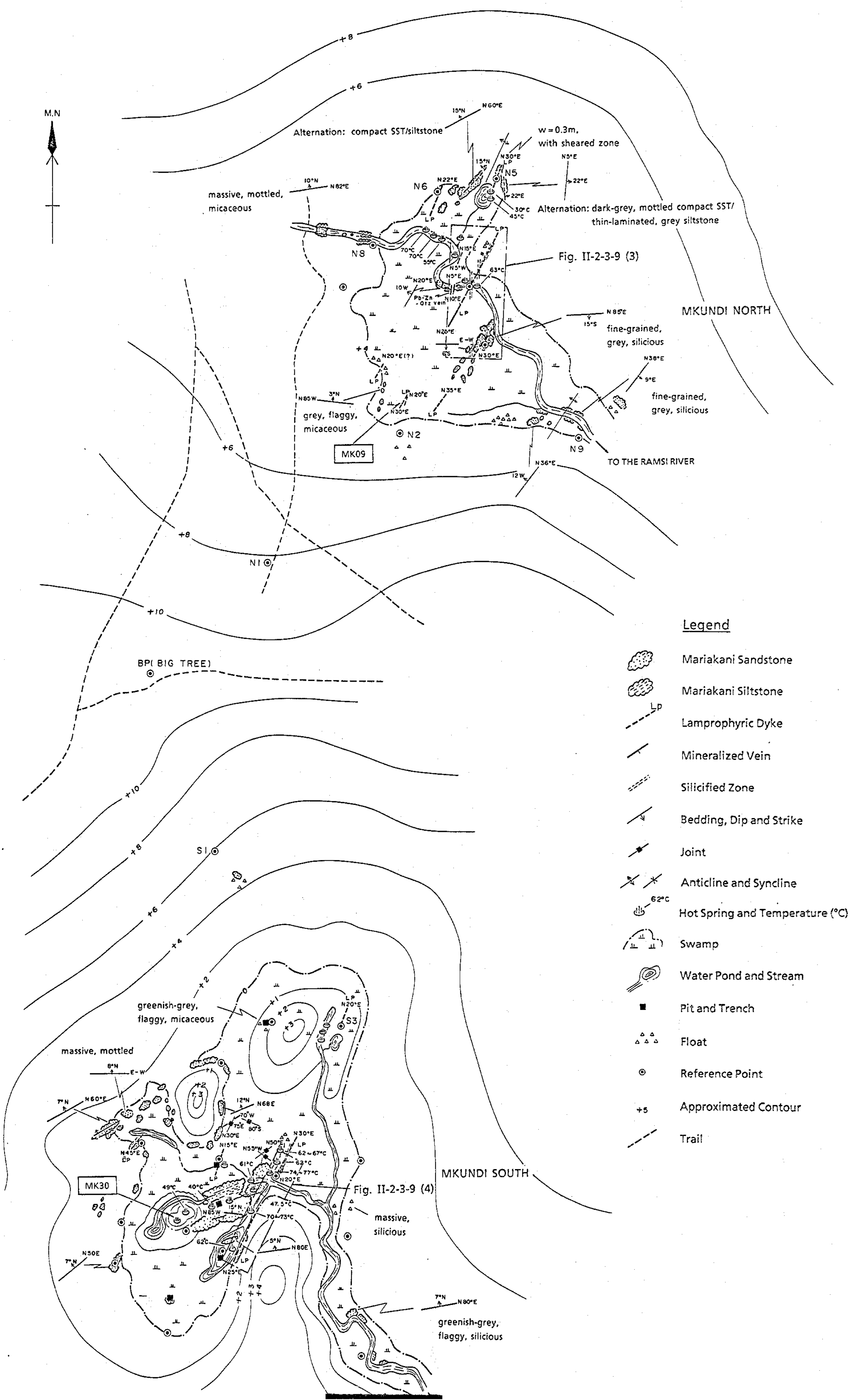


Figure II-2-3-9 (1) Geological Map of the Mkundi Area


M.N
Alternation: compact SST/siltstone
w=0.3m,
with sheared zone
massive, mottled,
micaceous
N6
N5
N8
Alternation: dark-grey, mottled compact SST/
thin-laminated, grey siltstone
Fig. II-2-3-9 (3)
MKUNDI NORTH
fine-grained,
grey, silicious
Pb-Zn
-Qtz vein
grey, flaggy,
micaceous
MK09
N2
N9
TO THE RAMSI RIVER
N1
BP(BIG TREE)
S1
S3
greenish-grey,
flaggy, micaceous
massive, mottled
MK30
MKUNDI SOUTH
Fig. II-2-3-9 (4)
massive,
silicious
greenish-grey,
flaggy, silicious
Legend
Mariakani Sandstone
Mariakani Siltstone
Lamprophyric Dyke
Mineralized Vein
Silicified Zone
Bedding, Dip and Strike
Joint
Anticline and Syncline
Hot Spring and Temperature (°C)
Swamp
Water Pond and Stream
Pit and Trench
Float
Reference Point
Approximated Contour
Trail

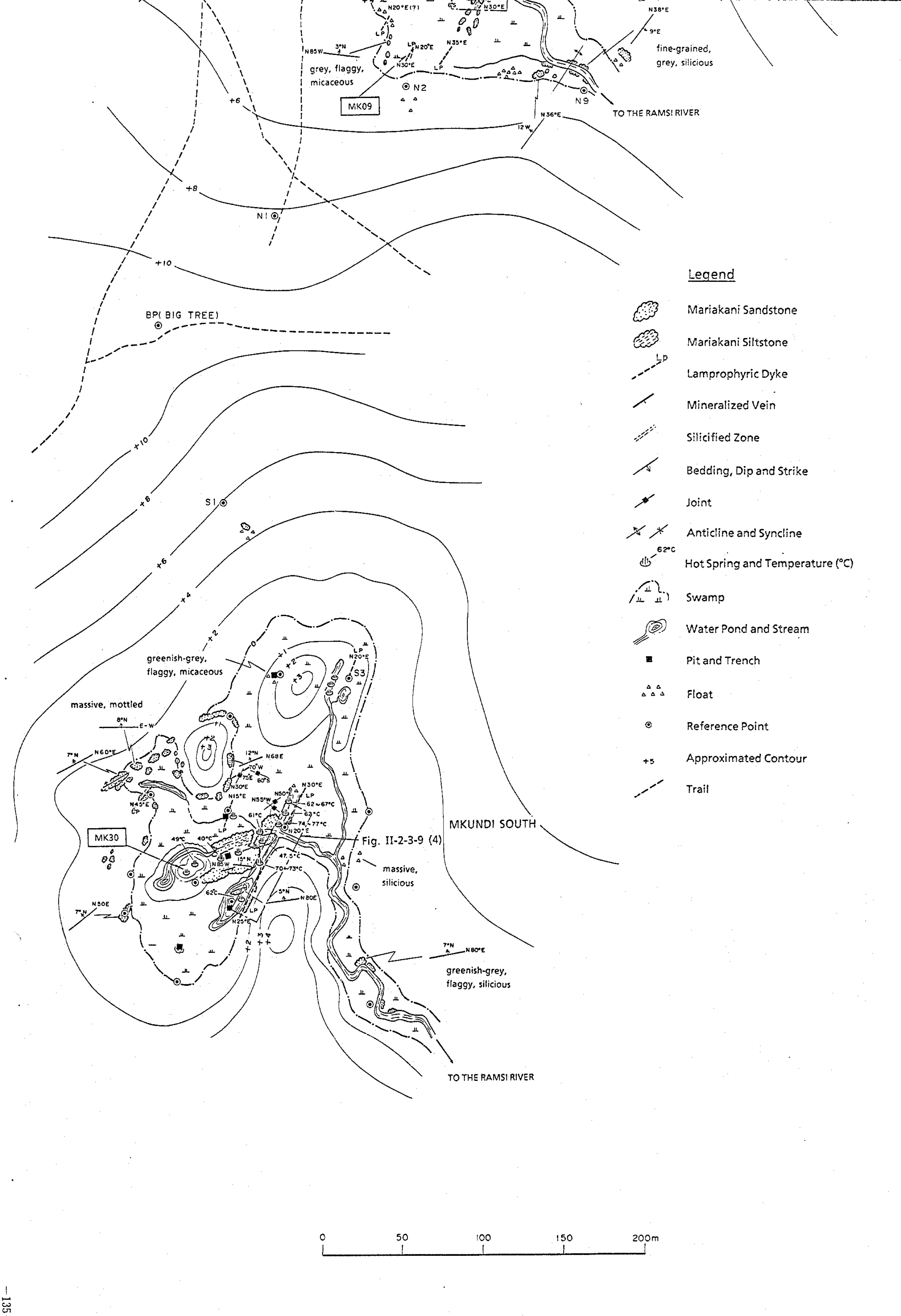
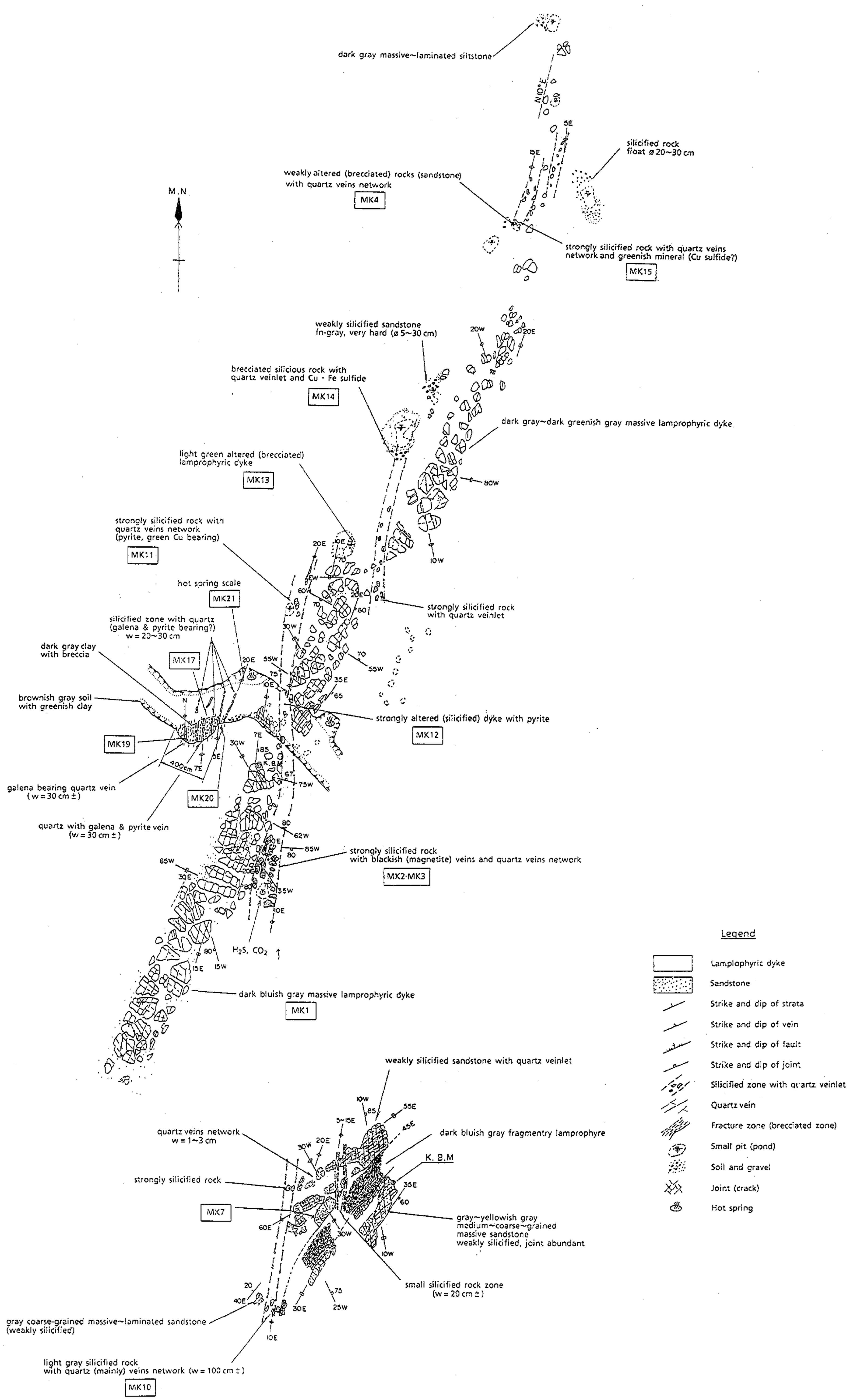


Figure II-2-3-9 (2) Geological Sketch Map of the Mkundi Area



dark gray massive~laminated siltstone
N10°E
silicified rock
float ø 20~30 cm
weakly altered (brecciated) rocks (sandstone)
with quartz veins network
MK4
strongly silicified rock with quartz veins
network and greenish mineral (Cu sulfide?)
MK15
M.N
weakly silicified sandstone
fn-gray, very hard (ø 5~30 cm)
brecciated silicious rock with
quartz veinlet and Cu · Fe sulfide
MK14
dark gray~dark greenish gray massive lamprophyric dyke
light green altered (brecciated)
lamprophyric dyke
MK13
strongly silicified rock with
quartz veins network
(pyrite, green Cu bearing)
MK11
strongly silicified rock
with quartz veinlet
hot spring scale
MK21
silicified zone with quartz
(galena & pyrite bearing?)
w = 20~30 cm
dark gray clay
with breccia
MK17
brownish gray soil
with greenish clay
strongly altered (silicified) dyke with pyrite
MK12
MK19
400cm
galena bearing quartz vein
(w = 30 cm ±)
MK20
quartz with galena & pyrite vein
(w = 30 cm ±)
strongly silicified rock
with blackish (magnetite) veins and quartz veins network
MK2·MK3
H_2S, CO_2
dark bluish gray massive lamprophyric dyke
MK1
weakly silicified sandstone with quartz veinlet
quartz veins network
w = 1~3 cm
dark bluish gray fragmentry lamprophyre
K. B.M
strongly silicified rock
MK7
gray~yellowish gray
medium~coarse~grained
massive sandstone
weakly silicified, joint abundant
small silicified rock zone
(w = 20 cm ±)
gray coarse-grained massive~laminated sandstone
(weakly silicified)
light gray silicified rock
with quartz (mainly) veins network (w = 100 cm ±)
MK10
Legend
Lamplophyric dyke
Sandstone
Strike and dip of strata
Strike and dip of vein
Strike and dip of fault
Strike and dip of joint
Silicified zone with quartz veinlet
Quartz vein
Fracture zone (brecciated zone)
Small pit (pond)
Soil and gravel
Joint (crack)
Hot spring

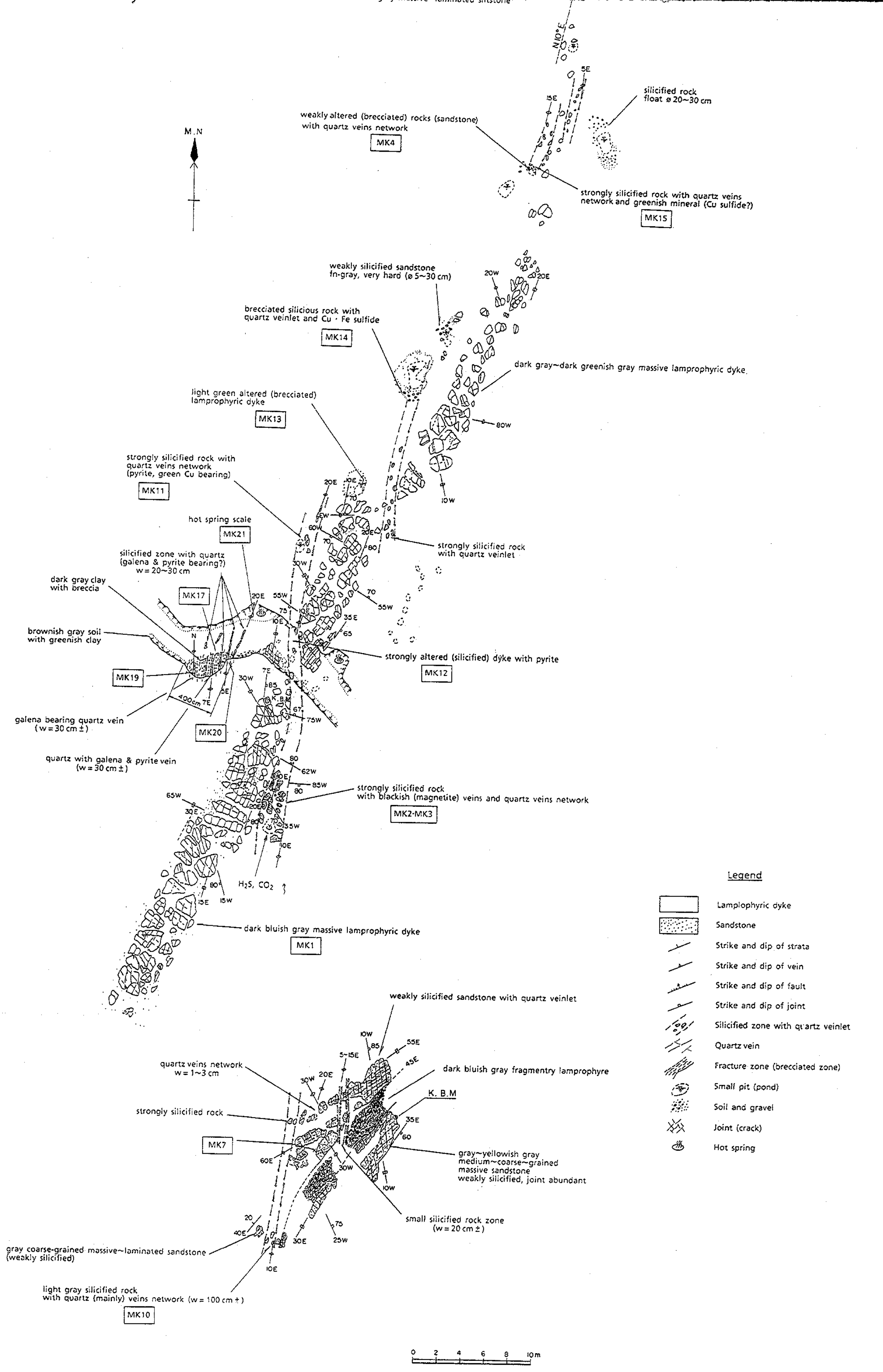


Figure II-2-3-9 (3) Geological Sketch of Mineral Showings in the Mkundi North

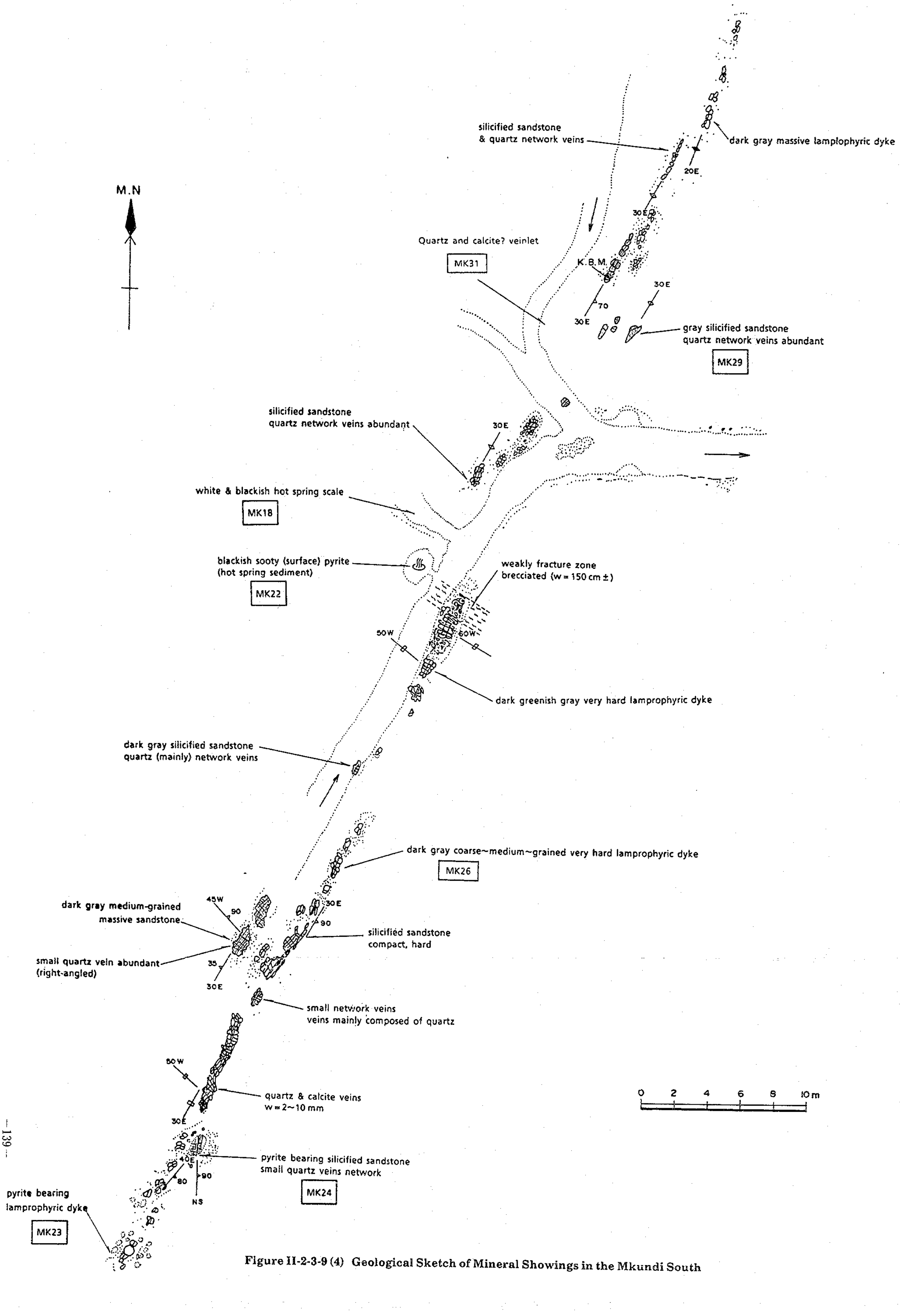


Figure II-2-3-9 (4) Geological Sketch of Mineral Showings in the Mkundi South

(10) Lunga Lunga Area

(A) Location, Access and Topography

(i) Location and Access

Lunga Lunga area is located 85 km southwest of Mombasa, 17 km northwest of Vanga. The area is accessible by driving from Mombasa to Lunga Lunga on the all weather Mombasa=Lunga Lunga road and southward from Lunga Lunga to the Immigration Customs Post of the Republic of Kenya. One can reach the ore showings by making right turn 1 km after the post, proceeding on gravel raod around the Gonia Forest for about 3 km and then westward for further 3 km.

(ii) Topography

The Lunga Lunga area is situated in the "Nyika" Zone explicated by Gregory, J.W. (1896). Consequently, the area show a very flat land, having an altitude difference within the area of approx. 150 ft (approx. 45 m). The eastern parts of the area show a flat land of an average altitude of approx. 200 ft (approx. 60 m) high above sea level, as being located in a basin of Umba River flowing down southeasterly in the area. A hilly land, where the ore showings are observed on gentle slopes, is formed in the western part of the area, approx. 350 ft (approx.105 m) above sea level.

(B) Existing Geological Studies

Existing geological informations publicly available are; Geological Sheet: Mombasa-Kwale Area, 1 to 125,000 scale, by Caswell, P.V. (1953) and Geological Sheet: Vanga, 1 to 50,000 scale, by Geological Survey of Kenya (1985). Geological Map, 1 to 25,000 and 50,000 scales, by Kenya-Austria Mineral Exploration Project (1977~1978) is also available.

Geochemical research works in the area by stream sediment sampling were initially implemented by the above Kenya-Austria Mineral Exploration Project (1973-1977) to examine geochemical anomalous values for lead, zinc, copper, barium, silver, mercury, chlomium, nickel and etc., in more than ten locations in the area. Detailed geochemical research works for the anomaly "N" were consecutively implemented to examine the geochemical anomalous values in the area in detailes (Githinji I.K. 1980), to be followed up by diamond drill exploration works.

Geological and mineralogical research works on ore showings in the area were implemented by Kenya-Austria Mineral Exploration Project (1977~1978) to reporting on the outlines of ore bodies themselves and by Bugg, S.F. (1980) to reporting on ore genesis.

Mineral prospecting by pitting trenching and diamond drilling was implemented in the area of the anomaly "N" to intersect ore veins of galena and sphalerite associated with barite. The above works have been followed up by open cast mining activity in small scale and pit trench prospecting since then.

(C) General Geology and Mineralization

A geological map and a geological cross section in the area are shown in Figure II-2-3-10 (1), a geological sketch map in Figure II-2-3-10 (2) and geological sketches of ore showings in Figure II-2-3-10 (3).

(i) General geology

General geology in the area consists of the lower member of the Maji ya Chumvi Formation of Upper Permian age and the middle member of the Maji ya Chumvi Formation of Lower Triassic age, in ascending order.

The lower member of the Maji ya Chumvi Formation mainy consists of siltstone and shale beds, which are minorly intercalated by sandstone beds.

The middle member of the Maji ya Chumvi Formation mainly consists of shale and siltstone beds at the lowermost part of which is underlain by the bed with nodules carriing ichthyo-fossils.

General geology in the area shows a monoclinal structure with north-northeasterly strikes and 5 to 10 degrees dips southeasterly. N-S trending lineament on air photographs are remarkable in western to southwestern parts of the area.

(ii) Mineralization

The Lunga Lunga area has 2 types of mineralization as follows:

- Type 1 : Ore veins mainly composed of barite associated with minor galena and sphalerite.
- Type 2 : Ore veins mainly composed of quartz associated only with limonite.

Type 1 is mostly observed in the central to southern parts of the area, while, Type 2 is in the Pit N-9 solely in the northernmost part of the area as shown in Figure II-2-3-10 (2). Both the mineralization of Types 1 and 2 occurs in shale and siltstone beds at the lowermost of the middle member of the Maji ya Chumvi Formation.

Barite veins in old prospecting and mining pits are arranged en echelon, and extensions of a single vein range 30 to 40 m in lengths (Figure II-2-3-10 (3)). Veins accompanying barite, with their strikes of roughly N-S directions and vertical dips, range 0.1 to 4 m in their thickness and contain angular fragments of barite , shale and siltstone in matrix composed of fine grained or powdery barite and clayey materials. The host rocks of the vein are highly distructed (Figure II-2-3-10 (3)). Major ore minerals of the vein are barite, witherite, barytocalcite, galena, sphalerite and pyrite.

A quartz vein, observed in Pit N-9 in the northernmost of the area, is composed of brecciated transparent quartz, accompanying limonite, strikes in the N-S direction, vertically dips and is 30 cm in maixmum. Chemical assay results of brecciated quartz show 0.5 to 1 g/t Ag, 0.17 to 0.22 % Pb and 0.1 to 0.2 % Ba.

Wall rock alteration, associated with the mineralization Type 1 is characterized by moderate to weak argillization and Type 2 by moderate silicification.

The lead age dating value of galena specimen, collected from the galena-barite-(witherite) vein in old working pit, sample-numbered TO-03, shows 96.4 Ma, which is to be estimatedly correlated to Middle Cretaceous age and is considered to be relatively later-formed in the current project area (Appendix-Ⅵ).

(D) Examination

Witherite and barytocalcite, associated with barite, were identified by the electron probe microanalysis and X-ray powder diffractometry. Chalcopyrtie and pyrite were also identified by microscopic observation of polished section and electron probe microanalysis. A small amount of chalcopyrite, partially replaced by covellite and chalcocite were also observed in barite ore vein, in association with galena and sphalerite.

According to the results of the above laboratory work, mineralization of lead, zinc and copper may be expected in this area together with barite mineralization.

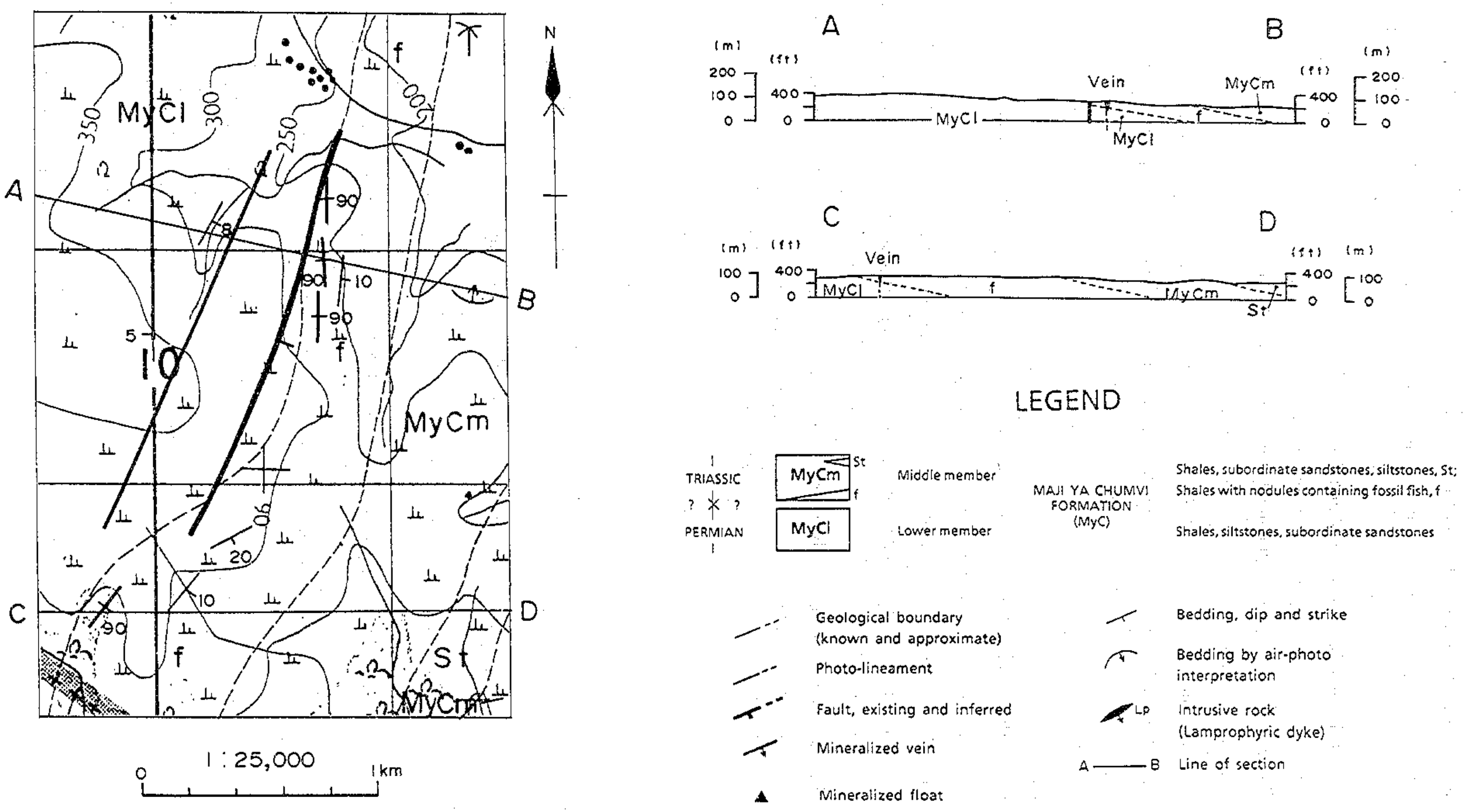
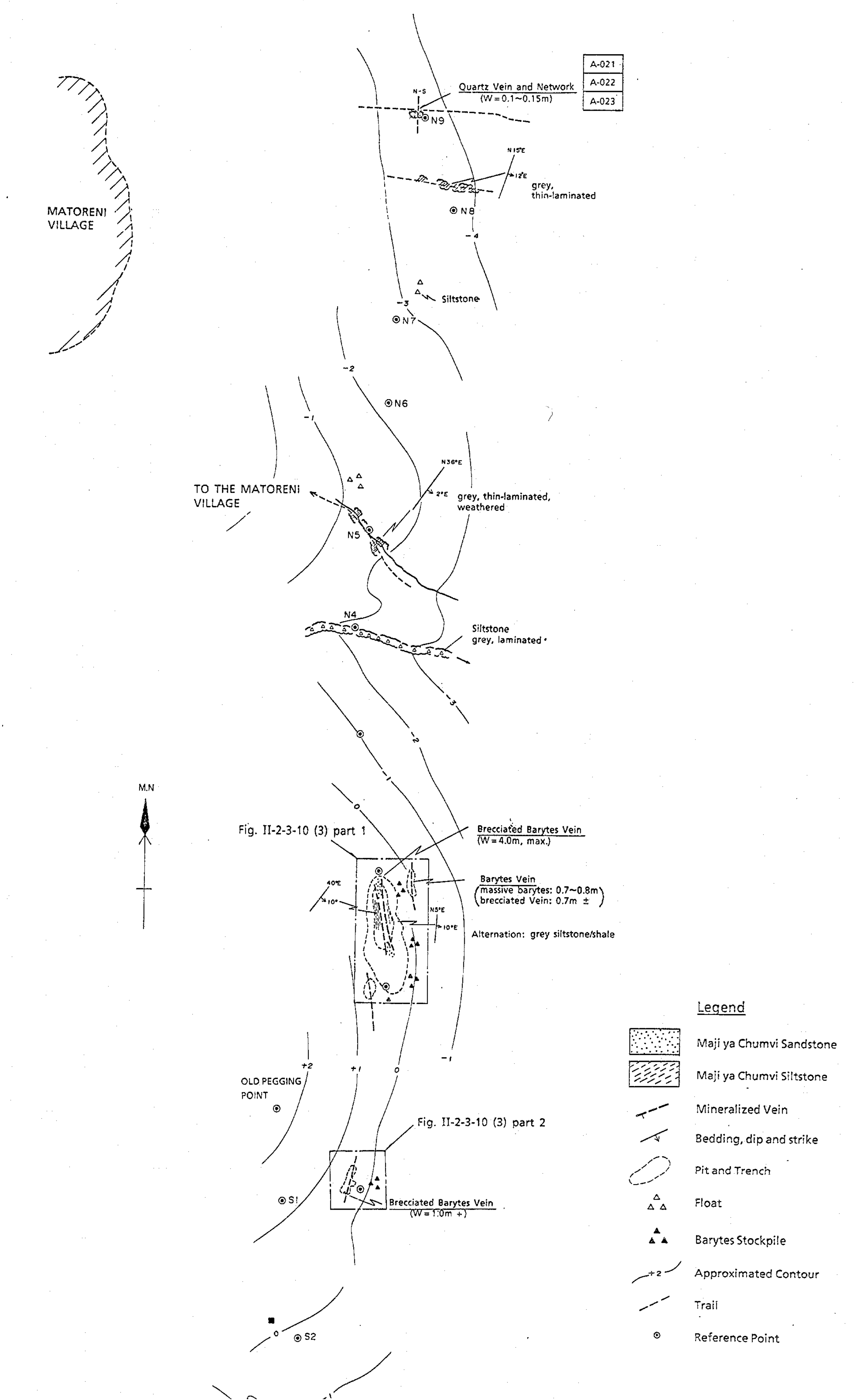


Figure II-2-3-10 (1) Geological Map of the Lunga Lunga Area



MATORENI VILLAGE
N-S
Quartz Vein and Network
(W=0.1~0.15m)
A-021
A-022
A-023
N9
N15°E
12°E
grey, thin-laminated
N8
-4
Siltstone
-3
N7
-2
N6
-1
N36°E
2°E
grey, thin-laminated, weathered
TO THE MATORENI VILLAGE
N5
N4
Siltstone
grey, laminated
-3
-2
-1
0
M.N
Fig. II-2-3-10 (3) part 1
Brecciated Barytes Vein
(W=4.0m, max.)
Barytes Vein
(massive barytes: 0.7~0.8m
brecciated Vein: 0.7m ±)
40°E
10°
N5°E
10°E
Alternation: grey siltstone/shale
+2
+1
0
-1
OLD PEGGING POINT
Fig. II-2-3-10 (3) part 2
Brecciated Barytes Vein
(W=1.0m +)
S1
S2
Legend
Maji ya Chumvi Sandstone
Maji ya Chumvi Siltstone
Mineralized Vein
Bedding, dip and strike
Pit and Trench
Float
Barytes Stockpile
Approximated Contour
Trail
Reference Point

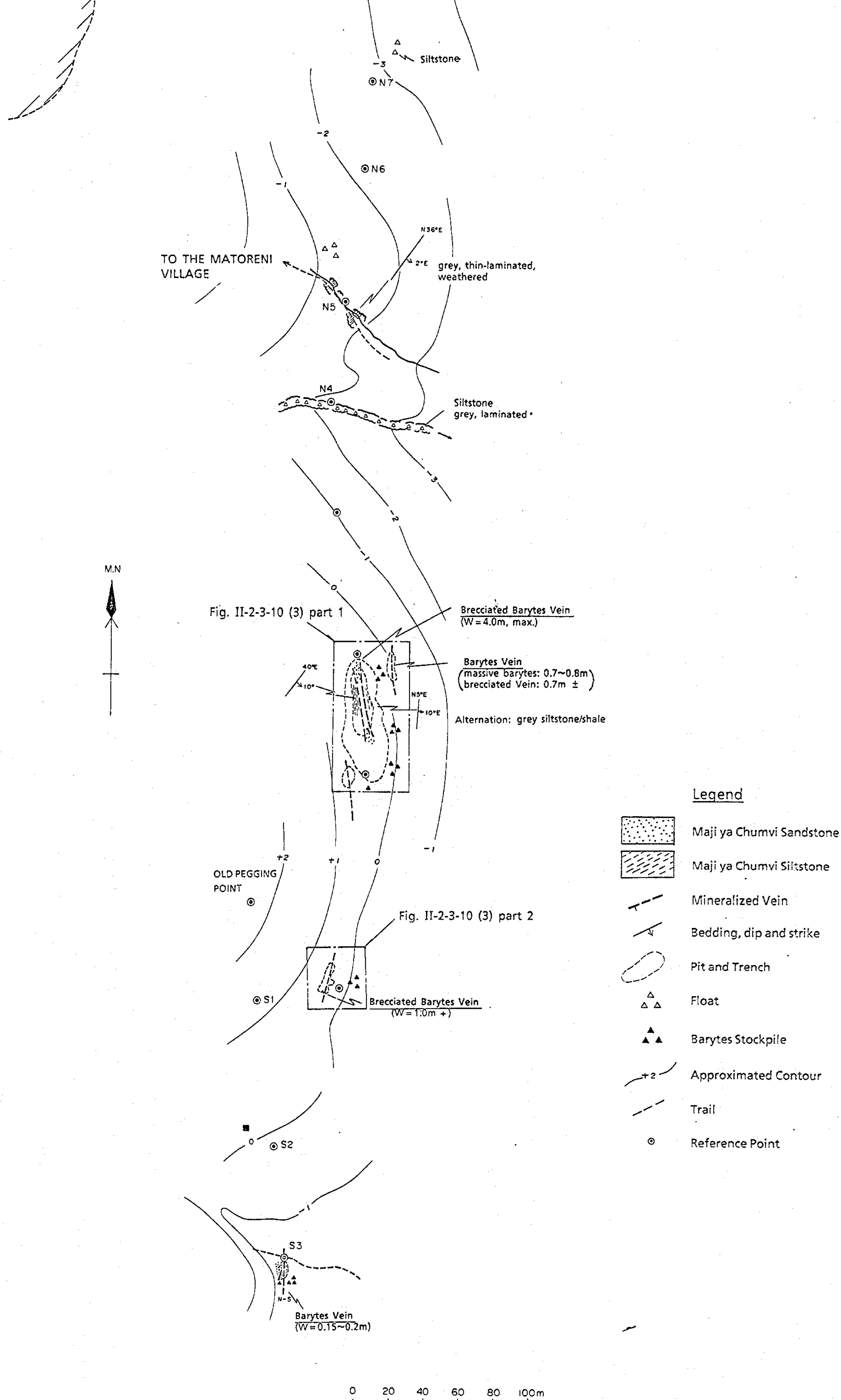


Figure II-2-3-10 (2) Geological Sketch Map of the Old Mining Pits in the Lunga-Lunga Area

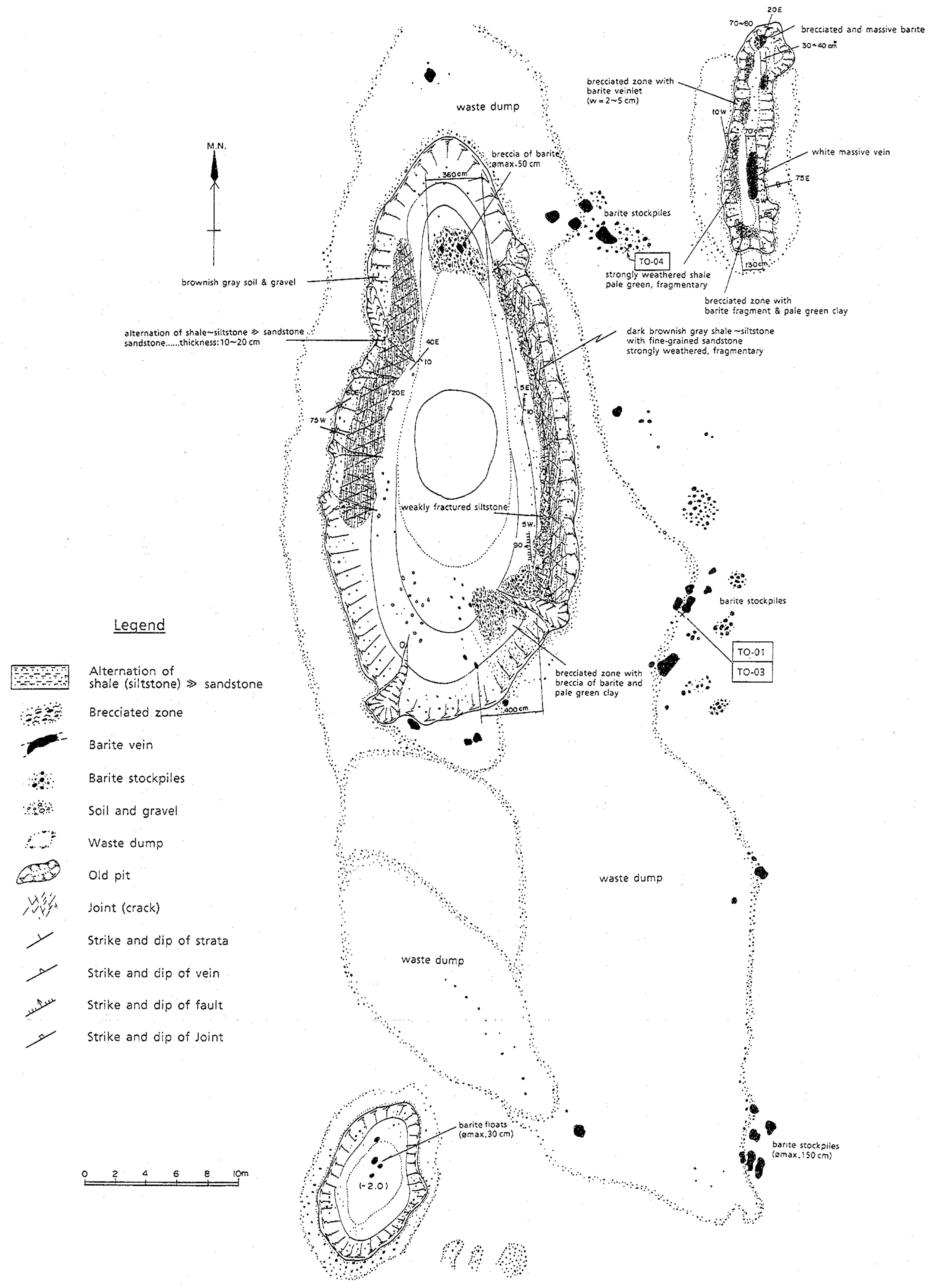


Figure II-2-3-10 (3) Geological Sketches of Mineral Showings in the Lunga Lunga Area (Part 1)

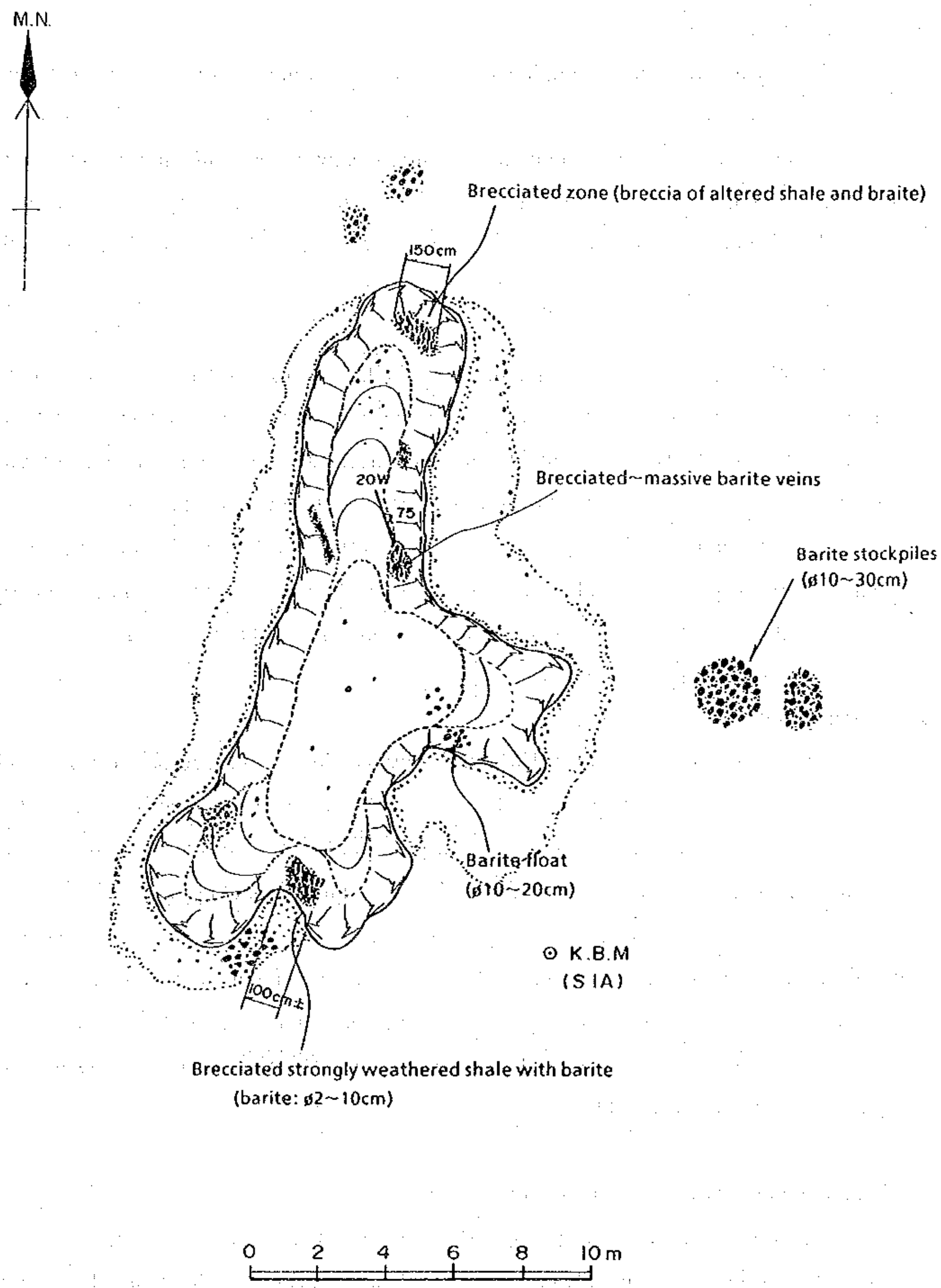


Figure II-2-3-10 (3) Geological Sketches of Mineral Showings in the Lunga Lunga Area (Part 2)

(11) Mwena Area

(A) Location, Access and Topography

(i) Location and Access

The Mwena area is located 75 km southwest of Mombasa and 27 km west-northwest of Ramsi. The area is accessible by driving from Mombasa to Mahuruni Village on the all-weather road, Mombasa = Lunga Lunga and northward from Mahuruni Village to Mwena Primary School for 6 km, to crossing the Mwena River on the way at the point 4 km from the Village. The ore showings in the area are a reached on foot some 300 m from the School.

(ii) Topography

The Mwena area is situated in the "Nyika" explicated by Gregory, J.W. (1896). General topography in the area is relatively gentle. The general altitude in the northeastern part of the area, the Dzirihini district, is relatively high, ranging approx. 350 to 400 ft (approx. 105 to 120 m) high above sea-level and tends gradually to lower toward the southwestern to southern parts of the area, where the Mwena River forms a low land of approx. 150 ft (approx. 45 m) high above sea-level. The ore showings in the area are located on the southwestern slopes of the high land transiting toward the low land.

(B) Existing Geological Studies

Existing geological informations publicly available are; Geological Sheet: Mombasa-Kwale Area, 1 to 125,000 scale, by Caswell, P.V. (1953), Geological Sheet: Ndavaya 1 to 50,000 scale, by Geological Survey of Kenya (1985), and Geological Map, 1 to 25,000 and 50,000 scales, by Kenya-Austria Mineral Exploration Project (1977~1978).

Geochemical research works in the area by stream sediments were initially implemented by the above Kenya-Austria Mineral Exploration Project to examine geochemical anomalous values for lead, zinc, copper, barium, nickel and chromium.

Geological and mineralogical research works of the ore showings were implemented by Kenya-Austria Mineral Exploration Project (1977~1978).

(C) General Geology and Mineralization

A geological map and a geological cross section are shown in Figure II-2-3-11 (1), a geological sketch map in Figure II-2-3-11 (2) and geological sketches of ore showings in Figure II-2-3-11 (3).

(i) General geology

General geology in the Mwena area consists of the lower member of the Maji ya Chumvi Formation composed of sandstone, siltstone and shale beds and is correlated to Triassic age, and the upper member of the Majii ya Chumvi Formation, which is composed of yellowish brown, flaggy sandstone beds, intercalated with thin shale beds rich in mica.

The lower member of the Maji ya Chumvi Formation is intruded by a Cretaceous alkaline complex and dikes which are mainly composed of syenite, lamprophyres and other related alkaline rocks.

The alkaline complex occurs in the Dzirihini district in the northeastern end of the area. Dikes of alkaline rock are mostly of lamprophyric composition and widely distributed in the whole area. The lamprophyric dykes are distributed radially in the central and marginal parts of the Dzirihini alkaline complex in the NE-SW or E-W direction in the other parts of the area.

(ii) Mineralization

Mineralization in the Mwena area is represented by showings of barite-quartz veins in sandstone beds of the Majii ya Chumvi Formation. The veins in outcrop show striking NW 50° to 52°, vertically dipping and widths of 2 to 3 cm in average or upto 30 cm at the widest part, and are composed of brecciated white barite accompanying quartz and limonite.

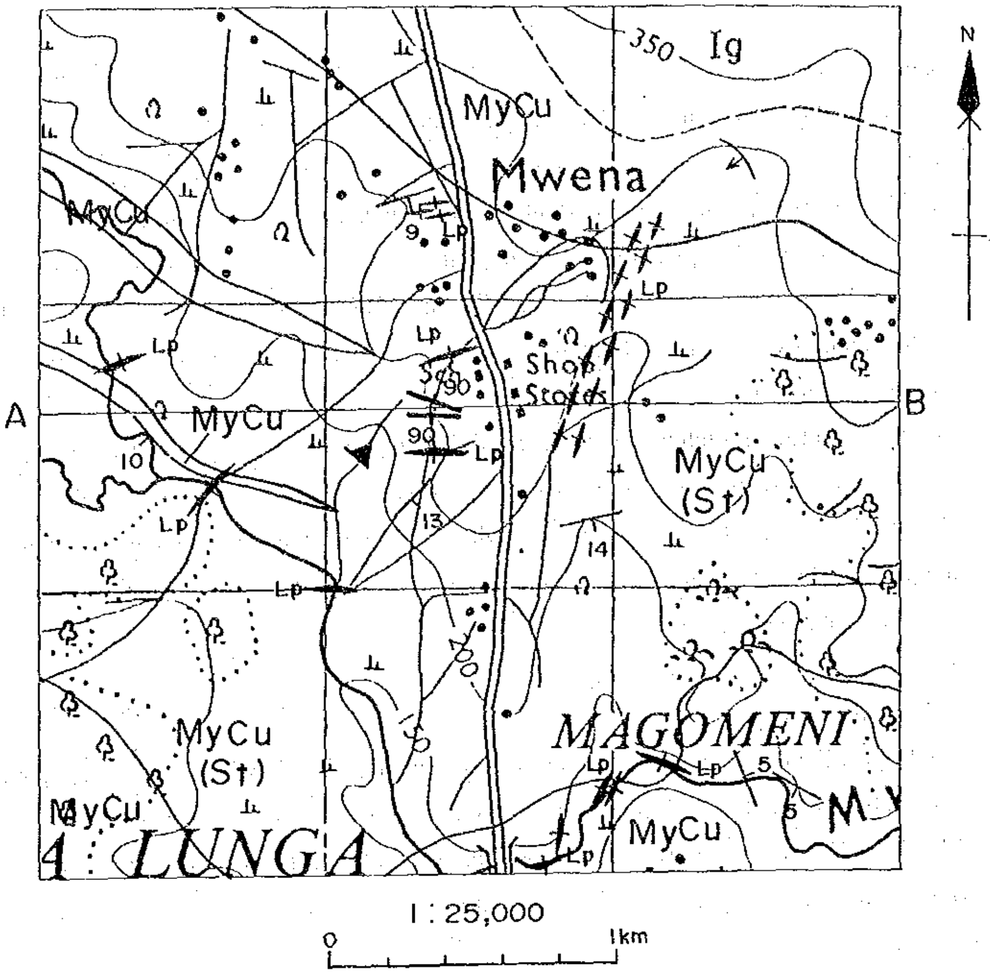
Several numbers of the veins are mapped by the current work. The vein with longest lateral extention is intermittently pursuable en echelon for some 40 m on surface, though a the single vein appears to be very small.

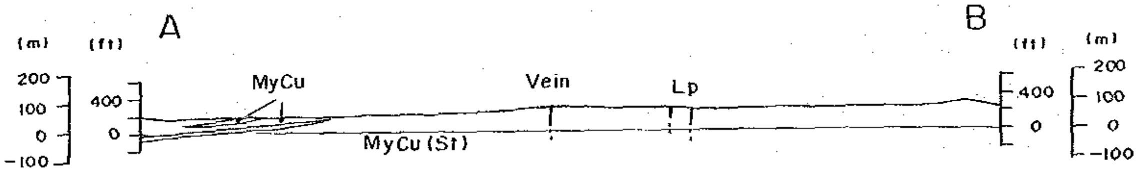
Weak wall rock alteration, weak silicification and weak argillization, being 10 to 20 cm wide along veins is observed.

The mineralization may be related to the alkaline complex and the lamprophyric dikes, but has formed later than the igneous activity.

(D) Examination

Geochemical anomalous zones shown by the previous geochemical research works are considered to be caused by the barite veins in the area.





LEGEND

TRIASSIC | MyCu (St) | Upper Member | MAJI YA CHUMVI FORMATION (MyC) | Sandstones/shales/siltstones (Siltstones, St)

Ig | Igneous rocks (Lamprophyric dyke, Lp)

Geological boundary (known and approximate)

Photo-lineament

Fault, existing and inferred

Mineralized vein

Mineralized float

Bedding, dip and strike

Bedding by air-photo interpretation

Intrusive rock (Lamprophyric dyke)

A —— B Line of section

Figure II-2-3-11 (1) Geological Map of the Mwena Area

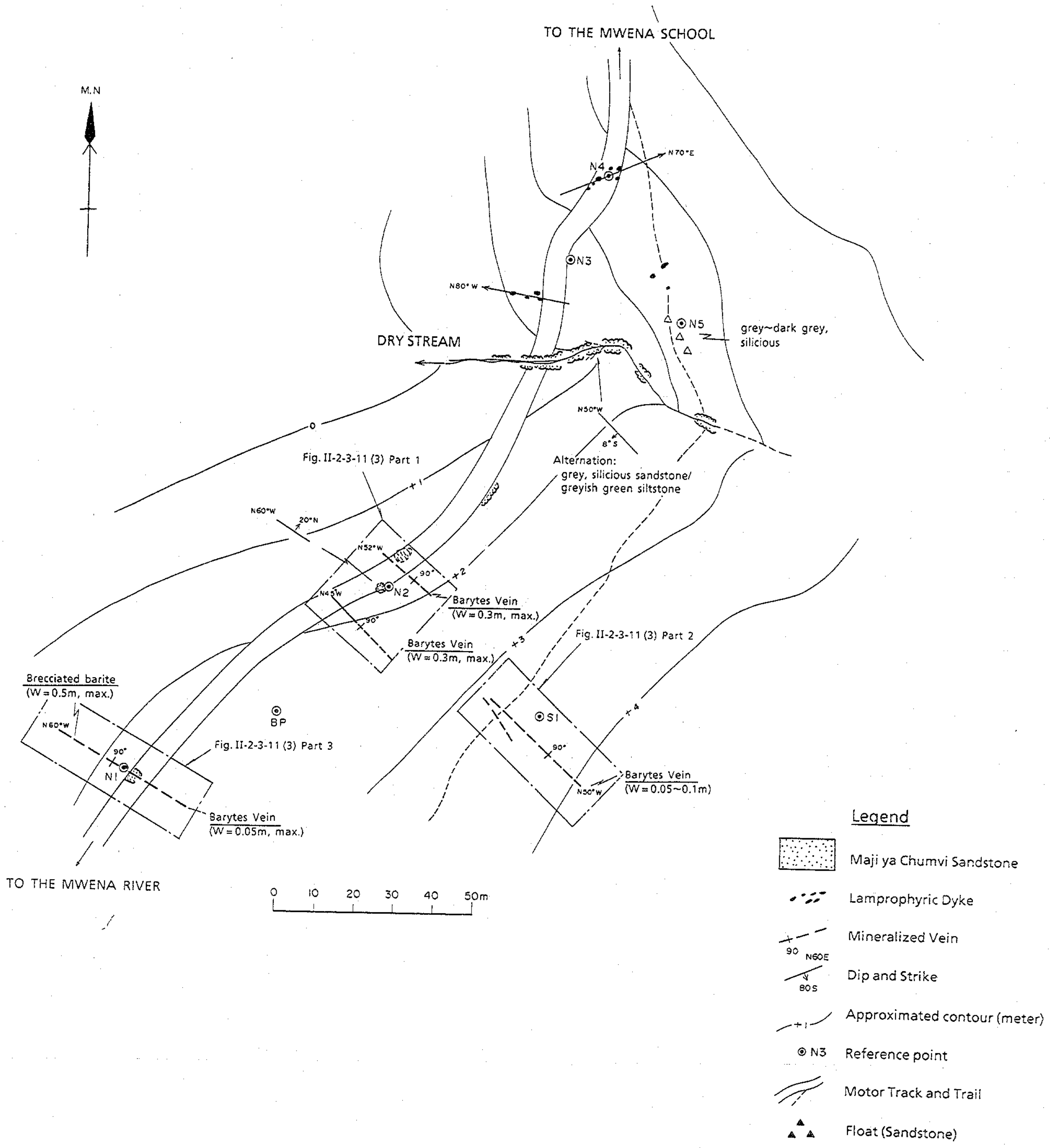


Figure II-2-3-11 (2) Geological Sketch Map of the Mwena Area

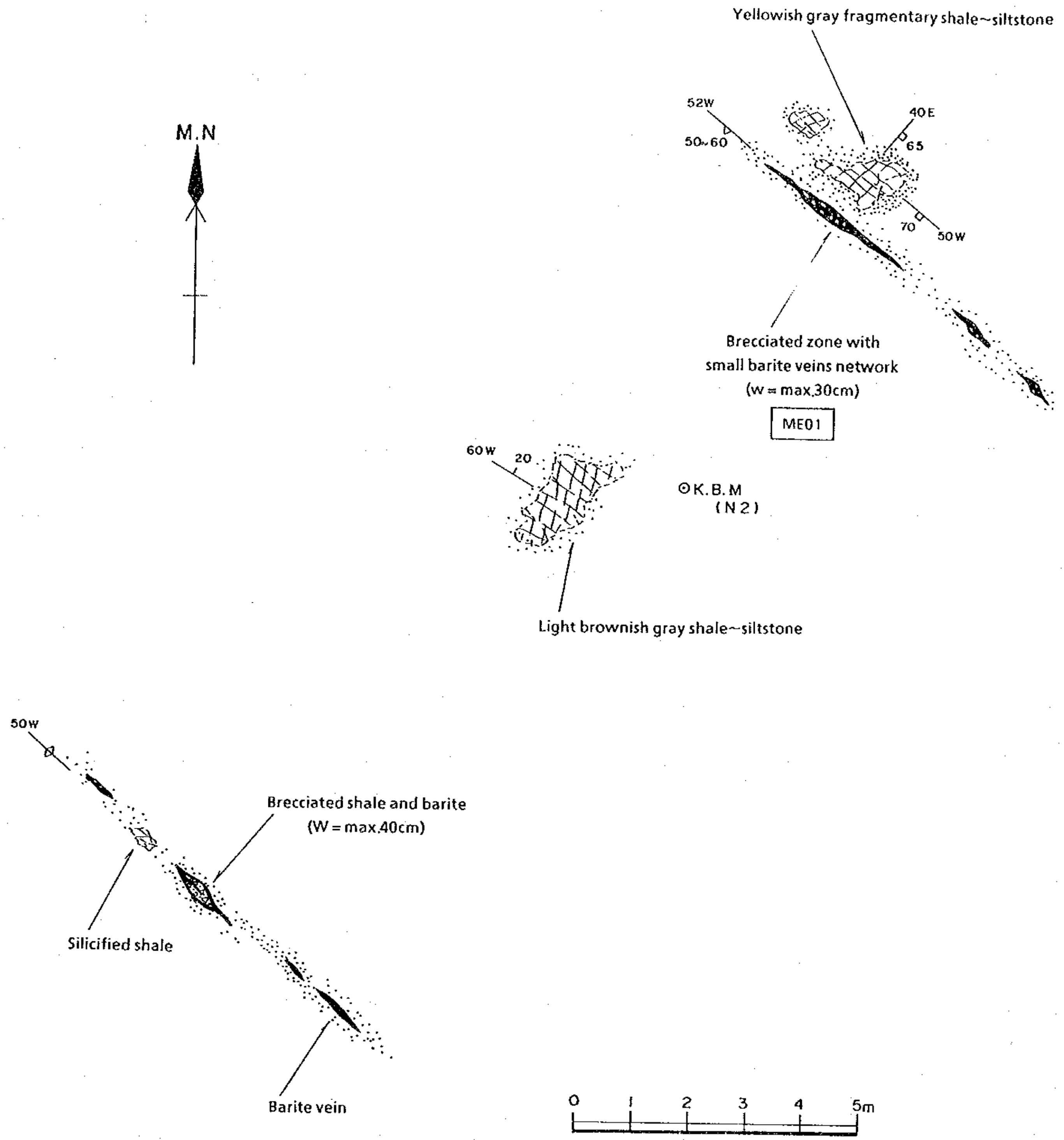


Figure II-2-3-11 (3) Geological Sketches of Barytes Veins in the Mwena Area (Part 1)

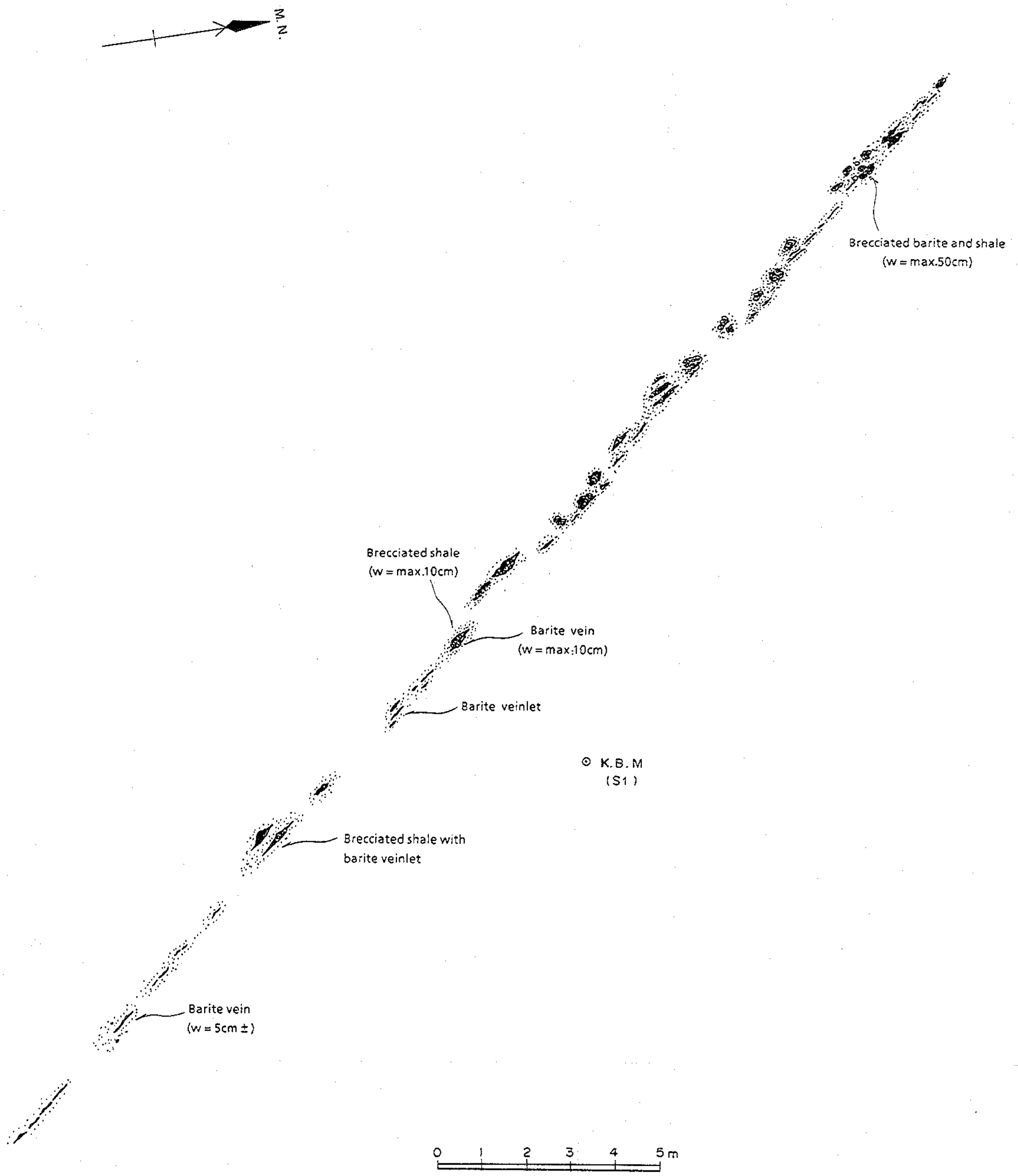


Figure II-2-3-11 (3) Geological Sketches of Barytes Veins in the Mwena Area (Part 2)

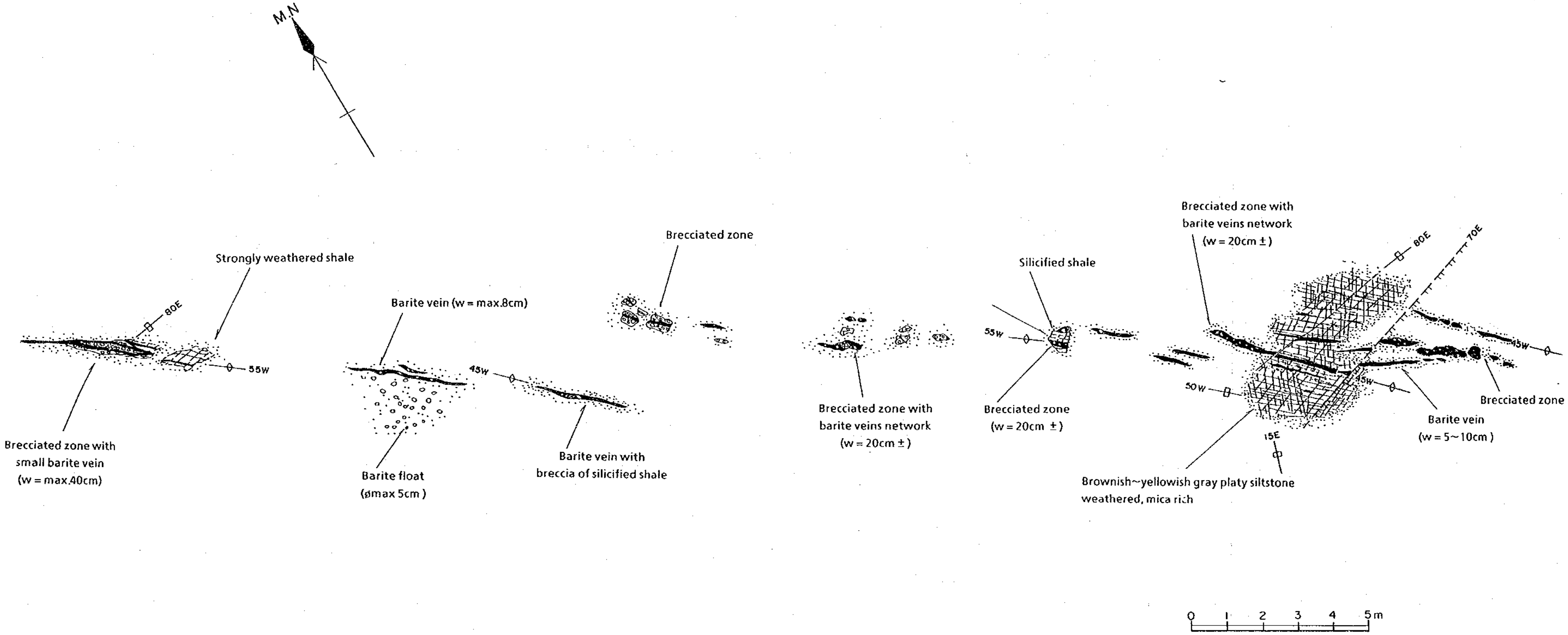


Figure II-2-3-11 (3) Geological Sketches Map of Barytes Veins in the Mwena Area (Part 3)