# LEGEND

| | SYMBOL | ROCK NAME | LITHOFACIES |
|---|---|---|---|
| | | CALCRETE | Less stratified calcrete |
| | | KALAHARI SAND. | |
| Upper Proterozoic | | DOLOMITE | Massive dolomite |
| | | | Well bedded dolomite |
| | | | Sandy dolomite |
| | | | Oolitic dolomite |
| | | | Stromatolitic dolomite |
| | | | Calcareous dolomite ~ limestone |
| | Δ Δ Δ | | Brecciated,flextured |
| | | CHERT | |
| | | SHALE | |
| | | ARGIL | Argillaceous zone |
| | | | Fractured zone |
| | | | Crackled zone |
| | | MINERALISATION | Pod,dot,speck |
| | | | Veinlets |
| | | | |

*ABBREVIATIONS*

COLOR AND FORM
- wht : white
- blk : black
- ppl : purple
- brn : brown
- irreg : irregular

MINERAL
- sp : sphalerite
- hmt : hematite
- clay : clay mineral
- py : pyrite

ALTERATION
- cal : calcitization
- dol : dolomitization
- arg : argillization
- ox : oxidation
- sil : silicification
- ser : sericitization

VEIN MINERAL
- Qtz : quartz
- Cal : calcite
- Dol : dolospar

MINERALISATION
- (f) : strong
- (m) : medium
- (p) : weak
- (pp) : very weak

- T : Thin section
- P : Polished section
- X : X-ray
- A : Assay
- H : Fluid inclusion
- B : Physical properties

**Fig. II −1−4 (1) Geological log for drill hole**

MJNM-5 (1) 0m- 75m

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No. | SAMPLE From (m) | SAMPLE To (m) | SAMPLE Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CALCRETE | pale brownish grey massive | | | | | | | | | | | | | |
| 5 | | | 6-7m water level | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | |
| 20 | | | grey to pale creamy calcrete quartz grains bearing | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | | | |
| 30 | | CALCRETE | | | | | | | | | | | | | | |
| 35 | | | black chert, brick red cuttings | | | | | | | | | | | | | |
| 40 | | | | | | | | | | | | | | | | |
| 45 | | | | | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | | | | | |
| 55 | | | brown to stain mottled cuttings predominant + pale green pebbles | | | | | | | | | | | | | |
| 60 | | | prominent water level | | | | | | | | | | | | | |
| 65 | | | | | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | | | | | |
| 75 | | | | | | | | | | | | | | | | |

**Fig. II −1−4 (2) Geological log for drill hole**

MJNM-5 (2) 75m-150m

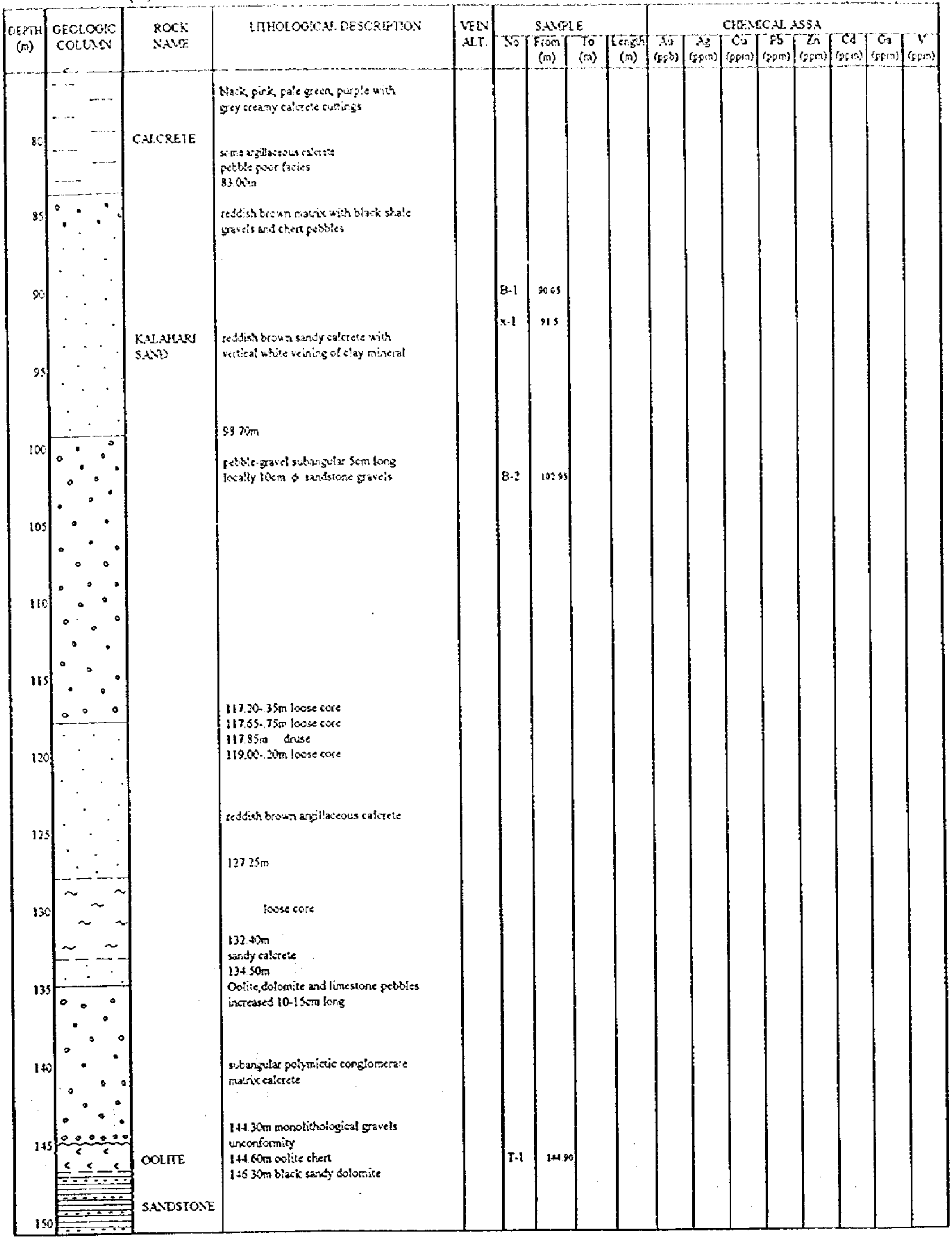



**Fig. II－1－4 (3) Geological log for drill hole**

MJNM-5 (3) 150m-225m

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No | SAMPLE From (m) | SAMPLE To (m) | SAMPLE Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | oolite | | | | | | | | | | | | | |
| 155 | | SHALE | black sandy shale with thin chert beds<br>black mineral films in cracks | | | | | | | | | | | | | |
| 160 | | | light browinsh grey dol.<br>shale patch and chert lense | | | | | | | | | | | | | |
| | | | fractured zone with red argil matrix | | | | | | | | | | | | | |
| | | DOLOMITE | | | | | | | | | | | | | | |
| 165 | | | | | | | | | | | | | | | | |
| | | SANDSTONE | grey grainitic dolomite intercalated<br>with oolitic chert | | T-2 | 168.00 | | | | | | | | | | |
| 170 | | | 170m | | | | | | | | | | | | | |
| | | SANDSTONE | black stripes in grey sandy dolomite<br>∠0-5°<br>grey to light grey fine sandy to<br>fine dolomite | | | | | | | | | | | | | |
| 175 | | | | | | | | | | | | | | | | |
| | | DOLOMITE | | | | | | | | | | | | | | |
| 180 | | | | | | | | | | | | | | | | |
| | | | 181.20-183.00m CAVITIES<br>red argil and weathered dol.<br>flat lying grey dolomite with thin<br>sandy white layers | | B-3 | 137.45 | | | | | | | | | | |
| 185 | | | | | | | | | | | | | | | | |
| | | | 186.40-189.60m CAVITIES karsting cave | | | | | | | | | | | | | |
| 190 | | | chert | | | | | | | | | | | | | |
| | | | 192.55m<br>dolomite | | | | | | | | | | | | | |
| 195 | | | | | | | | | | | | | | | | |
| | | | 195.40m<br>dark grey dolomitic shale with chert<br>intercalation<br>locally stylolitic | | B-4 | 197.30 | | | | | | | | | | |
| 200 | | SHALE | 200.70m | | | | | | | | | | | | | |
| | | | 203.10m<br>dark grey to black bandded dol shale | | | | | | | | | | | | | |
| 205 | | | | | | | | | | | | | | | | |
| | | DOLOMITE | grey dolomite<br>207.75-208.25m black shale flat lying | | | | | | | | | | | | | |
| | | | 209.70m | | | | | | | | | | | | | |
| 210 | | | dark grey to black argillaceous dol.<br>well stratified<br>211.10m fall out debris and clay | | | | | | | | | | | | | |
| | | SHALE | sandy dol. to dolomitic shale | | | | | | | | | | | | | |
| 215 | | | | | | | | | | | | | | | | |
| | | | 217.75m fall out debris and clay<br>218.82m | | | | | | | | | | | | | |
| 220 | | | black shale<br>220m STOPPED | | T-3<br>B-5 | 219.30<br>219.30 | | | | | | | | | | |
| 225 | | | | | | | | | | | | | | | | |

**Fig. II −1−4 (4) Geological log for drill hole**

argillaceous veins. The argil was identified as palygoroskite $(Mg,Al)_2[(OH,O)/Si_4O_{10}]$ which is of hydrothermal origin. The clay mineral occurs commonly in the Kalahari sand of holes. From 98.70m to 117m and from 134,50m to 144.60m it contains more pebbles of subangular form. In the lower part, the pebbles are oolite, chert and dolomite within calcareous matrix. The formations are post Tertiary sediments which are overlying the Proterozoic dolomite unconformably.

- 144.60m-220.00m Dolomite

Karst cavities are present right beneath the unconformity. Sandy dolomite is intercalated with black dolomite and oolite characterizing the upper Tsumeb subgroup. Under the microscope the chert at a depth of 145m formed from calcareous weed that has been replaced by fine quartz. From 181m to 190m Karst cavities develop with reddish argil deposited in it. From 195m black dolomitic shale is predominant with almost horizontal bedding plane.

The dolomite is generally composed of a fine grained dolomite groundmass and coarse grained dolomite and quartz filling the pores, implicating dolomitization at diagenesis stage. Older fracturing and cavities were recognized without psammitic filling sediment of Mulden group, they are therefore believed to have formed later than ore formation.

**MJNM-6**

- 0.00m- 94.05m Calcrete

The upper part consists of greyish white or pale brown calcrete with reddish brown pebble-like mottles. From 75m pebble calcrete dominates, of which pebbles of mottled sand, black chert and sandstone are predominant. This is underlain by an argillaceous facies some 3 metres thick. The basal facies, three metres in thickness, overlying unconformity include dolomite and chert pebbles within an argillaceous matrix.

- 94.05m-300.00m Calcareous dolomite

The characteristics of this formation is pale brick brown calcareous dolomite. This facies crops out in the vicinity of Abenab mine and therefore the formation is correlated to Abenab subgroup. It is intercalated with thin beds of reddish brown shale, chert and grainstone and is rich in vugs. The vugs are filled with coarse calcite, dolospar and quartz which may signify pervasive calcitization.

From a depth of around 240m a graded texture of dolomite occurs in which cycles from fine shale to coarse grainite are repeated. The beds are likely to dip less than 30° in the shale and grainstone. The formation is fractured at about 191m and 200m. No remarkable fracture zones were recorded except from those at a depth of 191m and 200m.

MJNM-6 (1) 0m- 75m

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No | From (m) | To (m) | Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CALCRETE | some quartz grains bearing sandy calcrete water level 3.5m | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | |
| 10 | | | brown pebbles in white matrix | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | |
| 25 | | | pale brown fine calcrete | | | | | | | | | | | | | |
| 30 | | CALCRETE | water table | | | | | | | | | | | | | |
| 35 | | | | | | | | | | | | | | | | |
| 40 | | | mottled brown pebbles to white matrix | | | | | | | | | | | | | |
| 45 | | | brown pebbles dominant greenish cutting included | | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | | | | | |
| 55 | | | some quartziferous pebbles | | | | | | | | | | | | | |
| 60 | | | sandy cuttings down to 80m | | | | | | | | | | | | | |
| 65 | | | | | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | | | | | |
| 75 | | | | | | | | | | | | | | | | |

**Fig. II − 1 − 4 (5) Geological log for drill hole**

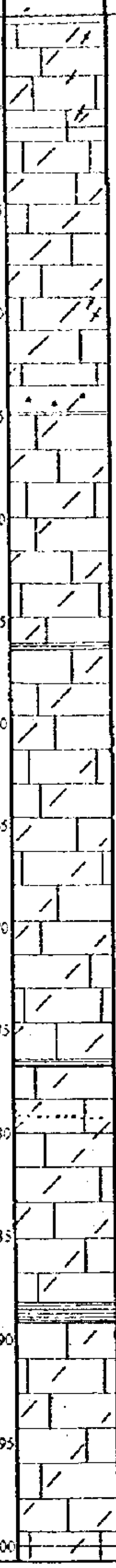
| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No. | SAMPLE From (m) | SAMPLE To (m) | SAMPLE Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| |  | | sandy and pebble cuttings<br>mottled coulor pebbles<br>dark green, purple, light to pale green,<br>white and reddich brick | | | | | | | | | | | | | |
| 80 | | CALCRETE | argillaceous/pebble calcrete<br>pebble: black cherty sand > 5 cm rare<br>reddish plagioclase porphyrite | | | | | | | | | | | | | |
| 85 | | | | | | | | | | | | | | | | |
| | | | 88.90m argillaceous | | B-6 | 89.15 | | | | | | | | | | |
| 90 | | | 91.89m dolomite/chert pebbles in argil | | | | | | | | | | | | | |
| | | | 94.05m | | | | | | | | | | | | | |
| 95 | | | gray dolomite fractured filled with<br>white calcite red spotted cavities | | B-7 | 96.6 | | | | | | | | | | |
| | | DOLOMITE | ∠10°<br>98.21-.40m chert bed | | | | | | | | | | | | | |
| 100 | | | grayish brown ∠20°<br>banded with sil. specks<br>high angled fractures cemented by cal.<br>sil. bands ∠15° | | | | | | | | | | | | | |
| 105 | | | 104.25-105.60m cavity<br>pseudomorph pyrite<br>stylolite texture | | B-8 | 107.30 | | | | | | | | | | |
| 110 | | SHALE | 110.95-112.00m reddish brown shale<br>112.00-113.40m sandy dolomite GRAINITE<br>112.75m black mineral dots | | B-9 | 111.50 | | | | | | | | | | |
| 115 | | | light brown grey massive dolomite ∠40° | | | | | | | | | | | | | |
| | | SHALE | 117.30-.90m pale green shale<br>118.80m fractured zone with blk mineral<br>W=5cm ∠30° | | | | | | | | | | | | | |
| 120 | | | 120.75-.80m chert<br>121.20-.37m chert ∠10°<br>123.05-.20m sandy dolomite +shale<br>123.90-.95m gossan 123.95-124.10m chert | | | | | | | | | | | | | |
| 125 | | DOLOMITE | gray dolomite stylolite with sulphide<br>patch<br>127.40m crs sandy dolomite with chert<br>beds | | | | | | | | | | | | | |
| 130 | | | grey fine grained dolomite ∠20-30° | | | | | | | | | | | | | |
| | | LIMESTONE | 134.20-.60m fractured<br>134.80-135.50m fractured | | | | | | | | | | | | | |
| 135 | | SHALE | 137.10-.50m stratified reddish shale<br>creamy grey limestone ∠10° | | | | | | | | | | | | | |
| 140 | | | 139.40-.70m sandy dolomite ∠20°<br>argil intercalated<br>140.70m chicken footmarks of dolospar | | T-4 | 140.70 | | | | | | | | | | |
| | | DOLOMITE | massive dolomitic limestone | | | | | | | | | | | | | |
| 145 | | | 146.18-.30m chert<br>147.50-149.40m white dots dolomite<br>< 3m/m φ dolospar<br>149.40-.95m sandy shale//ss alt.<br>149.95-150.23m chert | | | | | | | | | | | | | |
| 150 | | | | | | | | | | | | | | | | |

**Fig. II −1−4 (6) Geological log for drill hole**

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No. | From (m) | To (m) | Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | reddish brown dolomitic limestone<br>secondary filling in druse<br>153.84-.90m chert | | | | | | | | | | | | | |
| 155 | | | 153.90-154.50m brown ss to sandy shale ∠10°<br>light reddish brown porous limestone<br>157.55-.85m sandy shale<br>vuggy limestone | | | B-10 | 156.30 | | | | | | | | | |
| 160 | | LIMESTONE | 162.80-.85m chert irregular bed<br>163.00m less porous limestone, sandy fine massive | | | | | | | | | | | | | |
| 165 | | | 164.95-165.25m chert ∠20°<br>massive fine brownish grey dolomite?<br>165.65-.80m and to 170m chert beds 30cm | | | | | | | | | | | | | |
| 170 | | | porous dolomitic limestone<br>171.70-.90m shale layers+chert ∠20°<br>173.40-.43m chert<br>174.78-.92m chert | | | | | | | | | | | | | |
| 175 | | | | | | | | | | | | | | | | |
| 180 | | SHALE | 178.65-179.20m reddish brown shale ∠10°<br>massive brownish grey limestone<br>183.30-.60m sandy dolomite ∠30°<br>grey fine massive dolomite | | | | | | | | | | | | | |
| 185 | | | 184.80-185.10m sandy dolomite<br>188.40-.90m chert 5cm bed irregular secondary silicification | | | | | | | | | | | | | |
| 190 | | | 188.50m - white dolospar<br>pale reddish brown dolomitic limestone<br>locally banded sandy beds<br>191.30-.60m could be Zn sulphide | | | | | | | | | | | | | |
| 195 | | | | | | | | | | | | | | | | |
| 200 | | LIMESTONE | 198.44-.70m med ss. ∠20-30°<br>followed by 10cm thick chert<br>(five beds 25cm thick in total)<br>pale brownish grey fine massive ls.<br>locally ganded and stratified | | | | | | | | | | | | | |
| 205 | | | 205.30-.35m shale to clay | | | | | | | | | | | | | |
| 210 | | | 211.12-.60m minute grains of yellow sulphide(pyrite?)<br>212.00-.50m med. ss.<br>213.00m sulphide seam in stylolite plane | | | | | | | | | | | | | |
| 215 | | | light reddish brownish limestone<br>intercalated with chert beds < 15cm | | | | | | | | | | | | | |
| 220 | | | 220.06-.86m fractured zone with relict pyrite<br>224.70-.85m suphalerite? | | | | | | | | | | | | | |
| 225 | | | | | | | | | | | | | | | | |

**Fig. II − 1 − 4 (7) Geological log for drill hole**

## MJNM-6 (4) 225m-300m



| DEPTH (m) | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No | From (m) | To (m) | Length (m) | Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 225.30m<br>porous limestone reddish brown brecciated locally<br>228.75-.95m dol block in sandy dol matrix<br>230.30m | | | | | | | | | | | | | |
| 230 | | | | | | | | | | | | | | | |
| 235 | LIMESTONE | porous limestone with thin chert beds<br>235.30-.90m brecciated med dol fragments intercalated with 10cm thick chert | | | | | | | | | | | | | |
| 240 | | 243.32m chert fragments bearing<br>244.40m<br>top 40cm banded shaly dolomite<br>porous reddish crs. sandy ls<br>graded sequence | | | | | | | | | | | | | |
| 245 | | | | | | | | | | | | | | | |
| 250 | | 249.90m pebble ls. to crs ss.<br>subangular pebbles light grey < 1cm long | | T-5<br>B-11 | 250.70<br>250.70 | | | | | | | | | | |
| 255 | SHALE | 255.60-.85m top red shale | | | | | | | | | | | | | |
| 260 | | | | | | | | | | | | | | | |
| 265 | | 267.30-.40m red shale<br>268.60-.90m massive dolomite | | | | | | | | | | | | | |
| 270 | | | | | | | | | | | | | | | |
| 275 | SHALE | basal 15cm massive<br>275.80-176.20m bedded shale ∠5-10°<br>278.20-.51m pebble 1-2cm irregular<br>278.51-.80m bedded shale with cavities | | | | | | | | | | | | | |
| 280 | LIMESTONE | 279.15<br>281.60m<br>light brownish grey limestone<br>fine massive intercalated with < 10cm chert | | B-12 | 281.00 | | | | | | | | | | |
| 285 | | 287.40-288.40m reddish shale to sandy shale ∠30° | | | | | | | | | | | | | |
| 290 | | 293.45m | | | | | | | | | | | | | |
| 295 | | porous limestone | | B-13<br>T-6<br>X-2 | 296.30<br>296.30<br>296.45 | | | | | | | | | | |
| 300 | | 299.30m green yellow argil patch 1cm<br>STOP | | | | | | | | | | | | | |

**Fig. II − 1 − 4 (8) Geological log for drill hole**

**MJNM-7**

- 0.00m- 88.25m Calcrete

The lower part consists of pebble calcrete. Rounded to subrouded pebbles of gneiss, greenstone and shale 3 to 5 cm in diametre, are embedded within a sandy matrix.

- 88.25m-237.90m Dolomite and black shale

Tsumeb subgroup starts with black sandy shale underlain by grey dolomite.

From a depth of 120m black calcareous shale alternates with grainstone. Talc argillization appears from 127m down. A pure talc bed is enclosed over two metres from 156m to 158m as well as intense talc argillization zone at depths of 192, 194 and 207m. X-ray diffractometry indicates weak peaks of chlorite and quartz associated with talc.

- 227.90m-230.75m Dolerite

The dyke rock is dark green compact and is significantly magnetic. The upper contact with dolomite dips 45° , while lower contact dips 35° . The dip is almost coincident with that of beds of host rock. This rock is rich in altered yellowish brown pyroxene. The relict crystals have been fully serpentinized under microscope. X-ray diffractometry showed evident peaks of chrysotile and lizardite as well as biotite. The last is comparatively common but is not known whether this is of primary or secondary origin.

- 230.75m-300.00m Dolomite

The facies are uniform until around the depth of 260m where intense argillization is recognized. In part the talc shows a pink colour, suggesting it being manganiferous. X-ray diffractometry gave remarkable peaks of chlorite and smectite as well as talc. Between 270m and 300m black dolomitic shale and a fine sandy dolomite(packstone) associated with grey dolomite alternate every four to five metre.

**MJNM-8**

- 0.00m-128.00m Calcrete·Kalahari sand

In the upper part the formation is grey to pale brown and becomes mottled from 50m. From a depth of around 70m, it showed psammitic material within reddish argil. Pebble calcrete beds are intercalate from 90.40m to 91.50m, from 96.40m to 100m, from113.58m to 114.28m and from 118.60m to 128.00m.

- 128.00m-229.52m Dolomite/Shale alternate

The upper most two metres from the unconformity is dark grey porous dolomite which changes into fractured grey dolomite below. The fracture planes are filled with dolospar and calcite but are not associated with mineralisation. Such the crackled structure, which hasa good potential for sulphide

MJNM-7 (1) 0m- 75m

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No | SAMPLE From (m) | SAMPLE To (m) | SAMPLE Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CALCRETE | light grey massive calcrete | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| | | | honey colored calcrete argillaceous silty | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | |
| 25 | | | light brown to pale brown | | | | | | | | | | | | | |
| 30 | | CALCRETE | | | | | | | | | | | | | | |
| 35 | | | | | | | | | | | | | | | | |
| 40 | | | | | | | | | | | | | | | | |
| 45 | | | | | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | | | | | |
| 55 | | | | | | | | | | | | | | | | |
| | | | brick red mottled calcrete | | | | | | | | | | | | | |
| 60 | | | | | | | | | | | | | | | | |
| 65 | | | | | | | | | | | | | | | | |
| 70 | | | abundant in cherty pebbles | | | | | | | | | | | | | |
| 75 | | | | | | | | | | | | | | | | |

**Fig. II－1－4 (9) Geological log for drill hole**

## MJNM-7 (2) — 75m-150m

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No | SAMPLE From (m) | SAMPLE To (m) | SAMPLE Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 80 | | CALCRETE | 3-5cm ϕ boulder to pebbles<br>pebble: round to subround gneiss, pelite green volcanic rock<br>matrix: quartz grains/argillaceous | | B-14 | 82.9 | | | | | | | | | | |
| 85 | | | 88.25m<br>black sandy shale weathered surface | | | | | | | | | | | | | |
| 90 | | SANDSTONE | matrix: quartz sandy calcrete argillaceous<br>pebbles: uniformly black sandy shale | | | | | | | | | | | | | |
| 95 | | | 96.00m<br>black sandy shale fractured ∠60°<br>locally druses with calcite | | | | | | | | | | | | | |
| 100 | | | fractured matrix: calcrete reddish argil<br>fractured sandy shale | | | | | | | | | | | | | |
| 105 | | | 105.05m<br>grey dolomite steeply dipping banded fine to med. ∠60-70°<br>dolospar filling fractures of younger stage | | | | | | | | | | | | | |
| 110 | | DOLOMITE | | | B-15 | 110.50 | | | | | | | | | | |
| 115 | | CHERT | 113.00m dolospar<br>114.3-114.50m Oolitic chert | | | | | | | | | | | | | |
| 120 | | | 119.15m<br>creamy grey dolomite | | | | | | | | | | | | | |
| 125 | | SHALE | 121.80m<br>black calcareous shale with porous druse cavity abundant < 3cm ϕ<br>124.70m<br>black sandy shale flat lying ∠5-10°<br>126.20-127.20m grey to drk grey shale | | B-16 | 124.00 | | | | | | | | | | |
| 130 | | | spotted dolomite talc films<br>129.50m black sandy shale<br>130.50-131.70m grey dol. fractured | | | | | | | | | | | | | |
| 135 | | SHALE | black calcareous shale<br>135.25-136.00m sandy dol. grey with cherty beds<br>138.10m<br>grey to cream colored dolomite | | T-7 | 133.50 | | | | | | | | | | |
| 140 | | SANDSTONE | argillaceous film rich and local oolitic<br>sandy dol.·black shale (139m)<br>142.80-143.70m black shale | | T-8 | 139.10 | | | | | | | | | | |
| 145 | | DOLOMITE | grey dolomite<br>145.00-146.00m argil vein<br>banded black dolomitic shale·dol. ∠15-20°<br>cavity abundant | | | | | | | | | | | | | |
| 150 | | | | | | | | | | | | | | | | |

**Fig. II－1－4 (10) Geological log for drill hole**

# MJNM-7 (3) 150m-225m

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No. | SAMPLE From (m) | SAMPLE To (m) | SAMPLE Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 150.40m | | B-17 | 150.60 | | | | | | | | | | |
| | | SHALE | | | | | | | | | | | | | | |
| | | | 152.05m | | | | | | | | | | | | | |
| 155 | | DOLOMITE | dolomite banded talc argil layers intercalated | | | | | | | | | | | | | |
| | | | 156.00-158.20m pure white talc | | X-3 | 157.00 | | | | | | | | | | |
| | | TALC | | | B-18 | 157.20 | | | | | | | | | | |
| | | | 159.30-.55m fossiliferous sandy shale | | | | | | | | | | | | | |
| 160 | | SHALE | black shale micro porous | | | | | | | | | | | | | |
| | | | 160.30m | | | | | | | | | | | | | |
| | | | sandy dolomite with oolitic layers | | | | | | | | | | | | | |
| | | | black shale alt. with talc layers | | | | | | | | | | | | | |
| 165 | | DOLOMITE | 163.90-.95m druse poor shale | | | | | | | | | | | | | |
| 170 | | | 169.05-.35m banded sandy dol. ∠0-5° | | T-9 | 169.30 | | | | | | | | | | |
| | | | 169.75-170.15m | | | | | | | | | | | | | |
| | | SHALE | 172.45-173.70m horizontal shale | | | | | | | | | | | | | |
| 175 | | | grey to black dolomitic shale locally talc layers | | | | | | | | | | | | | |
| | | DOLOMITE | 177.70-.80m talc layer | | | | | | | | | | | | | |
| | | | 178.00m | | | | | | | | | | | | | |
| | | | sandy dolomite | | | | | | | | | | | | | |
| 180 | | SANDSTONE | 179.20-.90m banded sandy to dolomitic shale | | | | | | | | | | | | | |
| | | | 180.70m | | | | | | | | | | | | | |
| | | | grey to black dolomitic shale | | | | | | | | | | | | | |
| | | | talc veins and layers | | | | | | | | | | | | | |
| 185 | | SHALE | partly dolomite | | | | | | | | | | | | | |
| | | | 187.00m stromatolitic texture | | | | | | | | | | | | | |
| | | | 188.00m | | | | | | | | | | | | | |
| | | | grey dolomite stratified with talc | | | | | | | | | | | | | |
| 190 | | | oolite lying atop 10cm | | | | | | | | | | | | | |
| | | | 192.45-193.65m white pure talc | | | | | | | | | | | | | |
| | | | 193.95-194.10m white pure talc | | | | | | | | | | | | | |
| 195 | | | grey bedded dolomitic shale | | | | | | | | | | | | | |
| 200 | | DOLOMITE | | | | | | | | | | | | | | |
| | | | fracture zone | | | | | | | | | | | | | |
| 205 | | | | | | | | | | | | | | | | |
| | | | 207.05-.70m talc | | | | | | | | | | | | | |
| 210 | | | talc veins | | | | | | | | | | | | | |
| | | SHALE | 210.40-.90m black porous | | | | | | | | | | | | | |
| | | | 211.30-212.35m black sandy shale | | | | | | | | | | | | | |
| 215 | | | pervasive talc argillization | | B-19 | 215.60 | | | | | | | | | | |
| | | DOLOMITE | | | | | | | | | | | | | | |
| 220 | | | 221.50-222.30m grey-drk grey banded sandy dol. ∠40° | | | | | | | | | | | | | |
| | | SANDSTONE | 222.95-223.05m crs oolite ∠30° | | | | | | | | | | | | | |
| | | | stromatolitic tex. in part | | | | | | | | | | | | | |
| 225 | | | | | | | | | | | | | | | | |

**Fig. II－1－4 (11) Geological log for drill hole**

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No. | From (m) | To (m) | Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Cr (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 225.10m | | B-20 | 227.40 | | | | | | | | | | |
| | | DOLOMITE | grey fine dolomite | | T-10 | 227.50 | | | | | | | | | | |
| | | | 227.90m ∠45°(contact plane) | | P-1 | 227.60 | | | | | | | | | | |
| | | | drk green dolerite, olivine phenocryst | | X-4 | 227.60 | | | | | | | | | | |
| 230 | | DOLERITE | relict abundant | | | | | | | | | | | | | |
| | | | 230.25m ∠30°(contact plane) | | | | | | | | | | | | | |
| | | | 231.40-.45m dolerite seam ∠45° | | | | | | | | | | | | | |
| | | | dolomite bedding ∠60-70° | | | | | | | | | | | | | |
| 235 | | DOLOMITE | | | | | | | | | | | | | | |
| | | | 235.65-95m pure talc | | | | | | | | | | | | | |
| 240 | | | | | | | | | | | | | | | | |
| 245 | | | | | B-21 | 245.00 | | | | | | | | | | |
| | | DOLOMITE | grey dolomite | | | | | | | | | | | | | |
| 250 | | | | | | | | | | | | | | | | |
| | | | vuggy calcareous facies | | | | | | | | | | | | | |
| 255 | | | | | | | | | | | | | | | | |
| | | | stromatolitic tex. | | | | | | | | | | | | | |
| 260 | | | | | | | | | | | | | | | | |
| | | | shale-dolomite grey ∠30-45° | | | | | | | | | | | | | |
| | | | pale pink colored manganese talc | | X-5 | 262.70 | | | | | | | | | | |
| 265 | | | | | | | | | | | | | | | | |
| 270 | | | | | | | | | | | | | | | | |
| | | | 270.65m | | | | | | | | | | | | | |
| | | | dark grey to black sandy shale inter- | | | | | | | | | | | | | |
| | | SHALE | calated with dolomite ∠30° | | | | | | | | | | | | | |
| | | | 273.55m | | | | | | | | | | | | | |
| 275 | | DOLOMITE | | | | | | | | | | | | | | |
| | | | 275.50-278.75m | | | | | | | | | | | | | |
| | | LIMESTONE | dark grey limy dolomite | | | | | | | | | | | | | |
| | | | small cavities and dolospar rich ∠40° | | | | | | | | | | | | | |
| 280 | | DOLOMITE | | | | | | | | | | | | | | |
| | | | 282.90m | | | | | | | | | | | | | |
| | | | black dark grey med. sandy shale ∠45° | | | | | | | | | | | | | |
| 285 | | SANDSTONE | | | | | | | | | | | | | | |
| | | | 285.80m | | | | | | | | | | | | | |
| | | | grey fractured dol. with thin chert beds ∠20° | | | | | | | | | | | | | |
| 290 | | DOLOMITE | 290.05-.15m pyrite in slip plane ∠20° | | | | | | | | | | | | | |
| | | | 292.50-293.40m pale brown grey dol. | | | | | | | | | | | | | |
| | | | dark grey to black sandy shale with | | | | | | | | | | | | | |
| | | | chert bed 5cm thick | | | | | | | | | | | | | |
| 295 | | SANDSTONE | | | | | | | | | | | | | | |
| | | | 295.90m | | | | | | | | | | | | | |
| | | | grey well-stratified dolomite ∠20° | | | | | | | | | | | | | |
| | | | locally dark grey | | | | | | | | | | | | | |
| 300 | | DOLOMITE | STOP | | | | | | | | | | | | | |

**Fig. II −1−4 (12) Geological log for drill hole**

MJNM-8 (1) 0m- 75m

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No | SAMPLE From (m) | SAMPLE To (m) | SAMPLE Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CALCRETE | light grey to pale cream colored | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | |
| 20 | | | mixed with mottled cuttings | | | | | | | | | | | | | |
| | | | 24.0-25.0m almost slime, pale creamy brown | | | | | | | | | | | | | |
| 25 | | | white to light grey<br>27.0-31.0m almost slime | | | | | | | | | | | | | |
| 30 | | CALCRETE | | | | | | | | | | | | | | |
| | | | 34.0-35.0m almost fine slime | | | | | | | | | | | | | |
| 35 | | | 36.0m mottled cuttings increase | | | | | | | | | | | | | |
| 40 | | | 40.0-43.0m fine slime, pale light brown | | | | | | | | | | | | | |
| 45 | | | 47.0-50.0m fine slime pale-light brown reddish cream colored | | | | | | | | | | | | | |
| 50 | | | black stain mottled calcrete<br>pale green pebbles | | | | | | | | | | | | | |
| 55 | | | | | | | | | | | | | | | | |
| 60 | | | | | | | | | | | | | | | | |
| 65 | | | | | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | | | | | |
| 75 | | KALAHARI-SAND | | | | | | | | | | | | | | |

Fig. II −1−4 (13) Geological log for drill hole

MJNM-8 (2) 75m-150m

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT | SAMPLE No. | From (m) | To (m) | Length (m) | CHEMICAL ASSAY Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ca (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | reddish brown sandy calcrete<br>top arkose sand locally pebbles 5cm φ<br>calcareous sand | | | | | | | | | | | | | |
| 80 | | | | | | | | | | | | | | | | |
| 85 | | | | | B-22 | 84.25 | | | | | | | | | | |
| 90 | | | 90.40-91.50m pebble calcrete<br>crs sandy matrix red Fe-Ox argil | | | | | | | | | | | | | |
| 95 | | | 96.40m<br>pebble to gravel:chert, ss , dol.<br>max 5cm φ<br>matrix crs. sand<br>100.00m | | | | | | | | | | | | | |
| 100 | | | | | | | | | | | | | | | | |
| 105 | | KALAHARI-SAND | | | | | | | | | | | | | | |
| | | | 109.15-110.00m matrix argil rich | | | | | | | | | | | | | |
| 110 | | | 112.90m<br>113.58-114.28m | | | | | | | | | | | | | |
| 115 | | | 118.60m | | | | | | | | | | | | | |
| 120 | | | pebble calcrete | | | | | | | | | | | | | |
| 125 | | | 128.00m Uncomformity<br>porous weathered dark grey | | B-33 | 127.70 | | | | | | | | | | |
| 130 | | DOLOMITE | grey fractured dolomite<br>fractures cemented with calcite | | | | | | | | | | | | | |
| 135 | | SHALE | 136.00-137.80m<br>black calcareous well stratified ∠45°<br>less fractured | | | | | | | | | | | | | |
| 140 | | DOLOMITE | light grey intensely fractured dol.<br>filled with cal/qtz<br>140.25-141.90m grey to dark grey dol. | | T-11 | 140.00 | | | | | | | | | | |
| | | OOLITE | filled with dolospar<br>141.90m 2cm thick oolite | | | | | | | | | | | | | |
| 145 | | SHALE | 143.25-144.55m black shale calcareous<br>∠40°<br>chert 10cm thick at the top | | | | | | | | | | | | | |
| | | | grey dol. locally bedded and fractured<br>∠0-10°<br>slumping stracture | | | | | | | | | | | | | |
| 150 | | | | | | | | | | | | | | | | |

**Fig. II－1－4 (14) Geological log for drill hole**

MJNM-8 (3) 150m-225m

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No. | SAMPLE From (m) | SAMPLE To (m) | SAMPLE Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 155 | | DOLOMITE | 153.15-.35m slip plane argillization | | B-24 | 157.75 | | | | | | | | | | |
| 160 | | | fractured filled with dolospar<br>favourable for mineralisation<br>159.80m talc veining occurs<br>161.07m talc | | | | | | | | | | | | | |
| 165 | | | banded grey fractured dol. cal cemented | | | | | | | | | | | | | |
| | | SHALE | 166.50-167.85m calcareous black shale ∠15-20° | | | | | | | | | | | | | |
| 170 | | DOLOMITE | light grey with talc and cal. vein<br>171.37m ∠45° talc vein 5cm | | | | | | | | | | | | | |
| 175 | | | 173.37m<br>dark to light grey dolomite<br>porous seems penetrated by cal. veins<br>fractured | | | | | | | | | | | | | |
| 180 | | SHALE | 178.10-.90m black sandy shale ∠30°<br>light grey banded dolomite<br>179.30-180.00m sandy black shale<br>graded | | | | | | | | | | | | | |
| 185 | | DOLOMITE | light grey to white dol. ∠20°<br>local talc film veining<br>182.35m reddish shale seem<br>shale to grey sandy dol.<br>185.60-.75m chert | | | | | | | | | | | | | |
| 190 | | LIMESTONE | 187.55m<br>grey calcareous porous with flat lying<br>oolite layer intercalated | | T-12 | 188.70 | | | | | | | | | | |
| 195 | | | 190.02m<br>light grey to white calcareous dol.<br>calcite veining<br>∠20-70° variable<br>194.25m shale seem<br>196.60-.90m black sandy shale ∠15° | | | | | | | | | | | | | |
| 200 | | DOLOMITE | light grey dolomite<br>200.30-201.00m stromatolite or distorted<br>201.50-202.52m porous ls. calcitization | | | | | | | | | | | | | |
| | | SHALE | 202.52-203.05m black calcareous ∠5°<br>202.45m dol intense calcitization<br>coarse calcite crystals in druse | | | | | | | | | | | | | |
| 205 | | SHALE | 205.10-20m oolite layer<br>207.85m | | B-25 | 204.30 | | | | | | | | | | |
| 210 | | | grey dol. talc along the bed planes<br>211.65m | | | | | | | | | | | | | |
| 215 | | SHALE | black sandy shale med. to fin.<br>locally calcite spots | | | | | | | | | | | | | |
| 220 | | DOLOMITE | 215.32m<br>grey dol. banded fractured filled with cal.<br>217.40m talc layers<br>219.60m | | | | | | | | | | | | | |
| 225 | | | 224.75-225.30m oxidized pyrite | | | | | | | | | | | | | |

**Fig. II－1－4 (15) Geological log for drill hole**

MJNM-8 (4) 225m-300m

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No. | From (m) | To (m) | Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SHALE | 226.15m | | | | | | | | | | | | | |
| | | | 227.30-.60m pyrite network | | | | | | | | | | | | | |
| | | DOLOMITE | light grey dolomite | | P-2 | 227.80 | | | | | | | | | | |
| | | | 229.52-230.75m dark green dolerite | | B-26 | 229.52 | | | | | | | | | | |
| 230 | | | upper contact ∠60°5cm bleached zone | | T-13 | 230.75 | | | | | | | | | | |
| | | DOLERITE | lower contact 5cm pyrite zone | | X-6 | 230.75 | | | | | | | | | | |
| | | | black sandy shale | | | | | | | | | | | | | |
| | | | steeply dipping | | | | | | | | | | | | | |
| | | | 233.00m fractured filled with cal. | | | | | | | | | | | | | |
| 235 | | SHALE | | | | | | | | | | | | | | |
| | | | ∠60° | | | | | | | | | | | | | |
| | | | 237.45m oolite at the base | | | | | | | | | | | | | |
| 240 | | DOLOMITE | grey dol. talc layers ∠40° | | | | | | | | | | | | | |
| | | | 241.37m talc argillization zone | | | | | | | | | | | | | |
| | | | 241.52-.92m black banded dolomitic shale | | | | | | | | | | | | | |
| | | | 243.30-244.00m talc dominant | | | | | | | | | | | | | |
| 245 | | | | | | | | | | | | | | | | |
| | | | 245.15m | | | | | | | | | | | | | |
| | | DOLOMITE | grey dol. locally talc alteration | | | | | | | | | | | | | |
| | | | 248.00m ∠30° | | | | | | | | | | | | | |
| | | SHALE | dark grey to black dolomitic shale | | | | | | | | | | | | | |
| 250 | | | 249.80m ~cal.+dolospar+qtz vein rich | | | | | | | | | | | | | |
| | | | 280.85m | | | | | | | | | | | | | |
| | | | small cavity rich dol. | | | | | | | | | | | | | |
| | | DOLOMITE | crackled dol filled with dolspar+cal. | | | | | | | | | | | | | |
| 255 | | | 254.15-256.00m talc white vein rich | | | | | | | | | | | | | |
| | | | 256.47m ∠60-70° | | | | | | | | | | | | | |
| | | | calcareous sandstone | | | | | | | | | | | | | |
| | | SANDSTONE | | | | | | | | | | | | | | |
| 260 | | | | | | | | | | | | | | | | |
| | | | 261.40m | | T-14 | 261.79 | | | | | | | | | | |
| | | | upper 50cm white spotted dol. | | | | | | | | | | | | | |
| | | | detritus oolite | | | | | | | | | | | | | |
| 265 | | DOLOMITE | light grey vertical to steeply dipping | | | | | | | | | | | | | |
| | | | talc thin layers | | | | | | | | | | | | | |
| | | | 267.10-268.60m calcareous porous sand | | | | | | | | | | | | | |
| | | SANDSTONE | ∠30° | | | | | | | | | | | | | |
| | | SHALE | 269.40m banded dolomitic shale | | | | | | | | | | | | | |
| 270 | | | distorted bedding | | | | | | | | | | | | | |
| | | TALC | 271.43m pure white talc | | | | | | | | | | | | | |
| | | | spotted dol grey to light grey | | | | | | | | | | | | | |
| 275 | | | talc layers | | | | | | | | | | | | | |
| | | | 276.60-277.50m sandy calcareous dol. | | B-27 | 275.30 | | | | | | | | | | |
| | | | ∠50° | | | | | | | | | | | | | |
| 280 | | DOLOMITE | | | | | | | | | | | | | | |
| | | | grey dol. to argillaceous shale | | | | | | | | | | | | | |
| | | | 282.40-283.50m talc dominant zone | | | | | | | | | | | | | |
| 285 | | | | | | | | | | | | | | | | |
| | | | 289.52-.72m talc | | | | | | | | | | | | | |
| 290 | | | | | | | | | | | | | | | | |
| | | | basal 40cm sandy facies | | | | | | | | | | | | | |
| | | | 292.00-.45m black shale ∠20° | | | | | | | | | | | | | |
| | | | 292.97m Fe-ox vein(pseudo pyrite) | | | | | | | | | | | | | |
| 295 | | SHALE | 294.10m porous calcareous sandstone | | | | | | | | | | | | | |
| | | | 295.00m | | | | | | | | | | | | | |
| | | SANDSTONE | sandy dolomite less porous | | | | | | | | | | | | | |
| | | | bedding variable | | | | | | | | | | | | | |
| | | | 297.90-299.40m light grey dol. | | | | | | | | | | | | | |
| 300 | | | dolomitic shale ∠50°:STOP | | | | | | | | | | | | | |

**Fig. II −1−4 (16) Geological log for drill hole**

mineralisation is also recognized from 156m to 158m and from 161m to 162m.

In the lower part the grey dolomite is intercalated with black shale to black sandy dolomite (packstone) some tens centimetre to several metres thick.

From a depth of around 160m talc veins parallel to beds are present. Core logging showed that the beds dip 5 to 30°. Near the contact of dolerite dyke, a network mineralisation of pyrite occurs over 20cm. The diffractometric peaks of calcite, quartz and smectite as well as pyrite were detected. Under the microscope the limestone from 187m to 190m includes peloid and clastic calcite grains cemented by fine dolomite.

・ 229.52m-230.75m Dolerite

The dyke rock intrudes into the host rock at an angle of 60° forming bleached zone 5cm in width. Pyrite network 5cm wide occurs at the footwall side.

・ 230.75m-300.00m Dolomite ・ Shale

Fine grained dolomite is predominant in this section where it is intercalated with sandy dolomite and black dolomitic shale. Talc argillization is remarkable in the fine dolomite. Microscopic identification showed white spots in the dolomite from 261.40m to 267.10m were coarse subhedral crystals of dolomite which suggest right lateral detachment.

**MJNM-9**

・ 0.00m- 91.20m Calcrete・Kalahari sand

The lower part of calcrete consists of mottled pebbles from a depth of 50m. Kalahari sand occurs from 65m with black manganese stains and white argil identified to be palygoroskite in the cracks.

・ 91.20m-165.00m Dolomite/Shale alternate

The beds of grey sandy dolomite dip 30° to 50°. The cavities and fractures that occur are filled with reddish breccias and the Kalahari sand over 2m under the unconformity. The dolomite is intercalated with brown shale less than two metre thick. The section from 113m to 118m and from 124m to 128m is fractured and filled with calcite and quartz. This old fractured zone has a good potential for mineralisation. The grainstone is occasionally intercalated with thin beds of chert.

・ 165.00m-300.00m Grainstone

Sandy dolomite with frequent lenses of chert dominates. The first sphalerite mineralisation is evident at a depth of 186m where it is associated with silicification. Further mineralisation of sphalerite and galena dots occur from 231m to 253.60m. A vanadium mineral, possibly descloizite, occurs in the cracks overprinting the mineralisation. Under microscope veinlets of secondary dolomite and quartz were observed. From around 280m the formation consists of a black facies, similar to the lithofacies in

MJNM-9 (1) 0m- 75m

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No. | SAMPLE From (m) | SAMPLE To (m) | SAMPLE Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CALCRETE | black Mn-ox brown stained<br>sandy calcareous | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | |
| | | | brown stained cuttings | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| | | | aquifer | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | |
| | | | brown stained black cuttings | | | | | | | | | | | | | |
| 20 | | | reddish brown brick coloured | | | | | | | | | | | | | |
| 25 | | | black graphitic cuttings bearing<br>amber coloured<br>black cuttings rich | | | | | | | | | | | | | |
| 30 | | CALCRETE | | | | | | | | | | | | | | |
| 35 | | | reddish brown stained cuttings | | | | | | | | | | | | | |
| 40 | | | less pebble ~45m | | | | | | | | | | | | | |
| 45 | | | | | | | | | | | | | | | | |
| 50 | | | motley a few black cuttings | | | | | | | | | | | | | |
| 55 | | | | | | | | | | | | | | | | |
| 60 | | | possibly pebble bearing<br>black pale green red purple ± basic | | | | | | | | | | | | | |
| 65 | | | siliceous dark dark grey brown pebbles | | | | | | | | | | | | | |
| 70 | | KALAHARI-SAND | | | | | | | | | | | | | | |
| 75 | | | | | | | | | | | | | | | | |

**Fig. II —1—4 (17) Geological log for drill hole**

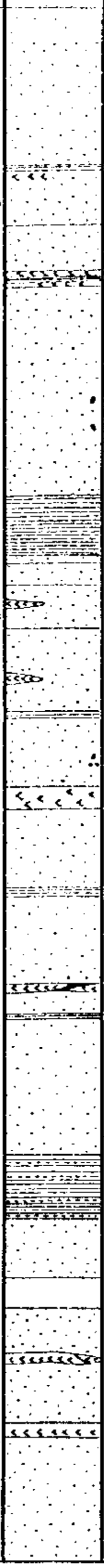
# MJNM-9 (2)

75m-150m

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No | From (m) | To (m) | Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Co (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 80<br>85 | | KALAHARI-SAND | reddish brown<br>fin-med argillaceous sand<br>black Mn stains+white clay veins<br>quartz + mica grains | | | | | | | | | | | | | |
| | | | | | B-28 | 87.65 | | | | | | | | | | |
| 90 | | DOLOMITE | base black dol. grainstone pebbles<br>91.20m<br>grey banded 91.40-.65m old cavities<br>filled with red breccia<br>93.47-.57m med. sandstone ∠30-40° | | | | | | | | | | | | | |
| 95 | | SHALE | 95.02-.87m brown shale//dol. | | B-29 | 95.02 | | | | | | | | | | |
| | | DOLOMITE | grey dol. shale patched, clay layers<br>Mn stains | | | | | | | | | | | | | |
| 100 | | SHALE | 101.00-.60m brownish yellow shale<br>103.50-.70m shale<br>104.10m 2cm thick chert | | | | | | | | | | | | | |
| 105<br>110 | | | dol intercalated with shale ∠45-50°<br>106.87-107.50m irregular chert<br>dark grey fine dol.<br>107.66-.85m shale<br>110.00m | | | | | | | | | | | | | |
| 115 | | SHALE | brownish yellow shale<br>112.30m<br>113.30m collapse breccia with calcite<br>115.60-116.65m | | X-7 | 113.30 | | | | | | | | | | |
| | | SHALE | 117.40-118.40m ∠25°<br>dark grey fin. dol. brown shale intercalated | | | | | | | | | | | | | |
| 120 | | | | | B-30 | 120.00 | | | | | | | | | | |
| 125 | | DOLOMITE | 121.00-.30m ∠20°<br>brownish shale 10-15cm thick intercalated ∠20°<br>dark grey dol. to sandy dol. with irreg. chert or silicification ∠45°<br>dark grey to black fine dolomite | | | | | | | | | | | | | |
| 130 | | SANDSTONE | 126.30-127.65m brown shale patch ∠70°<br>-128.70m black fin. to med sandy dol.<br>-129.50m brown shale partly chert ∠30° | | | | | | | | | | | | | |
| | | SHALE | black dol. fin. ss-shale<br>130.70-132.25m black graphitic shale | | T-15 | 132.00 | | | | | | | | | | |
| 135 | | DOLOMITE | dark grey fin. to med. sandy dol.<br>cherty irregular beds ∠30°<br>dolospar xtal in open cracks<br>136.70m black shale graphitic flextured/distorted | | | | | | | | | | | | | |
| 140 | | SHALE | | | | | | | | | | | | | | |
| 145<br>150 | | SANDSTONE | 145.57-145.35m black to dark grey fin. sandy dolomite cherty thin beds 1cm± abundant ∠20-30°<br>-147.85m black shale<br>-144.00m fine sandy dolomite | | | | | | | | | | | | | |

**Fig. II −1−4 (18) Geological log for drill hole**

MJNM-9 (3) 150m-225m



| DEPTH (m) | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No | SAMPLE From (m) | SAMPLE To (m) | SAMPLE Length (m) | CHEMCCAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | med sandy dol ∠20-30° | | | | | | | | | | | | | |
| | | brownish shale intercalated 1-2cm thick ∠45° | | | | | | | | | | | | | |
| | SANDSTONE | | | | | | | | | | | | | | |
| 155 | | bedding/stylolite ∠50° | | | | | | | | | | | | | |
| | | 157.72-.87m brown shale | | | | | | | | | | | | | |
| | | dark grey fin sandy dol. ∠50-60° | | | | | | | | | | | | | |
| 160 | | 160.58m sandstone 3 cm thick | | | | | | | | | | | | | |
| | | 162.77-163.65m dark grey to black chert //dol shale | | | | | | | | | | | | | |
| | | 163.95-164.20m light brown shale | | | | | | | | | | | | | |
| 165 | | 165.00m | | | | | | | | | | | | | |
| | | grey fin to med. sandy dolomite ∠20° | | | | | | | | | | | | | |
| | | intercalated with chert irreg beds | | | | | | | | | | | | | |
| 170 | | 169.80m green Vanadium mineral stains in cracks | | A-1 | 170.60 | 170.63 | 0.03 | < 1 | 0.50 | 6 | 811 | 220 | < 1 | 20 | < 1 |
| | | grey med dol accompanied with chert beds | | | | | | | | | | | | | |
| | | 173.60m | | | | | | | | | | | | | |
| 175 | SHALE | dark grey stratified fin ss to shale | | | | | | | | | | | | | |
| | | 175.40m ∠60° | | | | | | | | | | | | | |
| | | grey fin to med. sandstone with chert | | | | | | | | | | | | | |
| | | 177.00-.05m, 178.05-.10m, 180.20-.25m brown shale layers | | | | | | | | | | | | | |
| 180 | | 179.20-.60m chert//dol ss. | | | | | | | | | | | | | |
| | | 182.60-.70m chert | | | | | | | | | | | | | |
| | | 182.80m grey dolomitic fin ss to shale | | | | | | | | | | | | | |
| | | 184.10-.55m brown shale | | | | | | | | | | | | | |
| | | grey dolomitic sandstone | | | | | | | | | | | | | |
| 185 | | 185.27-.52m chert in part sphalerite mineralisation | | A-2 | 156.35 | 156.37 | 0.02 | 9 | 0.95 | 10 | 11 | 32 | < 1 | 7 | < 1 |
| | | 187.00-.30m chert with old fractures | | | | | | | | | | | | | |
| | CHERT | 187.70-188.90m chert or silicification zone of dol ss. | | I-16 | 188.30 | | | | | | | | | | |
| 190 | | med dolomitic sandstone ∠30° | | | | | | | | | | | | | |
| | | 192.59-.69m, 192.90-193.00m brown shale ∠30° | | | | | | | | | | | | | |
| 195 | | 197.35-.70m thin brown chert lenses in dark grey dol shale | | | | | | | | | | | | | |
| | | 198.60-.90m shale | | | | | | | | | | | | | |
| 200 | | fine sandstone | | | | | | | | | | | | | |
| | SANDSTONE | thin chert 0.2-3 cm | | | | | | | | | | | | | |
| | | stylolite ∠20° | | | | | | | | | | | | | |
| 205 | | 205.70m | | | | | | | | | | | | | |
| | SHALE | fine dol ss to shale | | | | | | | | | | | | | |
| | | 208.70m | | | | | | | | | | | | | |
| 210 | | med to crs. dolomitic sandstone | | B-31 | 210.10 | | | | | | | | | | |
| | | 211.55m | | | | | | | | | | | | | |
| | | grey fine dolomite | | | | | | | | | | | | | |
| | DOLOMITE | 212.25-.35m brown shale ∠20° | | | | | | | | | | | | | |
| | | 212.95-213.80m med ss. 10cm chert intercalated | | | | | | | | | | | | | |
| 215 | OOLITE | 215.10-.60m chert/oolite chert | | | | | | | | | | | | | |
| | CHERT | 218.45-219.20m chert or silicified dol. chert thin beds ∠20° | | | | | | | | | | | | | |
| 220 | | | | | | | | | | | | | | | |
| | SANDSTONE | | | | | | | | | | | | | | |
| 225 | | | | | | | | | | | | | | | |

**Fig. II —1—4 (19) Geological log for drill hole**

| DEPTH (m) | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No | From (m) | To (m) | Length (m) | Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 228.37-.55m local black shale | | | | | | | | | | | | | |
| 230 | | 231.10m,231.85m,232.50m,234.75m | | A-3 | 231.63 | 232.20 | 0.57 | 9 | 0.20 | 9 | 100 | 14 | 1 | 13 | < 1 |
| | | sphalerite ± yellow brown vanadium | | A-4 | 232.20 | 232.55 | 0.35 | 4 | 0.20 | 6 | 120 | 56 | < 1 | 5 | < 1 |
| | | 233.30-.40m dolospar associated with | | A-5 | 233.36 | 233.46 | 0.10 | 24 | 0.20 | 5 | 95 | 42 | < 1 | 5 | < 1 |
| | SANDSTONE | sphalerite | | A-6 | 234.20 | 234.30 | 0.10 | 2 | 0.50 | 12 | 322 | 5810 | 15 | 5 | < 1 |
| 235 | | | | A-7 | 234.73 | 234.82 | 0.09 | 13 | 0.95 | 10 | 560 | 108 | < 1 | 21 | < 1 |
| | | 235.25-.50m tiny dots of V yellow within | | A-8 | 235.30 | 235.55 | 0.25 | < 1 | 0.20 | 6 | 49 | 114 | < 1 | < 1 | < 1 |
| | | cracks | | P-3 | 232.07 | | | | | | | | | | |
| | DOLOMITE | 236.80-237.65m black fine dolomite | | P-4 | 241.97 | | | | | | | | | | |
| | | | | P-5 | 242.90 | | | | | | | | | | |
| 240 | | med dol ss | | T-17 | 243.40 | | | | | | | | | | |
| | | 240.20m vanadium mineral in crack | | P-6 | 243.15 | | | | | | | | | | |
| | | 241.95m thin chert | | A-9 | 241.97 | 242.60 | 0.73 | < 1 | 0.50 | 9 | 142 | 250 | 1 | 34 | 2 |
| | | 242.45m,242.90m,243.05m,243.92m | | A-10 | 242.60 | 243.35 | 0.75 | < 1 | 1.25 | 18 | 1560 | 8300 | 36 | 2 | 2 |
| | | sphalerite spots ± yellow films of V2O5 | | A-11 | 243.35 | 244.00 | 0.65 | < 1 | 0.50 | 5 | 288 | 95 | < 1 | 7 | < 1 |
| 245 | | med dol ss. ∠40° | | A-12 | 245.75 | 246.15 | 0.40 | < 1 | 0.65 | 13 | 269 | 142 | < 1 | 27 | 2 |
| | OOLITE | 246.75-247.00m oolite chert | | A-13 | 248.10 | 248.64 | 0.54 | 26 | 0.50 | 9 | 275 | 3130 | 14 | 3 | 1 |
| | | | | A-14 | 248.79 | 248.93 | 0.14 | 12 | 0.50 | 5 | 176 | 416 | 3 | 17 | 1 |
| | | 248.10-.85m intermittent sphalerite | | A-15 | 249.52 | 249.65 | 0.10 | 87 | 0.20 | 7 | 75 | 71 | < 1 | 17 | 2 |
| | | fracture filling mineralisation | | P-7 | 249.10 | | | | | | | | | | |
| 250 | | | | B-32 | 248.64 | | | | | | | | | | |
| | DOLOMITE | grey fine dolomite | | A-16 | 251.35 | 251.45 | 0.1 | < 1 | 0.50 | 12 | 152 | 541 | 31 | 13 | 1 |
| | | 251.45-.55m oolite chert/white to light grey fine dol ss. | | P-8 | 251.40 | | | | | | | | | | |
| | SHALE | 251.60-.75m fractured yellow V2O5 | | | | | | | | | | | | | |
| 255 | | 252.90-253.75m brown shale/spotted dark grey dolomite ∠40°sphalerite diss. | | | | | | | | | | | | | |
| | | grey dol distorted bedding or stromatolite,crackled with talc | | | | | | | | | | | | | |
| 260 | | dark grey dol. | | | | | | | | | | | | | |
| | | 262.50-.60m chert | | | | | | | | | | | | | |
| | | -263.40m dark grey med ss. ∠50°～∠60° | | | | | | | | | | | | | |
| | | yellowish green grains+vanadium | | | | | | | | | | | | | |
| 265 | DOLOMITE | dark grey fossil spotted(oolite?) | | | | | | | | | | | | | |
| | | dark grey fin ss to dol. | | | | | | | | | | | | | |
| | | 265.90m grey porous calc ss. with 20cm thick dolomite | | | | | | | | | | | | | |
| | | 268.55m grey to dark grey dol flexured with black/white stripes | | | | | | | | | | | | | |
| 270 | | | | | | | | | | | | | | | |
| | | 272.00-.10m chert | | | | | | | | | | | | | |
| | | 272.80-274.50m dark grey med sandy dol. | | | | | | | | | | | | | |
| | SANDSTONE | upper most calcareous | | | | | | | | | | | | | |
| 275 | | 274.10-.20m silicified zone | | | | | | | | | | | | | |
| | | dark grey spotted dol. | | | | | | | | | | | | | |
| | | 275.20m | | | | | | | | | | | | | |
| | | bedding vertical | | | | | | | | | | | | | |
| | | 277.45-.55m chert | | | | | | | | | | | | | |
| 280 | | in part porous sandstone | | | | | | | | | | | | | |
| | | 280.35-.45m chert black stripe ss. | | | | | | | | | | | | | |
| | | 281.55m | | | | | | | | | | | | | |
| | DOLOMITE | spotted dol brown shale intercalated | | | | | | | | | | | | | |
| | | 284.00m | | | | | | | | | | | | | |
| 285 | | dark grey fin ss. partly crackled | | | | | | | | | | | | | |
| | | 285.65-286.10m | | | | | | | | | | | | | |
| | | ∠70° | | | | | | | | | | | | | |
| | | dark grey med ss partly silicified | | | | | | | | | | | | | |
| | | ∠45° | | | | | | | | | | | | | |
| 290 | SANDSTONE | | | | | | | | | | | | | | |
| | | 291.45-292.00m dol. basal facies shale | | | | | | | | | | | | | |
| | | 292.35-.60m oblique chert 3cm thick | | | | | | | | | | | | | |
| | | 292.90-293.80m dol. ∠70° | | | | | | | | | | | | | |
| 295 | | 293.80-294.75m dol ss. | | | | | | | | | | | | | |
| | | brownish cream shale intercalated | | | | | | | | | | | | | |
| | DOLOMITE | ∠40-45° | | | | | | | | | | | | | |
| | | 297.90m | | | | | | | | | | | | | |
| | | ∠60-70° | | | | | | | | | | | | | |
| 300 | | STOP | | T-18 | 299.50 | | | | | | | | | | |

**Fig. II −1−4 (20) Geological log for drill hole**

MJNM-2.

**MJNM-10**

- 0.00m-117.95m Calcrete・Kalahari sand

The upper 91.85 metres from the surface consists of sandy calcrete and pale purple pebble bearing calcrete in descending order. Microscopic observation showed round clastic fragments of chert, andesite, dolomite and biotite schist embedded in fine calcareous matrix. From 91.85m the formation consists of psammitic sediment with characteristic of reddish argil.

- 117.95m-259.90m Grainstone・Dolomitic shale

Dark grey to grey calcareous sandstone and black dolomitic shale predominate with flat flying chert and oolite. Microscopic identification revealed that the chert was originated from oolite and the weed was silicified. Stromatolitic texture was recognized at around 165m.

- 259.90m-263.00m Dolerite

The upper and lower dips of the contact between dolomite and dolerite are steep anep and horizontal respectively. The dyke rock has dark green, medium to coarse magnetite and phenocrysts of altered pyroxene. X-ray diffractometry detected chlorite, smectite and calcite at 262m.

- 263.00m-300.00m Calcareous sand・Black shale

Down from a depth of 270m the formation changes into light grey facies with intense talc argillization from particularly 270m to 280m.

**MJNM-11**

- 0.00m- 32.05m Calcrete

It is a greyish white pebble calcrete which is locally argillaceous at the intersection with the aquifer.

- 32.05m-174.00m Sandstone of Mulden group

The formation is dark green and pale cream medium grained sandstone with weathered brittle zone over 10m from the unconformity. The sandstone is well sorted, arkosic and the grey band and reddish band repeat alternatively.

Disseminated pyrite occurs parallel to the horizontal beds suggesting syndepositional origin. The pyrite mineralisation is limited to the grey facies and is weak or absent in the dark green and reddish purple facies.

The matrix is poor and the calstic minerals are poorly grinded. The clastic minerals of grey facies consist of quartz, microcline, muscovite, tourmaline and pyrite under the microscope. The cross bedding occurs over 1.4m at around 160m suggesting litral or fluvial environment. The boundary of underlying Tsumeb subgroup is not obvious, however the non conformity was determined where calcareous sediment started.

MJNM-10 (1) 0m- 75m

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No. | SAMPLE From (m) | SAMPLE To (m) | SAMPLE Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CALCRETE | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | |
| | | | motley stains | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | | | |
| 30 | | CALCRETE | | | | | | | | | | | | | | |
| 35 | | | | | | | | | | | | | | | | |
| 40 | | | | | | | | | | | | | | | | |
| 45 | | | | | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | | | | | |
| 55 | | | | | | | | | | | | | | | | |
| 60 | | | | | | | | | | | | | | | | |
| 65 | | | | | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | | | | | |
| 75 | | | | | | | | | | | | | | | | |

**Fig. II − 1 − 4 (21) Geological log for drill hole**

MJNM-10 (2) 75m-150m

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No. | SAMPLE From (m) | SAMPLE To (m) | SAMPLE Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 80 | | CALCRETE | purple brown with grey bands<br>sandy calcrete<br>Mn oxide stains | | T-19<br>B-33 | 83.8<br>83.80 | | | | | | | | | | |
| 85 | | | | | | | | | | | | | | | | |
| 90 | | | 91.85m locally pebble bearing | | | | | | | | | | | | | |
| 95 | | | sandy calcrete: matrix red argil with white clay veins | | | | | | | | | | | | | |
| 100 | | | | | | | | | | | | | | | | |
| 105 | | KALAHARI-SAND | | | | | | | | | | | | | | |
| 110 | | | | | | | | | | | | | | | | |
| 115 | | | 117.95m | | | | | | | | | | | | | |
| 120 | | DOLOMITE | dark grey dol. 10-20cm thick argil sandy shale and chert lenses intercalated calcareous<br>123.80m chert 5cm thick<br>black shale not stratified | | | | | | | | | | | | | |
| 125 | | SHALE | 127.00-.75m sandy dol.<br>128.10-.24m chert | | | | | | | | | | | | | |
| 130 | | | 131.43-.80m oolite fossil calc shale<br>black shale not bedded<br>133.19-.25m,133.32-.43m chert<br>133.90-134.00m crs sandy chert | | T-20 | 131.43 | | | | | | | | | | |
| 135 | | SHALE | 134.30-135.40m reddish brown shale<br>light grey fin. cal sand<br>138.30-139.20m siliceous sandstone flat lying | | | | | | | | | | | | | |
| 140 | | | dark grey to black fine calcareous sand<br>143.10-.50m siliceous sand | | B-34 | 143.30 | | | | | | | | | | |
| 145 | | SANDSTONE | | | | | | | | | | | | | | |
| 150 | | OOLITE | 148.80-149.10m oolitic chert<br>-149.90m grey massive dol. | | | | | | | | | | | | | |

**Fig. II−1−4 (22) Geological log for drill hole**

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No. | From (m) | To (m) | Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DOLOMITE | 151.59m dark grey sandstone<br>152.03-.17m chert oolitic sand $\angle 10^\circ$ | | | | | | | | | | | | | |
| 155 | | | 157.55-.79m reddish yellow clay $\angle 10^\circ$ | | | | | | | | | | | | | |
| 160 | | SANDSTONE | calcareous sand $\angle 30^\circ$<br>161.80-162.40m black shale<br>light pale browinish grey dolomite<br>partly stromatolitic texture<br>chert thin beds intercalated | | | | | | | | | | | | | |
| 165 | | DOLOMITE | 165.49m relict pyrite<br>calcite vein $\angle 20^\circ$<br>chert lense $\angle 10^\circ$ | | | | | | | | | | | | | |
| 170 | | | 171.65-.80m chert<br>172.45m<br>light grey white fine sandstone<br>black dots=calcite stylolite $\angle 20^\circ$<br>vertical calcite + talc veins | | | | | | | | | | | | | |
| 175 | | | 175.80m<br>pale brn grey sandy dol.+chert<br>locally dark grey $\angle 45^\circ$ | | | | | | | | | | | | | |
| 180 | | | | | | | | | | | | | | | | |
| 185 | | | 185.15m reddish dolomite facies | | | | | | | | | | | | | |
| | | SHALE | 188.40m<br>reddish dolomitic shale $\angle 5^\circ$ | | B-35 | 188 60 | | | | | | | | | | |
| 190 | | | 190.10m<br>med.to fin.dolomite locally sandy<br>well bedded<br>193.59-194.09m chert | | | | | | | | | | | | | |
| 195 | | DOLOMITE | slightly calcareous dol.<br>tension gash filled with dolospar | | | | | | | | | | | | | |
| 200 | | | 201.50m stromatolitic texture or distorted bedding | | | | | | | | | | | | | |
| | | SHALE | 201.85-202.80m dark grey dolomite | | | | | | | | | | | | | |
| 205 | | SANDSTONE | sandy dol. showing graded texture/fin. dol alt. well stratified<br>207.22-208.45m black dolomitic shale<br>finely alternative $\angle 5\text{-}10^\circ$ | | | | | | | | | | | | | |
| 210 | | | black stripe dolomite<br>213.20m | | | | | | | | | | | | | |
| | | DOLOMITE | light grey dolomite | | | | | | | | | | | | | |
| 215 | | SHALE | 216.75-218.50m black dol shale $\angle 10^\circ$<br>218.00-.50m open crack | | | | | | | | | | | | | |
| 220 | | DOLOMITE | 220.65m ~ talc vein dominant<br>223.07-.27m talc fractured zone<br>223.37-224.00m black dol shale | | | | | | | | | | | | | |
| 225 | | | | | | | | | | | | | | | | |

**Fig. II −1−4 (23) Geological log for drill hole**

# MJNM-10 (4) 225m-300m

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No | SAMPLE From (m) | SAMPLE To (m) | SAMPLE Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 225.00-.31m talc | | | | | | | | | | | | | |
| | | | 229.50-.60m talc | | | | | | | | | | | | | |
| 230 | | | | | | | | | | | | | | | | |
| | | SHALE | black to dark grey dol shale ∠0-10° | | | | | | | | | | | | | |
| | | | 234.40m | | | | | | | | | | | | | |
| 235 | | | grey dolomite locally sandy ∠30° | | | | | | | | | | | | | |
| | | | 235.50-75m talc | | | | | | | | | | | | | |
| | | | 236.50m～sandy dol / black dol shale alt. | | | | | | | | | | | | | |
| | | SAND// SHALE | | | | | | | | | | | | | | |
| 240 | | | | | | | | | | | | | | | | |
| | | | black dol. | | | | | | | | | | | | | |
| | | | 243.25-.35m shale argil | | | | | | | | | | | | | |
| | | | balck sandy dolomite ∠30° | | | | | | | | | | | | | |
| 245 | | | | | | | | | | | | | | | | |
| | | | 245.00-.88m black shale | | | | | | | | | | | | | |
| | | | black med. dol sandstone stratified, | | | | | | | | | | | | | |
| | | SANDSTONE | 249.60m graded | | | | | | | | | | | | | |
| 250 | | | dark grey fine massive dol. | | | | | | | | | | | | | |
| | | DOLOMITE | 250.75-251.00m crackled | | | | | | | | | | | | | |
| | | | 251.72m ∠45° | | | | | | | | | | | | | |
| | | | dolomitic shale predominant G1918 | | | | | | | | | | | | | |
| 255 | | | talc intercalated | | | | | | | | | | | | | |
| | | | 255.60m | | | | | | | | | | | | | |
| | | | grey to black fine sandy dolomite | | | | | | | | | | | | | |
| | | | partly black shale | | | | | | | | | | | | | |
| 260 | | | 259.90m steep boundary | | | | | | | | | | | | | |
| | | | black magnetite grains rich | | B-36 | 261.90 | | | | | | | | | | |
| | | DOLERITE | altered olivine phenocrysts bearing | | X-8 | 262.00 | | | | | | | | | | |
| | | | 263.06m | | | | | | | | | | | | | |
| | | | 263.56-.90m sandy facies ∠20° | | | | | | | | | | | | | |
| 265 | | | | | | | | | | | | | | | | |
| | | SHALE | | | | | | | | | | | | | | |
| | | | 269.30m dark grey fine sandy dol. | | P-9 | 269.10 | | | | | | | | | | |
| 270 | | | | | | | | | | | | | | | | |
| | | SANDSTONE | light grey med ss. pink talc ∠20° | | | | | | | | | | | | | |
| | | | 272.30m | | | | | | | | | | | | | |
| 275 | | | intense talc argilization | | | | | | | | | | | | | |
| | | SHALE | | | | | | | | | | | | | | |
| 280 | | | 280.00m | | | | | | | | | | | | | |
| | | | uppermost 40cm porous calcareous sandy dolomite | | | | | | | | | | | | | |
| | | | light grey fine sand | | | | | | | | | | | | | |
| 285 | | | | | | | | | | | | | | | | |
| | | | 285.80-285.20m brown shale purple spots | | | | | | | | | | | | | |
| | | | -.65m sandy dolomite ∠20° | | | | | | | | | | | | | |
| | | | grey massive dolomite with basal chert | | | | | | | | | | | | | |
| | | | 288.55m | | | | | | | | | | | | | |
| 290 | | | | | | | | | | | | | | | | |
| | | | calcareous sandstone with black stripes | | | | | | | | | | | | | |
| | | | dolomitic shale | | | | | | | | | | | | | |
| | | DOLOMITE | oolite fragments predominant | | | | | | | | | | | | | |
| 295 | | | | | | | | | | | | | | | | |
| | | | 295.90-296.85m light grey mud | | | | | | | | | | | | | |
| | | | 297.80m | | | | | | | | | | | | | |
| | | | fine dolomitic bedded sandstone ∠10° | | | | | | | | | | | | | |
| 300 | | | STOP | | | | | | | | | | | | | |

**Fig. II－1－4 (24) Geological log for drill hole**

## MJNM-11 (1) 0m- 75m

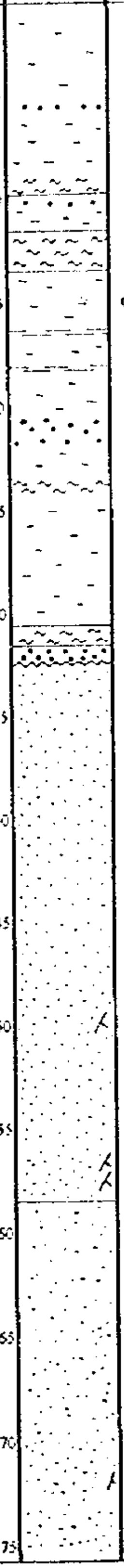
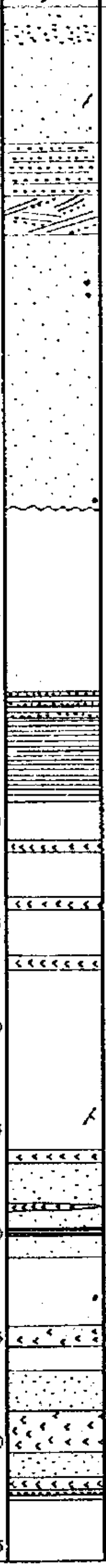
| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No. | SAMPLE From (m) | SAMPLE To (m) | SAMPLE Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| |  | | black Mn oxide stains/stripes and dots<br>light grey to white calcrete<br>pebble 1-2cm ϕ | | | | | | | | | | | | | |
| 5 | | | chert dolomite pebbles in reddish matrix<br>argillaceous calcrete | | | | | | | | | | | | | |
| 10 | | | 11.00-12.85m argillaceous calcrete<br>14.60-15.00m porous calcrete | | | | | | | | | | | | | |
| 15 | | CALCRETE | 15.80-.90m<br>16.10-.20m 16.40-.50m aquifers<br>17.15-.55m 17.70-.75m aquifers<br>black Mn-oxide stains rich<br>18.20m argillaceous calcrete | | | | | | | | | | | | | |
| 20 | | | brown round pebbles 2-3cm ϕ<br>white calcareous matrix<br>23.10-.70m reddish brown argillaceous calcrete | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | | | |
| 30 | | | 30.25-31.25m reddish argillaceous quartziferous basal facies<br>32.05m | | | | | | | | | | | | | |
| 35 | | | MULDEN GROUP sandstone<br>soft brown to pale green medium sand-stone in part argillaceous | | | | | | | | | | | | | |
| 40 | | | well sorted, no graded texture<br>43.26m stuff formation but still soft greenish brown ∠5° | | | | | | | | | | | | | |
| 45 | | | 46.35m white sand with brown stains<br>47.00-.25m 48.00m yellow clay mineral in cracks<br>arkose sandstone py+mgt | | | | | | | | | | | | | |
| 50 | | MULDEN SANDSTONE | 49.75m quartz vein 5cm thick<br>yellow mineral rich<br>51.00m ~ moderate pyrite dissemination<br>dark green ss band 5cm band ∠5° | | | | | | | | | | | | | |
| 55 | | | 56.25-.27m quartz vein, 56.95-57.06m quartz vein+pyrite<br>57.95-58.05m dark green fine sand<br>quartz vein abundant | | | | | | | | | | | | | |
| 60 | | | 59.07m green sandstone<br>62.65m purplish green facies with less pyrite dissemination | | | | | | | | | | | | | |
| 65 | | | crs to med. sandstone | | | | | | | | | | | | | |
| 70 | | | purple//green facies alt.<br>71.40-.45m flat lying quartz vein<br>crs quartz and mafic mineral | | | | | | | | | | | | | |
| 75 | | | fine to med ss. | | | | | | | | | | | | | |

**Fig. II −1−4 (25) Geological log for drill hole**

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No. | From (m) | To (m) | Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Cr (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 75.50m green med ss<br>green facies | | | | | | | | | | | | | |
| 80 | | | | | | | | | | | | | | | | |
| | | | 81.25-81.60m pyrite spots and impregnated<br>81.45m bleached zone<br>81.60m light greenish grey fin.ss ∠5°<br>84.32m ~ pyrite disseminated | | B-38 | 84.32 | | | | | | | | | | |
| 85 | | | 84.75m py.concentrated band 2cm thick | | | | | | | | | | | | | |
| | | | 87.35m green stratified bands ∠10°<br>quartz vein 4cm thick with pink feldspar | | | | | | | | | | | | | |
| 90 | | | | | | | | | | | | | | | | |
| | | | white cream with moss green stripes+weak<br>pyrite ∠20°<br>93.10m purple greyish green sand<br>93.60m,93.75m,96.60m quartz veins+py. | | | | | | | | | | | | | |
| 95 | | | | | | | | | | | | | | | | |
| | | | 97.80m,98.00-98.20m quartz veins ∠0-30° | | | | | | | | | | | | | |
| 100 | | | | | | | | | | | | | | | | |
| 105 | | MULDEN SANDSTONE | micaceous mineral bearing<br>dark green//purple facies alt. | | B-39 | 105.40 | | | | | | | | | | |
| 110 | | | | | | | | | | | | | | | | |
| | | | 110.85m light greenish grey facies | | A-17 | 110.60 | 110.70 | 0.10 | < 1 | 0.05 | 7 | 11 | 25 | < 1 | 32 | 6 |
| | | | 112.10m moderate pyrite impregnation<br>upper 20cm dark green<br>114.86m pyrite concentrated | | B-40 | 115.00 | | | | | | | | | | |
| 115 | | | | | | | | | | | | | | | | |
| | | | light grey facies with pyrite imp. | | | | | | | | | | | | | |
| | | | graded texture | | | | | | | | | | | | | |
| 120 | | | | | | | | | | | | | | | | |
| | | | 120.86m green facies stratified fin.to med. | | B-41 | 120.86 | | | | | | | | | | |
| | | | 124.50m | | | | | | | | | | | | | |
| 125 | | | med.to crs graded sandstone | | | | | | | | | | | | | |
| | | | 126.75m<br>light greenish grey med.to crs.<br>weak to moderate pyrite mineralisation | | | | | | | | | | | | | |
| 130 | | | | | | | | | | | | | | | | |
| | | | 131.70m dark green facies locally purple<br>facies medium grained<br>133.15m light grey to white sandstone<br>weak py mineralisation | | | | | | | | | | | | | |
| 135 | | | locally greyish green stripes ∠5-10° | | | | | | | | | | | | | |
| | | | 139.75-80m horizontal green band of sand | | | | | | | | | | | | | |
| 140 | | | | | | | | | | | | | | | | |
| | | | 142.00m green//purple facies | | B-42 | 140.55 | | | | | | | | | | |
| | | | fine to coarse graded | | | | | | | | | | | | | |
| 145 | | | | | | | | | | | | | | | | |
| | | | 147.65-148.00m dark green fine ss.<br>mafic grains rich<br>white to light grey facies | | | | | | | | | | | | | |
| 150 | | | 149.40m dark green coarser facies to | | | | | | | | | | | | | |

**Fig. II −1−4 (26) Geological log for drill hole**



| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No | SAMPLE From (m) | SAMPLE To (m) | SAMPLE Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | grey finer facies | | | | | | | | | | | | | |
| | | | 150.75-151.65m mottled crs ss. | | | | | | | | | | | | | |
| | | | fine to medium sandstone | | | | | | | | | | | | | |
| | | | dark green stripes bedded ss | | | | | | | | | | | | | |
| 155 | | | 154.90-.93m quartz vein parallel to bedding plane | | | | | | | | | | | | | |
| | | | no mineralised dark green stripes | | | | | | | | | | | | | |
| | | | 156.40m dark green fine sand ∠30° calcareous | | | | | | | | | | | | | |
| 160 | | | 159.75m cross bedded dark green calc. fine sandstone | | | | | | | | | | | | | |
| | | MULDEN SANDSTONE | 161.10m light grey med ss. bedding obscure. moderately diss. pyrite | | | | | | | | | | | | | |
| | | | 163.25-.30m,163.65-.70m,164.20m,164.50- | | | | | | | | | | | | | |
| 165 | | | .65m 164.90m pyrite rich layers | | | | | | | | | | | | | |
| | | | pale greenish grey facies | | | | | | | | | | | | | |
| | | | 166.93m grey pyrite diss. weak or | | | | | | | | | | | | | |
| | | | very weak, partly moderate to intense | | | | | | | | | | | | | |
| 170 | | | ∠10° | | | | | | | | | | | | | |
| | | | | | B-43 | 172.50 | | | | | | | | | | |
| | | | lowermost 1m dotted pyrite mineralised | | | | | | | | | | | | | |
| | | | 174.30m | | | | | | | | | | | | | |
| 175 | | | grey stylolite dolomitic sandstone | | | | | | | | | | | | | |
| | | | crs.to med. locally intercalated with | | | | | | | | | | | | | |
| | | | 10cm thich black shale | | | | | | | | | | | | | |
| | | | med.to fin. | | | | | | | | | | | | | |
| 180 | | DOLOMITE | | | | | | | | | | | | | | |
| | | | 183.70m | | | | | | | | | | | | | |
| | | | dark grey to black dolomitic shale to | | | | | | | | | | | | | |
| 185 | | | fine ss. | | | | | | | | | | | | | |
| | | | 184.65-.72m calcareous white dots | | | | | | | | | | | | | |
| | | | poorly sorted black fine to med shale | | | | | | | | | | | | | |
| | | SHALE | 188.50m | | | | | | | | | | | | | |
| | | | gradually to light grey to grey fine | | | | | | | | | | | | | |
| 190 | | | dolomite | | | | | | | | | | | | | |
| | | OOLITE CHERT | 191.60m,192.00m,192.50-193.00m | | | | | | | | | | | | | |
| | | | lost circulation | | | | | | | | | | | | | |
| | | | 193.16-.78m dark grey oolitic chert | | | | | | | | | | | | | |
| 195 | | | intercalated with dolomite | | | | | | | | | | | | | |
| | | | grey grainstone flat-lying fine to med. | | | | | | | | | | | | | |
| | | | 195.85-195.60m oolite chert | | | | | | | | | | | | | |
| | | | fine dolomite ∠5° | | | | | | | | | | | | | |
| 200 | | | 200.70-.90m fractured around stylolite | | | | | | | | | | | | | |
| | | DOLOMITE | | | | | | | | | | | | | | |
| | | | 203.85-.92m quartz vein+oxide | | | | | | | | | | | | | |
| 205 | | | | | | | | | | | | | | | | |
| | | OOLITE | 205.30-206.05m oolitic chert | | | | | | | | | | | | | |
| | | | grey dol.fine to med.ss. | | | | | | | | | | | | | |
| | | SANDSTONE | | | | | | | | | | | | | | |
| | | | 208.15-.35m oolite chert | | | | | | | | | | | | | |
| 210 | | | 209.20-.70m brown shale | | | | | | | | | | | | | |
| | | | 210.30-.32m dolospar 210.70m brown shale | | | | | | | | | | | | | |
| | | | 211.40m fractured | | | | | | | | | | | | | |
| | | DOLOMITE | 212.65m silicified with pyrite | | | | | | | | | | | | | |
| | | | 214.00-215.00m oolite chert | | | | | | | | | | | | | |
| 215 | | OOLITE | cream coloured bedded dol. | | | | | | | | | | | | | |
| | | | 216.50m chert 7cm thick,grainstone | | | | | | | | | | | | | |
| | | SANDSTONE | 218.65m oolite chert intercalated with | | | | | | | | | | | | | |
| | | | dolomite in the lowermost | | | | | | | | | | | | | |
| 220 | | OOLITE | 220.05m | | | | | | | | | | | | | |
| | | | 221.35-.85m oolite chert | | | | | | | | | | | | | |
| | | | -222.45m black ss to fine dol. ∠30° | | | | | | | | | | | | | |
| | | | 222.45m grey to light grey dol finely | | | | | | | | | | | | | |
| 225 | | | bedded ∠10-15°to grainstone | | | | | | | | | | | | | |

**Fig. II −1−4 (27) Geological log for drill hole**

## MJNM-11 (4) 225m-300m

| DEPTH (m) | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No | From (m) | To (m) | Length (m) | Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | chert beds intercalated 2cm thick | | | | | | | | | | | | | |
| | | 228.50m dark grey facies<br>sandy layers intercalated | | | | | | | | | | | | | |
| 230 | | 230.15-.85m oolitic chert | | | | | | | | | | | | | |
| | OOLITE | | | | | | | | | | | | | | |
| | | cream coloured fine dol stylolite<br>locally porous | | | | | | | | | | | | | |
| 235 | | 234.80m oxide ore vein 10 cm wide<br>235.48-236.20m oolite black crs 3-4m/m<br>236.93-237.00m chert diss with pyrite | | | | | | | | | | | | | |
| | | grey dol to med. bedded ss. | | | | | | | | | | | | | |
| 240 | | 239.45-.50m chert 5cm thick<br>fine to med. dolomitic sandstone<br>240.60-.82m, 90-.95m,241.15-.22m chert | | | | | | | | | | | | | |
| | DOLOMITE | brown shale 0.5cm | | B-44 | 243.30 | | | | | | | | | | |
| 245 | | fine dol. intercalated with chert ∠10° | | | | | | | | | | | | | |
| | | 246.80-248.05m fractured with red films | | | | | | | | | | | | | |
| 250 | | 249.25-.45m sandy dolomite | | | | | | | | | | | | | |
| | | fine grey dol. with thin chert | | | | | | | | | | | | | |
| | | 254.70-255.25m fossiliferous | | | | | | | | | | | | | |
| 255 | | 255.45-.70m sandy dolomite<br>dolostone vugs<br>-257.65m sand/fine dol. alt. | | | | | | | | | | | | | |
| 260 | | 260.36m 1cm thick shale | | | | | | | | | | | | | |
| | | grey dolomite | | | | | | | | | | | | | |
| 265 | | grey to dark grey fine dolomite with chert beds | | | | | | | | | | | | | |
| | | 268.05-.35m black oolite chert<br>268.70m Fe-ox quartz vein | | | | | | | | | | | | | |
| 270 | | 269.50m sandy dolomite | | P-10 | 270.70 | | | | | | | | | | |
| | | 269.90m vanadium mineral in dolospar<br>270.70-.75m calcite+Cu sulphide | | A-18 | 270.70 | 270.75 | 0.05 | < 1 | 2.95 | 283 | 1760 | 260 | 4 | 208 | 1 |
| | SANDSTONE | 272.30-.50m fractured 272.40m V+Cu oxide<br>-274.30m collapse breccia | | A-19 | 272.30 | 272.50 | 0.20 | < 1 | 0.95 | 270 | 1100 | 507 | 11 | 157 | 2 |
| 275 | | vertical reddish dol. breccia some m/m<br>to 2cm angular Fe-ox rich<br>274.80m<br>dark med ss. + chert ∠10° | | | | | | | | | | | | | |
| 280 | | 280.00m<br>dark grey fine dolomite intercalated<br>with chert less than 10cm ∠20°<br>283.15-.75m chert oolite ∠30°<br>283.50-.55m chert pyrrhotite+pyrite imp. | | | | | | | | | | | | | |
| 285 | DOLOMITE | | | | | | | | | | | | | | |
| | | 287.80-288.50m collapse breccia or fault<br>288.10-.60m ditto<br>288.75m black fine dol shale | | B-45 | 288.45 | | | | | | | | | | |
| 290 | | 289.50-290.95m fractured reddish network | | | | | | | | | | | | | |
| | | grey med ss dol. with black chert thin beds intercalated<br>293.73-293.83m chert ∠15° | | | | | | | | | | | | | |
| 295 | | fine dolomite with chert<br>295.80m dark grey med ss +chert | | | | | | | | | | | | | |
| | SANDSTONE | | | | | | | | | | | | | | |
| 300 | | STOP | | | | | | | | | | | | | |

**Fig. II −1−4 (28) Geological log for drill hole**

· 174.00m-300.00m Dolomite·Oolite chert· Black shale

Stylolite texture characteristically comes in the formation of Tsumeb subgroup. Fine grained grey dolomite dominates with intercalation of oolitic chert less than 1m thick. From a depth of 260m, dark grey dolomite, grainstone and black dolomitic shale. The formation from 275m to 290m is seriously broken and red arigil precipitated on the crackled planes. This is possibly fault fractured zone.

The mineralisation of copper oxide and vanadium mineral occurs in a minute vugs at 269.90m. The calcite veins occurring between 270.70m and 270.75m is mineralized with copper sulphide. Another vanadium and copper oxide mineral was recognized at 272.40m.

**MJNM-12**

· 0.00m- 16.60m Calcrete

The upper half is pebble calcrete less than 5cm in diametre and the lower half is argillaceous to fine sandy calcrete. Siliceous conglomerate lies at the base.

· 16.60m-135.60m Sandstone of Mulden subgroup

Less weathered zone of the formation shows dark green to light grey medium to coarse grained sandstone. The coarser facies is mostly reddish purple. The dissemination bands of pyrite predominantly occurs within light grey facies. The mineralisation underlies parallel to the sandstone beds which dip 20° to 30°. Cross bedding was recognized at a depth of 116m. The contact of the underlying Tsumeb subgroup is not definite from a view point of lithofacies and looks like transitional. X-ray diffractometry gave remarkable peaks of quartz, smectite, albite and potash feldspar for a specimen at 60m.

· 135.00m-219.70m Dolomite·Black shale

The formation is dark grey or black, fine grained dolomite with sandy dolomite. Down from 272m black dolomitic shale dominates and alternates with fine sandy dolomite and grey dolomite. No sulphide mineralisation was recognized. From 258m semi-transparent pink coloured talc alteration are embedded within the beds.

### II-1-5 Chemical assays

The result of chemical assays is shown in Table II-1-10. The mineralised cores were quartered using diamond blade and cut into samples more than 5 centimetre long. Each sample was prepared for chemical assay of eight elements including Au,Ag,Cu,Pb,Zn,Cd,Ga and V. The result is shown in the geological column sections as well as Fig.I-1-10. The analytical methods were atomic absorption method for Au,Ag,Cu,Pb Zn and Cd using Hitachi Z-6000 and Z-8100 (flameless) and absorbance optical density method for Ga and V. Detection limit for Au and Ag is 1 ppb whereas that for Cu,Pb,Zn,Cd,Ga and V is 1 ppm.

Sulphide mineralisation was recognized in the hole of MJNM-9,MJNM-11 and MJNM-12.

MJNM-12 (1) 0m- 75m

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No. | From (m) | To (m) | Length (m) | Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Co (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | soil | | | | | | | | | | | | | |
| | | | pebble calcrete<br>pebble ang to subang max 5cm ϕ<br>quartzite,oolite chert<br>matrix Fe-ox Mn-ox | | | | | | | | | | | | | |
| 5 | | | 6.30m black Mn-ox stains rich<br>6.45m sandstone pebble abundant | | | | | | | | | | | | | |
| 10 | | CALCRETE | 9.20m argillaceous to sandy calcrete | | | | | | | | | | | | | |
| | | | light brownish grey | | | | | | | | | | | | | |
| 15 | | | 16.05-16.60m siliceous pebbles<br>greyish brown med. well sorted<br>less stratified partly white veining<br>with calcretion | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | |
| 25 | | | ∠20° | | | | | | | | | | | | | |
| | | | 27.00m~pale green to reddish brown sand | | | | | | | | | | | | | |
| 30 | | | 30.40-.65m black Mn-ox along cracks | | | | | | | | | | | | | |
| | | | 34.15m stratified ∠20° | | | | | | | | | | | | | |
| 35 | | | 35.20-.30m green to dark shagreen sand<br>35.70m green ∠20° | | | | | | | | | | | | | |
| 40 | | MULDEN SANDSTONE | 38.60-.70m black stripe bedding in green sand ∠20° | | | | | | | | | | | | | |
| | | | 43.45-.60m,46.40-.50m Mn-ox<br>in oxidation zone, zone less stratified | | B-46 | 43.50 | | | | | | | | | | |
| 45 | | | | | | | | | | | | | | | | |
| | | | 48.40m yellow green crack filling clay mineral | | | | | | | | | | | | | |
| 50 | | | 49.70m crs ss. | | | | | | | | | | | | | |
| | | | subsequent 30cm thick fine sandstone<br>52.35m yellow clay mineral<br>less bedding | | | | | | | | | | | | | |
| 55 | | | 55.50m solidified sandstone<br>56.80-57.10m dark green med.arkose ss.<br>58.05-.60m dark green fine ss.<br>58.65-.70m fine brown ss. | | | | | | | | | | | | | |
| 60 | | | 59.70-61.50m light grey med to crs ss.<br>mgt+py weak mineralised<br>61.50m~synsedimentary pyrite | | X-9 | 59.60 | | | | | | | | | | |
| 65 | | | 65.90-66.00m dark green med. | | | | | | | | | | | | | |
| 70 | | | light grey med. ss. | | | | | | | | | | | | | |
| 75 | | | 72.90m,73.23-.30m,73.80-.85m,74.54-.60m<br>75.40-.50m,76.10-.15m,76.50m,80.10-.20m<br>80.70-.75m,82.00-.30m,82.80-83.15m<br>ration ∠20-30° | | | | | | | | | | | | | |

**Fig. II −1−4 (29) Geological log for drill hole**

## MJNM-12 (2) 75m-150m

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No. | From (m) | To (m) | Length (m) | Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 80 | | | | | | | | | | | | | | | | |
| 85 | | | 84.10-.20m pyrite clouds<br>84.80-.95m,85.45m,86.30-.40m,86.90-87.50m,87.95-88.10m pyrite bands<br>weathered sandstone | | A-20<br>B-47 | 85.2 | 86.25 | 0.05 | < 1 | 0.35 | 6 | 15 | 13 | < 1 | 27 | 7 |
| 90 | | | 89.90-90.30m concentrated py bands<br>stratified py thin sheems ∠15°<br>93.30-.55m,94.70-95.00m,95.50-.80m pyrite concentration bands | | | | | | | | | | | | | |
| 95 | | MULDEN SANDSTONE | 96.34-.95m dark green med ss.<br>97.00-97.60m silicification zone associated with clay<br>97.60-98.00m,98.35-.45m,98.90-.97m,99.90m pyrite intense concentration | | | | | | | | | | | | | |
| 100 | | | 101.20-.35m purple coloured sandstone<br>102.15m~ppl ss.<br>102.85-.90m potassic red quartz vein<br>103.10-104.35m ppl crs arkose ss.<br>104.90m locally green ss.<br>∠5-10° | | | | | | | | | | | | | |
| 105 | | | | | | | | | | | | | | | | |
| 110 | | | 110.55m,110.68m hematite sheems<br>111.75-112.80m green ss. | | | | | | | | | | | | | |
| 115 | | SILTSTONE | 115.07-116.05m fine green shale to fine ss. ∠15°cross bedding+pyrite<br>med ss grey in part greenish grey<br>117.00-.65m black mud foliation | | | | | | | | | | | | | |
| 120 | | | 118.40-.50m quartz vein+pyrite 1cm thick ∠60° | | A-21 | 118.50 | 118.55 | 0.05 | < 1 | 0.05 | 14 | 6 | 16 | < 1 | < 10 | 4 |
| | | | greyish green ss. with black mud foliation 121.05-.15m dark green-black foliation | | B-48 | 122.00 | | | | | | | | | | |
| 125 | | SILTSTONE | 123.10-124.45m fine green shale<br>dark green med ss. stratified ∠30°<br>calcareous | | | | | | | | | | | | | |
| 130 | | | 130.00-.50m black mud foliation<br>grey to greyish green with weak pyrite imp.<br>134.60-135.15m,135.45-.50m pyrite imp. | | | | | | | | | | | | | |
| 135 | | | 136.20m,136.80m stylolite<br>dark grey med. ss. | | B-49 | 139.70 | | | | | | | | | | |
| 140 | | SANDSTONE (TSUMEB SUB GROUP) | 141.80-142.20m grey fine dolomite<br>143.10m,143.25m,143.40m stylolite | | | | | | | | | | | | | |
| 145 | | DOLOMITE | dark grey calcareous fine to locally med. ss to dolomite massive to stratified ∠20°<br>146.30m fine dolomite<br>brownish grey sand sheem<br>149.02m fossiliferous bed | | | | | | | | | | | | | |
| 150 | | | | | | | | | | | | | | | | |

**Fig. II —1—4 (30) Geological log for drill hole**

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE | | | | CHEMICAL ASSA | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | No. | From (m) | To (m) | Length (m) | Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Cr (ppm) | V (ppm) |
| | | | grey dolomite | | | | | | | | | | | | | |
| | | OOLITE | 151.45-152 10m oolitic dolomite fossili- | | | | | | | | | | | | | |
| | | | 152 85-153.75m ferous locally reddish | | | | | | | | | | | | | |
| | | | planes ∠30° | | | | | | | | | | | | | |
| 155 | | DOLOMITE | | | | | | | | | | | | | | |
| | | | 156 95m | | | | | | | | | | | | | |
| | | | sandy dolomite porous in crs facies | | | | | | | | | | | | | |
| | | | 159.10m | | | | | | | | | | | | | |
| 160 | | | | | | | | | | | | | | | | |
| | | | 161.00m | | | | | | | | | | | | | |
| | | | med sandy dolomite | | | | | | | | | | | | | |
| | | | 161 95-162 07m chert thin bed | | | | | | | | | | | | | |
| 165 | | SANDSTONE | | | | | | | | | | | | | | |
| | | | 166.15-.20m chert | | | | | | | | | | | | | |
| | | | 166.40-.85m oolite chert | | | | | | | | | | | | | |
| | | | 167.70m grey fine dolomite intercalated | | | | | | | | | | | | | |
| | | | with brown shale | | | | | | | | | | | | | |
| 170 | | | 169.15m imbricated structure | | | | | | | | | | | | | |
| | | | 172 05-.25m light grey to cream coloured | | | | | | | | | | | | | |
| | | | fine sandy dolomite ∠10° | | | | | | | | | | | | | |
| | | | 173 20-174.30m oolite chert | | | | | | | | | | | | | |
| 175 | | | sandy dolomite | | | | | | | | | | | | | |
| | | | 175 55-.95m dark grey med ss | | | | | | | | | | | | | |
| | | | 175.95-176.10m siliceous sand black mud | | | | | | | | | | | | | |
| | | | fragments | | | | | | | | | | | | | |
| | | | laminated grey sandstone | | | | | | | | | | | | | |
| 180 | | | 177.25-.50m oolitic | | | | | | | | | | | | | |
| | | | med dol ss. | | | | | | | | | | | | | |
| | | SANDSTONE | 179.10m Cu oxide in calcite | | | | | | | | | | | | | |
| | | | porous calc ss 10cm thick ∠20° | | | | | | | | | | | | | |
| | | | 181.00-.10m chert | | | | | | | | | | | | | |
| 185 | | | grey med ss. | | | | | | | | | | | | | |
| | | DOLOMITE | 184 30m dolomite to fine ss | | | | | | | | | | | | | |
| | | | 186.80m med ss. brownish grey | | | | | | | | | | | | | |
| | | | 189.00-190 30m grey fine ss. | | | | | | | | | | | | | |
| 190 | | | | | | | | | | | | | | | | |
| | | | grey oolitic med ss. | | | | | | | | | | | | | |
| | | | 192.70m crs oolite 20cm thick grey to | | | | | | | | | | | | | |
| | | | black | | | | | | | | | | | | | |
| 195 | | | | | | | | | | | | | | | | |
| | | SANDSTONE | homog med ss. | | | | | | | | | | | | | |
| | | | very locally thin fine dolomite | | | | | | | | | | | | | |
| | | | 198.45-.50m chert ∠20° | | | | | | | | | | | | | |
| 200 | | | 200.09m thin shale | | | | | | | | | | | | | |
| | | | 200.90-.95m,210.75-.80m chert | | | | | | | | | | | | | |
| | | | 201.80-202 55m dolomite | | | | | | | | | | | | | |
| | | | sandy dolomite with thin intercalation | | | | | | | | | | | | | |
| 205 | | | of chert at 205.65-.75m,207.55-60m, | | | | | | | | | | | | | |
| | | | 208 55-.60m | | | | | | | | | | | | | |
| | | | 208 93m shale sheem | | | | | | | | | | | | | |
| | | | fine dolomite | | | | | | | | | | | | | |
| 210 | | | 209 20m oolitic sandstone | | | | | | | | | | | | | |
| | | | irregularly silicified | | | | | | | | | | | | | |
| | | | 211.15m 2cm thick chert bed | | | | | | | | | | | | | |
| | | | 213.20-214.50m fine sandy dolomite | | | | | | | | | | | | | |
| | | | locally black med siliceous ss. | | | | | | | | | | | | | |
| 215 | | | 215.20m 3cm thick chert bed | | | | | | | | | | | | | |
| | | | 216 00m | | | | | | | | | | | | | |
| | | | fine ss.//dol alt +3cm thick chert beds | | | | | | | | | | | | | |
| | | | 219.70-220.70m black to dark grey fine | | | | | | | | | | | | | |
| 220 | | | dol to ss. | | | | | | | | | | | | | |
| | | DOLOMITE | 221 30-223.00m grey dol.-dark grey dol | | | | | | | | | | | | | |
| | | | ss. ∠15° | | | | | | | | | | | | | |
| | | | fine grey dolomite | | | | | | | | | | | | | |
| 225 | | | 224.40-225.40m black to dark grey fine | | | | | | | | | | | | | |

**Fig. II −1−4 (31) Geological log for drill hole**

| DEPTH (m) | GEOLOGIC COLUMN | ROCK NAME | LITHOLOGICAL DESCRIPTION | VEIN ALT. | SAMPLE No. | SAMPLE From (m) | SAMPLE To (m) | SAMPLE Length (m) | CHEMICAL ASSA Au (ppb) | Ag (ppm) | Cu (ppm) | Pb (ppm) | Zn (ppm) | Cd (ppm) | Ga (ppm) | V (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DOLOMITE | dolomite with 1-2cm thick black chert lenses<br>226 55m fine black dol sandy facies alt. fractured | | | | | | | | | | | | | |
| 230 | | | grey fine dol.<br>231 50-232 50m med ss<br>fine dol to grey sandy dol with black | | | | | | | | | | | | | |
| | | SANDSTONE | cherty beds | | | | | | | | | | | | | |
| 235 | | | 235.20m dark grey fine dol.<br>235.45m black shale<br>235 65m black to dark grey facies<br>236 90m dotted dol black chert 10cm<br>grey dotted dol to fine sandy dol ∠20° | | | | | | | | | | | | | |
| 240 | | SHALE | well stratified grey med dolomitic sand<br>black//grey stripes<br>242.75m dark grey fine dol to fine ss.<br>black facies bedded fine ss /fine dol | | | | | | | | | | | | | |
| 245 | | | 247.10-247.90m black facies fine dolomitic shale<br>med ss grey to dark grey | | | | | | | | | | | | | |
| 250 | | SANDSTONE | 250.50-.95m black shale<br>251 30m fine to med grey ss stylolite ∠20° | | | | | | | | | | | | | |
| 255 | | | 254.20-.90m dark grey sandy dol<br>grey bedded dol ss.<br>255.70m grey fine dol to fine sandy dol.<br>256 35m dolospar<br>258 40m pink manganese talc | | | | | | | | | | | | | |
| 260 | | SHALE | 259.80-262.50m black dolomitic shale<br>260 30m dolospar 2cm wide<br>262 50m<br>grey to black fine dol to fine ss.<br>well stratified | | B-50 | 262.20 | | | | | | | | | | |
| 265 | | | 266 30-267.50m dolomitic black shale<br>fine med. black ss.<br>dark grey dol to fine ss. | | | | | | | | | | | | | |
| 270 | | DOLOMITE | stratified dolomitic shale//fine ss. | | | | | | | | | | | | | |
| 275 | | | 276 00-277.00m black/grey stripe alt. ss //shale<br>277.75m grey dol with black shale<br>279.00m grey med ss. ∠5° | | | | | | | | | | | | | |
| 280 | | SANDSTONE | dark grey dolomite to shale<br>black//grey stripe flowage pattern<br>283.30m pink talc 1cm wide<br>284.10m med ss. over 15cm | | | | | | | | | | | | | |
| 285 | | | 285 50m pink Mn talc<br>286 25-.50m black shale | | | | | | | | | | | | | |
| | | SHALE | 287.90m black to dark grey dol shale<br>dark grey fine to med ss. | | | | | | | | | | | | | |
| 290 | | | 290 30m talc<br>grey to light grey dolomite<br>291.40m,292.20m,293.20,.40,.45m pink talc | | B-51<br>X-10 | 291.45<br>291.45 | | | | | | | | | | |
| 295 | | DOLOMITE | fine ss //grey ss alt.<br>294.30m light grey dol.<br>296.10m talc+dolospar+yellow film<br>296.30m,296.80m,297.05m talc<br>298.75m sandy dolomite ∠0° | | | | | | | | | | | | | |
| 300 | | | STOP | | | | | | | | | | | | | |

Fig. II −1−4 (32) Geological log for drill hole

**Table II - 1 - 10　Result of Chemical Assay**

| Sample No. | Minerals | Hole No. | Depth(m) | Length | Chemical assay ( ppb for Au and ppm for others ) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Au | Ag | Cu | Pb | Zn | Cd | V | Ga |
| A-1 | Gn+Sp | MJNM-9 | 170.60 | 0.05 | <1 | 0.80 | 6 | 811 | 320 | <1 | 20 | <1 |
| A-2 | ditto | MJNM-9 | 186.35 | 0.08 | 9 | 0.95 | 10 | 11 | 32 | <1 | 7 | <1 |
| A-3 | ditto | MJNM-9 | 231.63-232.20 | 0.57 | 9 | 0.20 | 9 | 100 | 14 | 1 | 18 | <1 |
| A-4 | ditto | MJNM-9 | 232.20-232.55 | 0.35 | 4 | 0.20 | 6 | 122 | 56 | <1 | 8 | <1 |
| A-5 | ditto | MJNM-9 | 233.36-233.46 | 0.10 | 24 | 0.20 | 5 | 95 | 42 | <1 | 5 | <1 |
| A-6 | ditto | MJNM-9 | 234.10-234.50 | 0.40 | 2 | 0.50 | 12 | 322 | 5810 | 15 | 5 | <1 |
| A-7 | ditto | MJNM-9 | 234.73-234.82 | 0.09 | 13 | 0.95 | 10 | 560 | 108 | <1 | 21 | <1 |
| A-8 | ditto | MJNM-9 | 235.30-235.55 | 0.25 | <1 | 0.20 | 6 | 49 | 114 | <1 | <1 | <1 |
| A-9 | ditto | MJNM-9 | 241.87-242.60 | 0.73 | <1 | 0.50 | 9 | 142 | 250 | 1 | 34 | 2 |
| A-10 | ditto | MJNM-9 | 242.60-243.35 | 0.75 | <1 | 1.25 | 18 | 1660 | 8300 | 36 | 2 | 2 |
| A-11 | ditto | MJNM-9 | 243.35-244.00 | 0.65 | <1 | 0.50 | 5 | 288 | 95 | <1 | 7 | <1 |
| A-12 | ditto | MJNM-9 | 245.75-246.15 | 0.40 | <1 | 0.65 | 13 | 269 | 142 | <1 | 27 | 2 |
| A-13 | ditto | MJNM-9 | 248.10-248.64 | 0.54 | 26 | 0.50 | 9 | 275 | 3130 | 14 | 3 | 1 |
| A-14 | ditto | MJNM-9 | 248.79-248.93 | 0.14 | 12 | 0.50 | 5 | 176 | 416 | 3 | 17 | 1 |
| A-15 | ditto | MJNM-9 | 249.52-249.65 | 0.13 | 87 | 0.20 | 7 | 75 | 71 | <1 | 17 | 2 |
| A-16 | ditto | MJNM-9 | 251.35-251.45 | 0.10 | <1 | 0.50 | 12 | 182 | 541 | 31 | 18 | 1 |
| A-17 | Pyrite | MJNM-11 | 110.60 | 0.10 | <1 | 0.05 | 7 | 11 | 25 | <1 | 32 | 6 |
| A-18 | Cu? | MJNM-11 | 270.70-270.75 | 0.05 | <1 | 2.95 | 283 | 1760 | 260 | 4 | 208 | 1 |
| A-19 | Cu+V2O5 | MJNM-11 | 272.30-272.50 | 0.20 | <1 | 0.95 | 270 | 1100 | 807 | 11 | 167 | 2 |
| A-20 | Pyrite | MJNM-12 | 86.20 | 0.05 | <1 | 0.35 | 6 | 15 | 13 | <1 | 27 | 7 |
| A-21 | Vein Py | MJNM-12 | 118.50 | 0.05 | <1 | 0.05 | 14 | 6 | 16 | <1 | <1 | 4 |

The cumulative length of the mineralised cores of MJNM-9 reaches to 5.24 metres, while the cumulative value of the mineralised lengths by assay values amounts to 0.22 metre · percent(m·%) for Pb and 1.08 m·% for Zn totaling 1.29 m·% for Pb+Zn. Of the assayed samples, no mineralised sections gave more than 1 % and the sections with more than 0.1% are as follows.

234.10m-234.50m(0.40m) Zn=0.58%

242.60m-243.35m(0.75m) Pb=0.17% Zn=0.83%

248.10m-248.64m(0.54m) Zn=0.31%

More than a half of Au assays are less than detection limit and the values over 1 ppb of Au came from the samples in which Pb and Zn are concentrated. The silver assays show a positive correlation with Pb assays. The copper assays are invariable regardless of Pb and Zn assays. The relation between Pb and Zn is obscure. The one group shows considerably obvious relations while another group show deviant relations. Cd assays are definitely proportional to Zn content. Comparison with Tsumeb ore which contains 3% Zn with 400 ppm Cd in average, may indicate that the core samples show lower Cd content for Zn assays than Tsumeb ore. Gallium is less than detection limit for more than a half of the samples and for others very low. Vanadium assays are also low compared to the mineralisation of MJNM-11.

Pyrite mineralisation intersected by MJNM-11 and MJNM-12 is hosted within the sandstone of Mulden group. No significant concentration of Au and Cu was assayed in this mineralisation but the dolospar and calcite veinlets embedded in dolomite of MJNM-11 indicated a significant concentration of Cu,Pb and Zn.

270.70m-270.75m(0.05m) Pb=0.18%

272.30m-272.50m(0.20m) Pb=0.10%

The above mentioned mineralised sections are illustrated in Fig. II-1-4 as well as Fig. II-1-6.

Pyrite mineralisation of MJNM-11 and MJNM-12, which s hosted in the sandstone of Mulden group, assayed no significant mineralisation of sulphide was Intersected in the hole of MJNM-9, MJNM-10 and MJNM-11. Total length of mineralisation is 5.24 metres and the cumulative values of each length by ore grade are 0.22 m% Pb, 1.08m% Zn a n d 1.29 m% for Pb+Zn. The ore grade is less than 1 % and the mineralised sections higher than 0.1 % are as follows.
copper and gold, however the sulphide associated with dolospar and calcite veinlets in the dolomite of MJNM-11 showed significant concentration of copper, lead and zinc. The above mentioned mineralisation is illustrated in Fig. II -1-4.

### II -1-6 Homogenization temperature and salinity of fluid inclusion

Ten thin sections were prepared for the measurement out of silicified dolomite associated with lead and zinc mineralisation of MJNM-9. The occurrence and form of the fluid inclusions including two phases were examined and the homogenization temperature and salinity was determined. The heating device T H-600 manufactured by Lincam Co. was used for the measurement. Two sections of both sides polished at each sample and the inclusions of two phases were measured. The temperatures were measured at a final increasing rate of 1.0 to 0.1 degree centigrade per minute. Benazanilide(163° C) and sodium nitrate(305° C) were used for temperature compensation.

Regarding to salinity, the sections were cooled down to -60° C using liquid nitrogen and thereafter heated until the ice starts melting where the temperature was measured for salinity. The salinity was determined by the values and the quantitative line for a standard specimen. The result of the measurement is shown in the Table II -1-11.

**Table II - 1 - 11 Result of measurement of homogenization temperature and salinity**

| Sample | Hole No. | Depth(m) | Mean Temp.(°C) | Mean Salinity(wt%) |
|---|---|---|---|---|
| H-1 | MJNM-9 | 232.00 | 139.4 | 14.95 |
| H-2 | MJNM-9 | 232.40 | 129.9 | 15.83 |
| H-3 | MJNM-9 | 233.35 | 131.8 | 16.78 |
| H-4 | MJNM-9 | 234.45 | 150.4 | 15.25 |
| H-5 | MJNM-9 | 234.75 | 149.5 | 17.18 |
| H-6 | MJNM-9 | 241.92 | 159.4 | 14.71 |
| H-7 | MJNM-9 | 242.22 | 136.1 | 0.12 |
| H-8 | MJNM-9 | 242.60 | 156.2 | 7.67 |
| H-9 | MJNM-9 | 243.20 | 157.8 | 0.14 |
| H-10 | MJNM-9 | 248.75 | 155.7 | 14.37 |

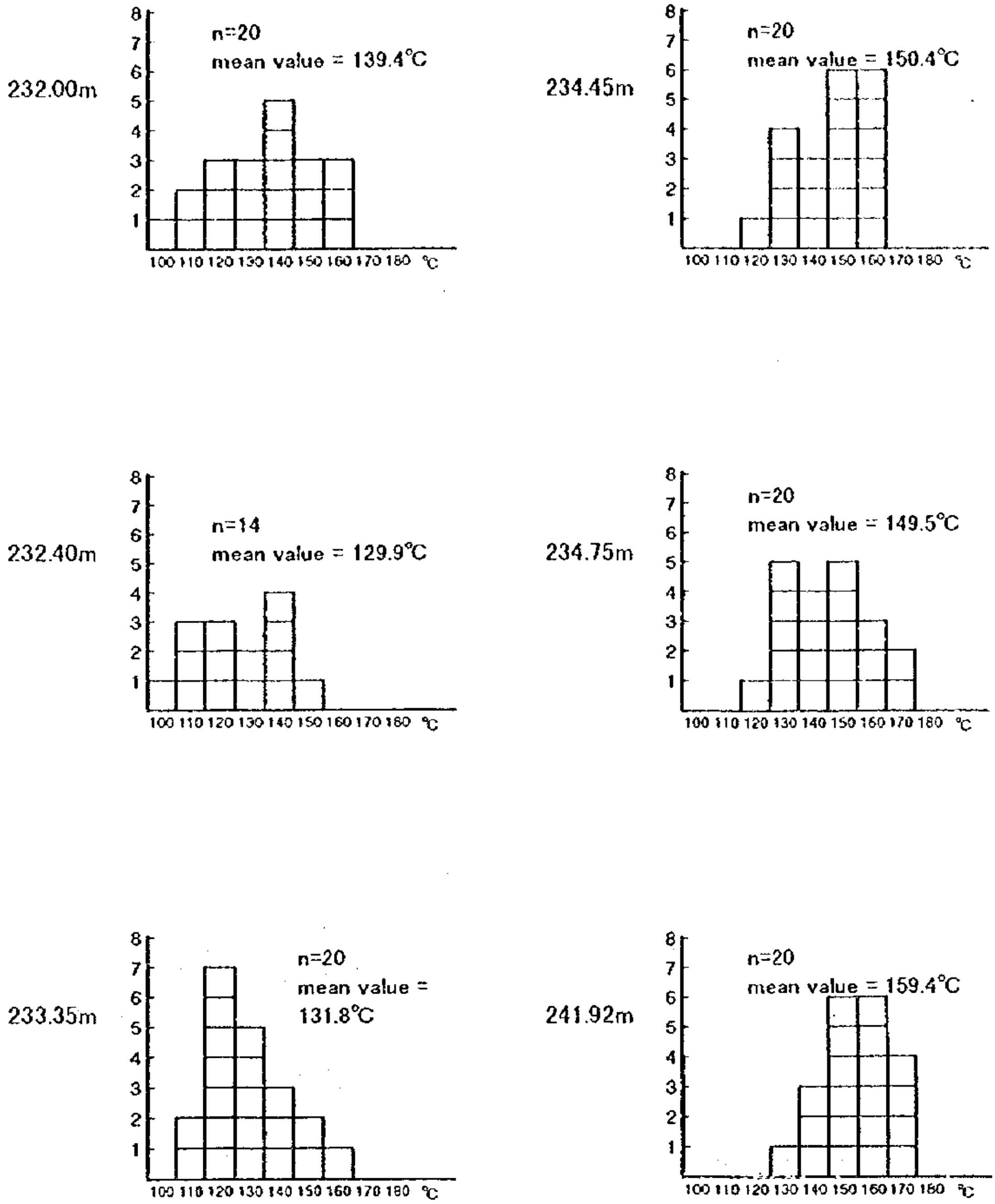



**Fig. II −1−5 (1) Homogenization temperature of fluid inclusions**

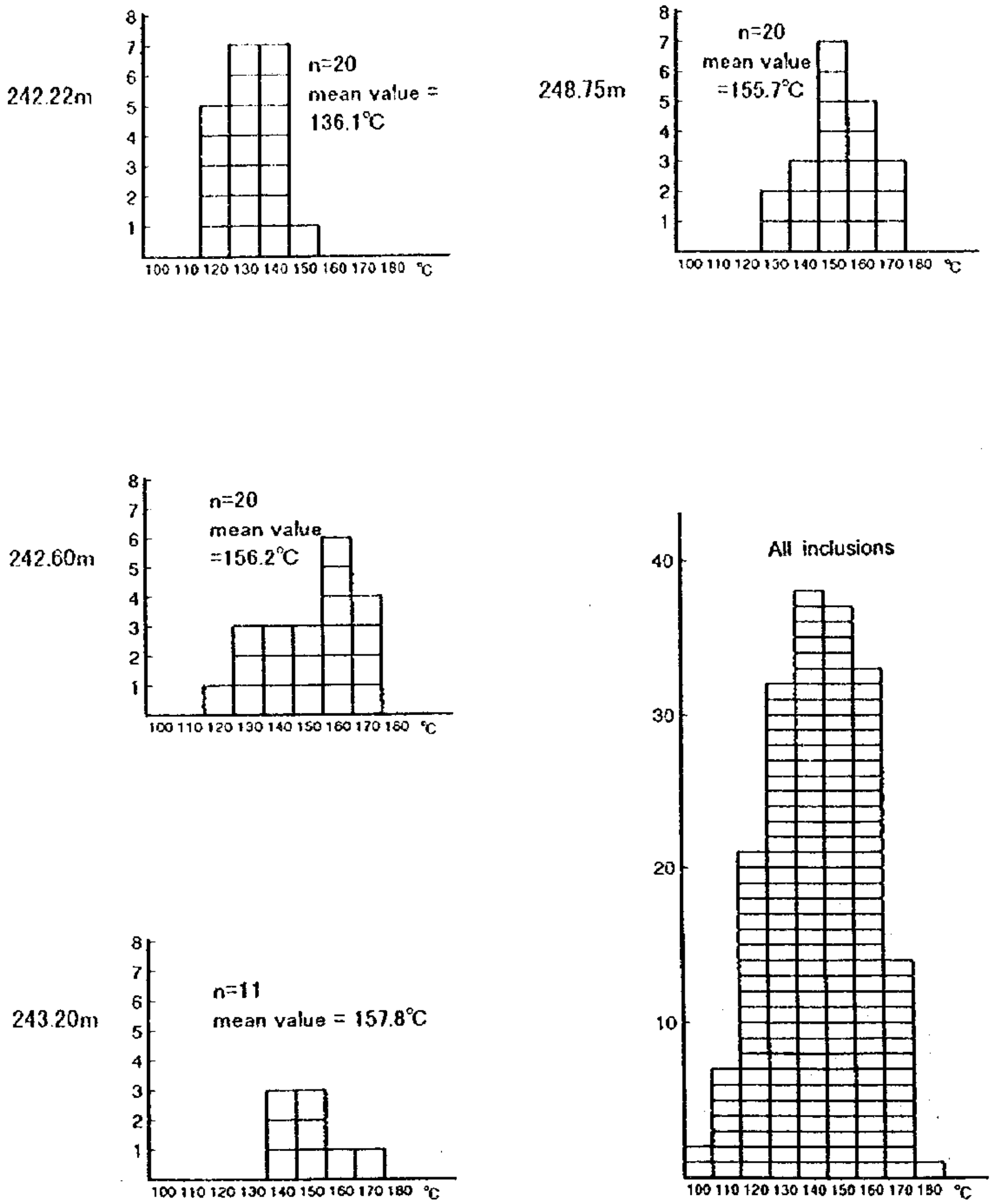



**Fig. II −1−5 (2) Homogenization temperature of fluid inclusions**

In every sample the size of inclusions enclosed in quartz were mostly smaller than 10 micron but it seems that there is few difference in temperature by difference in size in the same sample. The most fluid inclusions were of single phase of liquid and its number was considerably large. Some samples included a number of secondary inclusions. In most samples more than 20 inclusions were used for measurement. The observed temperatures range from 100 to 180℃ with a significant deviation and gave two distinct types of distribution. One type shows two groups of population and another show a normal distribution with an obvious mean value. Total values for ten samples gave a sound normal distribution pattern with mean value of temperature of 146.6℃. The salinities from two samples indicated unreasonably low because of the melting temperature point was near ice point, however other samples gave almost the same order of salinity.

### Ⅱ-1-7 Physical Properties of Core Samples

(1) Properties and amount

Physical properties of core samples were measured. The property includes magnetic susceptibility, resistivity and chargeability. The number of samples was 51. Time-domain method was used for measurement of resistivity and chargeability.

(2) Equipment and treatment

The specifications of equipment is shown in Table Ⅱ-1-12. For magnetic susceptibility measurement, Bison magnetometer was used. Acquired data was compensated according to core diameter and length and the cgs unit was converted to SI unit.

The core samples for resistivity and chargeability measurement were cut into 5 to 10 cm long and were submerged into clean water for about one day prior to measurement. The term of chargeability will be replaced by IP from now on.

(3) Results and interpretation

The results of measurement are presented in Table Ⅱ-1-13. Mean values of magnetic susceptibility,IP and resistivity by drill hole and lithofacies are presented in Table Ⅱ-1-14 as well as detailed IP and resistivity in Table Ⅱ-1-15. For processing the chargeability data the values for 12 channel; mid-point 935 msec were used.

**Magnetic susceptibility data**

Average values by rock type or facies from the drill cores are conformable to those of Phase Ⅰ and Ⅱ. The dolerite showed extremely high susceptibility with great difference from others. Of the sedimentary rocks, surface calcrete and sandstone of the Mulden group gave comparatively high susceptibility. Those of Tsumeb subgroup are low. Kalahari sand is a new type joined in Phase Ⅲ, and its magnetic susceptibilities are in the same order as calcrete, which could be an obstacle to the survey searching low magnetic anomalies of underlying formations. The number of core samples is not enough though, the characteristics of magnetic susceptibility by drill hole are discussed below.

MJNM-5: The susceptibility of Kalahari sand is high compared to that of Tsumeb subgroup.

MJNM-6: The susceptibility is low all over the hole, that of calcrete is comparatively high. The dolerite dyke gave obviously high at a depth of 227.40 m and less altered from resistivity

MJNM-7: The rate is high in calcrete compared to other formations. The dolerite at a depth of 227.40m is believed to be less altered from high resistivity. The magnetic susceptibility was the highest of all samples and suggested that it could be a prominent source of magnetic anomaly even though it is thin and If it is continuous.

MJNM-8: The same said as MJNM-7. The susceptibility of dolerite at a depth of 229.5m was lower than that of MJNM-7 but is distinguishable from the host rock. The lower resistivity than MJNM-7 may indicate advanced weathering. The low susceptibility may be caused by oxidation of magnetic minerals.

MJNM-9: The rate is comparatively high in calcrete as the holes mentioned above. The dolomite of Tsumeb subgroup at a depth of 120m showed higher susceptibility compared to other dolomites.

MJNM-10: The same said as MJNM-8. Reddish shale beds showed high susceptibility as much as surface calcrete. Iron oxides included could be a source.

MJNM-11: Sandstone of Mulden group gave high susceptibility. The sandstone includes a couple of facies, of which upper pink facies and middle white facies gave high susceptibility and grey facies lower compared to the formers. The mineralised sandstone with pyrite at a depth of 84m showed low susceptibility.

MJNM-12: The highest susceptibility value was acquired from mineralised sandstone at a depth of 86.2m in the hole. The value stays in the same order with that of calcrete.

**Resistivity and IP value**

The result of measurement was analyzed using the classification table which had been used from Phase I and Fig. II-1-8 was produced for comparison with previous work. Resistivity and IP values were divided into three or four groups using relative thresholds for interpretation. The characteristics of sample properties pertinent to the division are explained below. Low resistivity surface layers such as Kalahari sand and calcrete, of which resistivity is less than 100 Ω · m, weathered dolerite and some shales could be a barrier to resistivity survey method. While the source of noise of IP survey could be argillaceous calcrete, pyrite mineralised zone, some dolerite and shale with IP value of larger than 10mV/V.

| Zone | range | characteristics |
| --- | --- | --- |
| Resistivity A | less than 300 Ω·m | • massive sulphide and argillaceous minerals<br>• Kalahari sand,calcrete,shale and talc<br>• sometimes barrier for interpretation |
| Resistivity B | 300 to 4,000 Ω·m | • disseminated ore minerals and weathered shale<br>• could be favourable target but cores of Phase III commonly falls within this zone<br>• could be an obstacle to exploration |
| Resistivity C | more than 4,000 Ω·m | • fresh massive dolomite and sandstone of Mulden group<br>• mineralisation of galena dots in dolomite |
| IP I | no less than 100mV/V | • massive sulphide.<br>• favourable target for mineralisation if the volume is enough<br>• no sample is recognized in this zone |
| IP II | 100 to 10mV/V | • disseminated ore minerals<br>• the most common zone for IP survey<br>• Mulden sandstone disseminated with pyrite and dolerite, calcrete and some shale are also plotted |
| IP III | 10 to 1mV/V | • weak dissemination of ore minerals and rock abundant in argillaceous mineral<br>• Almost all core samples are plotted indicating high back ground of IP for many rock facies |

| | | |
|---|---|---|
| IP Ⅳ | less than 1 mV/V | · Only six samples of all collected Phase Ⅲ are plotted such as black shale |

The resistivity values were studied because the resistivity anomalies were targets for drilling survey of Phase Ⅲ. The characteristics of resistivity by hole is mentioned below.

MJNM-5: The value of Kalahari sand, a new member of this phase, is low as much as 68 Ω·m. The number of samples is few though, this could be one of the probable source of low resistivity.

MJNM-6: Argillaceous calcrete at a depth of around 89m showed extremely low value less than 50Ω·m. The underlying Tsumeb subgroup indicated high values more than 3000Ω·m The argillized calcrete is believed one of the sources of low resistivity.

MJNM-7: Talc argillization zones intersected at 157.2m and 215.6m gave low values as much as 100 to 300Ω·m and are deemed to be a source for low resistivity.

MJNM-8: Surface calcrete, dolerite and talc zones showed low values and believed to be sources for low resistivity.

MJNM-9: Surface down to a depth of 120m and Tsumeb subgroup gave values. The Kalahari sand was of the lowest resistivity of 35Ω·m of all samples measured.

MJNM-10: The Kalahari sand of this hole gave comparatively high value but still low compared to other rock types. Dolerite at a depth of 261.8m gave low value as much as 45Ω·m possibly because of weathering.

MJNM-11: Mineralised sandstone with pyrite at 84.3m gave considerably low value of 71Ω·m. The underlying Mulden group and Tsumeb subgroup all showed high values larger than 4000Ω·m. A source of ellipsoidal anomaly of low resistivity is of question. It could be a mineralised sandstone near surface.

MJNM-12: Mineralised sandstone lying shallower than 120m, sandstone and shale beds of the Mulden group gave low values indicating potential sources for low resistivity.

**Table Ⅱ－1－12 Equipment for Measurement of Physical Properties**

| Equipment | Maker | Type | Specifications | No |
|---|---|---|---|---|
| IP Transmitter | IRIS Instrument | IP-L<br>Time domain O.S.C. | Output:1μA-100μA<br>max10V | 1 |
| IP Receiver | SCINTREX | IPR-12<br>Multichannel rec. | Input:8ch 14 windows<br>Range:50μV-14V | 1 |
| Electrode | | Platinum | | 1 |
| Magnetometre | Bison | Model-3101A | Sensitivity:1×1E-6 cgs, Range:0.00-999 ×1E-3 SI | 1 |

Table II－1－13 Result of Measurement of Physical Properties

| Sample No. | Drillhole No. | Lith. | Depth m | Rock, Mineral name | Physical properties Mag.sus. *1E-3 SI | Resistivity Ω·m | IP(M12) mV/V |
|---|---|---|---|---|---|---|---|
| B-1 | MJNM-5 | K | 90.05 | Kalahari sandstone | 0.10 | 68 | 7.74 |
| B-2 | MJNM-5 | C | 102.95 | Pebble calcrete | 0.03 | 1,162 | 3.92 |
| B-3 | MJNM-5 | | 187.45 | Druse filling | 0.01 | 206 | 0.32 |
| B-4 | MJNM-5 | T | 197.80 | Black shale | 0.01 | 4,899 | 0.84 |
| B-5 | MJNM-5 | T | 219.30 | Black shale | 0.04 | 4,763 | 0.45 |
| B-6 | MJNM-6 | C | 89.15 | Clay rich calcrete | 0.08 | 47 | 18.66 |
| B-7 | MJNM-6 | A | 96.60 | Gray dolomite | 0.05 | 6,023 | 0.97 |
| B-8 | MJNM-6 | A | 107.30 | Pink limestome | 0.01 | 4,697 | 3.81 |
| B-9 | MJNM-6 | A | b | Brown shale | 0.05 | 5,784 | 3.78 |
| B-10 | MJNM-6 | A | 156.30 | Porous limestone | 0.03 | 4,497 | 5.34 |
| B-11 | MJNM-6 | A | 250.70 | Coarse sandy dolomite | 0.02 | 4,590 | 7.43 |
| B-12 | MJNM-6 | A | 281.00 | Massive limestone | 0.02 | 5,003 | 2.29 |
| B-13 | MJNM-6 | A | 296.30 | Porous limestone | 0.01 | 3,447 | 4.97 |
| B-14 | MJNM-7 | C | 82.90 | Calcrete | 0.34 | 2,233 | 2.94 |
| B-15 | MJNM-7 | T | 110.50 | Brecciated dolomite | 0.02 | 4,372 | 4.99 |
| B-16 | MJNM-7 | T | 124.00 | Porous shale | 0.02 | 4,898 | 0.95 |
| B-17 | MJNM-7 | T | 150.60 | Black shale | 0.02 | 4,805 | 4.54 |
| B-18 | MJNM-7 | T | 157.20 | Talc | 0.02 | 97 | 1.10 |
| B-19 | MJNM-7 | T | 215.60 | Talc rich dolomite | 0.03 | 289 | 4.36 |
| B-20 | MJNM-7 | D | 227.40 | Dolerite | 60.77 | 1,083 | 15.52 |
| B-21 | MJNM-7 | T | 245.00 | Dolomite | 0.02 | 947 | 2.93 |
| B-22 | MJNM-8 | C | 84.25 | Calcrete | 0.45 | 197 | 0.68 |
| B-23 | MJNM-8 | C | 127.70 | Pebble calcrete | 0.02 | 521 | 1.50 |
| B-24 | MJNM-8 | T | 157.75 | Dolospar | 0.01 | 4,709 | 4.69 |
| B-25 | MJNM-8 | T | 204.30 | Calcite | 0.04 | 10,079 | 3.35 |
| B-26 | MJNM-8 | D | 229.52 | Dolerite | 22.99 | 83 | -2.92 |
| B-27 | MJNM-8 | T | 275.30 | Talc | 0.02 | 745 | 4.33 |
| B-28 | MJNM-9 | K | 87.65 | Kalahari sandstone | 0.18 | 35 | 2.05 |
| B-29 | MJNM-9 | T | 95.02 | Brown shale | 0.04 | 368 | 3.49 |
| B-30 | MJNM-9 | T | 120.00 | Dolomite | 0.11 | 631 | 2.77 |
| B-31 | MJNM-9 | T | 210.10 | Sandy dolomite | 0.03 | 5,486 | 3.58 |
| B-32 | MJNM-9 | T | 248.64 | Mineralized dolomite | 0.02 | 4,935 | 1.16 |
| B-33 | MJNM-10 | K | 83.80 | Kalahari sandstone | 0.34 | 610 | 1.48 |
| B-34 | MJNM-10 | T | 143.30 | Siliceous sandstone | 0.04 | 4,936 | 4.94 |
| B-35 | MJNM-10 | T | 188.60 | Red dolomitic shale | 0.35 | 2,973 | 4.19 |
| B-36 | MJNM-10 | D | 261.80 | Dolerite | 36.51 | 45 | 3.61 |
| B-37 | MJNM-10 | T | 279.30 | Talc | 0.05 | 4,565 | 3.68 |
| B-38 | MJNM-11 | M | 84.32 | Pyrite mineralized sand | 0.02 | 71 | 17.56 |
| B-39 | MJNM-11 | M | 105.40 | Pink Mulden sandstone | 4.00 | 4,725 | 5.11 |
| B-40 | MJNM-11 | M | 115.00 | Grey Mulden sandstone | 0.03 | 4,767 | 5.68 |
| B-41 | MJNM-11 | M | 120.86 | Green Mulden sandstone | 0.26 | 4,834 | 3.11 |
| B-42 | MJNM-11 | M | 140.55 | White Mulden sandstone | 1.31 | 4,723 | 1.79 |
| B-43 | MJNM-11 | M | 172.90 | Grey Mulden sandstone | 0.05 | 4,514 | 4.47 |
| B-44 | MJNM-11 | T | 243.30 | Broken breccia | 0.06 | 4,860 | 0.70 |
| B-45 | MJNM-11 | T | 288.45 | Sandy dolomite | 0.06 | 4,191 | 2.50 |
| B-46 | MJNM-12 | M | 43.50 | Mulden sandstone | 0.02 | 242 | 6.08 |
| B-47 | MJNM-12 | M | 86.20 | Pyrite mineralized sand. | 0.24 | 487 | 19.24 |
| B-48 | MJNM-12 | M | 122.00 | Green shale | 0.01 | 225 | 3.15 |
| B-49 | MJNM-12 | M | 139.70 | Medium Mulden sand. | 0.02 | 5,014 | 2.37 |
| B-50 | MJNM-12 | T | 262.20 | Black shale | 0.04 | 3,808 | 12.06 |
| B-51 | MJNM-12 | T | 291.45 | Pink talc | 0.07 | 4,347 | 1.72 |

K: Karahari sand C: Calcrete T: Tsumeb M: Mulden D: Dolorite

Table II－1－14 Physical Properties of Core Samples by Formation and Lithofacies

| Drill core geophysical properties (average of each lithology) | | | | | |
|---|---|---|---|---|---|
| Formation | Rock name with Lithological description | Mag.sus. *1E-3 SI | Resistivity Ω・m | IP(M12) mV/V | sample sum |
| Top sequence | Calcrete | 0.10 | 416 | 2.94 | 5 |
| | Kalahari sandstone | 0.18 | 114 | 2.86 | 3 |
| Dyke | Dolerite | 37.08 | 159 | 7.49 | 3(2;ip) |
| Mulden formation | Druse filling | 0.01 | 206 | 0.32 | 1 |
| | Green shale | 0.01 | 225 | 3.15 | 1 |
| | Pyrite mineralized sandstone | 0.06 | 185 | 18.38 | 2 |
| | Mulden sandstone | 0.14 | 3,110 | 3.75 | 7 |
| Tumeb subgroup | Siliceous sandstone | 0.04 | 4,936 | 4.94 | 1 |
| | Black shale | 0.04 | 4,288 | 2.09 | 6 |
| | Brown shale | 0.04 | 1,459 | 3.63 | 2 |
| | Dolomite | 0.03 | 2,366 | 2.84 | 5 |
| | Sandy dolomite | 0.03 | 4,725 | 4.05 | 3 |
| | Talc rich dolomite | 0.03 | 289 | 4.36 | 1 |
| | Mineralized dolomite | 0.02 | 4,935 | 1.16 | 1 |
| | Limestone | 0.02 | 4,369 | 3.90 | 4 |
| | Talc | 0.04 | 1,095 | 2.34 | 4 |
| | Calcite | 0.04 | 10,079 | 3.35 | 1 |
| | Broken breccia | 0.06 | 4,860 | 0.70 | 1 |

# Table II −1−15 Aquired Values of Resistivity and IP of Core Samples

| Sample No. | Drillhole No. | Depth m | Rock,Mineral name | Electric property Resistivity Ω·m | IP property M=4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B-1 | MJNM-5 | 90.05 | Kalahari sandstone | 68.21 | 25.97 | 23.30 | 20.89 | 18.46 | 16.10 | 13.80 | 11.64 | 9.60 | 7.74 | 6.11 | 4.68 |
| B-2 | MJNM-5 | 102.95 | Pebble calcrete | 1161.59 | 13.93 | 12.09 | 10.59 | 9.15 | 7.85 | 6.66 | 5.63 | 4.71 | 3.92 | 3.23 | 2.63 |
| B-3 | MJNM-5 | 187.45 | Druse filling | 205.64 | 3.18 | 2.21 | 1.62 | 1.18 | 0.86 | 0.64 | 0.51 | 0.40 | 0.32 | 0.25 | 0.21 |
| B-4 | MJNM-5 | 197.80 | Black shale | 4899.30 | 3.89 | 3.25 | 2.79 | 2.36 | 1.95 | 1.60 | 1.30 | 1.04 | 0.84 | 0.68 | 0.56 |
| B-5 | MJNM-5 | 219.30 | Black shale | 4763.22 | 3.11 | 2.49 | 2.08 | 1.69 | 1.35 | 1.06 | 0.81 | 0.61 | 0.45 | 0.35 | 0.28 |
| B-6 | MJNM-6 | 89.15 | Clay rich calcrete | 46.89 | 92.26 | 80.33 | 69.35 | 58.37 | 48.28 | 39.13 | 31.18 | 24.32 | 18.66 | 14.03 | 10.40 |
| B-7 | MJNM-6 | 96.60 | Gray dolomite | 6023.14 | 6.38 | 5.18 | 4.28 | 3.46 | 2.72 | 2.14 | 1.69 | 1.29 | 0.97 | 0.69 | 0.50 |
| B-8 | MJNM-6 | 107.30 | Pink limestome | 4697.49 | 20.21 | 16.85 | 14.05 | 11.50 | 9.32 | 7.50 | 6.03 | 4.79 | 3.81 | 3.03 | 2.33 |
| B-9 | MJNM-6 | 111.50 | Brown shale | 5783.72 | 17.18 | 14.64 | 12.53 | 10.52 | 8.73 | 7.18 | 5.85 | 4.73 | 3.78 | 3.00 | 2.37 |
| B-10 | MJNM-6 | 156.30 | Porous limestone | 4496.85 | 24.08 | 20.67 | 17.74 | 14.91 | 12.39 | 10.18 | 8.29 | 6.69 | 5.34 | 4.23 | 3.34 |
| B-11 | MJNM-6 | 250.70 | Coarse sandy dolomite | 4590.07 | 31.06 | 26.81 | 23.13 | 19.60 | 16.45 | 13.64 | 11.24 | 9.16 | 7.43 | 5.98 | 4.78 |
| B-12 | MJNM-6 | 281.00 | Massive limestone | 5002.68 | 10.36 | 8.76 | 7.50 | 6.29 | 5.22 | 4.29 | 3.50 | 2.84 | 2.29 | 1.84 | 1.47 |
| B-13 | MJNM-6 | 296.30 | Porous limestone | 3447.39 | 22.91 | 19.70 | 16.92 | 14.21 | 11.78 | 9.63 | 7.81 | 6.25 | 4.97 | 3.92 | 3.07 |
| B-14 | MJNM-7 | 82.90 | Calcrete | 2233.10 | 12.85 | 10.88 | 9.31 | 7.84 | 6.56 | 5.43 | 4.47 | 3.64 | 2.94 | 2.36 | 1.88 |
| B-15 | MJNM-7 | 110.50 | Brecciated dolomite | 4372.41 | 21.34 | 18.14 | 15.49 | 13.01 | 10.86 | 9.00 | 7.44 | 6.10 | 4.99 | 4.06 | 3.29 |
| B-16 | MJNM-7 | 124.00 | Porous shale | 4897.63 | 5.35 | 4.46 | 3.80 | 3.12 | 2.51 | 2.02 | 1.59 | 1.23 | 0.95 | 0.74 | 0.57 |
| B-17 | MJNM-7 | 150.60 | Black shale | 4805.30 | 16.37 | 14.31 | 12.58 | 10.86 | 9.29 | 7.86 | 6.60 | 5.50 | 4.54 | 3.74 | 3.05 |
| B-18 | MJNM-7 | 157.20 | Talc | 97.41 | 11.05 | 8.03 | 5.90 | 4.28 | 3.16 | 2.38 | 1.82 | 1.42 | 1.10 | 0.83 | 0.61 |
| B-19 | MJNM-7 | 215.60 | Talc rich dolomite | 289.34 | 16.09 | 13.82 | 11.97 | 10.25 | 8.75 | 7.42 | 6.27 | 5.25 | 4.36 | 3.59 | 2.92 |
| B-20 | MJNM-7 | 227.40 | Dolerite | 1082.55 | 44.30 | 39.42 | 35.18 | 31.06 | 27.28 | 23.82 | 20.76 | 17.97 | 15.52 | 13.33 | 11.43 |
| B-21 | MJNM-7 | 245.00 | Dolomite | 947.14 | 16.07 | 13.13 | 10.80 | 8.71 | 7.01 | 5.64 | 4.54 | 3.65 | 2.93 | 2.34 | 1.87 |
| B-22 | MJNM-8 | 84.25 | Calcrete | 197.35 | 7.24 | 5.43 | 4.06 | 2.90 | 2.01 | 1.38 | 0.99 | 0.77 | 0.68 | 0.67 | 0.70 |
| B-23 | MJNM-8 | 127.70 | Pebble calcrete | 520.91 | 7.40 | 6.04 | 5.03 | 4.15 | 3.41 | 2.76 | 2.25 | 1.84 | 1.50 | 1.22 | 1.01 |
| B-24 | MJNM-8 | 157.75 | Dolospar | 4708.77 | 16.93 | 14.76 | 12.94 | 11.15 | 9.53 | 8.06 | 6.78 | 5.65 | 4.69 | 3.87 | 3.18 |
| B-25 | MJNM-8 | 204.30 | Calcite | 10079.40 | 12.79 | 11.09 | 9.68 | 8.29 | 7.04 | 5.91 | 4.93 | 4.07 | 3.35 | 2.73 | 2.24 |
| B-26 | MJNM-8 | 229.52 | Dolerite | 82.88 | -6.67 | -7.10 | -7.02 | -6.64 | -6.04 | -5.28 | -4.49 | -3.68 | -2.92 | -2.23 | -1.64 |
| B-27 | MJNM-8 | 275.30 | Talc | 744.73 | 21.53 | 17.83 | 14.80 | 12.11 | 9.86 | 8.02 | 6.54 | 5.32 | 4.33 | 3.54 | 2.91 |
| B-28 | MJNM-9 | 87.65 | Kalahari sandstone | 35.50 | 14.75 | 11.49 | 8.74 | 6.25 | 4.98 | 3.21 | 2.24 | 1.56 | 2.05 | 0.49 | 1.64 |
| B-29 | MJNM-9 | 95.02 | Brown shale | 368.04 | 17.31 | 14.31 | 11.89 | 9.70 | 7.95 | 6.46 | 5.26 | 4.27 | 3.49 | 2.87 | 2.35 |
| B-30 | MJNM-9 | 120.00 | Dolomite | 631.31 | 9.42 | 8.48 | 7.73 | 6.81 | 5.95 | 5.14 | 4.31 | 3.42 | 2.77 | 2.19 | 1.68 |
| B-31 | MJNM-9 | 210.10 | Sandy dolomite | 5485.66 | 14.64 | 12.61 | 10.93 | 9.29 | 7.81 | 6.51 | 5.37 | 4.39 | 3.58 | 2.88 | 2.32 |
| B-32 | MJNM-9 | 248.64 | Mineralized dolomite | 4935.31 | 12.78 | 10.61 | 8.92 | 7.19 | 5.55 | 4.04 | 2.79 | 1.82 | 1.16 | 0.74 | 0.49 |
| B-33 | MJNM-10 | 83.80 | Kalahari sandstone | 610.10 | 9.34 | 7.22 | 5.65 | 4.33 | 3.33 | 2.58 | 2.07 | 1.71 | 1.48 | 1.35 | 1.25 |
| B-34 | MJNM-10 | 143.30 | Siliceous sandstone | 4936.37 | 18.75 | 16.35 | 14.29 | 12.26 | 10.40 | 8.71 | 7.25 | 5.99 | 4.94 | 4.02 | 3.24 |
| B-35 | MJNM-10 | 188.60 | Red dolomitic shale | 2973.38 | 19.20 | 16.28 | 13.85 | 11.59 | 9.61 | 7.90 | 6.44 | 5.22 | 4.19 | 3.35 | 2.67 |
| B-36 | MJNM-10 | 261.80 | Dolerite | 45.00 | 13.50 | 11.86 | 10.60 | 9.33 | 8.10 | 6.89 | 5.74 | 4.63 | 3.61 | 2.66 | 1.86 |
| B-37 | MJNM-10 | 279.30 | Talc | 4565.33 | 15.28 | 13.09 | 11.30 | 9.57 | 8.05 | 6.69 | 5.52 | 4.52 | 3.68 | 2.98 | 2.40 |
| B-38 | MJNM-11 | 84.32 | Pyrite mineralized sand | 70.53 | 65.59 | 56.77 | 49.21 | 42.08 | 35.77 | 30.20 | 25.43 | 21.23 | 17.56 | 14.37 | 11.62 |
| B-39 | MJNM-11 | 105.40 | Pink Mulden sandstone | 4725.23 | 22.27 | 18.97 | 16.22 | 13.65 | 11.39 | 9.41 | 7.73 | 6.31 | 5.11 | 4.13 | 3.33 |
| B-40 | MJNM-11 | 115.00 | Grey Mulden sandstone | 4766.66 | 29.45 | 24.56 | 20.50 | 16.79 | 13.65 | 11.02 | 8.88 | 7.10 | 5.68 | 4.51 | 3.59 |
| B-41 | MJNM-11 | 120.86 | Green Mulden sandstone | 4834.47 | 19.58 | 15.99 | 13.11 | 10.55 | 8.38 | 6.59 | 5.16 | 4.01 | 3.11 | 2.39 | 1.84 |
| B-42 | MJNM-11 | 140.55 | White Mulden sandstone | 4723.25 | 8.42 | 7.09 | 6.04 | 5.04 | 4.17 | 3.41 | 2.76 | 2.23 | 1.79 | 1.43 | 1.12 |
| B-43 | MJNM-11 | 172.90 | Grey Mulden sandstone | 4513.83 | 17.35 | 14.99 | 13.03 | 11.15 | 9.46 | 7.94 | 6.62 | 5.46 | 4.47 | 3.62 | 2.92 |
| B-44 | MJNM-11 | 243.30 | Broken breccia | 4860.26 | 4.09 | 3.32 | 2.78 | 2.27 | 1.83 | 1.46 | 1.15 | 0.90 | 0.70 | 0.56 | 0.44 |
| B-45 | MJNM-11 | 288.45 | Sandy dolomite | 4190.63 | 11.44 | 9.68 | 8.27 | 6.95 | 5.78 | 4.75 | 3.88 | 3.13 | 2.50 | 1.98 | 1.57 |
| B-46 | MJNM-12 | 43.50 | Mulden sandstone | 241.58 | 27.67 | 23.48 | 19.92 | 16.64 | 13.82 | 11.41 | 9.37 | 7.59 | 6.08 | 4.79 | 3.72 |
| B-47 | MJNM-12 | 86.20 | Pyrite mineralized sand. | 487.34 | 78.53 | 68.37 | 59.35 | 50.60 | 42.63 | 35.46 | 29.24 | 23.83 | 19.24 | 15.37 | 12.18 |
| B-48 | MJNM-12 | 122.00 | Green shale | 225.20 | 9.91 | 8.69 | 7.75 | 6.84 | 5.99 | 5.18 | 4.44 | 3.77 | 3.15 | 2.58 | 2.08 |
| B-49 | MJNM-12 | 139.70 | Medium Mulden sand. | 5013.95 | 10.72 | 9.14 | 7.84 | 6.62 | 5.51 | 4.51 | 3.68 | 2.96 | 2.37 | 1.89 | 1.53 |
| B-50 | MJNM-12 | 262.20 | Black shale | 3808.24 | 47.09 | 40.93 | 35.55 | 30.35 | 25.66 | 21.50 | 17.85 | 14.72 | 12.06 | 9.84 | 7.99 |
| B-51 | MJNM-12 | 291.45 | Pink talc | 4347.39 | 7.51 | 6.28 | 5.34 | 4.48 | 3.73 | 3.09 | 2.55 | 2.09 | 1.72 | 1.40 | 1.14 |

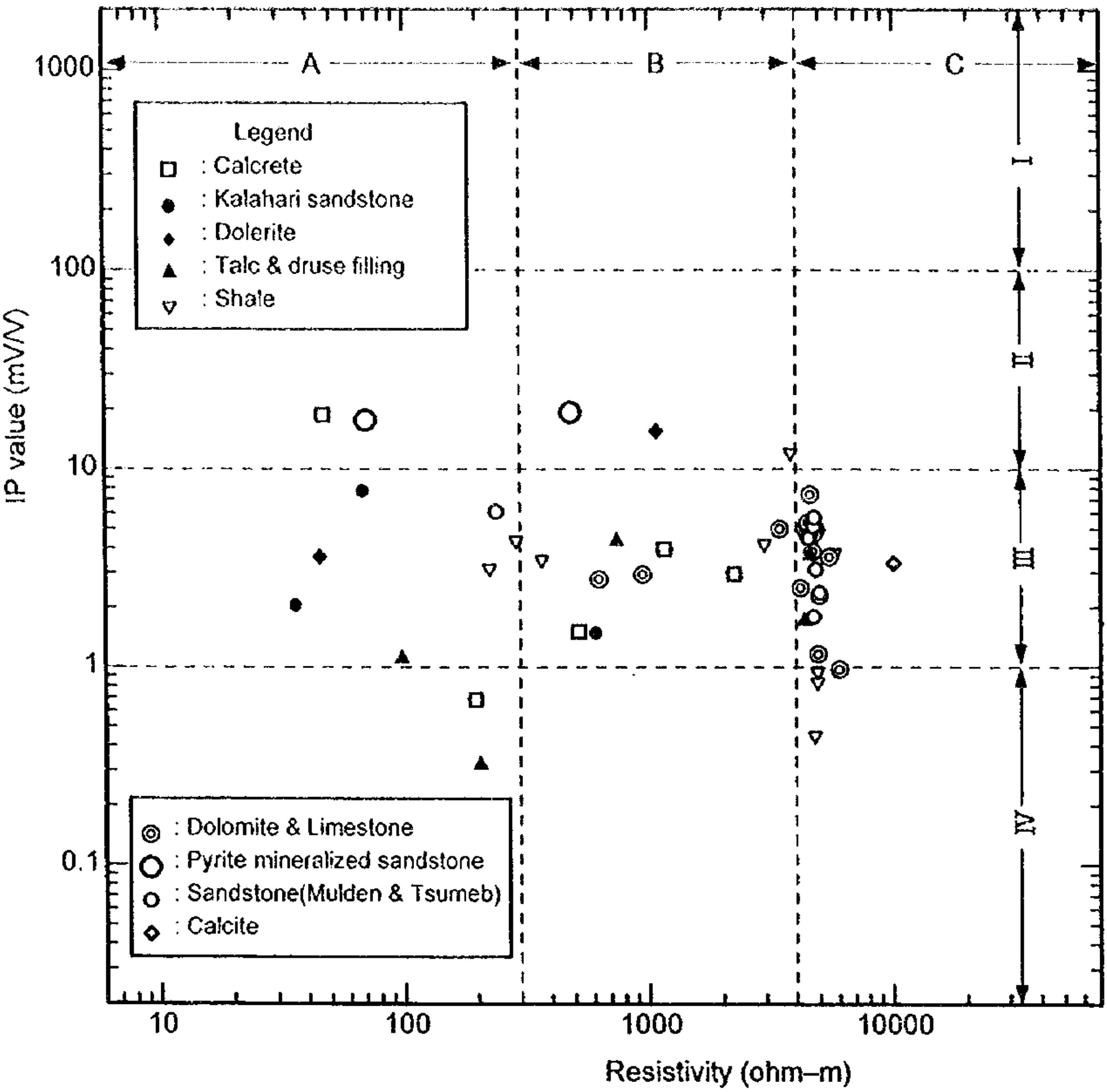



**Fig. II −1−6 Resistivity v.s.IP value of core samples**

## II-1-8 Discussion

### II-1-8-1 Stratigraphical correlation

The formation of the holes were correlated to the standard stratigraphic sequence based upon the criteria and the result of the logging. The result is illustrated in Fig II-1-6.

MJNM-5 was correlated to T7 because dark grey fine grained dolomite dominated. But the upper formation than 195m could be assigned to T8.

MJNM-6 is pale brick coloured calcareous deeper than 131 metre and therefore unique. The formation was correlated to Abenab subgroup according to the type locality.

MJNM-7 was correlated to T7 because of well laminated dolomite intercalated with shale beds. A part of black shale cores gave smell which is characteristic of lagoonal sediment of T7 orT8.

MJNM-8 showed similar succession to that of MJNM-7 and therefore correlated to T7.

MJNM-9 encountered medium grained sandy dolomite dominantly deeper than 170m and so was assigned to the upper T4 where transgression started towards T5. The formation upper than 170m which hosts old fractured zone is possibly correlated to T4 as well as the upper formation.

MJNM-10: black facies predominate at a depth greater than 200m and was identified as the same position with MJNM-7. The shallower part was correlated to T8 based upon characteristic stromatolitic texture at around 163m.

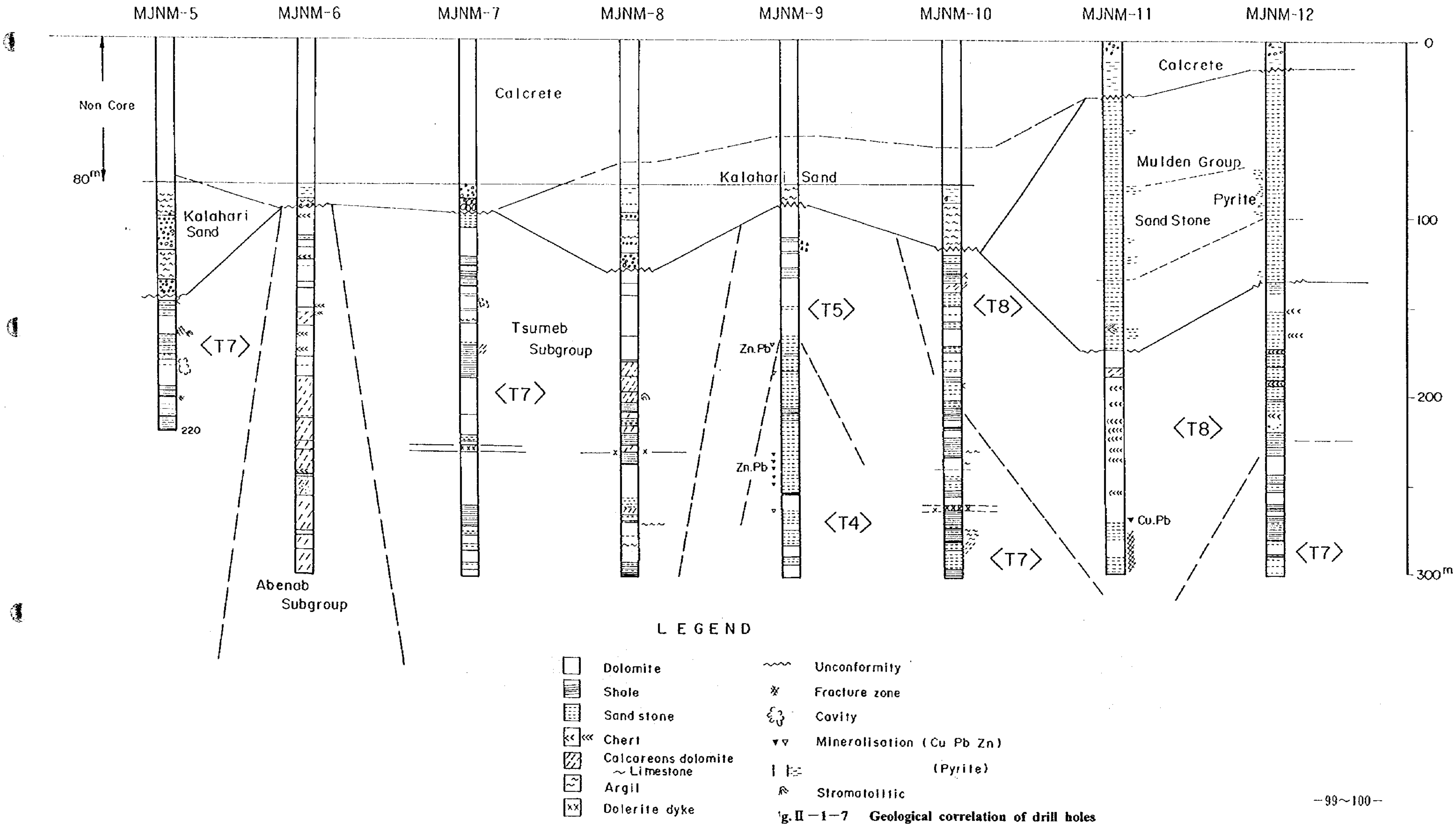
MJNM-11 was assigned to T8 because of the multiple thin beds of chert and intercalation of oolite within the dolomite deeper than 174m.

MJNM-12: The formation deeper than 220m is different from that of MJNM-11 and is characterized by black dolomitic shale. Therefore it was correlated to T7 and the upper formation than 220m to T8.

### II-1-8-2 Geological structure

The geological structure was introduced as illustrated in Fig. II-1-7 as a result of the stratigraphic correlation of the holes drilled in the east of the survey area combined with overall geological structure indicated by airborne geophysical survey.

In the drilling profile along NW-SE parallel to the low resistivity trend, the formation underlying the calcrete seems to form a synclinorium of which axis runs near MJNM-5 and the basement may underlie at a shallow depth 2.5km south of MJNM-6. The sequence of the lower Tsumeb subgroup from T1 to T6 forms the south wing of the syncline between MJNM-6 and MJNM-7. There could be T8 under the




'g. II −1−7 **Geological correlation of drill holes**

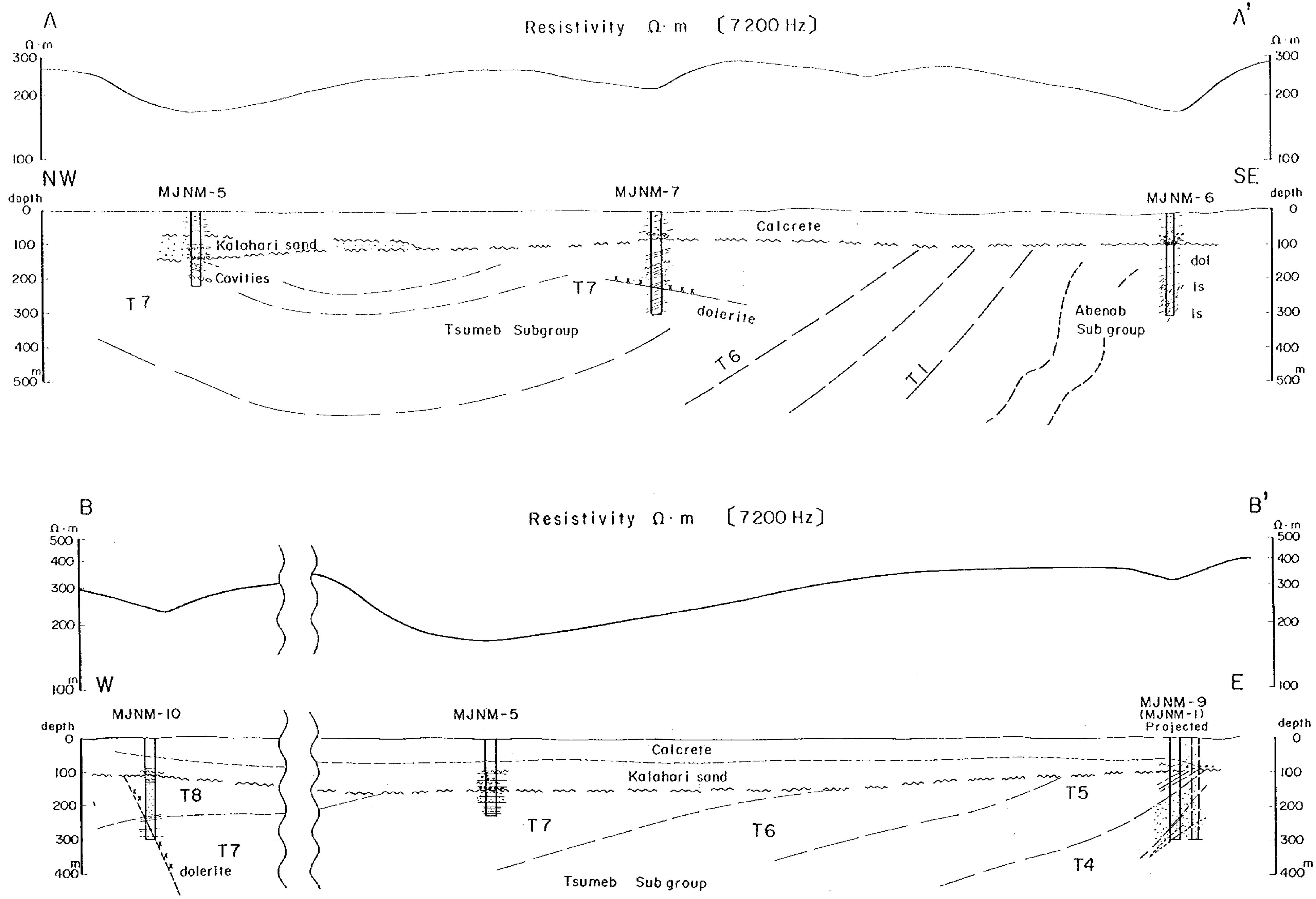



Fig. II－1－8 (1) Geologic cross section of drill holes

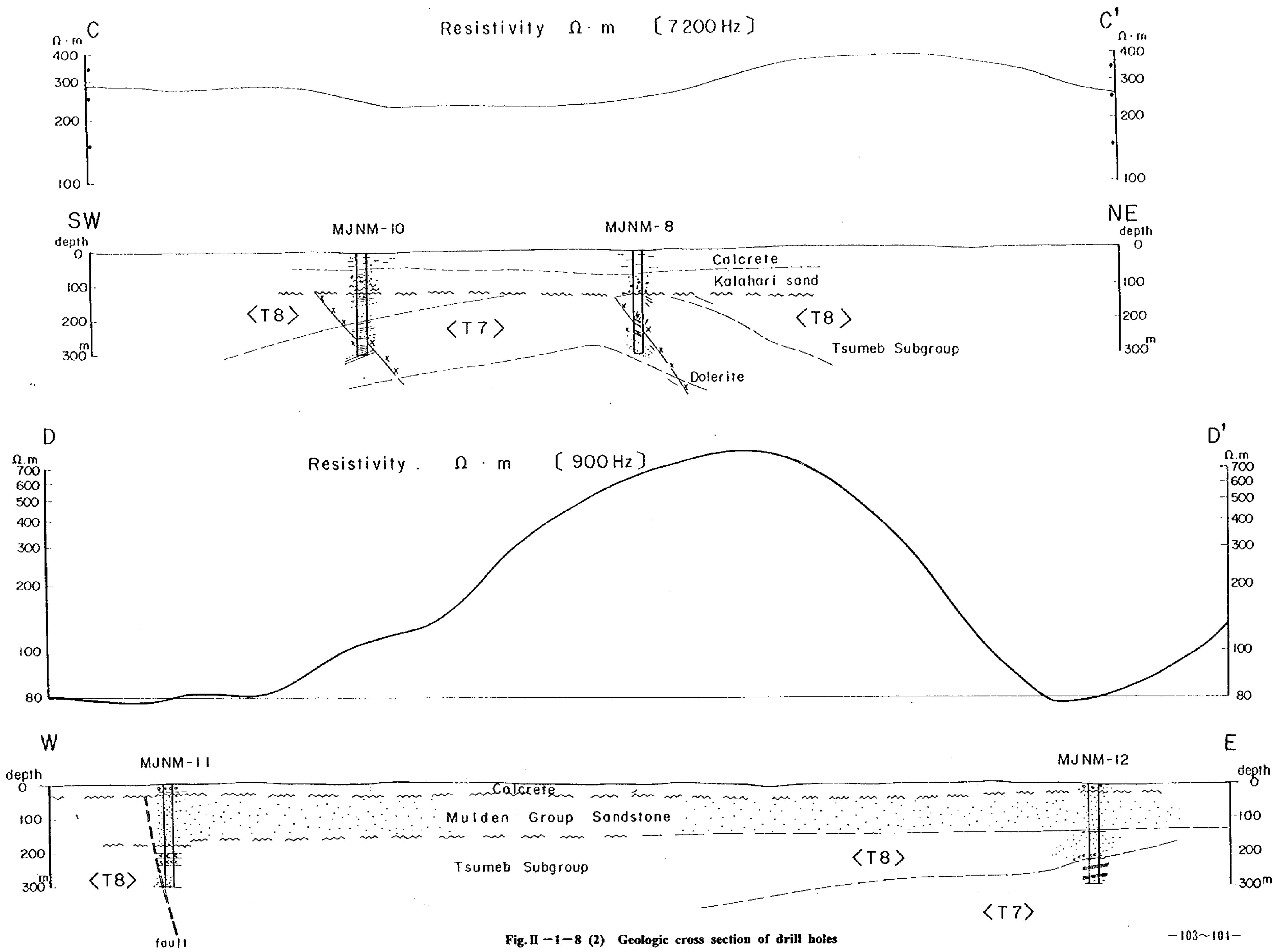



Fig. II −1−8 (2) Geologic cross section of drill holes

calcrete unconformity between MJNM-5 and MJNM-7. Many cavities revealed in MJNM-5 may be related to the proximity of the synclinal axis. In other words these cavities may have formed by the ground water circulating through fractures which develop in the vicinity of the axial part. The dolerite of MJNM-7 is running parallel to the direction of the profile.

In MJNM-5 the Kalahari sand was recognized between calcrete and Damara carbonate and seems to extend north from MJNM-5. Fig. II-1-7 indicates the geological structure along WNW-ESE profile where the holes of MJNM-10, MJNM-5 and MJNM-9 are involved. This profile suggests that Kalahari sand commonly underlies the calcrete and that the sequence from T4 to T8 forms a monoclinic structure dipping west. The apparent dip of the formation between MJNM-5 and MJNM-10 seems to be small along this direction.

In the profile along NNE-SSW direction passing the hole of MJNM-10 and MJNM-8, it seems that MJNM-10 is located at the north wing of the syncline whose axis runs easterly passing around MJNM-5, while MJNNM-8 is located at a local anticline. These two holes intersected dolerite dykes at the almost same depth, however the aeromagnetic anomaly map indicates the dolerite dykes are separately running parallel to the NW-SE direction.

The geological structure in the west of the survey area was interpreted as follows on the basis of stratigraphical correlation of MJNM-11 and MJNM-12.

It had been believed that this area was located at a local anticline between two large syclinal structure from the image interpretation and airborne geophysical anomaly map. Nevertheless, the sandstone of Tschudi formation of Mulden group was intersected over more than 100 meters below the calcrete. Therefore, this area was interpreted to be included within the broader synclinorium.

In the lower part of MJNM-12, back facies of dolomite predominate, whereas the upper part consists of grainstone and chert as MJNNM-11 do. That translates gently dipping structure to the west as a whole in the E-W profile. It is uncertain where in the broad synclinorium the area is situated.

### II-1-8-3 Mineralisation

It had been believed that this area was located at a local anticline between two large synclinal structure from the image interpretation and airborne geophysical anomaly map. Nevertheless, the sandstone of Tschudi formation of Mulden group was intersected over more than 100 meters below the calcrete. Therefore, this area was interpreted to be included within the broader synclinorium.

The characteristics of the mineralisation encountered in MJNM-9 was high Zn/Pb ratio as much as 4.9

and higher than that of Tsumeb type ore indicating that the mineralisation is similar to that of Mississippi Valley Type ore deposits of North America. , On the other hand the minute mineralisation intersected by MJNM-11 gave higher concentration of lead than zinc and seems to rather be of Tsumeb ore type. Concerning to the ratio of cadmium to zinc, MJNM-11 is higher than MJNM-9 indicating the same trend as Tsumeb ore. Vanadium mineralisation overprints the sulphide mineralisation of MJNM-11 with comparatively significant concentration. Regarding to Au and Ag, no specific relationship between the other elements and drill holes was recognized. It had been believed that this area was located at a local anticline between two large synclinal structure from the image interpretation and airborne geophysical anomaly map. Nevertheless, the sandstone of Tschudi formation of Mulden group was intersected over more than 100 meters below the calcrete. Therefore, this area was interpreted to be included within the broader synclinorium. .

### II-1-8-4 Homogenization temperature and salinity

The average values of samples fall into the area from 130℃ to 159℃. The number of datum is not enough though, there seems to be a rough trend of higher homogenization temperatures at the deeper mineralisation within the interval of 15m. The mean value of 146.6 ℃ is comparable to that of typical Mississippi Valley Type ore deposits which varies from 75 to 200℃ and is lower than the temperature of the important phase of mineralisation at Tsumeb which varies from 230 to 250℃.

The salinity mean value of 14.59 wt% eq. NaCl is also comparable to that of common Mississippi Valley Type ore which varies from 10 to 30 wt% when the samples with erratic small value are excluded. Meanwhile that of Tsumeb ore varies from 2 to 7 wt% and obviously different from those of MJNM-9. That resulted in the conclusion the mineralisation of MJNM-9 may have formed under diagenetic environment as Mississippi Valley Type ore.

## II-1-8-5. Physical property of core samples

(1) Possible source of low resistivity anomaly

Many cores of calcrete from a depth of 100 meters and Kalahari sand gave less than 100 Ω·m indicating such formations could be a potential source of broad low resistivity zone delineated in the anomaly map. Some of the dolerite and talc argillaceous zones associated with it gave less than 50 Ω·m and may also result in the low resistivity lineament.

Mineralised sandstone with pyrite of MJNM-11 showed low values of 71 Ω·m giving good contrast with hosting sandstone of Mulden group and therefore is believed to be an important source of low resistivity window centred by this hole.

With regard to shale, while black facies of dolomitic shale gave some 1000 Ω·m being as high as the hosting sandstone and dolomite, green facies in the Mulden group and brown shale gave low as much as several hundred Ω·m. Such shales as the latter two may result in the elongated low resistivity zone parallel to the geological trend.

(2) Study of exploration method

Some sulphide ores from the known ore deposits showed some 10 Ω·m of resistivity in Phase I. Since such an ore is embedded within a sandstone or dolomite with some 1000 to some tens thousands Ω·m, the resistivity method had been deemed to be effective for Tsumeb·Kombat type ore deposit. But the drilling survey of Phase Ⅲ revealed less resistive facies and conductive ground water at a shallow depth and that is expected to be a barrier for resistivity method for extraction of underlying low resistive mineralisation. In addition, some shale and dolerite with alteration halos could be a source of resistivity anomalies. That would not necessarily explain that resistivity method is the only most effective method, however the method is considered to be useful if the less resistive formation is previously known.

For a search of a subsurface structure and a concealed ore deposit thereby, the resistivity survey is inevitable as well as magnetic survey in the non exposed area.

With regard to IP, because of very high IP value of ore IP method is useful when the IP values of host rock is small enough, but practically dolerite and accompanying argillacous alteration zone, some shales of Damara system and surface group showed a comparatively high IP value, so those could be an obstacle to ore exploration.

When IP method is used, the survey area should be well extracted prior to it using TDEM method, magnetic survey and preliminary drilling because practical efficiency of IP survey is quite low.

### II-1-8-6 Interpretation of the anomalies of airborne geophysical survey

(1) MJNM-5,6,7,8,9 and 10 east of the survey area

Fig. I -1-2 and Fig.II-2-1 illustrate relationships between the result of drilling survey and the geophysical anomalies particularly airborne aeromagnetic method used in Phase II. General view allows the geological structure to be two layer-structure being composed of surficial calcrete 100 to 120 metre deep combined with Kalahari sand and underlying Damara carbonates or basement rocks.

The calcrete had been esteemed to be of comparatively high resistivity. However, percussion drilling revealed that it hosted some argillized aquifers within 100 metre thickness giving such calcrete low resistivity enough. Although resistivity map of 56000 Hz generally shows deeper resistivity structure of shallow depth, the difference of anomaly patterns between 7200 Hz and 900 Hz the observed values of resistivity, may indicate 56000 Hz map project the resistivity structure at a depth of 60 metre or within calcrete as illustrated in resistivity profile in Phase II report. The sand is a terrestrial sediment of paleo Kalahari desert. The quartz grains are filled with a large amount of reddish argil and shows remarkably low resistivity when the water percolates in it. It lies 100 to 120 meter deep and is possibly translated to a partly 7200 Hz resistivity structure. It looks like extending to the north of the synclinal axis which is formed in the carbonate sequences. These young sediments is unconformably underlain by mainly dolomite, limestone and chert which shows high resistivity.

The holes of MJNM-5,6 and 7 are spot anomalies on a low resistivity lineament traversing northwesterly the synclinorium with E-W trending axis. The drilling survey showed lineament could be deep-seated ruptured zone along which a swarm of dolerite dykes of pre-Tertiary age intruded. Core logging indicated the dolerite dips 45 to 60 degree and is subjected to intense hydrothermal alteration forming a great deal of talc. Only MJNM-7 of the holes drilled on the low resistivity lineament intersected the dolerite dyke, however the interpretation combined with the aeromagnetic anomalies would show that the dolerite could run intermittently in parallel with the low resistivity lineament. MJNM-8 and MJNM-10 intersected the dolerite dykes at the same depth. The dykes are possibly a pair of parallel dyke swarm.

The key depth of resistivity structure 900 Hz may vary with resistivity values of the formation, but the resistivity profile of Phase II combined with the result of the drilling survey indicates that the map account for the structure at a depth of 200 to 250 metre. That may translate that the geological structure including dolomite dominant formation may be responsible to 900 Hz resistivity map.

MJNM-5 intersected some cavities filled with a large amount of water and clay. It is believed that the

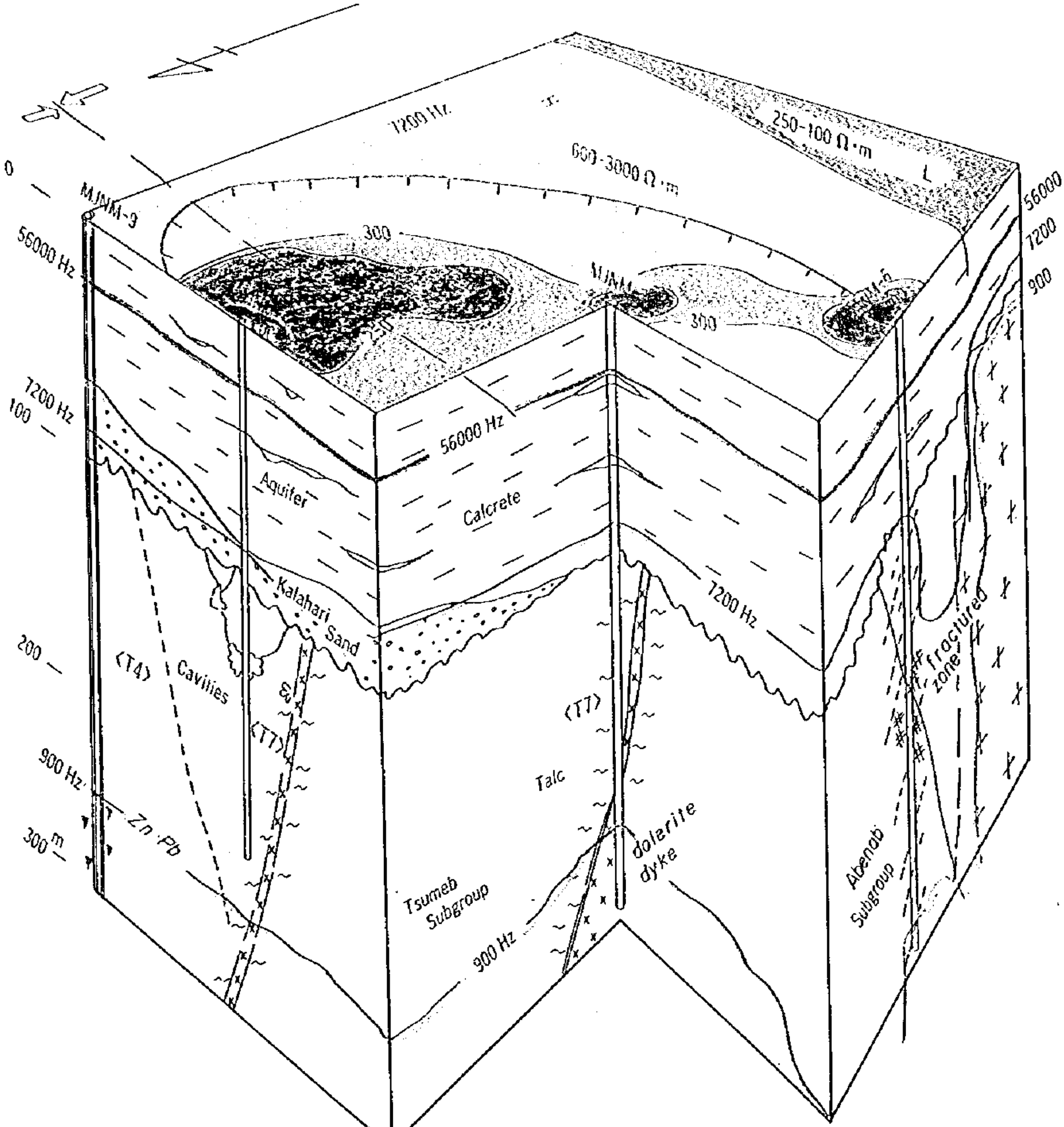



Fig. II −2−1 (1) Block model of compilation and interpretation

low resistivity anomalies of 7200 and 900 Hz at the vicinity of MJNM-5 was enhanced by such sources of low resistivity. Such cavities are believed to be one of the most preferable criteria for loci of ore deposition. From a viewpoint of timing of ore formation, this potential cavities should have been filled with molasse sand of the Mulden group. Therefore, the cavities of MJNM-5 filled with clay and water is believed to be far young than potential mineralisation. The cavities may be possibly formed through circulation of ground water into argillaceous zone resulted from hydrothermal alteration at the time of intrusion of dolerite dykes.

(2) MJNM-11,12 West of the survey area

The anomaly pattern of the area varies with the depth. The low resistivity zones are more widely extended and the observed values are lower at the shallower depth(56000 Hz) than at the deeper depth(7200 and 900 Hz). The characteristics of the shallower layer at 56000 Hz are remarkable NNE-SSW trending lineaments, however at 7200 Hz ENE-WSW becomes more obvious instead of NNE-SSW and both of ENE-WSW and NW-SE trending lineament at 900 Hz.

MJNM-11 was targeted at the intersection of the two lineaments. One is ENE-WSW trending low resistivity lineament and the other is NNE-SSW trending low resistivity.

MJNM-12 was sunk at the center of isolated low resistivity window within high resistivity zone. The resistivity profile calculated from differential resistivity gives the depth of 10-20 metres for 56000 Hz and 50-100 metres for 7200 Hz respectively.

The interpretation combined with the result of drilling survey indicates that the low resistivity anomalies may be caused by ruptured zone running through up to calcrete, pyrite disseminated in the sandstone of Mulden group, weathered zone of the formation or intercalated shale beds. Although the pyrite is most likely source of low resistivity, that contradicts obviously the fact that the sandstone is encountered commonly in both holes and that the pyrite shows syndepositional origin and also that MJNM-12 is located at the isolated low anomaly.

The hole of MJNM-11 intersected intensely fractured zone with black dolomitic shale beneath Mulden unconformity suggesting ENE striking fault which may pass near the Tsumeb ore deposit. If the fault would dislocate the formation up to the Mulden sandstone it could be a source of low resistivity at 7200 Hz. The NNE-SSW trending resistivity lineament at 56000 Hz may coincides with the direction of groundwater channels within calcrete in this area.

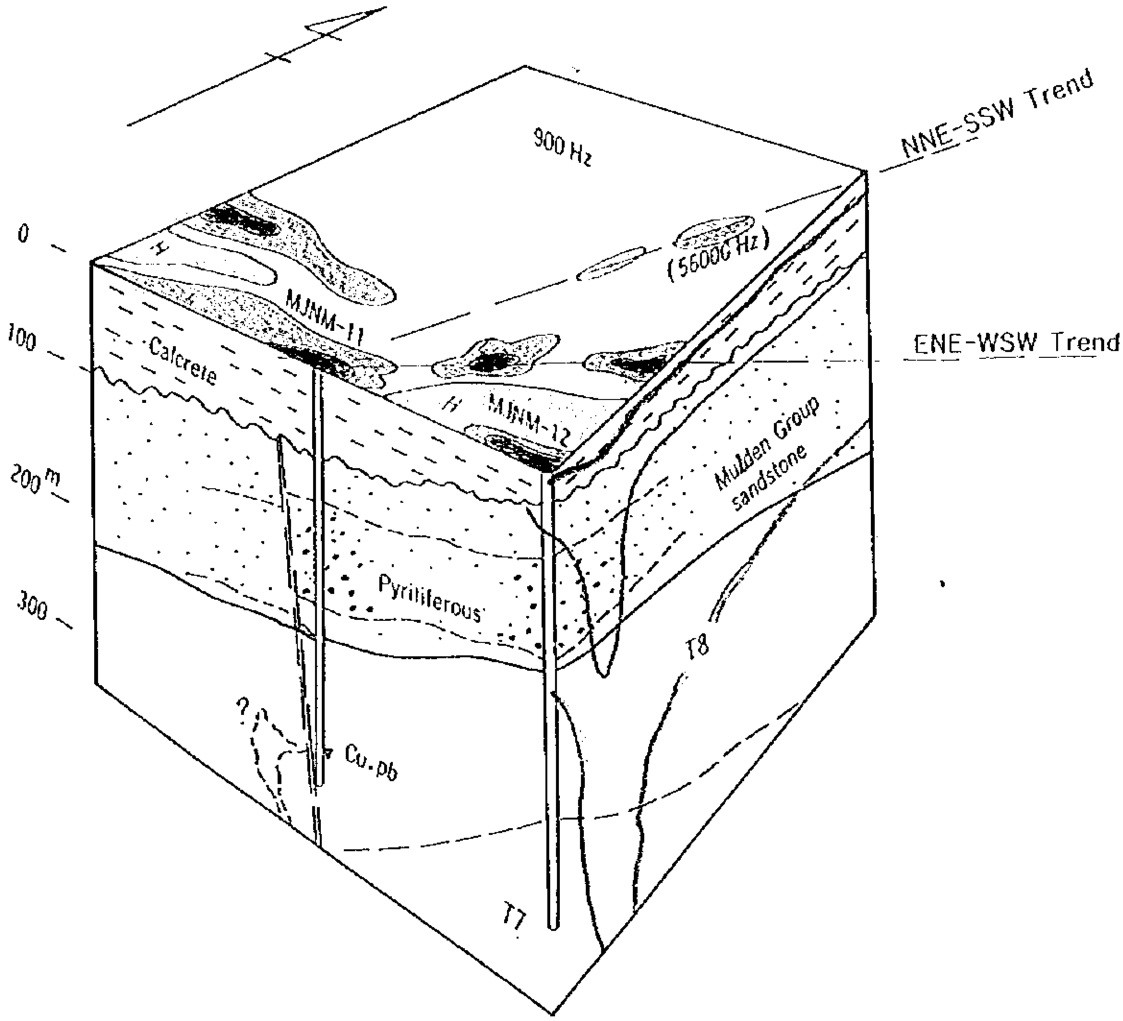



Fig. II −2−1 (2) Block model of compilation and interpretation

## Chapter 2 Compilation and Interpretation

Eight holes totaling 2,320 metres were drilled using the exploration model prepared on the basis of the results of Phase I and Phase II survey which consisted of compilation of the previous exploration, airborne geophysical survey and wide-spaced drilling.

The hole of MJNM-9 intersected an extension of the medium to weak lead and zinc mineralisation of so called Mississippi Valley Type which was encountered in MJNM-1 of Phase II. The average grade of Pb combined with Zn over 5.24m of cumulative length of mineralised section was 0.129 % and lower in comparison with MJNM-1. The mineralisation is hosted within grainstone as with MJNM-1 the stratigraphic control of T4 is suggested.(Fig. II -2-1(1))

Intense pyrite mineralisation was intersected by both holes of MJNM-11 and MJNM-12 which occur within the sandstone of the Mulden group. Chemical assays indicate that the pyrite was not associated with copper concentration. The occurrence of pyrite is of syndepositional origin under a reducing environment.

MJNM-11 targeted the intersection of the ENE-WSW trending low resistivity lineament and the NNE-SSW trending lineament, encountered a copper-lead-vanadium mineralisation associated with dolospar and calcite veinlets hosted within T8 dolomite. This mineralisation could be grouped into Tsumeb type ore rather than Mississippi Valley Type as the metal ratio indicated high concentration of copper compared to lead and zinc. This weak mineralisation was believed to be hosted at the fringes of an intensely fractured zone. A potential ore deposit could be expected along the extension of the fracture zone which could develop into karst breccias and therefore further exploration is recommended in this area in the future.( Fig. II -2-1(2))

No mineralisation was encountered in the low resistivity lineaments or in spots anomalies traversing the Mulden group unconformity which was accounted for the original exploration rationale. The drilling revealed that the low resistivity lineaments might coincide with NW-SE trending dolerite dykes and associated with hydrothermal alteration including talc argillization. No low resistivity spots anomalies so far drilled coincided with any karst breccias and solution breccias.

The Mulden sandstone was expected to underlie extensively the area east of the survey area. This was based on the interpretation of resistivity map combined with aeromagnetic anomaly map. However, the drilling intersected no sandstone in these areas. The ore potential under the Mulden unconformity were not tested sufficiently. For a more detailed exploration of potential karst structure in the Mulden group terrain, a ground geophysical survey as TDEM would be needed with narrower-spaced survey lines prior to drilling.

In the west of the survey area, the sandstone of Mulden group was intersected over more than 100m where it had not been expected on the basis of image interpretation and airborne geophysical data.(Fig. II-2-1(2)) This explains limited interpretation of the underlying formation using resistivity data. In the east of the survey area, the Kalahari sand could be a source of low resistivity at a shallow depth, which possibly mask the low resistivity anomalies which might originate from a potential ore deposit.(Fig. II-2-1(2))

There could thus be various sources for low resistivity anomaly including aquifer and clay minerals formed during weathering process at a shallower depth which may mask the deeper structure of resistivity. In other words, practically the lower frequency may receive the signals of a shallower depth and this may make the deep exploration less effective.

Nonetheless, an airborne geophysical survey is believed to be the most favourable because of high efficiency of data acquisition and cost performance in such an area poorly exposed like the Otavi mountainland area. An aeromagnetic combined with an airborne electromagnetic survey could give detailed analysis and interpretation. But the detailed physical properties of surface sediments and consideration of the key depth would be inevitable for the survey.