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1966/76

GEOLOGICAL INVESTIGATION OF MUGGA QUARRY. A.C.T., 1965

by

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GEOLOGICAL INVESTIGATION OF MUGGA QUARRY, A.C.T. 1965.

SUMMARY

The southern part of Mugga Hill (Mount Mugga Mugga) was mapped in detail to aid in evaluating the possibility of extending the present quarry towards the south-east. Quartz-feldspar porphyry was found to crop out over 25 percent of the area of the suggested extension; it ranges from solid fresh porphyry to soft, crumbly (altered) porphyry. A zone of soft, crumbly, porphyry occurs in a south-east trending fault zone to the east of the existing quarry and probably extends across the area proposed for development, Soft crumbly porphyry is exposed along road cuttings in the southern part of the area. Some patches of deep soil may be underlain by unexposed zones of soft crumbly porphyry. No sulphides were found in the area.

A programme of pattern percussion drilling is recommended to determine the depth of overburden in the area of the proposed extension and to locate any undetected zones of unsound rock. Three diamond drill holes are recommended to obtain samples of the porphyry at depth for detailed petrographical examination and mechanical testing.

INTRODUCTION

In response to a request by the Department of Works (Minute 64/4906, of 7th July, 1965) to examine the possibility of extending the Department's Mugga Quarry towards the south, the south-eastern slopes of Mugga Hill were geologicaly mapped at 200 feet to the inch to determine the extent of outcropping porphyry, the quality of the rock, the pressure of faults and shear zones and associated unsound soft crumbly rock, the presence of deleterious minerals, and the depth of overburden.

Previous work by Dallwitz (1949) and Noakes had shown the presence of zones of soft crumbly porphyry, the condition of which was ascribed to autometamorphism, along faults and shears in the porphyry. Hawkins (1965), as a result of a resistivity survey, suggested the presence of a deep zone of soft altered rock trending south-eastward from the present quarry, i.e. across the area of the proposed extension (see Figure 1). Percussion drilling in 1959, supervised by D.E.Gardner, confirmed the presence of a deep zone of soft crumbly porphyry to the east of the quarry and trending south-eastwards. (see Figure 2). In places this zone is over 100 feet deep.

Alteration was therefore directed to delineating the zone of soft crumbly porphyry in the area of the proposed extension of the quarry and determining the depth of overburden in the area. The outcrops of porphyry were mapped and examined to check whether the rock is sound or whether any deleterious minerals are present.

ROCK TYPES AND THEIR DISTRIBUTION

Rock types:

The rock exposed on Mugga Hill and in Mugga Quarry is a compact blue-grey quartz-feldspar porphyry. Weathered outcrops on the ridge between the trigonometrical station and the magazine, and in the quarry, exhibit well-marked bands or layers which generally dip 25 degrees towards the south-west. The layering may be bedding.

The fresh porphyry consists of phenocrysts of clear glassy quartz and white or grey feldspar, up to 5 mm. across, and flakes of black mafic minerals set in a fine-grained blue-grey matrix. The porphyry is quite diverse in texture and mineral content; some parts are finer-grained than others, quartz is more common in some parts than in others, and potash feldspar is the dominant feldspar in some places, whereas plagioclase is dominant in others.

Under the microscope, the phenocrysts of quartz in the fresh rock from the quarry (R65360037, 38, 39) are seen to be embayed euhedral crystals. Some are strained, some are cracked, and some contain stylolites (mutual intergrowths produced by recrystallization and solution under pressure). Most of the potash feldspar occurs as embayed phenocrysts of orthoclase microperthite, but euhedral crystals of uniaxial negative sanidine, the high temperature potash feldspar, are common. Plagioclase occurs as euhedral phenocrysts of oligoclase and andesine, some are zoned and most are altered in various degrees to sericite and calcite. No primary mafic minerals were seen - only masses of chlorite and sericite with lines of hematite granules arranged along what were presumably the cleavage planes of the original minerals. From a study of the patterns of the hematite granules and the shapes of the chloritic masses, it is concluded that the original mafic minerals were biotite, augite, and hornblende.

The matrix of the rock consists of minute irregular intergrowths of quartz, feldspar, and chlorite. Some of the intergrowths are radial. Hematite, zircon and apatite are accessary

Even the freshest rock exposed in the quarry is cut by veins up to 5 mm across of calcite, epidote and hematite, and many of the grains of quartz are coloured deep red by a coating of hematite. A few veins and patches of chalcedony up to 10 mm. across were found. Although pyrite and other sulphides are common in the porphyries around Canberra, and were reported from Mugga Hill by Mahoney and Griffith Taylor (1913), none were found in the exposures in, or specimens examined, from Mugga Quarry.

Distribution

The outcrops of porphyry (see Figure 3) were mapped as:

(a) solid blue porphyry : Phenocrysts of glassy quartz and greenish-grey feldspar, set in a blue-grey matrix. Breaks into sharp, irregularly shaped fragments. Exposed in the lowest quarry bench.

(b) solid porphyry : Phenocrysts of glassy and rock quartz, grey and pink feldspar, set in a blue-grey matrix. Hackly fracture, sharp edges. Exposed in floor main quarry.

(c) weathered porphyry : Phenocrysts of red and glassy quartz, and white feldspar, set in a dark grey matrix. Limonite stains, uneven fracture, blunt edges.

(d) soft crumbly porphyry : Phenocrysts of red and glassy quartz and soft white feldspar, set in a soft light brown matrix. Extensive limonite staining. Crumbles easily.

The solid blue porphyry crops out in the lowest quarry, in the northern quarry, the northern part of the main quarry, and around the summit of Mugga Hill. It is a hard, compact porphyry with little weathering; joints are sparse and tight. The rock is cut by numerous veins of calcite, epidote and hematite. The solid blue porphyry passes south-eastwards into solid porphyry in the southern part of the main quarry, and forms the crest of the ridge from the summit of Mugga Hill towards the magazine. Some of the phenocrysts of quartz and feldspar show hematite staining. The porphyry crops out as low rounded masses with well developed joints. A set of north-west trending green joints is prominent in the quarry face. Weathered porphyry crops out between the magazine and the crushing plant and forms low rounded outcrops with wide open joints. Limonite staining is extensive. The soft crumbly porphyry consists of phenocrysts of red quartz and soft white feldspar set in a soft grey crumbly matrix. It occurs along fault planes and sub-horizontal shear planes in the main quarry. The largest mass occurs in a 50-foot-wide south-east trending zone, in the south-east corner of the quarry. The cuttings along the access rocks to the crushing plant expose over twenty feet of closely jointed, soft, crumbly, pale-brown porphyry.

Structure:

The porphyry exposed alomg the ridge from the trigonometrical point to the magazine exhibits a well marked layering that dips at 25 degrees towards the south-west. This layering is also apparent in the large fault faces exposed in the northern part of the main quarry and in slightly weathered parts of the lowest quarry. This layering is either bedding or flow banding.

The porphyry in the main quarry is cut by several zones of sheared, shattered and slickensided porphyry from ten to twenty feet wide (Figure 3). Most of them trend northwards and dip steeply towards the east at 75 to 95 degrees (Figure 4). Several slickensided surface, dipping at 70 degrees towards the south-west were found in the soft crumbly porphyry near the crushing plant.

The porphyry is cut by three sets of joints. The most prominent set strikes at 130 degrees and dips at 70 degrees towards the north-east. The other two sets are vertical; one strikes 060 degrees and the other strikes at 360 degrees (Figure 4). Subhorizontal joints are noticeable in the upper part of the main quarry and in the outcrops on top of the ridge. They may be "expansion" or "unloading" joints developed by stress release in response to the removal of overlying rock by erosion. One set is subhorizontal and the other set is parallel to the layering of the porphyry and dips at 25 degrees towards the south-west.

Alteration

In several places the porphyry has broken down into a loose crumbly rock consisting of phenocrysts of quartz and of white feldspar pseudomorphs set in a soft, crumbly, pale-grey matrix. The original plagioclase in the phenocrysts and in the matrix has been altered to a mass of minute flakes of sericite and illite with patches of calcite. Hematite has been altered to brown limonite with the advance of weathering. The matrix changes from dark blue-grey to dark brown and then to light brown.

Soft crumbly porphyry occurs in vertical north-trending shear zones and fault zones ten to fifty feet wide along the south and east faces of the main quarry. It also occurs in two to four feet thick subhorizontal lenses between layers of massive porphyry in the northern part of the main quarry. Other zones of crumbly porphyry were delineated by a programme of percussion drilling in 1959 (Figure 2). Deep shot-hole drilling during quarrying operations has shown the zone in the south-east corner of the quarry to be over one hundred feet deep. Figure 2 shows that the deep zone of crumbly porphyry is not a continuous zone trending north-westwards. It appears to be a discontinuous series of zones which trend north-westwards and have associated minor off-shoots trending northwards. Thus the zones of soft crumbly porphyry could be the result of alteration of porphyry along intersections of north trending faults with the north-west trending faults which dip at 75 degrees to the south-west.(Figure 4).

PROPOSED EXTENSION OF QUARRY

The main factors to be considered in evaluating the proposed quarry extension are: the extent and depth of overburden, the quality of the exposed and underlying rock down to the lowest level of a free-draining quarry; the distribution of the zones of unsound crumbly rock, and the presence or absence of deleterious minerals.

The proposed extension covers the gently sloping (15 degrees to the horizontal) southern side of Mugga Hill. Seventy-five percent of the area is soil-covered. Some patches of soil are extensive and, judging by the absence of boulders and the size of some of the eucalypt trees (more than thirty feet high), the soil in places appears to be deep. The deep soil may overlie soft crumbly porphyry. Over wide areas the soil is shallow.

Figure 3 clearly shows the distribution and type of outcrop. The northern outcrops of porphyry along the crest of the ridges consist of low rounded outcrops of fresh blue-grey porphyry with well-marked layering and subhorizontal jointing. The outcrops farther south consist of low slabs with rounded boulders of slightly weathered porphyry; the porphyry is composed of red iron-stained phenocrysts of quartz and phenocrysts of sericitized plagioclase, set in a grey iron-stained matrix. A few outcrops exhibit well-marked banding and prominent joints. Outcrops are sparse in the southern part of the area; they consist of low slabs of weathered porphyry with wide open joints, and are surrounded by boulders.

The road between the magazine and the trigonometrical station has been excavated into soft crumbly porphyry composed of crystals of red and glassy quartz and soft sericitized feldspar, set in a soft pale-brown and white matrix. This zone of altered porphyry may be an extension of the deep zone which extends south-eastwards from the south-western corner of the main quarry.

Over twenty feet of crumbly weathered porphyry is exposed in the access roads to the crushing plant to the south of the area. The solid porphyry (types a and b), appears to be of similar quality to that being worked in the main quarry and is presumably suitable for all purposes for which the present quarry output is used (but see below). Experience in the present quarry suggests that sound useable rock underlies the weathered porphyry (type c), but at what depth is at present unknown.

No deleterious minerals, such as sulphides or chalcedony, were noted in any of the outcrops in the area of the proposed extension. However, chalcedony has been found in vugs and veinlets in the main quarry; pyrite has been reported from Mugga Hill (Mahoney and Taylor, 1913), and galena has been found in Mugga Porphyry, a mile to the south-east of the quarry (Oldershaw, 1965a).

It is concluded that there is a substantial volume of rock, of similar type and quality to that in the existing quarry, available for exploitation. Further work is needed to delineate the sound rock for purposes of volume estimation and quarry design, and to verify the suitability of the sound rock in the area for use as concrete aggregate and for road surfacing. Additional work is recommended in the next section.

RECOMMENDATIONS

A seismic timer survey over the area of the proposed extension is recommended to determine the depth of over-burden. Owing to the high noise level in the area it is advisable to use detonators or explosives when carrying out the seismic survey. If this is done some information may also be obtained on the distribution of unsound rock. The depth of overburden, and the occurrence and depth of zones of soft crumbly porphyry should be proved by percussion drilling on a grid pattern. Samples of the solid porphyry for petrographic examination and physical testing should be obtained from a few diamond drill holes.

A grid pattern for percussion drilling has been proposed (Oldershaw, 1965b) and was pegged out on 6th July, 1965 (Figure 5). Examination of chips and dust from the drill-holes and a study of their depths would determine the depth of bedrock and would delineate any zones of soft crumbly porphyry. A proposed pro forma for logging each drill hole is given on Figure 6. Changes in colour of the chips, changes in drilling rates, and of the depth at which solid porphyry was encountered should be noted.

Three diamond drill holes are recommended (Figure 5), to be drilled vertically to the floor level of the quarry. The cores should be examined petrographically in detail to study the alteration of the porphyry and look for deleterious minerals. Samples of core should be subjected to the usual tests for strength, resistivity with cement, resistance to abrasion, durability, bonding with bitumen, and any other standard tests to prove the suitability of the material for use as concrete and bitumen aggregate.

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FIG. 1

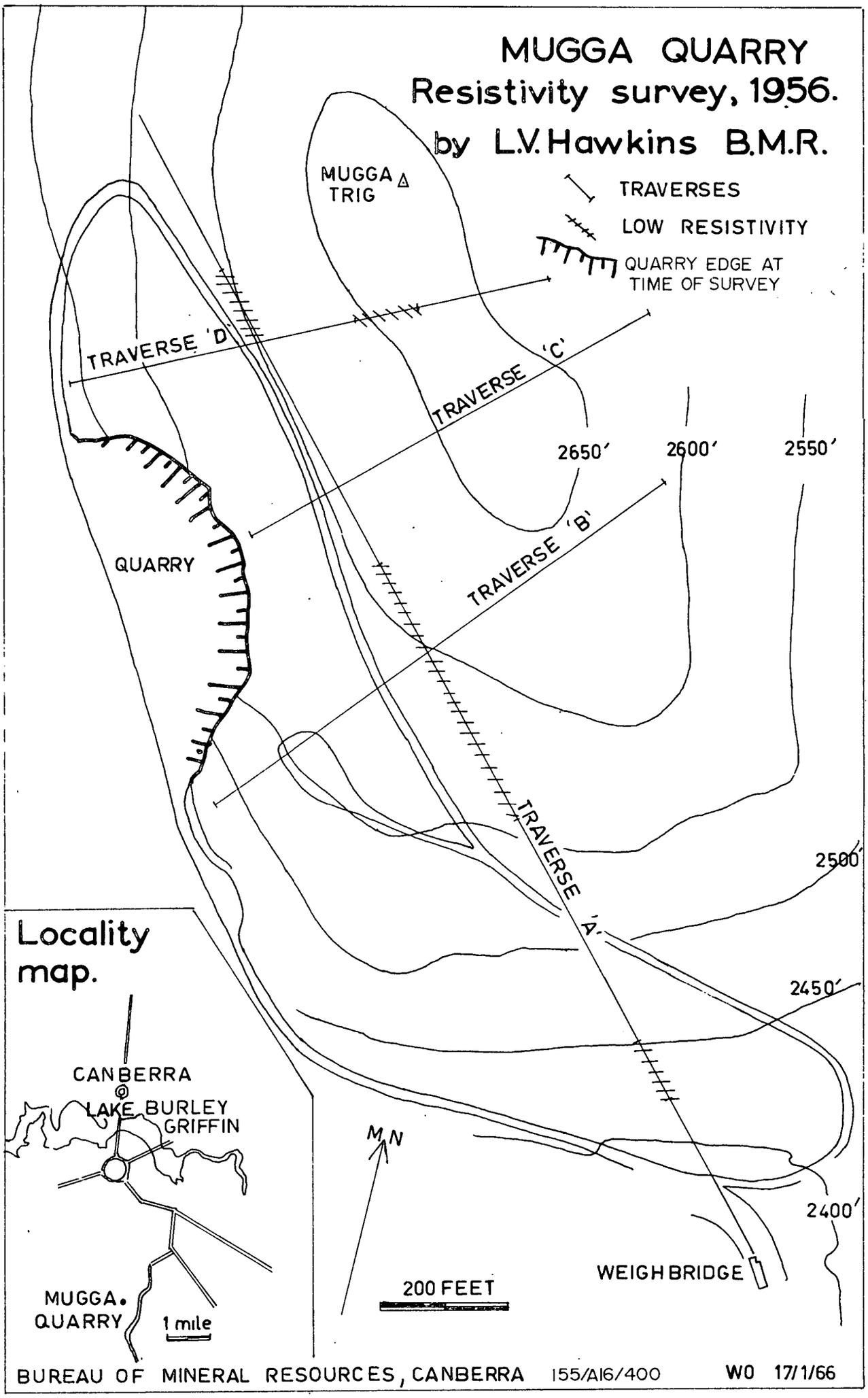

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FIG. 2.

MUGGA QUARRY

Results of the 1959 pattern percussion drilling programme (D.E. Gardner & J. Harding)

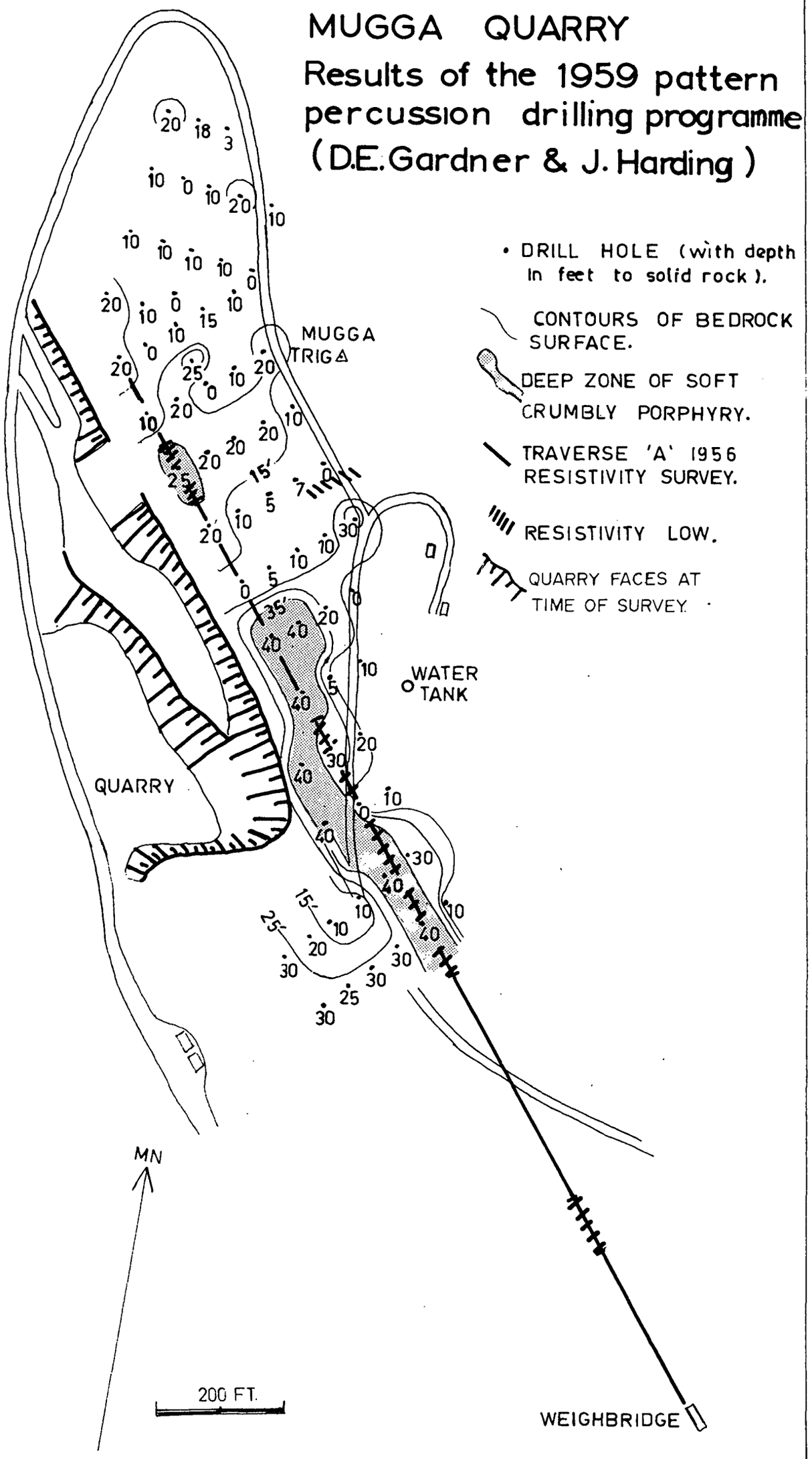

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FIG. 3

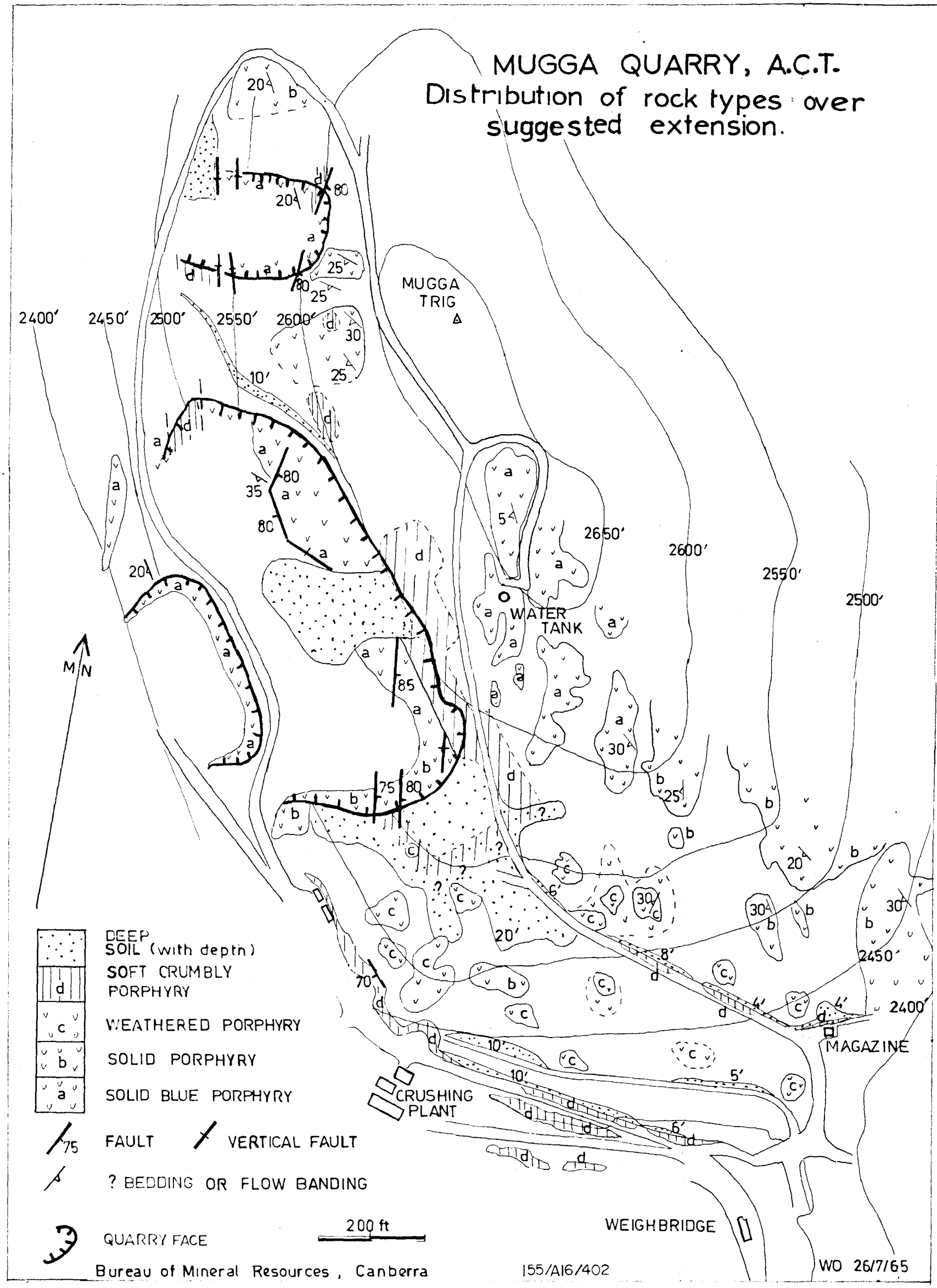

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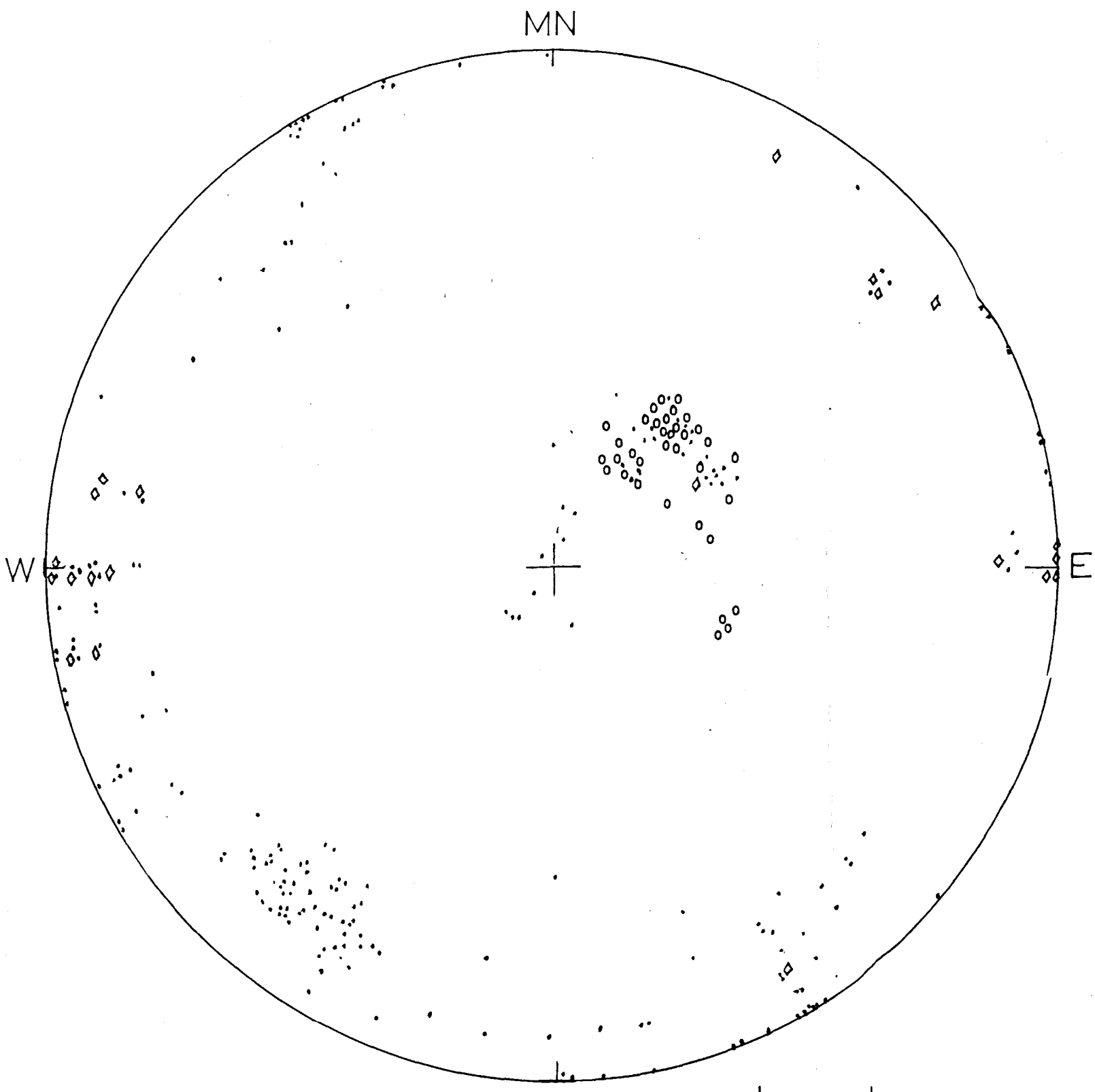
FIG. 4

MUGGA QUARRY
joint pattern



equal area stereogram
lower hemisphere

- poles to joint planes
- poles to bedding planes
- poles to fault planes

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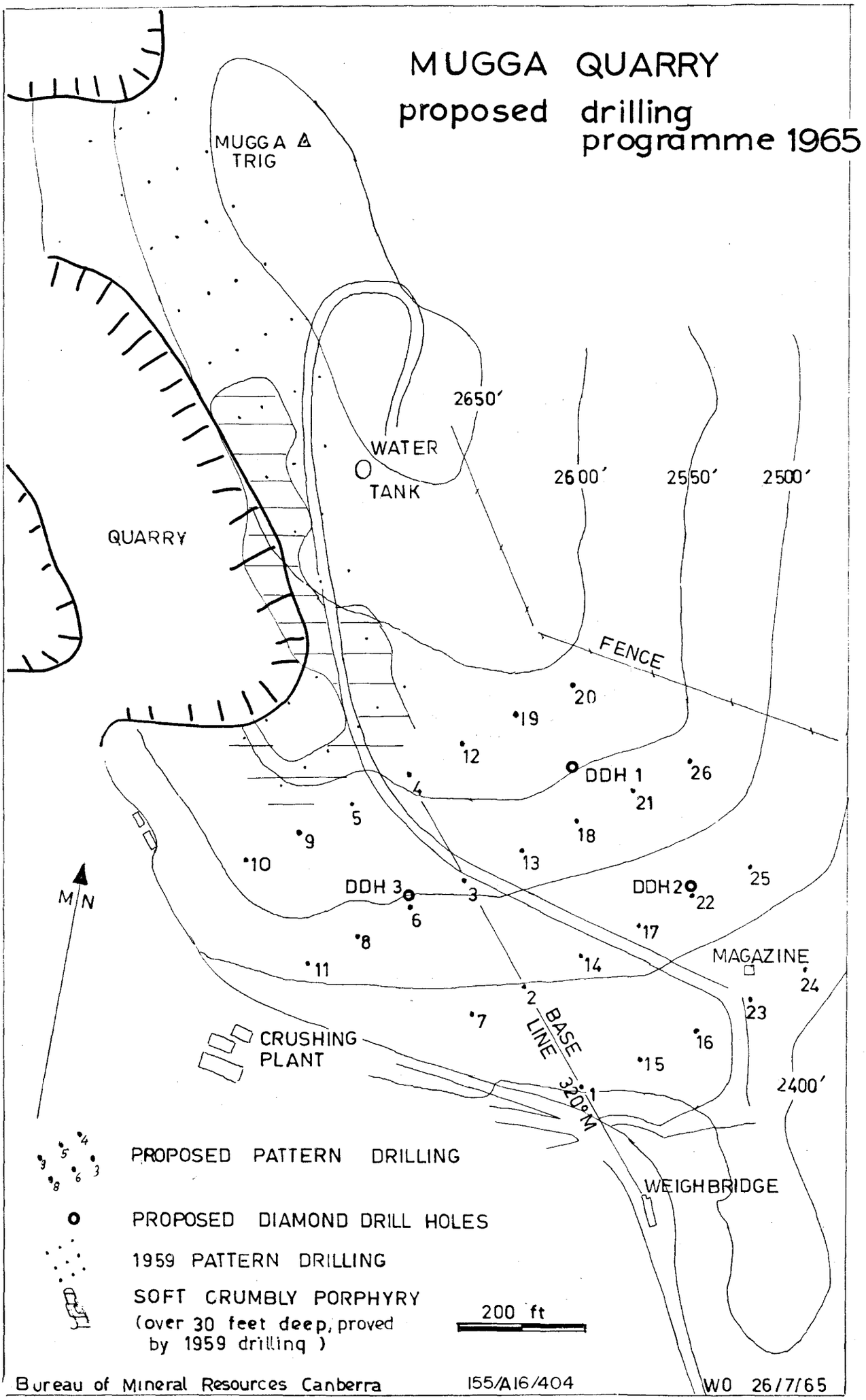
FIG. 5



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Commonwealth Department of Works Mugga Quarry, A.C.T. Figure 6.

Investigation of Possible Development to South-East.

LOG OF AIR DRILLING

Type of Drilling Rig:

Hole Commenced (Date): Hole Completed: Hole No.....

Depth (feet)(1) From	To	Dust & Cuttings(2) Colour	Feet	Rock Type(3)	Drilling Conditions Ease of Drilling (4)	Penetration Rate(5) (feet/hour)	Remarks(6)

Notes: (1) Entry to be made for each change in drilling conditions.
Short sections of easy drilling in hard rock to be carefully logged.
(2) For example - greasy, smooth, gritty.
(3) To be filled in if possible, e.g. soil, weathered rock, porphyry, quartz.
(4) Indicate whether full air or reduced air used, tendency to plug, etc.
(5) Entry to be made for each change, particularly in hard rock.
(6) Any other observations which may help geologist to form an opinion about rock quality should be included here. Also depths from which samples were collected.
(7) Record depth at which hole finished.

Signed . . . . . .
Driller.

Date . . . . . .