RECORDS

1949/32

THE GEOLOGY OF THE COTTER RIVER VALLEY WITH RELATION TO THE PROPOSED EXTENSION TO THE DAM.

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS

RECORDS:

1949/32

1949/32

THE GEOLOGY OF THE COTTER RIVER VALLEY WITH RELATIONSHIP TO THE PROPOSED EXTENSION TO THE DAM.

by

W.B. DALLWITZ.

REPORT NO. 1949/32

(Geol. Ser. No. 15)

THE GEOLOGY OF THE COTTER RIVER VALLEY WITH RELATIONSHIP TO THE PROPOSED EXTENSIONS TO THE DAM.

by W. B. Dallwitz

Petrologist.

TABLE OF CONTENTS

THE GEOLOGY OF THE COTTER RIVER VALLEY WITH RELATIONSHIP TO THE PROPOSED EXTENSIONS TO THE DAM.

Report No. 1949/32
(Geol. Ser. No. 15).

SUMMARY.

1. The rock on both sides of the Cotter River Valley near the dam is felspar-quartz porphyry. Due to the steepness of slope there is only shallow soil cover on the northern side, but the gentler southern slope is largely covered by soil and scree which are from four to eight feet deep. A steeply dipping fault passes under the dam near its northern end, and the proposed extensions will cross a ten foot wide crush zone at the southern end.

2. No difficulty in construction will arise from the presence of the fault, as the extended wall will pass to the north of it. However, it is suggested that a hole be drilled north through the fault from a point near the foot of the apron, so that any additional flow due to increase of head may be detected; grouting would be necessary if such flow takes places.

The rock in the crush zone is deeply weathered; it will have to be excavated down to fresh material, and grouting will be necessary to prevent the permeation of water through even the unweathered rock, which will be traversed by surfaces of movement like those seen at the surface. The necessity for removing the thick layer of scree and soil on the southern side of the valley will add to the cost of the work.

So far no leakage appears to have taken place through joints in the porphyry, and it may be assmed that this condition will continue when the wall is raised; in any case, any possible leakage through joints will probably be amply provided against in dealing with the fault and the crush zone.

3. The proposed aggregate for the extensions is a felspar-quartz porphyry whose groundmass is much finer than that of the porphyry used in the existing wall. Arrangements are in hand to have the new aggregate tested, because porphyries with fine-grained groundmasses may contain opaline or chalcedonic silica which will react with high-alkali cement.

INTRODUCTION.

On 29th September, 1948, the writer, assisted by K. R. Fleishman, spent one day examining the rocks of the Cotter River Valley in the neighbourhood of the dam and mapping geological features which would have a bearing on the proposed extensions. Representative rocks were collected from the quarries on the right bank of the River below the dam. The mapping was done by chain, compass and Abney level.

DESCRIPTIVE GEOLOGY

The rock on both sides of the valley is massive felspar-quartz porphyry.

From the engineering point of view the most important structures are a fault on the northern side of the dam and a crush zone on the southern side.

The fault is exposed over a length of about 15 feet beginning from the top of the path on the left bank of the stream (see Plate 1). Its strike here is 70°*, and dip 85°SSE. A minor fault branches off at a point about 8 feet from the south western end (as exposed) of the main one; its dip is 85°N. Gouge in the main fault reaches a maximum thickness of 1 foot. The small gully trending NNE from near the top of the path is due to the fault's extending in that direction; a slight change in strike to 80° was noted there. The rock in the gully is fairly heavily weathered, whereas the outcrops on either side of it are solid and more or less fresh at the surface.

Rather irregular jointing at a short distance north of the dam railing was measured as follows :

Strike	125°,	Dip	60° NE
"	150°,	"	65° NE
"	155°,	"	45° WSW (major).

At a point 70 feet down the path from the railing, the following jointing was recorded :

Strike	13°,	Dip	85° W
"	26°,	"	10°-20° WNW
"	95°,	"	80° S
"	137½°,	"	45° NE

The most important of these joint-directions appears to be that striking 26° and dipping 10°-20° WNW. It shows up strongly on the cliff face about 30 feet above the point where the readings were taken, and in the first 40 feet downhill from the railing water is seeping out of a flat-dipping joint of similar strike; this joint is actually open over lengths of several feet for widths of up to half an inch.

On the south side of the dam a crush zone about 10 feet wide is exposed (see Plate 1). This zone strikes 70°, dips 70° SE and follows rather closely the base of the apron down the side of the gully. The rock in a small quarry on the northern side of the crush zone just above the level of the wall is solid and fresh, whereas that in the crush zone itself is rather friable, deeply weathered and strongly iron-stained, generally much more so than that near the northern fault. Actual movement in the crush zone was probably small; however the rocks there were moderately squeezed and are traversed by irregular, semi-parallel surfaces of movement whose spatial concentration and individual intensity diminish outwards from the centre of the zone. A large amount of scree and soil lies on the slope above the dam, making it impossible to trace the crush zone more than about 40 feet (plan distance) uphill from the end of the wall; however, for constructional purposes, it is safe to assume that it will continue for at least another 100 feet towards the south west.

* All bearings given as true.

In the small quarry at the southern end of the dam the porphyry is only slightly weathered. The depth of severe weathering plus accumulated scree as seen in profile above the quarry face and to the south and south west thereof is 4 to 8 feet.

Following are joint readings taken in the quarry :-

Strike 20°,	Dip 85° ESE
" 30°,	" 40° NW
" 42°,	" 80° SE
" 103°,	" 85° S
" 110°,	" 50° SSW
" 112°,	" 60°-75° SSW
" 128°,	" 77° SW
" 180°,	" 15°-25° W.

A slickensided surface in the quarry strikes 166½° and dips 40°E; the striations run in the direction of strike.

ENGINEERING GEOLOGY

Leakage through joint planes does not appear to be taking place now, and therefore the presence of joints should not have a very important bearing on the problem of raising the dam. In any case, any possible leakage along joint planes should be more than adequately cared for in the process of dealing with the difficulties presented by the fault and the crush zone.

A. Northern Fault.

Up to the time of the examination water did not seem to have been escaping through the fault. This is probably due partly to the fact that the concrete is well bedded down on fresh rock, and partly to the presence of rather impervious clayey gouge in the fault.

However, if the dam is raised, it is not unlikely that the additional head would cause water to seep through the fault. It is suggested, therefore, that a horizontal or slightly upwardly directed hole be drilled due north through the fault from a position near the base of the apron (see Plate 1). Flow from this hole would show seasonal variation, of course, and would not, unless an indicator is placed in the reservoir, show whether water is escaping from the storage basin; however, if there is any (additional) escape of water due to increased hydrostatic head after the wall is raised, this would easily be made apparent. If leakage is found, the rock in the vicinity of the fault could then be grouted.

The fault will not interfere with the new structural work, because the wall will be placed to the north of it, where the rock is fresh and solid. (See Plates 1 and 2).

B. Southern Crush Zone.

It is certain that the cost and difficulty of construction will be increased by the presence of the crush zone Furthermore, the quantity of scree and the deeper weathering on the gentler slope on this side of the valley will add to the cost quite independently.

The weathered rock in the crush zone is so friable that a deep excavation will have to be made before anything like fresh rock can be expected. It is suggested, then, that the crush zone and neighbouring rocks be tested by excavating down to rock which will be solid enough for bedding the foundations, part of which will be within the crush zone over a plan length of about 70 feet if the wall is raised 40 feet (see Plates 1 and 2).

Grouting will almost certainly be necessary even if the concrete is laid on fresh rock, because the surfaces of movement will still be present in the crush zone at depth, and they will very probably allow escape of water even under a comparatively small head.

As the crush zone, if not adequately treated, may well impart structural weakness to the whole wall and cause loss of water as well, it is recommended that it be closely investigated, not only by excavation but by drilling also, if this should be considered to be advantageous as the work goes on. If this investigation is sufficiently thorough and provision is made against any source of weakness that may be revealed, there is, at present, no discernible reason why the proposed additions to the dam should not be successfully completed, provided also that the concrete in the present dam is sound enough to bear the additional strains that will be placed upon it.

NOTES ON AGGREGATES.

A description of the porphyry used as aggregate in the present wall was given by P.B. Nye and H.B. Owen in Mineral Resources Survey Report No. 1944/25, which was sent to Mr. L. Thornton on 15th August, 1944. They also discussed the properties on the rock from the point of view of their probable effects on the concrete.

It is intended here to give a generalized description of the rock from the quarries on the right bank of the Cotter River, downstream from the dam, for comparison with that above the dam on the left bank of the River. The rock from the latter place will probably be used as aggregate in the proposed extensions.

a. Rock from quarries on right bank of Cotter River below the dam.

In the hand-specimen this is a medium-grey porphyry carrying phenocrysts of white felspar and vitreous quartz. A little pyrite and possible chalcopyrite are visible to the naked eye. Scattered(?)xenolithic fragments of milky quartz are present.

In several places in the quarries the rock is quite heavily pyritised, and this material, when weathered, becomes strongly stained with limonite.

The groundmass of the porphyry consists of felspar (75 per cent.), chlorite (20 per cent.) and quartz (5 per cent.). The average grainsize of the felspar and quartz is 0.14 mm., whereas the chlorite is much finer-grained (0.01 mm. or less).

Among the phenocrystalline minerals, felspar is predominant; next in order of abundance is an altered ferromagnesian and finally there is quartz.

As far as could be determined, all of the felspar is plagioclase, which is found in two generations of crystals having the approximate composition $Ab_{64}\ An_{36}$ (andesine) A little sericite has formed as an alteration product in the andesine.

No primary ferromagnesian remains. The mineral (or minerals) is now represented by chlorite and leucoxene, which may have been derived from biotite, though the shapes of some of the crystals suggest that the alteration products may in part, at least, be pseudomorphous after pyroxene or amphibole.

Quartz phenocrysts make up between 8 and 10 per cent of the whole rock. Some of the grains of this mineral have been strongly corroded at a late-magmatic stage.

Accessory minerals in the groundmass are leucoxene, zircon, and apatite. No pyrite appears in the slide at hand.

If the rock is intrusive, it is a grandodiorite-porphyry; if it is volcanic, it is a dacite. The relatively coarse groundmass suggests that the rock is intrusive.

b. Rock from left bank of Cotter River above the dam.

In the hand specimen this rock differs from the one just described in four respects :-

1. Its groundmass is darker grey
2. The felspar is flesh-coloured
3. The quartz phenocrysts are larger
4. The percentage (15 to 20) of phenocrystalline quartz is higher.

The groundmass is almost fine enough to be called felsitic; its average grainsize is about 0.02 mm. It appears to consist almost entirely of felspar, but some chlorite and a little quartz and sericite are also present.

The porphyritic crystals comprise felspar, alteration products of ferromagnesian minerals, and quartz.

No undoubted orthoclase was identified among the two generations of felspar phenocrysts which must, therefore, be taken as being largely or entirely plagioclase, whose composition was found to be $Ab_{67}\ An_{33}$ (andesine). Small quantities of zoisite and sericite occur as alteration products in the andesine. One glomeroporphyritic mass of felspar crystals was noted in the slide.

There may have been more than one primary ferromagnesian mineral present. That this is possible is shown by the several combinations of alteration products which now represent them. By far the most common combination is chlorite + black iron ore + leucoxene. Others are chlorite + black iron ore + leucoxene + haematite; chlorite + leucoxene + black iron ore + felspar; sericite + chlorite + black iron ore + leucoxene; and chlorite + leucoxene + felspar + sericite. Aggregates of these minerals are obviously pseudomorphous after some primary subhedral to euhedral crystals, which were probably biotite, but in some cases appear to have been pyroxene or amphibole.

In addition there are irregular masses of chlorite alone. These are of various sizes, and the chlorite polarizes in anomalous browns, whereas the chlorite in the aggregates previously described has anomalous grey-blue interference-colours. It is not possible to make a statement regarding the origin of this chlorite, though it may be that the mineral was introduced during the process of alteration which has attacked the ferromagnesians and the andesine.

As in the rock from the quarries, the quartz is fairly commonly corroded.

Accessories are leucoxene, haematite, zircon and apatite.

The rock is a granodiorite-porphyry.

Probably the only significant difference between these two rocks is that the groundmass of the rock which it is proposed to use as aggregate is finer than that of the one used in the present dam. Though this in itself is not necessarily a disqualifying factor, arrangements have been made to have the rock tested for reactivity with the type of cement which is likely to be used in the construction, as it has been found that some felsites and acid porphyries react with high-alkali cements, particularly in cases where the groundmass is fine-grained and may contain opaline or chalcedonic silica.

No pyrite was noted in the newly-selected aggregate, and this is a point in its favour. It is always possible that pyrite will oxidise and cause weakness in concrete through the formation of sulphate.

CONCLUSIONS

An examination of the Cotter River valley in the neighbourhood of the dam has shown the presence of a fault, of a crush zone and of jointing in the porphyry.

The jointing should cause no difficulty, as the present dam does not appear to have been affected thereby, nor should the northern fault cause concern, largely for the same reason, though it is suggested that a hole be drilled through the fault to ascertain whether water will escape when the dam is raised. If it does, grouting will be necessary.

The crush zone which will be taken in by the extended wall on the right bank of the River, though presenting difficulties which should be fairly readily soluble, needs careful investigation, first by excavation and secondly by drilling, if this is thought necessary during the progress of the work. It would be advisable to grout part of the crush zone, because it is anticipated that the rock therein will not be impervious even when all weathered material is removed.

Comparison of the proposed new aggregate with that used in the present wall reveals no obvious deleterious properties in the new rock. However, on account of its finer grain, it is imperative that it be thoroughly tested at the laboratories of the C.S.I.R., Division of Industrial Chemistry, before construction begins. It would be convenient to test a possible alternative aggregate at the same time, in case the proposed material is unsuitable.

W. B. Dallwitz

W. B. DALLWITZ

PETROLOGIST.

Canberra, A.C.T.
23rd February, 1949.

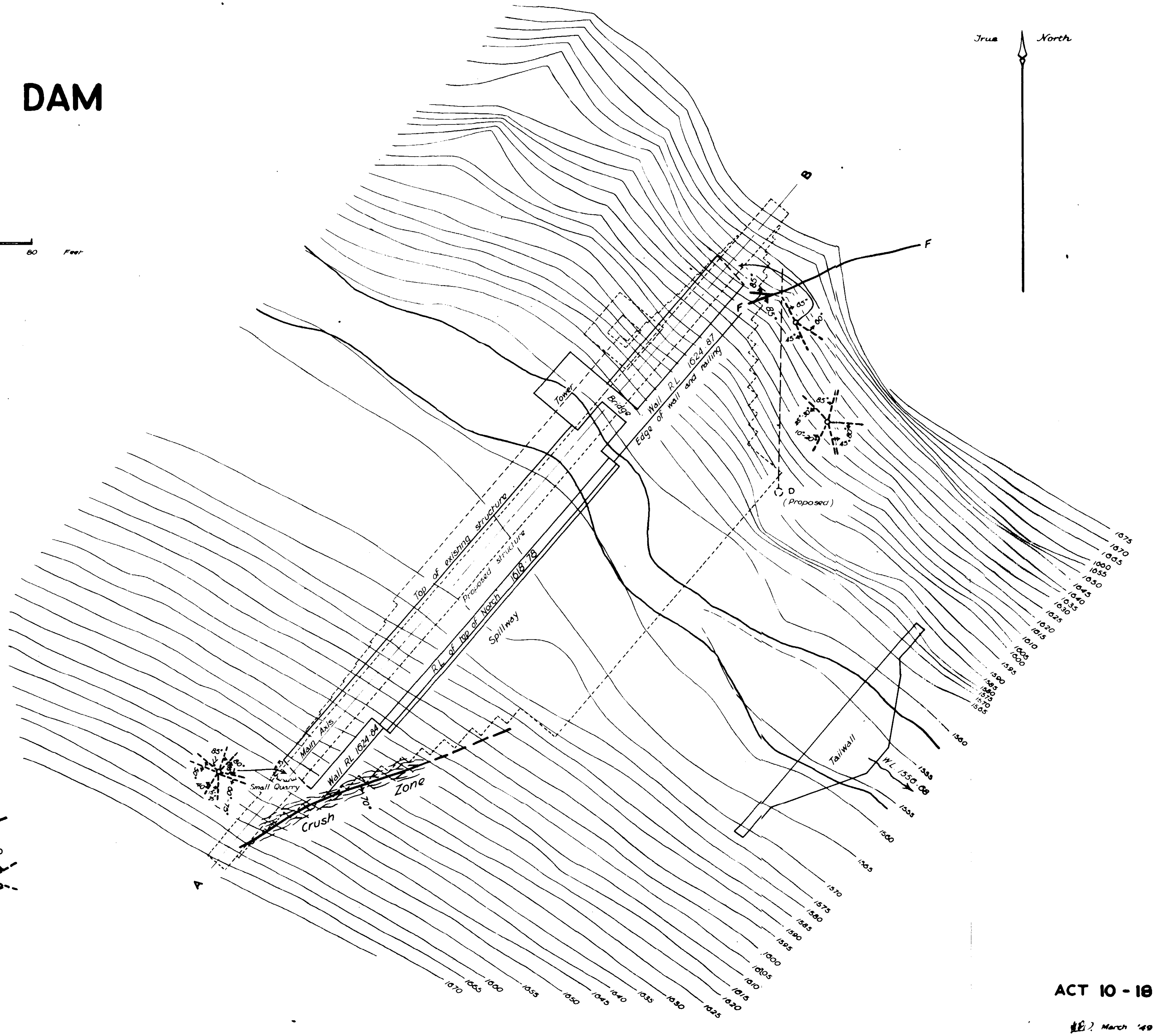
COTTER RIVER DAM

PLAN

SCALE

Feet 40 30 20 10 0 40 80 Feet

Geology by
W.B. Dallwitz & K.R. Fleischman



SYMBOLS

Faults

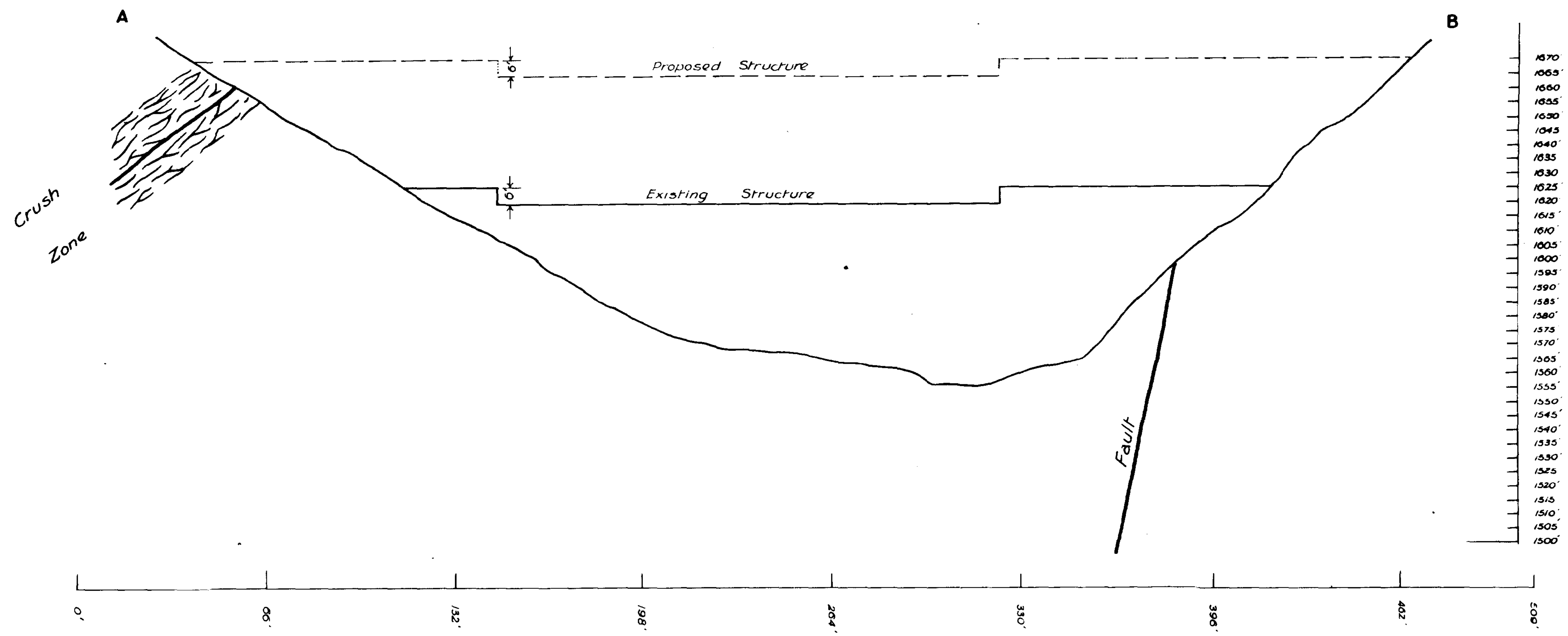
Diamond Drill Hole

Jointing

ACT 10 - 18

BUREAU OF MINERAL RESOURCES,
GEOLOGY AND GEOPHYSICS.

March '49



COTTER RIVER DAM

SECTION ALONG MAIN AXIS LOOKING UPSTREAM

Geology by W.B. Dallwitz and K.R. Fleischman.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

ACT 10 - 19

March '49