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RECONNAISSANCE SEARCH FOR PHOSPHATE
IN TASMANIA

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by

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SUMMARY AND RECOMMENDATIONS

Slightly more than 600 specimens of Cambrian, Ordovician, Siluro-Devonian and Permian rocks were collected in northern Tasmania and analysed for phosphate. Only about a dozen of these gave positive tests on analysis by the Shapiro method, and all these were from rocks thought to be Ordovician. None of the 125 specimens of Ordovician and Permian rocks from Southern Tasmania gave positive phosphate tests.

An Upper Ordovician limestone from near Marakoopa Caves, Mole Creek, and several specimens of limestone (probably Middle Ordovician) from Flowery Gully, as well as a specimen of Middle Ordovician limestone from Railton reported by Twelvetrees, contain small quantities of phosphate. Wavellite and turquoise occur in cleavages, joints or filling cavities in breccia at Turquoise Bluff near Back Creek and along the southern part of the Den Range. These secondary phosphates are thought to have been derived from beds containing primary phosphate lying within the "lutite" (siltstone) association of the Mathinna Beds which is also thought to be Ordovician.

It is recommended that the known deposits be more thoroughly tested, and that a detailed survey be made of the "dome" along the Den Range, that the phosphatic bed at Marakoopa Caves be more closely sampled, and that closer sampling be done in the vicinity of the phosphatic materials at Sulzberger's Quarry and south-west of R. Beams' house, Flowery Gully. The detailed survey of the Den Range "dome" should attempt to establish the stratigraphic succession as closely as possible, to allow proper deduction of the structure and to relate the breccias, especially the wavellite-bearing ones, to the stratigraphy and structure. Some costeaning to provide good exposures in critical areas may be needed. This may lead to discovery of surface outcrops of phosphatic beds or allow some prediction of the depth of the source of the wavellite.

The above work may suggest stratigraphic targets to be sought by detailed work on the Upper Ordovician limestones in the Liena-Mole Creek-Chudleigh area, on the Gordon Limestone and Mathinna Beds south of Beaconsfield, and on the anticlinal areas within the lutite association of the Mathinna Beds between Bangor, Back Creek and west of Lefroy. The target areas are delineated on the geological map (Fig. 14). The most likely area for exposure of phosphatic rocks is the Den Range and the Pipers River to Lefroy area.

INTRODUCTIONHISTORY.

The project of making a reconnaissance of Tasmania for phosphate deposits arose from a report submitted to Utah Development Company in January, 1964, at the request of their Staff Geologist, Dr. P. Howard. This report was followed up in August, 1966, by a letter from Mr. O. Warin, Staff Geologist, to the author enquiring as to the feasibility of organising and supervising a reconnaissance survey during the 1966-67 summer.

Permission to participate was given by the University of Tasmania, and two graduates in geology, Mr. E. A. Smith and Mr. D. J. Kennedy, were approached to carry out the field work. They agreed, but stated that they could be available for two months only instead of the three envisaged in Mr. Warin's letter. This shorter term was accepted after consultation with Mr. Warin.

The Tasmanian Director of Mines was approached on the question of Exploration Licences so that access could be gained to some areas of interest where possible access difficulties existed. Exploration Licences covering three areas were later granted.

Work started with Mr. Warin, Mr. Smith, Mr. Kennedy and myself sampling in the Beaconsfield-Flowery Gully area in northern Tasmania (see map, Fig. 1) during the week commencing November 28, 1966. A routine of sampling and testing was established and subsequently followed wherever possible. Early in December Mr. Kennedy advised that he would have to withdraw from the project after Christmas because of University examinations, and I suggested (letter December 19, 1966) replacing him with Mr. J. B. Jago, an honours graduate in geology. In the same letter I formalised the programme earlier discussed with Mr. Warin after seeing progress during the first week of the survey. During January (January 6, 1967) Mr. Smith submitted an interim report on the wavellite deposits on the Den Range. Arising from initial survey of the Den Range area, a somewhat more detailed survey was made in January. This site was visited later in January by Mr. Warin and Mr. P. Rix with Messrs. Smith and Jago. Mr. Smith and Mr. Jago finished work on the project late in January. On March 4 I visited the Den Range area with Mr. Smith.

Specimens from the collection of the Department of Geology, University of Tasmania, from the Ordovician at Zeehan, Queenstown, Bubs Hill,

Florentine Valley and Ida Bay and from the Permian at Maydena, Hobart, Cygnet, Coles Bay and Maria Island were analysed by Mr. M. Rubenach at the Department of Geology during March and April.

PURPOSE:

The survey was designed to test Cambrian cherts and siltstones, Ordovician limestones and siltstones, Siluro-Devonian sandstones and Lower Permian siltstones and limestones in all parts of the State, except the south-western quadrant, with special emphasis on the base and top of the Ordovician in the Beaconsfield-Flowery Gully area. The survey was designed as a systematic reconnaissance survey to assess the presence and geographical distribution of phosphate at the stratigraphical levels listed above, in order to suggest targets for more detailed work, targets based on assessment of palaeogeographical situations with reference to known and likely phosphate distribution.

PLAN AND METHOD.

The broad timetable of planned operations is outlined below:

29. 11. 66 - 2. 12. 66:	Beaconsfield-Flowery Gully area.
5. 12. 66 - 9. 12. 66:	Back Creek, Bangor, Lebrina, Patersonia area.
12. 12. 66 - 16. 12. 66:	Poatina area, Mole Creek area.
19. 12. 66 - 23. 12. 66:	Railton, Devonport, Gunns Plains and Oonah areas.
2. 1. 67 - 6. 1. 67:	Rosebery, Renison Bell, Zeehan, Queenstown, Gormanston, Darwin areas.
9. 1. 67 - 13. 1. 67:	Bubs Hill, Florentine Valley, Hobart areas.
16. 1. 67 - 20. 1. 67:	Ida Bay, Cygnet and Hobart areas.
23. 1. 67 - 30. 1. 67:	Maria Island, St. Marys areas.

In each area, the two field geologists were to measure specified sections, recording their observations on prepared sheets (see sample enclosed Appendix 1), and collecting samples (serially numbered from beginning to end of the whole survey with different numbers for each observer, e. g. S 1-x for Smith; K 1-x for Kennedy). The field geologists were particularly asked to record accurately any gaps in the sections. The samples were allowed to accumulate for several days, and then all specimens from an area analysed before the geologists moved to a new area. The Shapiro method (Amer. Min. Vol. 37, 1952) was used in the analyses. Specimens lacking phosphate in determinable quantities were thrown away.

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Mr. Smith acted as liaison with Mr. Warin and myself, and reported at least once a week.

The survey did not proceed quite according to plan, and the programme achieved is set out below:

- 29. 11. 66 - 2. 12. 66: Beaconsfield-Flowery Gully.
- 5. 12. 66 - 9. 12. 66: Turquoise Bluff; Den Range, Denison Gorge; pegging.
- 12. 12. 66 - 16. 12. 66: Myrtle Bank area, Poatina; analysis.
- 19. 12. 66 - 23. 12. 66: Myrtle Bank area; analyses.
- 28. 12. 66 - 30. 12. 66: Analyses, Poatina.
- 3. 1. 67 - 6. 1. 67: Mole Creek.
- 9. 1. 67 - 13. 1. 67: Eugenana, Preston, Den Range with Mr. Warin and Mr. Rix.
- 16. 1. 67 - 20. 1. 67: Railton, analyses.
- 23. 1. 67 - 27. 1. 67: St. Marys area; St. Pauls Dome; analyses.
- 31. 1. 67 - 3. 2. 67: Elephant Pass area, Rossarden, analyses.

The variation from the proposed programme arose from a number of causes: (a) some of the equipment ordered from firms in Melbourne did not arrive in time, but improvisations minimised delay, (b) some time was lost owing to mechanical troubles with the Company Landrover, but this was not great, (c) Messrs. Smith and Kennedy found the analyses time-consuming, and an extra man would have reduced the time needed for analysis considerably, (d) the need to peg out the Exploration Leases resulted in several days being alienated from field survey, and (e) work east of the Tamar River was more detailed than initially planned.

The addition of a third person would have speeded up both the field work and the analyses, and may have been worthwhile.

RESULTS

CAMBRIAN.

The only Cambrian rocks tested were four samples of the Barrington Chert from the Preston area (Fig. 2). All lacked detectable phosphate.

ORDOVICIAN.Gunns Plains:

The top of the Gordon Limestone (about top 250 m.) near Gunns Plains Caves was sampled along the section shown (Fig. 2). Seven samples were tested, but none had detectable phosphate.

Eugenana:

Twenty-five specimens were analysed from the Gordon Limestone in the Eugenana area. Their distribution is shown in Fig. 3. None contained phosphate.

Railton:

Seven specimens were collected from the basal part of the Gordon Limestone at Blenkhorns Quarry, Railton (Fig. 4). No phosphate was detected, but an analysis quoted in the Limestone Resources Bulletin (Hughes, 1957, p. 28) showed 1.02% P_2O_5 from this quarry. No appreciable phosphate occurs in the limestone (probably Middle Ordovician) worked by the Goliath Portland Cement Co. at Railton.

Mole Creek:

Three sections through the Gordon Limestone were measured in the Mole Creek area (Fig. 5). Eighty-eight specimens were collected and analysed for phosphate, and one (365) gave a positive test. A scale of 1000 : 1 (83.3 ft. = 1") was used in measuring and recording the sections, except for the upper part of the limestone near Marakoopa Caves where the scale used was 100 : 1 (8.3 ft. = 1"). The best section, that near Marakoopa Caves (A - B on Fig. 5), disclosed a thickness of about 5,900 ft. of limestone plus a gap at the base of the section. The section is summarised as Appendix 2. The phosphatic specimen came from a coralline limestone and purplish siltstone unit at least 42 ft. thick about 820 ft. stratigraphically below the top of the limestone. Outcrop is lacking on either side of the phosphatic unit. The phosphatic unit occurs 1,870 ft. stratigraphically above a very silty unit which may be the correlate of the Florentine Bridge Siltstone of the Florentine Valley. This would imply that the phosphatic limestone is within the Upper Limestone Member of Corbett (1963).

The other sections (C - D and E - F on Fig. 5) measured did not yield phosphatic material, and are summarised as Appendices 3 and 4.

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Flowery Gully:

The sections covered are shown in the accompanying map (Fig. 6).

Two samples of the sandstone underlying the Gordon Limestone and about 70 specimens of limestone were analysed.

One specimen from Sulzberger's Quarries gave a positive phosphate test (S 12), two specimens from these quarries and one from south of R. Beams' house contain a trace of phosphate (S 9, 10, K 15). Those in Sulzberger's Quarries lie about 320 ft. (98.45 M.) stratigraphically below the base of the chert zone and consist of a thinly-bedded (5 mm.) limestone 14 ft. thick, overlain by about 8 ft. of limestone, also thinly-bedded (about 5 mm.) and containing a little dolomite. Both limestones contain very thin silty partings. After an interval of about six feet, 30 inches of fine grained, very thinly-bedded (about 1 mm.) siltstone occurs and this gave a moderately strong phosphate test. A copy of the appropriate Phosphate Log is appended (Appendix 5). Specimen K 15 was collected on the western edge of the flattish hilltop south of R. Beams' house (see Fig. 6), and is about 145 ft. (53 m.) stratigraphically above the base of the limestone outcrops. This places it about 206 ft. (75 m.) above the base of the Chert Zone. Appendix 6 is a copy of the Phosphate Log of the traverse on which the specimen was collected. The unit containing the specimen is at most 52 ft. (19 m.) thick, but because the limestone appears very uniform in the outcrops, the phosphatic part may be only a small part of this. More detailed sampling would be needed to define the phosphatic bed more closely.

Beaconsfield:

The Leonardsburg Siltstone, lying beneath the Gordon Limestone, was tested in several places in the area (see Fig. 7). Gordon Limestone was tested in two outcrops close to Beaconsfield and the Grubb Beds, overlying the limestone from two other outcrops close to Beaconsfield. Analyses of all these specimens were negative.

Zeehan:

Ten Departmental specimens from the Gordon Limestone near Zeehan gave negative tests for phosphate.

Bubs Hill:

Thirteen specimens from the Gordon Limestone from Bubs Hill were analysed and contained no determinable phosphate. These specimens were from the Departmental collection.

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Maydena Area:

Thirty-six specimens in the collections of the Department of Geology, University of Tasmania, were analysed from the Florentine Valley. Their stratigraphic distribution was as follows:
Florentine Valley Mudstone 14, Gordon Limestone Cherty Limestone Member 2, Cashions Creek Member 3, Lower Limestone Member 7, Florentine Bridge Siltstone 5, Upper Limestone Member 5. None contained determinable phosphate.

A specimen of Gordon Limestone from close to Maydena also lacked phosphate.

Ida Bay:

A number of specimens (11) from the Gordon Limestone were analysed but gave negative results.

Mathinna Beds:

The Mathinna Beds of north-eastern Tasmania consist of two sedimentary associations, one predominantly siltstone (probably Ordovician), the other sandstone and siltstone (Banks, 1962, p.182). During the last few years these two associations have been shown separately on geological maps (Pipers River Sheet, Launceston Sheet and Groves, 1965).

Phosphate minerals were recorded from these beds as follows:

Petterd (1910) -

Barrendite
Variscite (? turquoise)
Vivianite

Wavellite

Lyndhurst
Back Creek and Lefroy
Waterhouse (No. 1 north Pioneer Reef);
Supply Creek
Australasian Slate Quarry, Back Creek;
Den, Lefroy; Golconda; Scamander;
in cleavages and quartz reefs.

Twelvetrees (1902) -

Wavellite

Den Range

Sutherland (1964) -

Turquoise)
Wavellite)

Australasian Slate Quarry, Back Creek

The deposits at Back Creek and Den Range occur in the siltstone ("lutite") association but the exact provenance of the phosphate minerals from Lyndhurst, Supply Creek, Golconda, Waterhouse and Scamander is uncertain. Several sections in the siltstone association were sampled fairly intensively near Back Creek, Den Range, Lebrina and Patersonia (Figs. 8 - 10).

Back Creek:

Turquoise, variscite and wavellite have been reported from the Australasian Slate Quarry and the Turquoise Bluff area, Back Creek. Twelve specimens were collected from a traverse at 193° up the southern wall of the old slate quarry near the Turquoise Mine and from the Turquoise Mine. Only one specimen, containing visible turquoise, from the Turquoise Mine gave a positive phosphate test. The turquoise occurs as a secondary deposit on joint and cleavage planes.

Pipers River:

Twenty-two specimens were collected from small road cuts, bases of upturned trees, and from mine dumps in the section A - B (see Fig. 8) along the road south-west of Pipers River. All gave negative results. A specimen from G was negative, as were three specimens collected between H and J (Fig. 8).

The Glen:

Forty-four specimens were collected from small road cuts, mine dumps, upturned trees and float along the south-western and south-eastern spurs of the Den Range just north of the Glen. A further 32 were collected between D and Br (Sm-1) (Fig. 8). Several of these, all showing visible wavellite and/or turquoise, in joint planes or cementing breccia, gave positive tests, although the siltstone matrix itself is not phosphatic. Outcrop is not sufficient in this area to allow detailed stratigraphic sampling. This occurrence was the subject of a preliminary report by E. A. Smith early in January, and was later visited by Mr. Warin and Mr. Rix, and subsequently by the author. Samples collected by Mr. Warin have been examined by A. M. D. L., and wavellite with an encrustation of goethite identified (report of February 2). Samples collected by the author in the area were thin-sectioned and examined by the author at high power under a petrological microscope.

The wavellite occurs about half way down the south-western slopes of several spurs, in breccias or in joints in siltstone. Search in the float exposed by recent bush fires further up the slopes and on the tops of the main ridge failed to show any wavellite, but further down the slope wavellite-bearing float occurred. From this preliminary investigation, it may be postulated that the breccia occurs in a zone trending just west of north through black shales of the lutite association (line W-W-W of Fig. 8). Breccia was noted in situ further north-west (Br (Sm 1) on Fig. 8) by Smith but not found to contain wavellite. A fault (almost a strike fault) may be suggested as the cause of the breccia. Breccia reported by Smith at the Glen (Br (Sm 4) on map) is superficial talus cemented by "limonite" and is associated with pisolitic ironstone. It is probably part of the B horizon of a pedalfer soil of Late Cainozoic age.

Examination in the laboratory of the aerial photographs covering the Den Range (Launceston-Pipers Run 2, T322-31 to 34) suggests that the wavellite-bearing rocks occur in the central portion of an elongate, north-north-westerly trending, structure which is probably a dome, delineated by ridges of more resistant rock and extending from the Pipers River Road to The Glen (see Fig. 8 for localities, Fig. 9 for suggested structure and the wavellite localities). A strike fault or crush-zone in the axial region of the dome is a distinct possibility.

The wavellite occurs filling cavities in a breccia or with "turquoise" filling joints in thickly (4 cm.) bedded fine grained siltstone associated with thinly-bedded (1 mm.) carbonaceous pyritic siltstone. The pyrite is represented by moulds. The order of events in one specimen seen was deposition in pre-existing joints of wavellite, followed by deposition of "turquoise" and then solution of the pyrite.

Three types of breccia were noticed in the field:

(a) wavellite-bearing breccia, (b) breccia cemented by quartz and (c) ferruginous breccia with wavellite. Some of the wavellite-bearing breccia, as seen in a costean, resulted from movement along shear zones and kink bands. Other specimens of the wavellite-bearing breccia showed fragments of carbonaceous siltstone with a thin (< 1 mm) decarbonised (oxidised) rim cemented by wavellite. Field examination of a specimen of ferruginous breccia suggested that quartz, then wavellite and finally "limonite" (probably goethite as in A. M. D. L. report) were deposited in the cavities in the breccia. Analyses of the siltstone fragments in the breccia failed to show any phosphate.

Microscopic examination of specimens revealed that the siltstones were a very thinly-bedded alternation of carbonaceous and non-carbonaceous layers containing quartz and muscovite, the latter mainly oriented parallel to bedding.

"Augen" of coarser grains of quartz, all showing mosaic texture indicative of recrystallisation, occur with long axes parallel to the bedding. In specimens which show crenulation of the bedding, the "augen" cause "drag dip" of the axial surfaces of the crenulations, thus suggesting that the "augen" were already present at the time of folding. Quartz veins with diffuse margins (possibly of replacement origin) occur and some appear to have preceded the development of the crenulations. One specimen shows a complex history of brecciation. Fragments of siltstone outlined by "limonitic" margins are present, some of them cut by quartz veins with diffuse margins which are pre-brecciation. These fragments are cemented by a fine mosaic of quartz and some fragments have very diffuse margins against the quartz. The cemented breccia was subsequently cracked and the cracks filled with quartz to form quartz veins and later cracked again, the cracks of this generation being filled with "limonite" and later wavellite. The siltstone fragments show partial decarbonisation. Several specimens show two generations of iron deposition, one pre- and one post-wavellite deposition. One specimen shows quartz veins cut by veins containing (?) dahlite margins and (?) collophane centres. It is clear that the brecciation and vein-filling history is complex. A possible sequence to cover all observations is (a) recrystallisation, (b) quartz veins formed at depth, (c) crenulation, (d) brecciation, (e) limonitic coating of breccia fragments with (?) concomitant oxidation of carbonaceous matter in siltstone, (f) filling of cavities in breccia by quartz, (g) further quartz veining, (h) development of veins of ferruginous infilling, possibly further decarbonisation, (i) further deposition in these veins, deposition being of phosphate minerals, (j) deposition of goethite, leaving some cavities.

The dating of the events in the brecciation and vein-filling history is not possible with certainty yet. The crenulation is almost certainly associated with Lower and Middle Tabberabberan Orogeny, and it is plausible that the initial brecciation and ferruginous siliceous infillings were not much later in developing. Lack of demonstrable quartz veining in Permian rocks in the area, as in most of the rest of Tasmania, may suggest that all quartz veining and infilling was pre-Permian and probably Devonian. However, quartz veins do occur in Permian sediments near Rossarden and at Rex Hill. It is most likely that only minor limonitic veining, deposition of phosphate and finally deposition of goethite, was post-Devonian. All could well be Tertiary or Quaternary as from Permian to early Tertiary time the area was probably covered by Permian and later rocks to a considerable depth. It would be plausible to suggest that the two generations of ferruginous deposition were formed during periods of "lateritisation" during the Tertiary, the earlier, poorly-developed one, early in the Tertiary at some depth and the later, stronger one, late in the Tertiary (Pliocene) or in the Quaternary and that the wavellite deposition, possibly requiring more arid conditions,

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took place as the humid subtropical climatic belt which included Tasmania during much of the Tertiary (Gill 1962, p. 250) migrated north late in the Tertiary (Upper Miocene to Middle Pliocene) as the climate cooled towards the Pleistocene Ice Age (Dorman and Gill 1959). Climatic fluctuations during the Pleistocene also occurred and may have been responsible for these variations in vein and cavity filling. It is even faintly possible that the wavellite was deposited during the Holocene dry period about 5,000 years ago.

The open nature of the breccia (as opposed to breccia tightly held in a fault gouge) suggests that the fault was not a shallowly dipping thrust fault. The line of breccia occurrences happens to be almost on and parallel to a minor anticline (on Pipers River Sheet of Mines Department) and may have originated as a "break-thrust" in or near the axial surface of this anticline or the larger dome earlier suggested and have been revitalised by relaxation of compression at a later stage in folding or even in the Tertiary as a normal fault. Mapping is not yet adequate to provide satisfactory answers.

The source of the phosphate-bearing solutions is unclear. A plausible hypothesis is that a bed rich in phosphate occurs in the siltstone association of the Mathinna Beds and has been cut by the fault postulated, with later solution at depth and deposition after movement up or along the fault plane. The siltstone association is thought likely to be Ordovician (Banks 1962, p. 187) and deposited on the continental slope or outer edge of the continental shelf on the shallower parts of which limestone (Gordon Limestone) was being deposited. Limestone, probably Lower or early Middle Ordovician, at Railton and Flowery Gully and Upper Ordovician at Mole Creek contains traces of phosphate and the deeper water equivalents might be expected to contain more. The wavellite deposits at Turquoise Bluff and the Den Range are both close to the top of the siltstone association and may be Upper Ordovician. It is interesting to recollect that the phosphate deposits at Mansfield, Victoria, occur in Lower Ordovician thinly bedded shales (Marsden 1967, p. 92) probably deposited in a similar environment.

If this reconstruction is correct, the best area to seek primary phosphate deposits of any significance in Tasmania will be in the siltstone association north and west of Bangor and east of the Tamar River, especially in anticlinal cores such as between Lefroy and Back Creek (Groves 1965, p. 69) and along the Den Range. Examination of the drill cores taken recently in the Beaconsfield area by the Tasmanian Mines Department might also be worthwhile, as might reconnaissance of the area of Mathinna Beds south and east of Flowery Gully.

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To test the possibility of occurrence of phosphate in the siltstone association further east, sections were examined at several slate quarries near Bangor, north of Turners Marsh in railway exposures between Lebrina and Wyena, and in road cuttings near Patersonia.

Bangor:

Three specimens were collected and analysed from road cuttings a quarter of a mile east of the Bangor Slate Quarry and one from the Bangor Slate Quarry (see Fig. 8). All gave negative results.

Lower Turners Marsh:

Fifteen specimens collected from road cuts at points indicated between E and F (Fig. 8) gave negative results.

Lebrina-Wyena:

Twenty-two specimens collected from railway cuttings along the Denison Gorge (K - L, Fig. 8) were negative.

Patersonia:

Thirty-two specimens were collected between A and B (Fig. 10) on the Patersonia-Lisle Road, and fifty-six between B and C from exposures adjacent to the road. All were negative. A further 26 specimens collected between D and E on the Patersonia-Lilydale Road (see Fig. 10) were also negative.

SILURO-DEVONIAN.

Eugenana:

Nine specimens from the Eugenana Beds in the quarries at Eugenana (Fig. 3) gave negative results.

Mole Creek:

Three specimens from the base of the Eldon Group at Western Bluff (Fig. 5) also gave negative results.

Flowery Gully and Beaconsfield:

Five specimens from the Grubb Beds in this area were negative.

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PERMIAN.

The Permian succession in Tasmania may be conveniently summarised as:

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- Cygnnet Coal Measures
- Ferntree Group
- Malbina Formation
- Cascades Group
- Mersey Group (Coal Measures)
- Golden Valley Group
- Quamby Group
- Wynyard Tillite

Small percentages of phosphate have been recorded from the Cascades Group at St. Marys, and there is some possibility of phosphate in the Quamby Group, Golden Valley Group and Cascades Group. The Quamby and Golden Valley Groups were sampled near Beaconsfield, at Poatina and near Latrobe, and the Cascades Group at St. Marys, St. Pauls Dome and Rossarden.

Beaconsfield:

A grab sample of the Quamby Group was obtained from a cutting in the Quamby Group on the road from Exeter to Winkleigh, half a mile north of the Supply River. It contained no detectable phosphate.

Latrobe:

Three samples from the Quamby Group siltstone at Luck Bros' clay pit at Dulverton, near Latrobe (Fig. 4) gave negative results.

Poatina:

Twenty-one specimens collected from the Golden Valley and Quamby Groups in the H. E. C. road section from the cattle grid at the entrance to the H. E. C. property and the turn-off to Poatina Village (Fig. 11) gave no positive tests.

Rossarden:

Five specimens from the Castle Carey Mudstone and Burnt Gully Limestone near Rossarden gave negative results.

St. Pauls Dome:

Eight specimens from the Cascades Group on the south side of St. Pauls Dome, Avoca, all gave negative tests. Their stratigraphic distribution is shown in the columnar section (Appendix 7).

St. Marys Area:

Two sections were sampled, one at Rays Hill, north of St. Marys, the other along Elephant Pass near Grey, south-east of St. Marys, whence Hughes (1957) reported a limestone with 0.87% calcium phosphate and Twelvetrees (1917) reported a sample with 11% calcium phosphate (localities shown in Figs. 12-13).

From Rays Hill (Fig. 13) ten samples were collected (see Appendix 8 for stratigraphic position) but none showed detectable phosphate. The glauconitic sandstone near the top of this section had been analysed previously and showed less than 1% phosphate.

None of the 36 specimens collected in the Elephant Pass section (Fig. 12) from the Grey Mudstone and Berriedale Limestone showed detectable phosphate. The position of the specimens analysed is shown on Fig. 12, and in Appendices 9 and 10. The exact source of the specimen quoted by Twelvetrees at 11% calcium phosphate is unknown.

Cygnet:

Two specimens from the Quamby Group and two from the Bundella Mudstone at Cygnet gave negative phosphate tests.

Maydena:

Four specimens of Darlington Limestone and three of Bundella Mudstone from the Maydena Range gave negative tests.

Hobart:

Specimens of Quamby, Golden Valley and Cascades Group rocks in the Hobart area were analysed, but none of the 26 specimens analysed yielded detectable phosphate.

Coles Bay:

Eighteen specimens from the Cascades Group at Mt. Peter near Coles Bay were analysed and proved negative.

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5 cm

PHOSPHATE LOG

171021 APPENDIX I.

Quadrangle No.

Section of Group, formation etc.

Sheet No.

Section begins at E. N; elevation m. (ft.); traverse proceeds in direction T
with elevation /depression

Beds dip T at

Scale of compilation m. /cm.

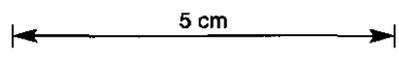
OBSERVER

DATE

Unit Number	Thickness (m.) φ Min. φ Mod. φ Max.	Chert	Clastics %	Phosphate %	Pyrite	Carb. Matter	Oolites	Glauconite	Bed Thickness (m.) C. B.	Stamps	Concretions	Algae %	Main Fossil	GPS.	Specimen Number	Name	Notes
-------------	--	-------	------------	-------------	--------	--------------	---------	------------	-----------------------------	--------	-------------	---------	-------------	------	-----------------	------	-------



022



PHOSPHATE LOG

171023 20

Quadrangle No.

Section of GORDON LIMESTONE Group, formation etc.
MAYBERRY SECTION

Sheet No. 2

Section begins at E. N; elevation m. (ft.); traverse proceeds in direction T
 with elevation / depression

Beds dip T at

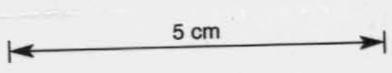
Scale of compilation 30 m. / cm.
 3000'' ; 250' = 1''

OBSERVER E.A. Smith, J.B. Jago

DATE Jan., 1967

Unit Number	Thickness (m.) φ Min. φ Mod. φ Max.	Chert	Clastics %	Phosphate %	Pyrite	Carb. Matter	Oolites	Glauconite	Bed Thickness (m.) C. B.	Stumps	Concretions	Algae %	Main Fossil	GPS.	Specimen Number	Name	Notes
9 F			+	-		+			0.2					-	S 368 S 369	lst.	Creek across road; dolerite boulders in creek. light grey; highly sty.
8 G				-		+									S 370	lst.	
7																N.O.	
6 H			+	-		+									S 371 S 372	lst.	
5 I			+	-					1.5					-	S 373	lst, slts	
4 J			+	-		+									S 374	lst.	sty.
3 K				-											S 375	lst. slts	
3 L				-											S 376	lst.	sty.
3 M				-											S 377 S 378 S 379 S 380 S 381	slts and Clastic lst.	Fossil F ₁
2 N			+	-		+										N.O.	small side rd. abt. 200 yds west of main Maracoopa Caves Rd.
1 O			+	-		+									S 382	lst.	Sirvanella
1 P				-		+									S 383	lst.	sty.
1 Q																N.O.	
1 R			+			+									S 384	Clastic lst.	

026



PHOSPHATE LOG

171027 APPENDIX 4

Quadrangle No.
Sheet No. 1

Section of GORDON LIMESTONE Group, formation etc.

Section begins at E. N; elevation m. (ft.); traverse proceeds in direction T
with elevation /depression

Beds dip T at

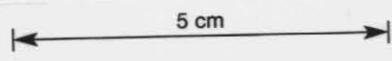
Scale of compilation... 30 m./cm.
3000:1; 250'=1"

OBSERVER J. B. Jago

DATE Jan., 1967

Unit Number	Thickness (m.) φ Min. φ Mod. φ Max.	Chert	Clastics %	Phosphate %	Pyrite	Carb. Matter	Oolites	Glauconite	Bed Thickness (m.) C. B.	Stamps	Concretions	Algae %	Main Fossil	GPS.	Specimen Number	Name	Notes
9																	
8																	
7																	
6																	
5																	
4																	
3																	
2																	
1															S444	N. O.	top of hill sandstone float
															S445		
															S443		
A															S442	Lst. sty.	dip 60° N. ∪ 35°

027



PHOSPHATE LOG

171028 APPENDIX 5

Quadrangle No.

Sheet No. 3

Section of GORDON LIMESTONE Group, formation etc.
SULZBERGERS' QUARRIES, NORTH END OF

Section begins at E. N; elevation m. (ft.); traverse proceeds in direction... 70 ° T
 with elevation / depression

Beds dip... 70 ° T at 45 °.

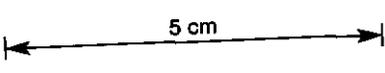
Scale of compilation... 1 : 100 m. / cm.

OBSERVER E. A. Smith

DATE 30.11.1966

Unit Number	Thickness (m.) φ Min. φ Mod. φ Max.	Chert	Clastics %	Phosphate %	Pyrite	Carb. Matter	Oolites	Clauconite	Bed Thickness (m.) C. B.	Slumps	Concretions	Algae %	Main Fossil	GPS.	Specimen Number	Name	Notes
9																	
8																	
7																	
6																	
5	F	>5	-	+	-	-	-	-	5 x 10 ⁻³	-	-	-	-	-	S13	Lst.	"augen" of dolomite; some shale bands
4	E	>5	-	+	+	-	-	-	1 x 10 ⁻³	-	-	-	-	-	S12	Shale	very shaly bands; moderate phosphate test.
3	D	>5	-	+	-	-	-	-	5 x 10 ⁻³	-	-	-	-	-	S11	Lst.	'Augen' of dolomite; shale band about 1 ft from top.
3	C	>5	-	+	+	-	-	-	5 x 10 ⁻³	-	-	-	-	-	S10	Lst.	little dolomite; less shaly bands than B; little stronger test than Sq.
2	B	>5	-	+	Tr.	-	-	-	5 x 10 ⁻³	-	-	-	-	-	S9	Lst.	no dolomite; weak positive test.
1																	
09	A	>5	-	+	-	+	-	-	3.5 x 10 ⁻³	-	-	-	-	-	S8A	Shale	somewhat fissile; micaceous material on bedding planes.
09	A	>5	-	+	-	+	-	-	3.5 x 10 ⁻³	-	-	-	-	-	S8	Lst.	

023



PHOSPHATE LOG

171029 APPENDIX 6

Quadrangle No.

Section of GORDON LIMESTONE Group, formation etc.
South-west of R. BEAMS' HOUSE

Sheet No. 1

Section begins at E. N; elevation m. (ft.); traverse proceeds in direction .. 104° T
with elevation / depression

Beds dip 104° T at 45°

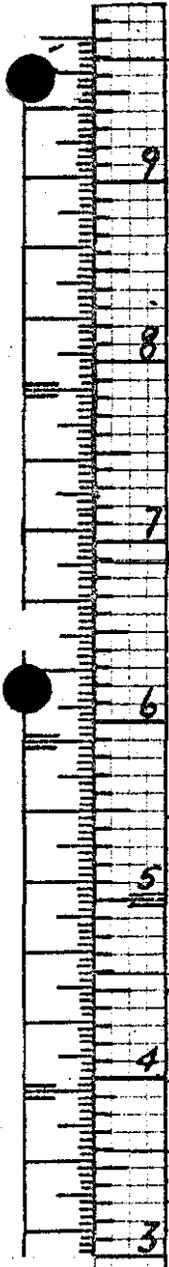
Scale of compilation 10 m. / cm.
1000:1

OBSERVER D. J. KENNEDY

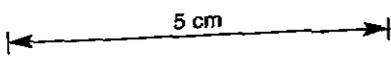
DATE 30.11.1966

< indicates change of slope

Unit Number	Thickness (m.) ϕ Min. ϕ Mod. ϕ Max.	Chert	Glaucites %	Phosphate %	Pyrite	Carb. Matter	Oolites	Chertite	Thickness	Stalags	Concretions	Algae %	Main Fossil	GPS.	Specimen Number	Name	Notes
															K25	sltst	Mathinna Beds
															K24		
															K23	lst.	change upwards from fine to med g'nd sand grade calcite g'ns which appear as "porphyroblasts"
															K22		
																	Main Rd. south of R. Beams' house at entrance to B.L.P. Quarry.
																N.O.	
															K21 K20	Lst. and Mn sltst	in big depression
															K19	cherty lst.	
															K18	Mn sltst	chert present
															K17	cherty lst.	
															K16	Lst. & sltst.	few metres of interbedded Lst. & sltst.
															K15	cherty lst.	
															K14	lst.	
															K13	cherty dolomitic lst.	
															K12 K11		15% dolomite as fucooidal masses
																N.O.	Gap; approx 14.5m. above base of Smith's traverse (Appendix 5)



0229



PHOSPHATE LOG

171030 APPENDIX 7

Quadrangle No.

Section of BURNT GULLY LST Group, formation etc.
South Side of S^t Pauls Dome

Sheet No. 1

Section begins at E. N; elevation m. (ft.); traverse proceeds in direction T
 with elevation / depression

Beds dip T at

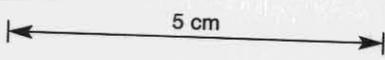
Scale of compilation... 2.5 m. / cm.
 250:1

OBSERVER J.B. Jago

DATE Jan. 1967

Unit Number	Thickness (m.) φ Min. φ Mod. φ Max.	Chert	Clastics %	Phosphate %	Pyrite	Carb. Matter	Oolites	Glauconite	Bed Thickness (m.) C. B.	Stamps	Concretions	Algae %	Main Fossil	GPS.	Specimen Number	Name	Notes
J																lst.	Mainly float
I					-										J 89	lst.	foetid; fossils silicified
H					-										J 88	lst.	pink; less siliceous than lower units
					-										J 87	lst.	
G					-										J 86	lst.	less siliceous than F.
F																lst.	
E					-										J 85	lst.	very siliceous; a few qz pebbles.
					-								stenoporiid fenestellid corals Strophalosia bryozoans sponges		J 84	Sandy lst.	siliceous; pale pink.
D					-								ramose Stenoporids		J 83	Mdst.	brown (pale).
C																N. O.	
B					+	-			0.25					+	J 82	Mdst.	siliceous
A					+	-								+	J 81	Mdst.	Senestellid

030



PHOSPHATE LOG

171031 APPENDIX 8

Quadrangle No.

Section of PERMIAN SYSTEM Group, formation etc.
RAYS HILL, ST MARYS

Sheet No.!

Section begins at E. N; elevation m. (ft.); traverse proceeds in direction T
 with elevation / depression

Beds dip T at

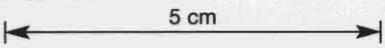
Scale of compilation $2:5$ m. / cm.
 $250:1$

OBSERVER J. B. Jago

DATE Jan., 1967

Unit Number	Thickness (m.) φ Min. φ Mod. φ Max.	Chert	Clastics %	Phosphate %	Pyrite	Carb. Matter	Oolites	Glauconite	Bed Thickness (m.) C. B.	Stumps	Concretions	Algae %	Main Fossil	GPS.	Specimen Number	Name	Notes
9				-				+							J 62	Ss	
8				-				+						+	J 61	Mdst.	Lohreys Gully Mudstone (glauconitic)
7				+											J 60		
6				-										+	J 59	Lst	very fossiliferous
				-											J 58		Emstone Park limestone
5				-										+	J 57	lst	silty lst
														+		lst	
4																	
3													ostracodes brachs.		J 56	sltst	On flat on hill slope Binns Gully Mdst.
2																	
1																N.O.	
00															J 55	Pebby Sst.	Rays Hill Arkose near top of Rays Hill Arkose
															J 54	sst	Rays Hill Arkose

037



PHOSPHATE LOG

171032 APPENDIX 9

Section of BERRIEDALE (= ENSTONE PARK) Lst
 Group, formation etc. C-D (creek section), Elephant Pass (fig. 12).
 Section begins at E..... N; elevation..... m. (ft.); traverse proceeds in direction..... °T
 with elevation..... °/depression..... °
 Beds dip..... ° T at..... °

Quadrangle No.....
 Sheet No..... 1

Scale of compilation 2.5 m./cm.
 250:1

OBSERVER J. B. Jago DATE Jan., 1967

Unit Number	Thickness (m.) φ Min. φ Mod. φ Max.	Chert	Clastics %	Phosphate %	Pyrite	Carb. Matter	Oolites	Glauconite	Bed Thickness (m.) C. B.	Stumps	Concretions	Algae %	Main Fossil	GPS.	Specimen Number	Name	Notes	
9																		
8																		
7																		
6					-									++	J106	Lst.		
														++	J105			
																N.O.		
					-									++	J104	Lst.		
					-				0.8					++	J103 J102	Lst.		
5					-									++	J101	Lst. and sltst.	3' bed of sltst.	
														++		Lst. and sltst.		
					-				0.2 to 0.6						J100			
					-									++	J99	Lst.		
4					-									++	J98		some sltst. bands	
					-									++	J97	sltst	light grey to brown	
3																N.O.		
					-									++	J96		sltst. and Lst. float	
					-										J95	sltst.	Lst. float	
2					-										J94		Lst. float	
					-											N.O.		
1					-										brachs. stenoporus	J93	sltst.	calcareous
														++		sltst. Sst.		
					-									++	J92	Sst	pebble layer at top; Keeneia	
					-									+	J91	Calc. sltst.	pebbles present	
00					-									+	J90	Calc. sltst.		

032

5 cm

PHOSPHATE LOG

171033 APPENDIX 10

Quadrangle No.

Section of BERRIEDALE LST. Group, formation etc.
A-B (Road Section), Elephant Pass (fig. 12).

Sheet No. 1

Section begins at E. N; elevation m. (ft.); traverse proceeds in direction T
 with elevation / depression

Beds dip T at

Scale of compilation ... 2.5 m. / cm.
 250:1

OBSERVER J. B. Jago

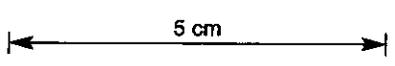
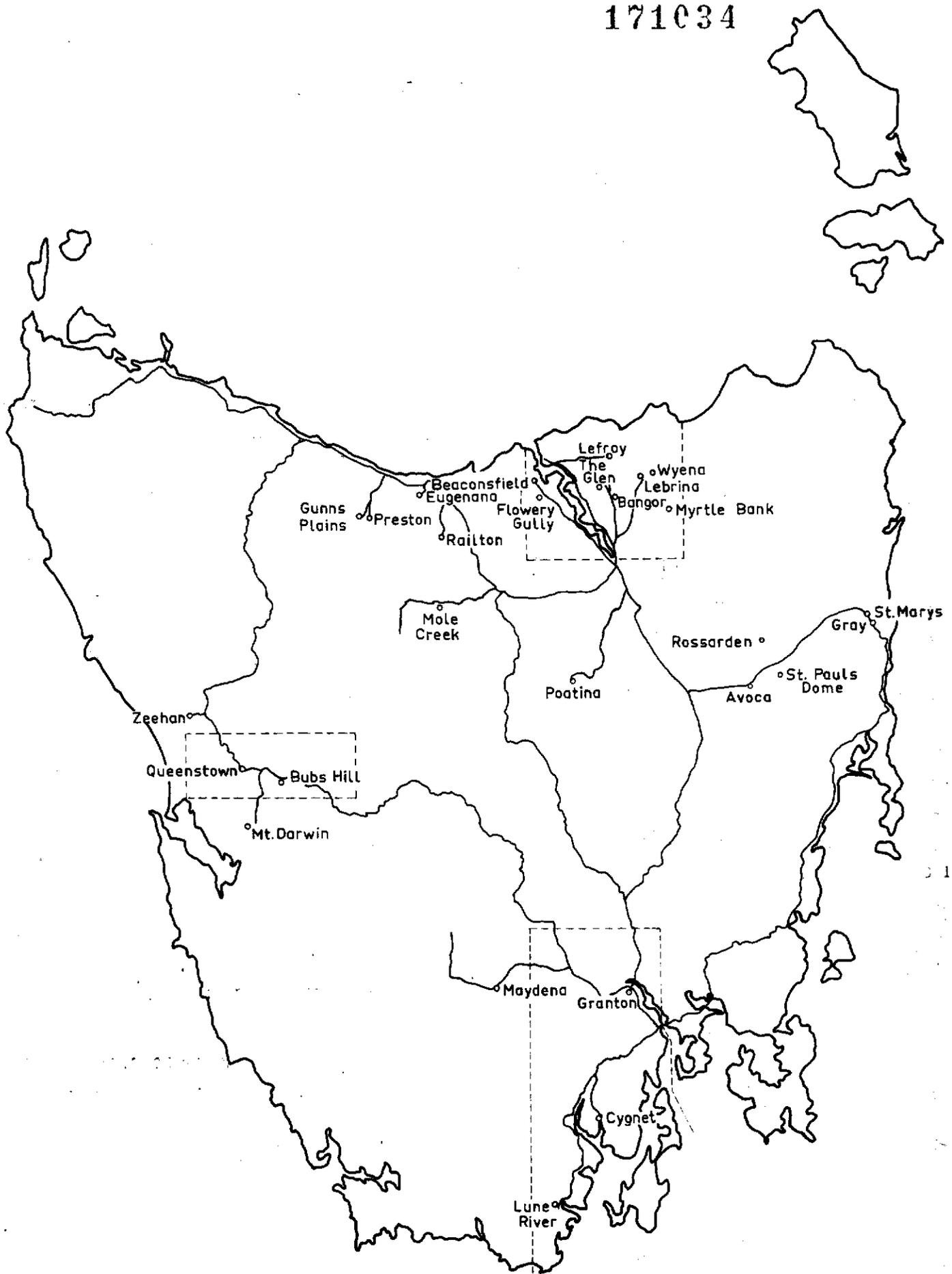
DATE Jan., 1967.

Unit Number	Thickness (m.) φ Min. φ Mod. φ Max.	Chert	Clastics %	Phosphate %	Pyrite	Carb. Matter	Oolites	Glauconite	Bed Thickness (m.) C. B.	Stamps	Concretions	Algae %	Main Fossil	GPS.	Specimen Number	Name	Notes			
9																				
8																				
7																				
6																				
5																Q	+	J80	Sltst.	with some pebbles
4																P	+	J79	Lst.	weathered
3																O	+	J78 J77	Lst.	
																N	+		sstst; sst.	
																M	+	J76	Sltst.	
																L	+	J75	Lst.	
																K	+	J74	Lst.	weathered
																J	+		Lst.	thick beds
																I	+	J73	Lst.	thick beds
																H	+		Lst., Sltst.	beds thicker than in Unit F, espec- -ally sltst. beds.
																G	+	J72	Lsb.	Lens
																F	+	J71 J70	Lst. Sltst.	J71 J70 sandy
																E	+		Sst.	pebbly
																D	+	J69 J68	Sltst. Sst.	friable; some pebbles
																C	+	J67	Sst.	
																B	+			
																A	+	J66	Sltst.	friable



033

171034



UTAH DEVELOPMENT COMPANY

Locality Map

Figure I
 Report No. CR 575
 May 1967

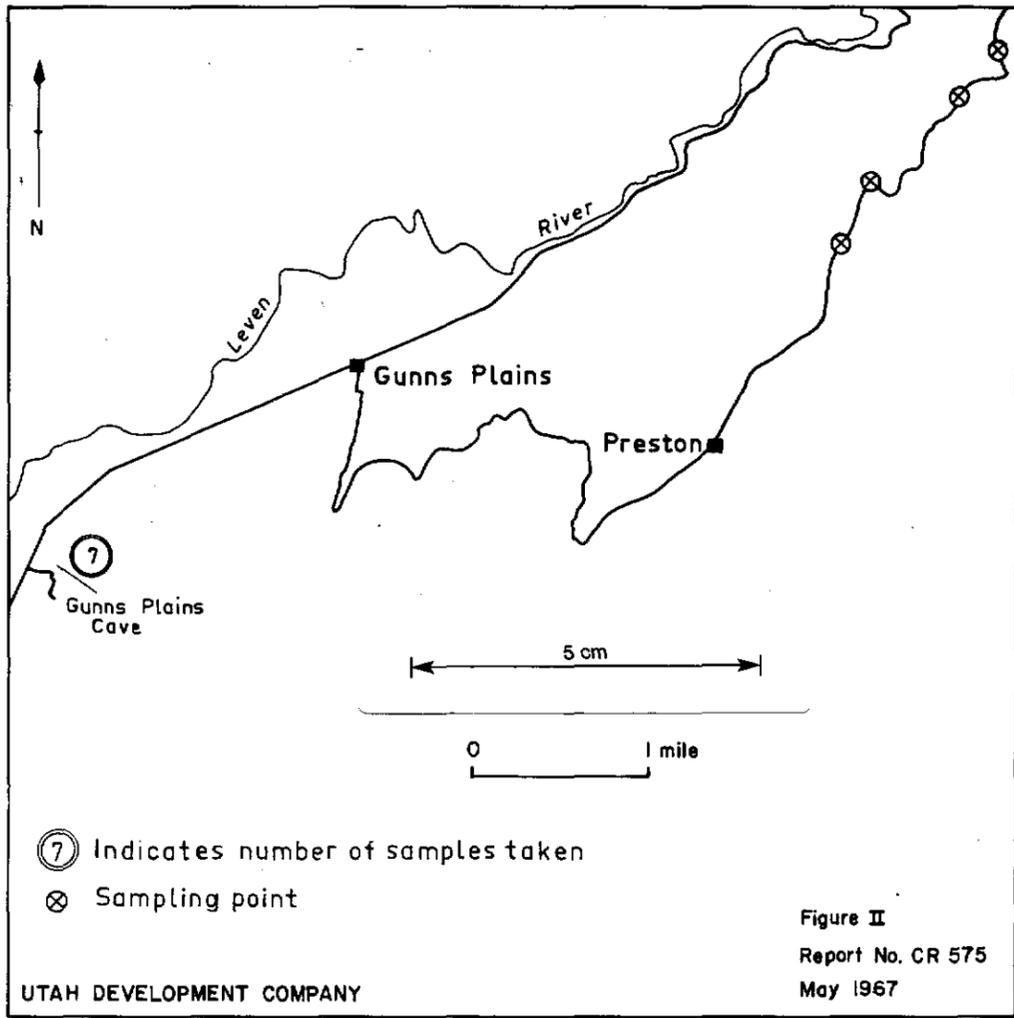
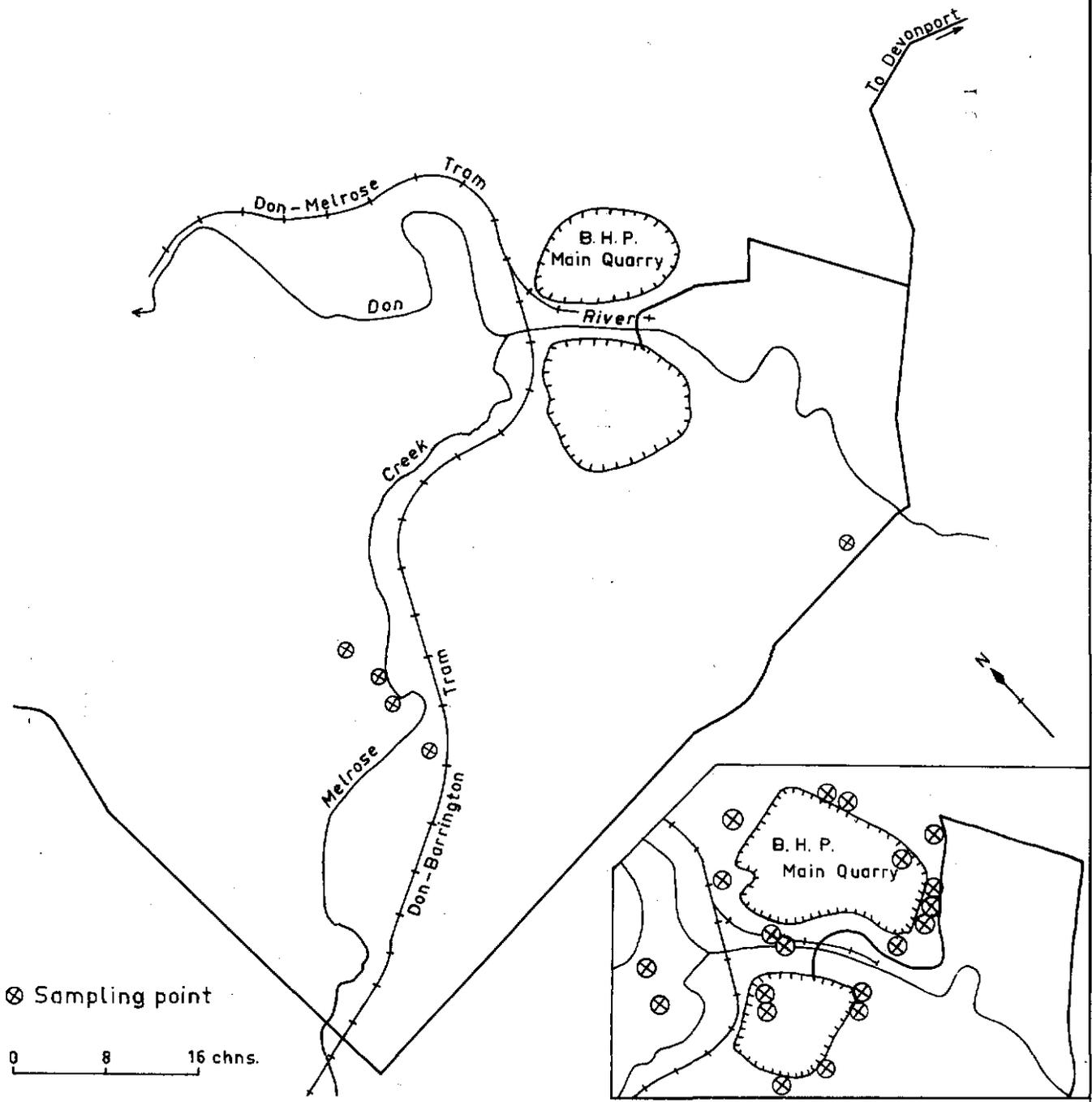


Figure II
 Report No. CR 575
 May 1967

UTAH DEVELOPMENT COMPANY

035

171030



⊗ Sampling point

0 8 16 chns.

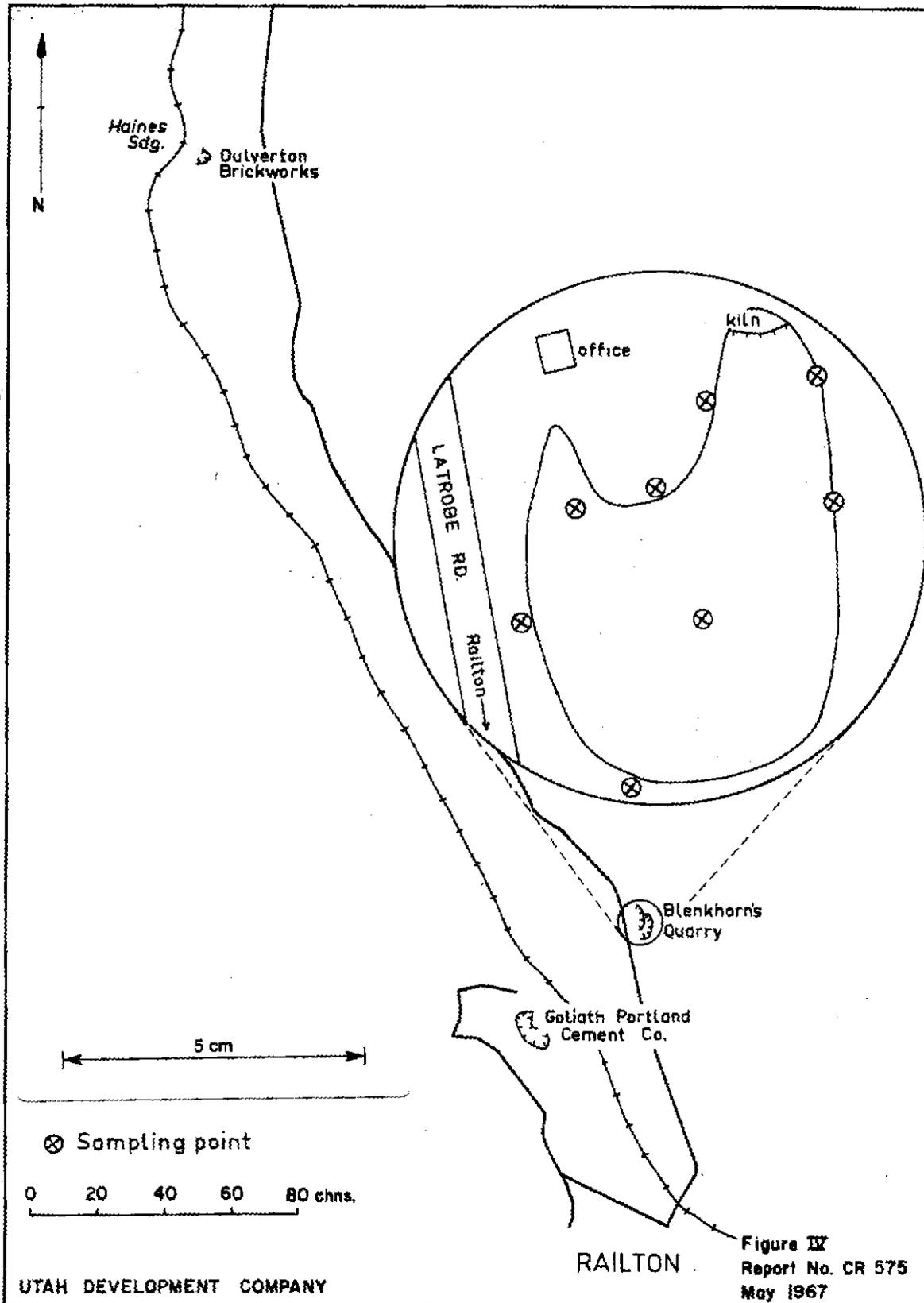
5 cm

UTAH DEVELOPMENT COMPANY

Figure III
Report No. CR 575
May 1967

036

171037

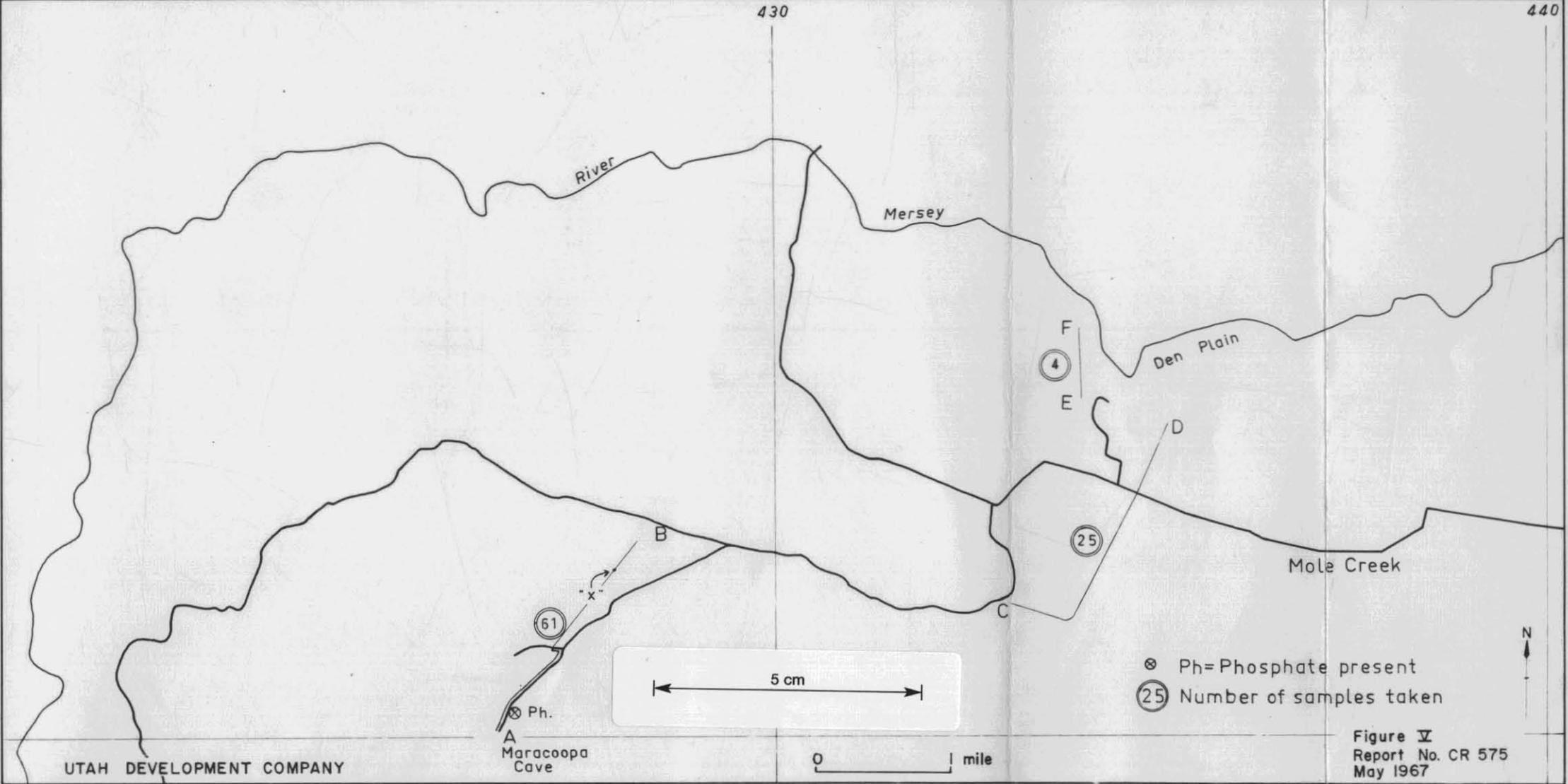


037

171038

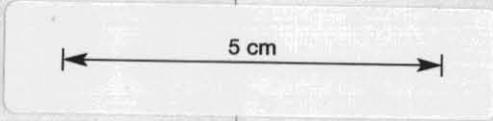
430

440



UTAH DEVELOPMENT COMPANY

A
Maracooopa
Cave



- ⊗ Ph=Phosphate present
- Ⓢ Number of samples taken

Figure V
Report No. CR 575
May 1967

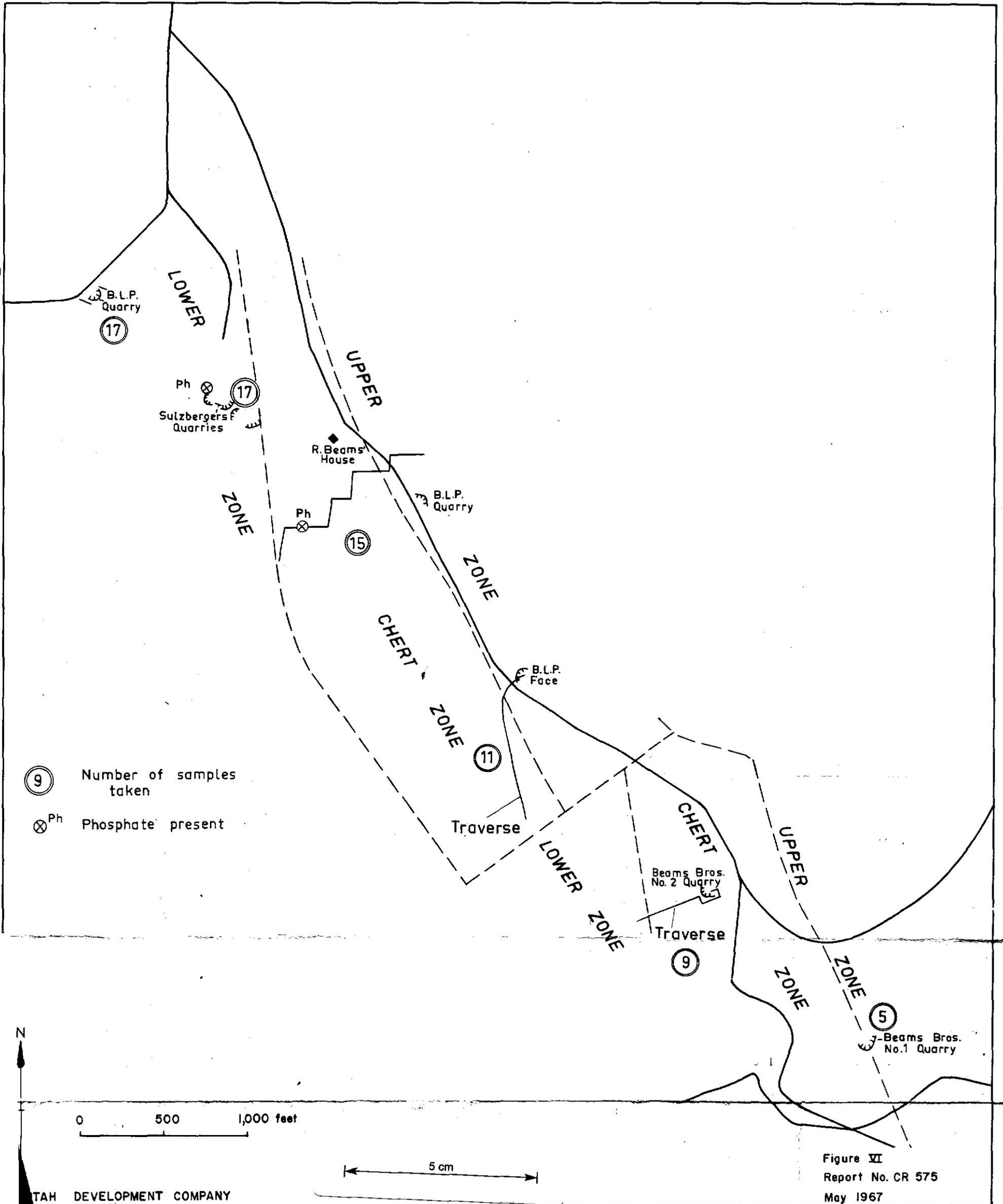


Figure VI
 Report No. CR 575
 May 1967

TAH DEVELOPMENT COMPANY

033

171040

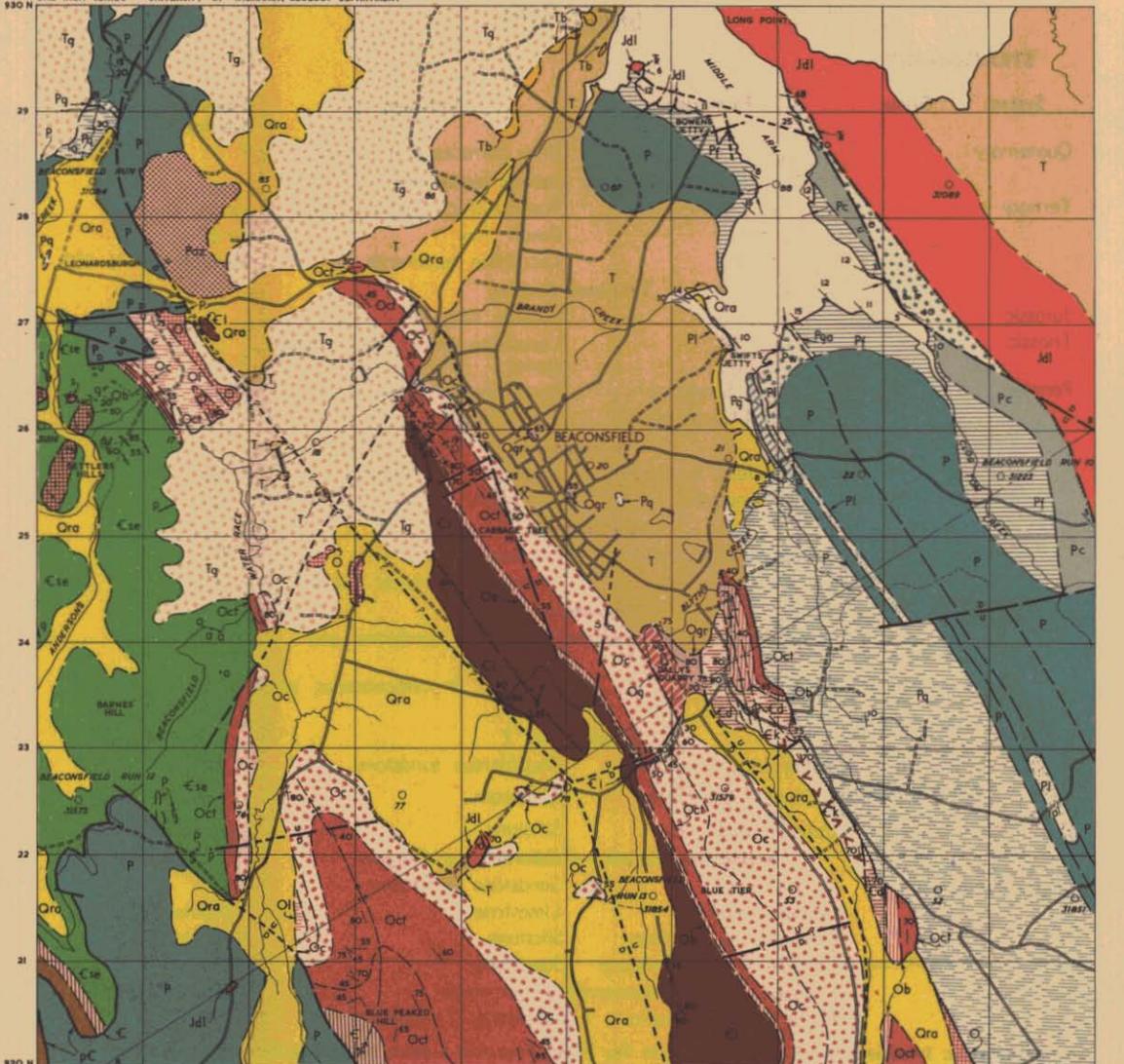
5 cm

GEOLOGY OF TASMANIA

BEACONSFIELD

4792

ONE INCH SERIES — UNIVERSITY OF TASMANIA, GEOLOGY DEPARTMENT



Quaternary System		Ordovician System	
Qra	ALLUVIUM	Ogr	GRUBB BEDS
Tg	POST BASALTIC GRAVELS	JG	JUNE GROUP
T	UNDIFFERENTIATED CLAYS, SANDS, AND CONGLOMERATES	G	GORDON LIMESTONE
Ts	UNDIFFERENTIATED SANDSTONES	L	LEONARDSBURGH SILTSTONE
Pc	CLOG TOM SANDSTONE	C	CAROLINE CREEK CONGLOMERATE
F	FERTREE MUDSTONE	Oc	CABBAGE TREE CONGLOMERATE
Pga	GARCIA SANDSTONE	Ob	BLYTHS CREEK FORMATION
Pb	WOODBIDGE GLACIAL FORMATION	U	UNDIFFERENTIATED
Pi	LIFFEY SANDSTONE	C	Cambrian System
Pg	GOLDEN VALLEY GROUP	D	DALLY'S SILTSTONE
Pq	QUAMBY SILTSTONE	I	ILFRACOMBE SLATE
P	UNDIFFERENTIATED	U	UNDIFFERENTIATED
		L	Lower Palaeozoic
		U	UNDIFFERENTIATED
		P	Precambrian
		U	UNDIFFERENTIATED

LEGEND

METAMORPHIC ROCKS

IGNEOUS ROCKS

Tertiary System

Jurassic ? System

Cambrian System

Cambrion ? System

Lower Palaeozoic

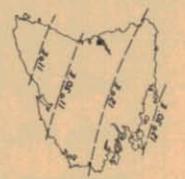
Precambrian

Igneous Boundaries

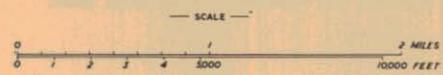
Other Geological Symbols

Compilation from Aerial Photographs
Base Map by courtesy of the Forestry Commission, Hobart
Origin of co-ordinates 400000 yds West and 1000000 yds South of True Origin of Zone 7 of the International Grid

KEY MAP SHOWING MAGNETIC DECLINATIONS 1957
SECULAR VARIATION 7 MINUS PER ANNUM



MAPPED AND COMPILED BY
D.H. GREEN 1956



OTHER GEOLOGICAL SYMBOLS USED ARE AS IN BROCKETT OF STANDARD GEOLOGICAL SYMBOLS, BUREAU OF MINERAL RESOURCES 1950.

Figure VII

038A

GEOLOGY OF BEACONSFIELD

171041

SHEET 4792

STRATIGRAPHY

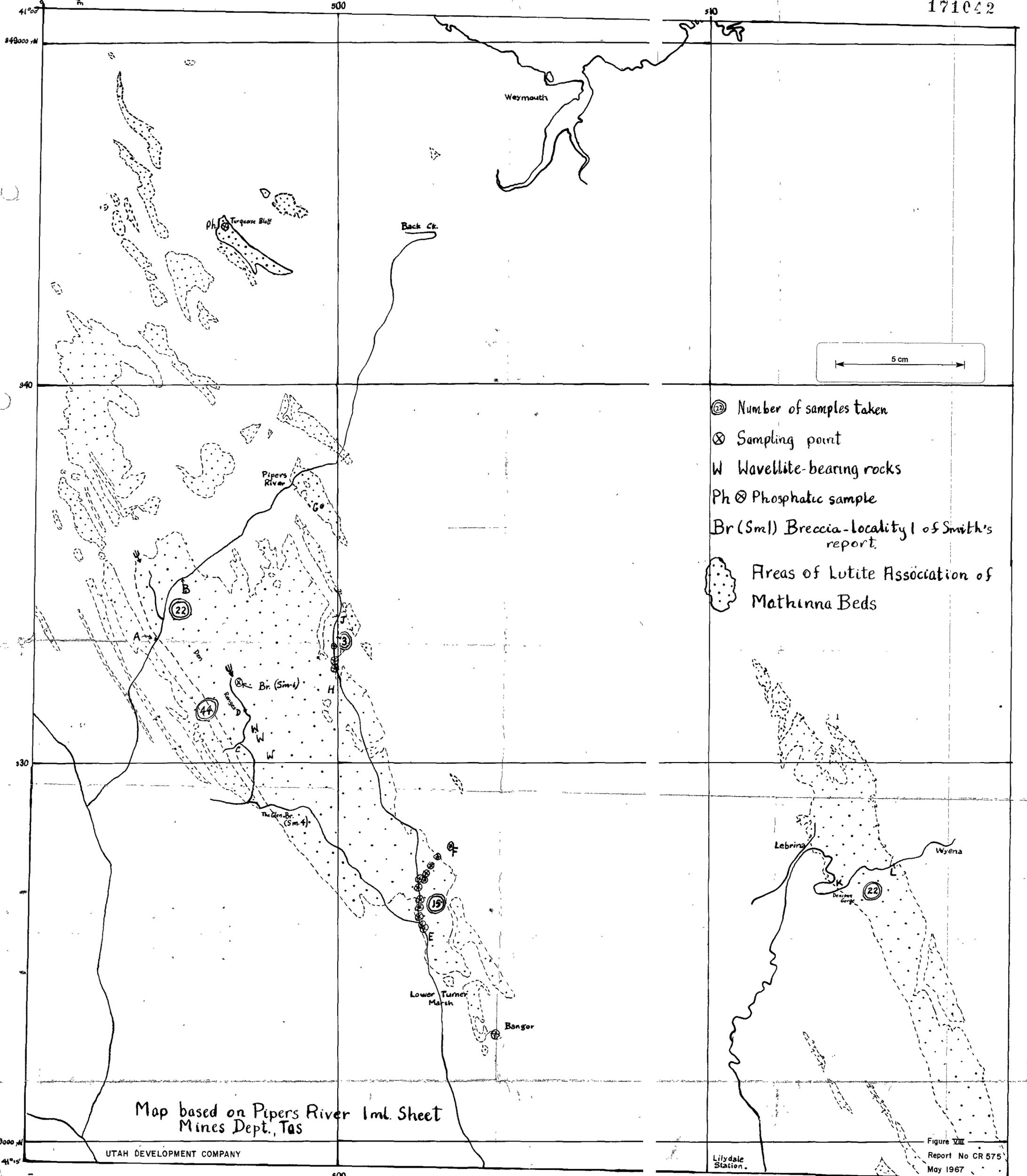
System	Group	Formation	Lithology	Thickness (in feet)
Quaternary			River terraces and alluvium	?
		Erosion with minor eustatic movements		
Tertiary			Post-basaltic Quartz Gravels	up to 50
			Basalt flow	50-60
			Lacustrine sediments	Variable, up to 600
		Tensional Faulting		
Jurassic			Dolerite intrusions	
Triassic			Lacustrine quartz, mica sandstones	?
Permian		Clog Tom Sandstone	Lacustrine sandstone	?
		Blackwood Conglomerate	Conglomerate	2
		Disconformity		
	Ferntree	Bowen's Jetty Sandstone	Sandstone and siltstone	400
		Palmer Sandstone	Sandstone	21
		Disconformity ?		
		Springmount Siltstone	Siltstone	255
		Garcia Sandstone	Sandstone and basal breccia	10
		Disconformity ?		
		Woodbridge Glacial Formation	Fossiliferous sandstone and siltstone	70
		Liffey Sandstone	Graphitic & carbonaceous sandstone	10
		Disconformity ?		
	Golden Valley	Swifts Jetty Sandstone	Fossiliferous sandstone	50
		Darlington Limestone	Limestone	4
		Quamby Mudstone	Siltstone	up to 850
		Major Unconformity—Tabberabberan Orogeny		
Siluro—Ordovician		"Grubb Bed"	Sandstone & Siltstone	?
		Gordon Limestone	Limestone	Variable 0-650
		Leonardsburgh Siltstone	Siltstone	Variable 950-0
Ordovician Junee Group		Caroline Creek Sandstone	Sandstone	750
		Cabbage Tree Conglomerate	Conglomerate	Variable 20-2900
		Blyths Creek Formation	Sandstone, Limestone	100
		Ultrabasic Intrusion, Local Unconformity in the West, Probable Erosion and Disconformity in the East		
Cambrian		Dally Siltstone	Siltstone & Keratophyre	1100+
		Ilfracombe Slate	Slate	1600+
		Major Unconformity		
Precambrian			Quartzites & quartz sericite schists	?

STRUCTURAL GEOLOGY

Post-Ordovician (Tabberabberan) orogenic movements with the maximum stress directed to the WSW resulted in asymmetrical folding, steep thrusting and transcurrent faulting of the Lower Palaeozoic sediments. This stress field also caused diapiric cold movement of the previously emplaced ultrabasic complex.

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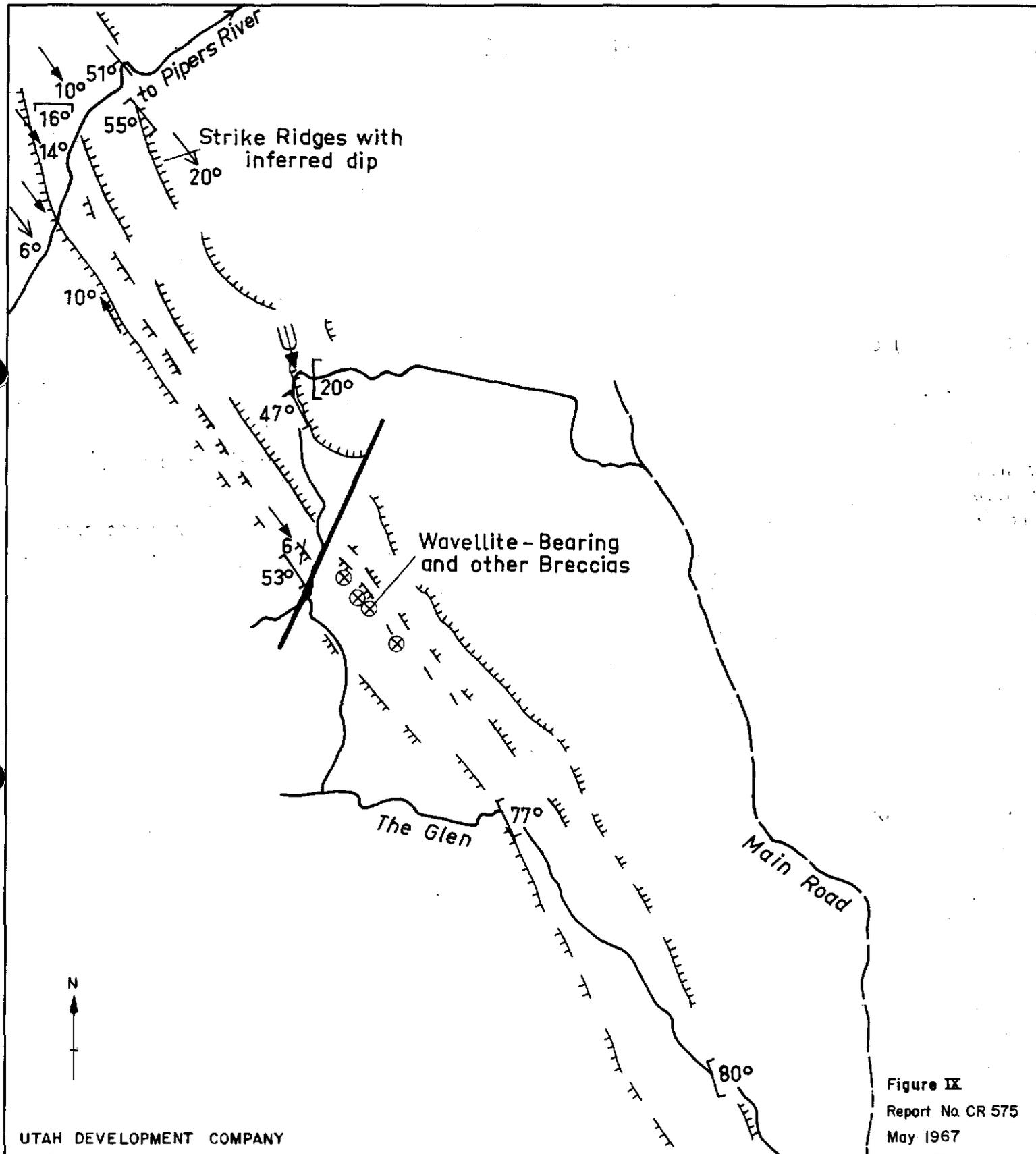
- ⊙ Number of samples taken
- ⊗ Sampling point
- W Wavellite-bearing rocks
- Ph ⊗ Phosphatic sample
- Br (Sm1) Breccia-locality 1 of Smith's report.
- ⊙ Areas of Lutite Association of Mathinna Beds

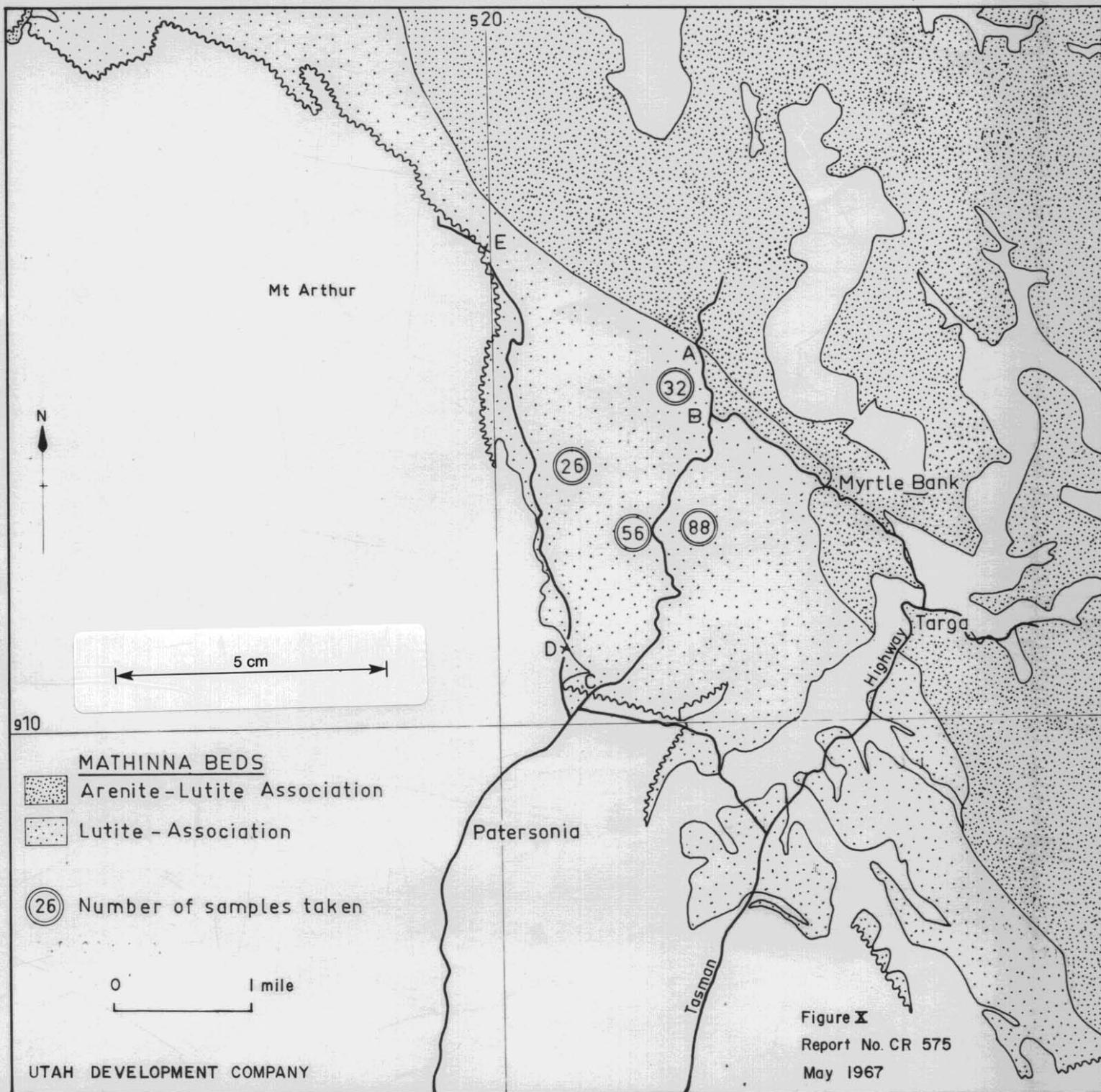
Map based on Pipers River Impl. Sheet
Mines Dept., Tas

UTAH DEVELOPMENT COMPANY

Lilydale Station.

Figure VIII
Report No CR 575
May 1967





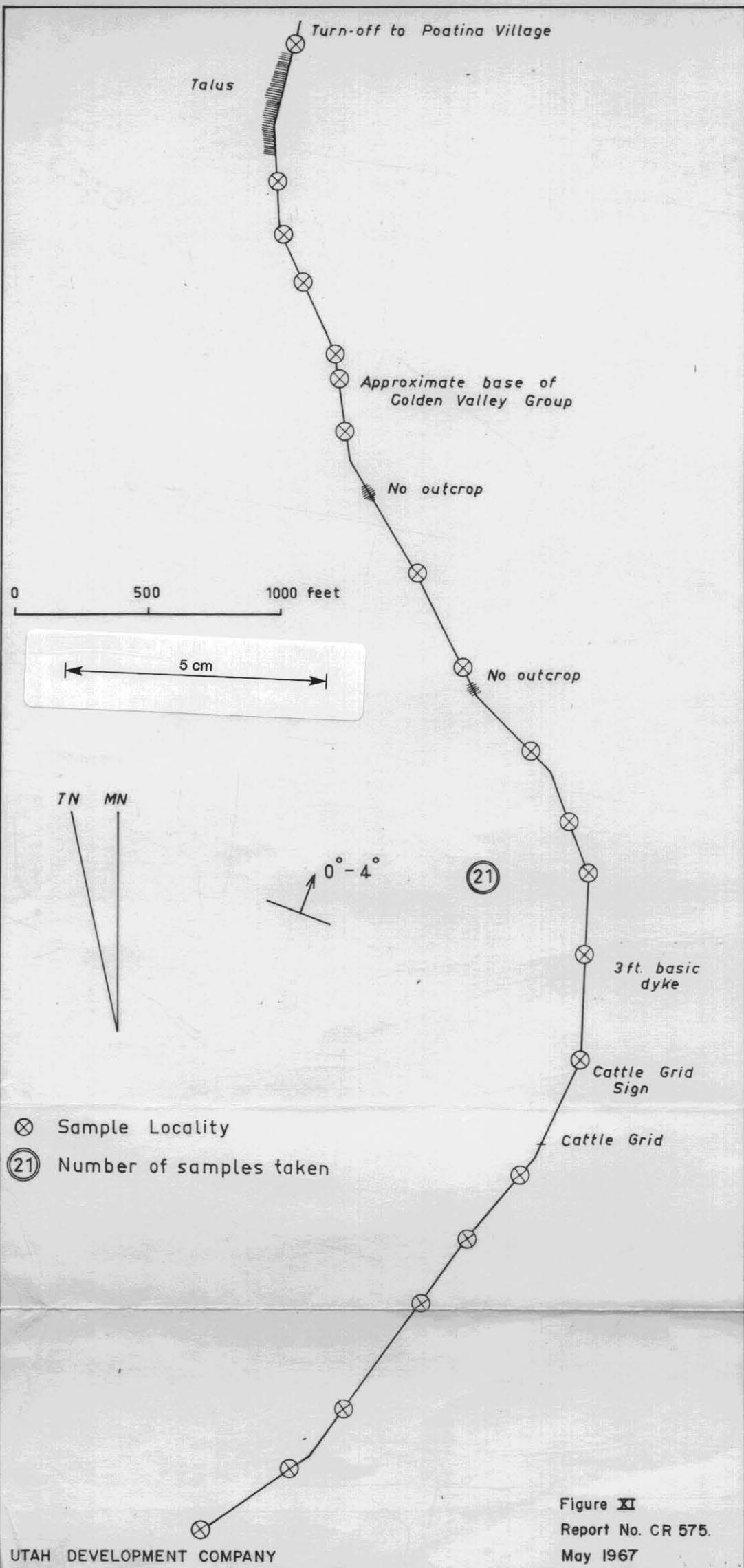


Figure XI
 Report No. CR 575.
 May 1967

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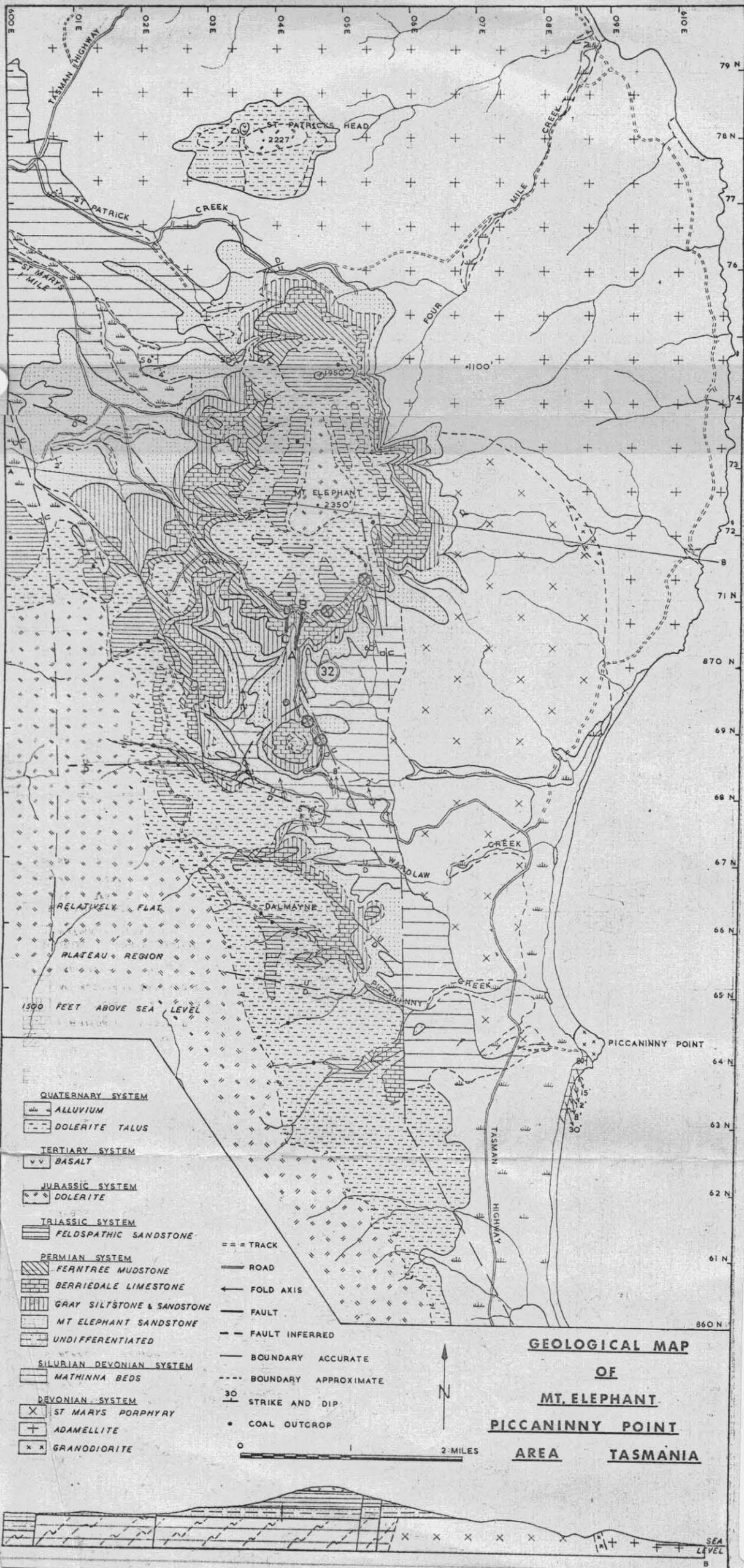
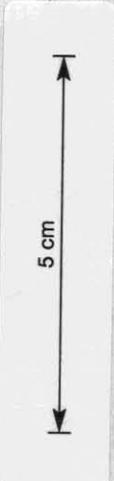
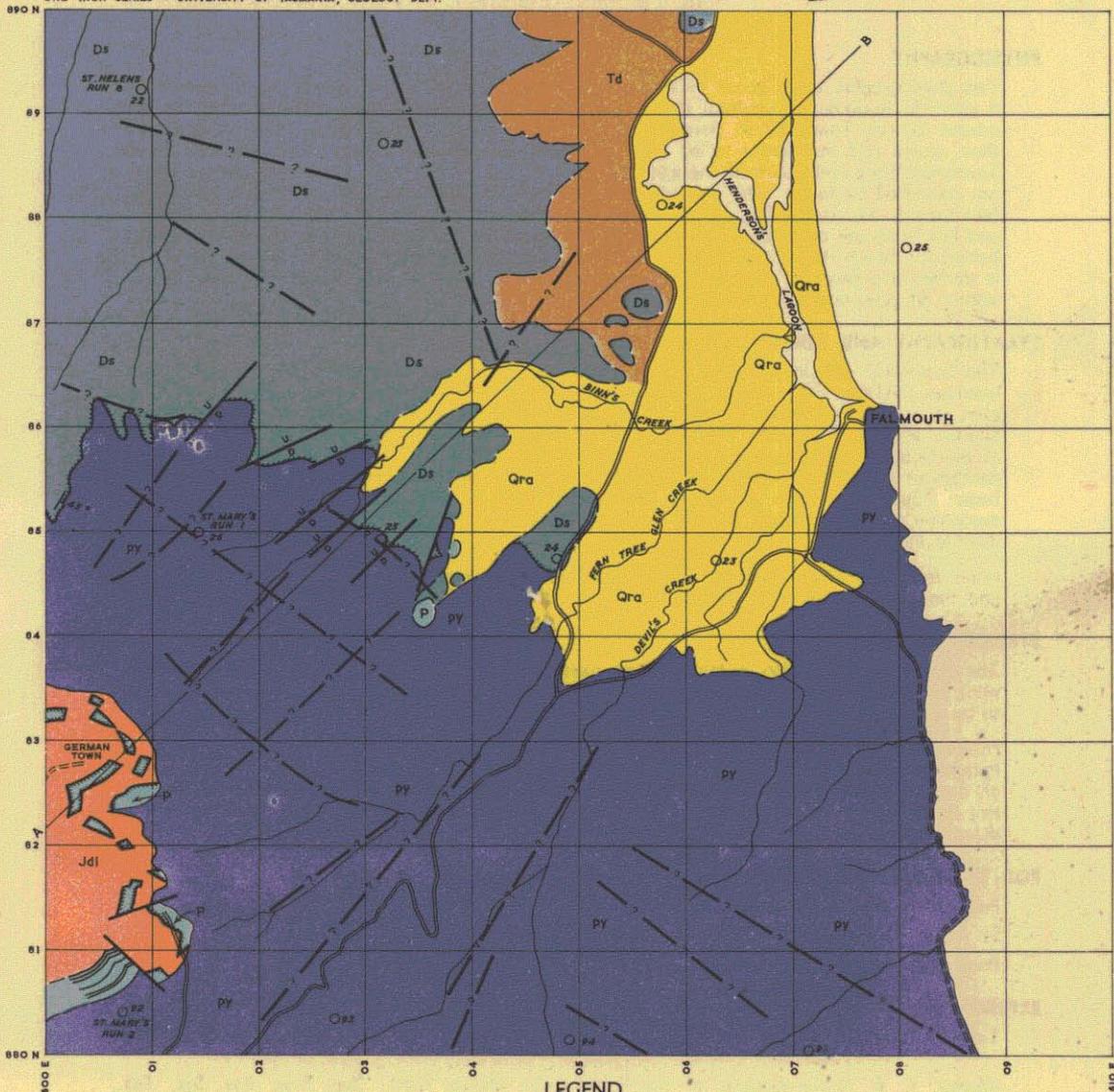


FIGURE 12
 A-B } Measured and
 C-D } sampled sections
 ⊗ Other samples



043



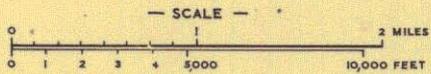
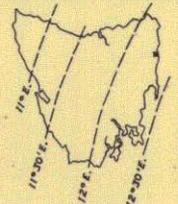
LEGEND

- FAULT WITH DOWNTROWN SIDE INDICATED
- PHOTO-INTERPRETED FAULT
- ESTABLISHED BOUNDARY - POSITION ACCURATE
- ESTABLISHED BOUNDARY - POSITION APPROXIMATE
- DISCORDANT INTRUSIVE BOUNDARIES
- DISCORDANT INTRUSIVE BOUNDARY WITH CONCOMITANT FAULTING
- STRIKE AND DIP
- ROADS
- VEHICULAR TRACK
- TRACK
- PHOTO CENTRE

- Quaternary System
- RECENT SERIES
- Qra ALLUVIUM
- Tertiary System
- Td DIANA'S BASIN SANDS AND GRAVELS
- Permian System
- P
- Mathinna Group
- Ds SCAMANDER SLATE AND QUARTZITE
- IGNEOUS ROCKS
- Jdl JURASSIC DOLERITE
- py ST. MARY'S PORPHYRY
- Dc COASTAL RANGE QUARTZ MONZONITE

Compilation from Aerial Photographs.
Trigonometric Station Control by courtesy Lands and Surveys Dept.
Origin of co-ordinates 400,000 yds. West and 1,800,000 yds. South of True Origin of Zone 7.

KEY MAP SHOWING MAGNETIC DECLINATIONS
SECULAR VARIATION 7 MINS. PER ANNUM



MAPPED AND COMPILED BY
K. R. WALKER 1953

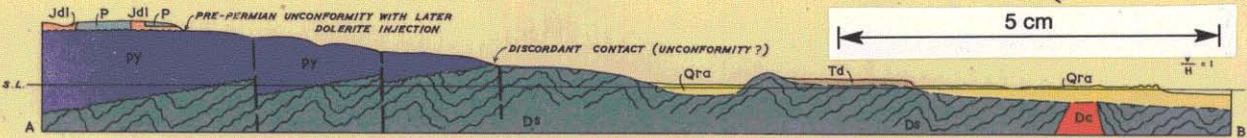


Figure XIII

044

GEOLOGY OF FALMOUTH

SHEET 6088

PHYSIOGRAPHY.

Two physiographic units occur in this area, a low, mountainous, early mature hinterland and a partially rejuvenated, youthful coastal plain. Drainage more or less radiates from the area around German Town and St. Patrick's Head. The streams are in mountain tract for about half their course and then enter valley tract in which they remain till they reach the sea. In the Scamander Slate and Quartzite the joints control the streams and in the St. Marys Porphyry streams are controlled by faults. The coastal plain ranges from 350 feet above sea level inland to 170 feet towards the coast. This plain is deeply dissected but the hills still carry a cover of sediment and hill levels are accordant. Still closer to the coast are the barred lakes, lagoons and swamps behind the beach ridges and beaches. South of Falmouth the coast is cliffed but to the north it is mainly long beaches, and the coast is comparatively straight. The Scamander River is considered to have originally flowed into the sea near Falmouth.

STRATIGRAPHY AND IGNEOUS ROCKS.

The basement rock in the area is the Scamander Slate and Quartzite. This formation is of unknown thickness and contains argillites and arenites of the sub-greywacke suite. North of the area it contains primitive vascular plants and fragmental marine fossils. It may be in part Silurian or Lower Devonian. The deposition of these beds was followed by folding, then intrusion of the Coastal Range Quartz Monzonite. Sometime later the St. Marys Porphyry was emplaced, perhaps as a lava flow. Tilting and erosion followed before deposition of the Permian sediments began. Several Permian formations are present and include a limestone and a glauconitic sandstone. Later, probably in the Jurassic Period, the Permian sediments were disrupted by dolerite intrusions.

Later faulting further disrupted the Permian and older rocks and after this the coastal plain and the sediments on it developed.

STRUCTURAL GEOLOGY.

The Scamander Formation is folded along axes trending N15°E to N20°E and generally somewhat overturned to the east. Where the base of the St. Marys Porphyry is exposed it is seen to be dipping 15° to the south. The Permian and Tertiary beds are virtually horizontal.

Faults affect the Scamander Formation, Coastal Range Monzonite, St. Marys Porphyry and the Permian sediments. These form a conjugate system, trending north-west and north-east. Some of these at least are post-Permian as the Enstone Park Limestone (Permian) occurs on Rays Hill and much lower topographically at Enstone Park. Faults associated with the intrusion of dolerite also affect the Permian beds near German Town.

POINTS OF SPECIAL INTEREST.

- Permian Section on Rays Hill (600.5E.880.5N)
- St. Marys Porphyry in St. Marys Pass (602.5E.880.5N)
- Base of St. Marys Porphyry (602.2E.886N)

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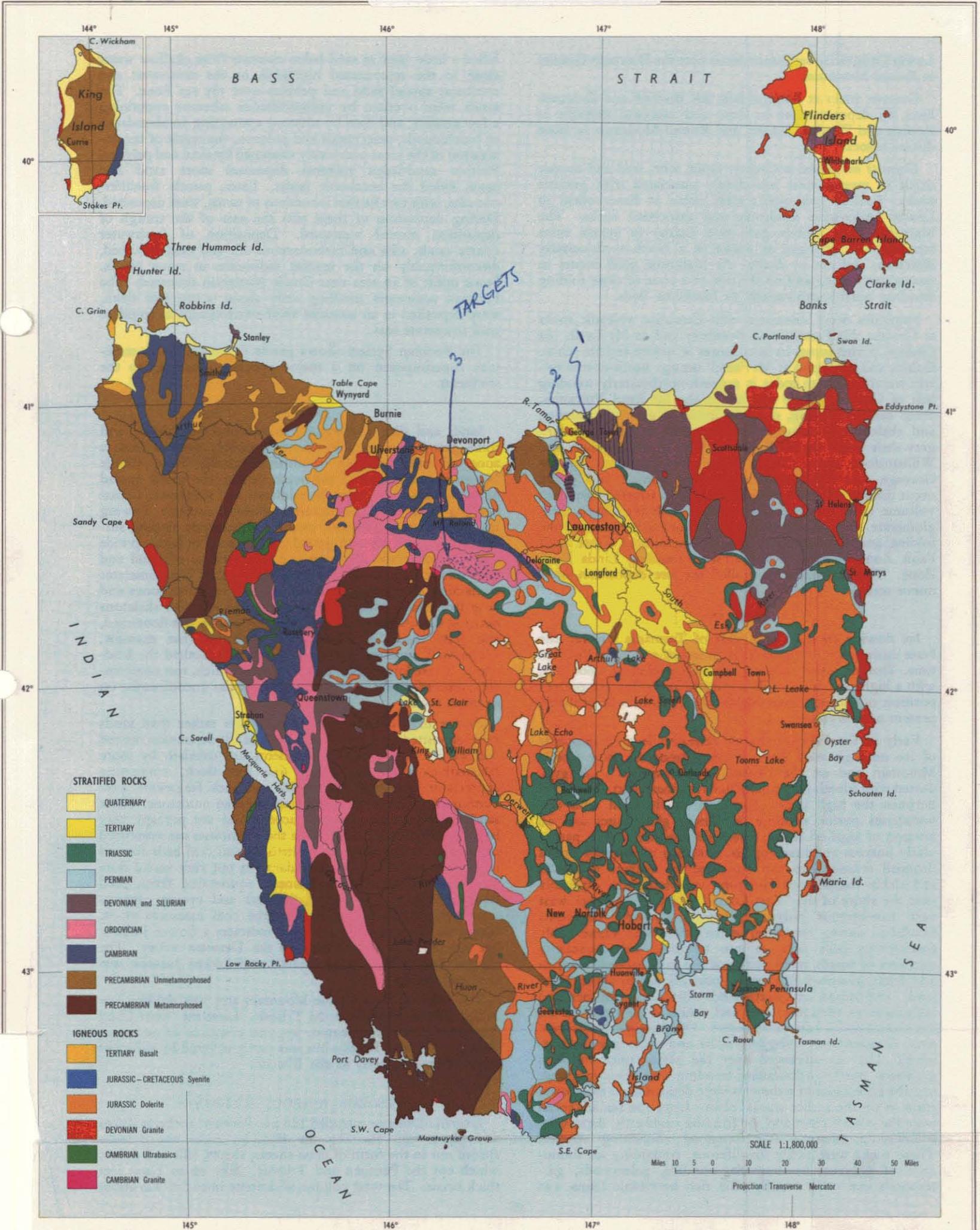
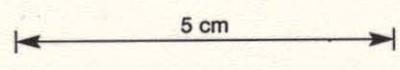


Figure XIV

Lower Ordovician sandstone occur near the Dolcoath Granite at Round Mountain.

Granitic rocks at Renison Bell, Mt Bischoff and Dolcoath have tin deposits close to them and zinc-lead deposits at Zeehan and Dundas, Magnet and Round Mountain as more distant haloes.

Deposits not related to Granite: Gold, zinc, lead and copper occur in several areas not closely associated with granitic rocks. Faulted gold-quartz reefs occur at Beaconsfield in Lower Ordovician sandstone and associated rocks. The Mathinna Beds contain gold near Lefroy in quartz veins trending 80° , arranged *en echelon* in a north-northwesterly direction, and cut by faults. At Mathinna gold occurs in quartz veins along and on the side of a zone of close folding trending north-northwesterly in Mathinna Beds.

Sulphides occur associated with Cambrian volcanic rocks at Chester, Mt Farrell, near Rosebery and at Mt Lyell. At Chester, pyrite occurs in steep lenses in quartz sericite schist. Galena and sphalerite at Mt Farrell occupy north-northwesterly trending fissure lodes in a north-northeasterly trending belt of Cambrian shale and tuff in the Mt Read Volcanics. Steep easterly dipping, *en echelon* lenses of galena, sphalerite, and chalcopryrite occur in sericite schist overlain by dark grey shale under the Mt Read Volcanics in the Rosebery and Williamsford areas. These lenses are controlled by the cleavage. At Mt Lyell chalcopryrite, bornite and pyrite occur disseminated in a meridional strip in schisted Cambrian volcanic rocks close to their contact with the Owen Conglomerate. The ore deposits were formed subsequent to the folding and were controlled by the meridional Great Lyell Fault Zone and the west-northwest trending Linda Fault Zone. The schistosity controlled the ore deposition on a minor scale.

PERMIAN

Ice flowing from an area west of Tasmania covered the State during part of Upper Carboniferous and early Permian time. This ice rested on a surface with a relief of 3,000 feet, with a high area near Cradle Mountain and along the present position of the east coast highlands. A fjord was probably present near Wynyard.

Early in the Permian the ice retreated leaving remnants of ice on high areas such as the promontory near Cradle Mountain and on the "East Coast Peninsula". A gulf, dotted with islands particularly in its northern part, developed between the high areas. This gulf slowly filled with carbonaceous pyritic siltstone containing glendonites and a horizon of algal oil shale. These silts contain fossils, particularly polyzoa and brachiopods. Icebergs of westerly origin dropped erratics into the silt. The sea became shallower and richly fossiliferous limestone was deposited, especially near the shore of the "East Coast Peninsula". Further west very fossiliferous polyzoal siltstone formed. *Eurydesma* flourished during formation of the limestone. These richly fossiliferous beds pass up into siltstone with decreasing numbers of fossils as the water of the gulf became brackish and deltas advanced into the sea, possibly due to uplift of the land. Deposition of quartz sandstones and siltstones and carbonaceous siltstones, coal and cannel coals occurred on the coastal plains behind the deltas. On these plains *Glossopteris*, *Gangamopteris*, *Noeggerathiopsis* and other plants flourished. The sea advanced over the plains once to form a narrow north-northwesterly trending gulf then retreated, and the same types of sediments were deposited on the coastal plain as on the earlier coastal plain. Later the sea advanced over the coastal plain and the fringing highlands, depositing fossiliferous siltstone and limestone containing erratics. These rocks were richly fossiliferous, containing an abundance of polyzoa, brachiopods, crinoids, pelecypods, gastropods and other fossils. The rich benthonic fauna was

killed a little later as sand-laden currents from shallow water close to the rejuvenated highlands to the northwest and northeast spread sand and pebbles over the sea floor. The sands were overlain by unfossiliferous siltstone containing a few erratics, and then by siltstone containing an abundance of brachiopods, pelecypods and polyzoa, the result of recolonization of the areas previously swamped by sand and pebbles. Further sand-laden currents deposited more sand and again killed the benthonic fauna. Later, poorly fossiliferous silts, with two further incursions of sands, were deposited. During deposition of these silts the axis of the trough of deposition moved westward. Deposition of freshwater quartz sands, silts and carbonaceous silt and coal followed, disconformably on the marine sediments in some places. Some uplift of an area near Cradle Mountain occurred. The Permian sediments totalling only about 2,500 feet thick, were deposited in an unstable shelf environment in frigid to cool temperate seas.

The Permian System shows gentle dome and basin structure superimposed on a major syncline plunging to the southeast.

TRIASSIC

Sands and silts, consisting predominantly of quartz, and some granule and pebble gravels probably derived from a zone of hills trending south-southeasterly from Cradle Mountain and higher to the north than to the south, spread over a lowland area, now the midlands and southeast. Cross-bedding and slump structures indicate currents flowing mainly from the northwest over a southeasterly sloping surface. The sand, silt and gravel accumulated in lakes, ponds and river channels. Erosion and redeposition of pond and lake silts during floods produced clay pellet conglomerates containing disarticulated amphibian and reptilian bones and lung fish teeth. More complete reptilian and fish skeletons occur in the siltstone. During this time equisetals flourished, and ferns such as *Cladophlebis*, seedferns (for example, *Dicroidium*), conifers, ginkgoes and cycads clothed the landscape. These lower beds, up to 1,300 feet thick, rest conformably, disconformably and with slight angular unconformity on Permian rocks.

As the hilly country was eroded, silts rather than sands were deposited and the western limit of silt deposition moved westward. The quartzose sediments are overlain by more feldspathic sandstones about 650 feet thick, containing appreciable quantities of chlorite and rock fragments, predominantly volcanic but including Permian mudstone. These sandstones may be partly tuffaceous and are perhaps very largely redistributed tuffs. With the sandstones are associated carbonaceous claystones and siltstones and coal beds formed in swamps and lakes. An abundant but not very varied flora flourished. It included liverworts, equisetals, ferns, seed ferns, ginkgoes, *Phoenicopsis*, conifers and cycads. Insects were present. Spores show that the coal measures at St. Marys are Rhaetic and a seed fern indicates a Lower Jurassic age for the coal at Hamilton in the Derwent valley. The climate during the Upper Triassic and Lower Jurassic was cool and humid.

The Lake St. Clair-Cradle Mountain area was uplifted late in the Permian or early in the Triassic. Later the "East Coast Peninsula" was rejuvenated, became a source of sediment during the Upper Triassic but was partly covered by sediment again at least as early as the Rhaetic.

MESOZOIC IGNEOUS ACTIVITY

Dolerite: Dolerite intruded the pre-Permian rocks as dykes and pipes. On reaching the Permian rocks the dolerite spread out in the form of cone-sheets, sheets, sills and dykes, which cut the Permian and Triassic. Sills up to 1,400 feet thick occur. The total volume of dolerite intruded was about