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3. Exploratory diamond drilling in the Moina area.

P.L.F. Collins

Moina, situated approximately 45 km south of Devonport, on the southern shores of Lake Gairdner in the central north of Tasmania (fig. 3), has been the centre of continued mineral exploration in the Middlesex district since the first discoveries of tin and tungsten ores on Dolcoath Hill in the 1890s.

Between January 1966 and May 1972, the Mount Lyell Mining and Railway Company undertook extensive exploration of the Middlesex district, including a detailed examination of the area in the immediate vicinity of Moina, which was part of the licence area of E.L. 8/65. Investigations included geological mapping, geochemical sampling and geophysical surveying of the area; and diamond drilling at the Shepherd and Murphy mine to test the lateral extent of the lode system. As a result of these investigations, it was considered that the area of greatest potential for disseminated scheelite mineralisation, disseminated bismuth-copper sulphide mineralisation, or cassiterite-wolframite vein deposits lies between Bismuth Creek and Ti-Tree Creek (fig.3).

When the exploration licence covering the area was relinquished in May 1972, the Department of Mines initiated an exploratory diamond drilling programme to evaluate the economic potential of this area for possible fissure lode and disseminated mineralisation. The drilling programme was originally supervised by G. Green and, since February 1973, by the writer.

GEOLOGY

Concise descriptions of the surface geology and mineralisation of the Middlesex district are given in previous reports (*e.g.* Jennings, 1963 and 1965; Gee, 1966; Reid, 1967) and need not be duplicated here. However a brief outline of the relevant geology of the area in the immediate vicinity of Moina is presented below, including modifications and additional information from recent mapping by the writer, the Mount Lyell Mining and Railway Company and the Hydro-electric Commission.

The geology of the Moina area (fig. 4) is dominated by an extensive cover of Tertiary volcanics and sediments which partially obscure the underlying Ordovician and Cambrian sequences. The stratigraphic succession in the Moina area is summarised in Table 1.

The oldest rock in the area is the massive, light green, quartz-feldspar porphyry of the Bull Creek Volcanics which is part of a Middle-Upper Cambrian sequence of greywacke and volcanic rocks at least 1500 m thick. To the south-east of Moina these volcanic rocks are unconformably overlain by 50-60 m of the Ordovician Roland Conglomerate (fig. 4), a formation of pink and white quartz conglomerate with quartzite horizons, which is in turn conformably overlain by the thick marine sequence of interbedded sandstone and quartzite with minor shale, siltstone and conglomerate horizons of the Moina Sandstone. Conformably overlying the Moina Sandstone is the grey, fossiliferous and stylolitic Gordon Limestone, cropping out sporadically in the lower areas from Bismuth Creek west to the Iris River (fig. 4). The top of the Gordon Limestone is not exposed and it is unconformably overlain by rocks of Tertiary age. The Gordon Limestone was also intersected beneath 15-25 m of Tertiary sediments in the Hydro-electric Commission's four diamond drill holes on the eastern shore of Lake Gairdner (fig. 4), and was exposed on the banks of the Iris River near its confluence with the Lea River prior to the formation of Lake Gairdner.

Table 1. STRATIGRAPHIC SUCCESSION OF THE MOINA AREA (after Jennings, 1965; Gee, 1966; Reid, 1967).

Age	Thickness (m)	Unit	Lithology
Quaternary	?		Alluvial sand and gravel.
Tertiary	0-250	Basalt	Olivine basalt.
	0-20	Greybilly	Quartz conglomerate and grit.
	0-100		Sand, clay and gravel.
Devonian		Dolcoath Granite	
Ordovician	>100	Gordon Limestone	Limestone (including skarn).
	250	Moina Sandstone	Quartzite, sandstone and siltstone.
	0-245	Roland Conglomerate	Quartz conglomerate and quartzite.
Cambrian	>445	Bull Creek Volcanics	Quartz-feldspar porphyry.

The Cambrian and Ordovician formations have been intruded by a stock-like body of Devonian granite (the Dolcoath Granite) which crops out on Dolcoath Hill 5-6 km east of Moina, and has been dated at 345 m.y. (McDougall and Leggo, 1965). During intrusion of the Dolcoath Granite the basal sections of the Gordon Limestone were metamorphosed and metasomatised to a magnetite-chlorite skarn and garnetiferous calc-silicate skarn which is exposed in Bismuth Creek at the Shepherd and Murphy mine, and 2 km west in the Ti-Tree Creek area (fig. 4). Rapid variation in both the composition and thickness of the skarn is indicated by the occurrence of minor, poorly developed, calc-silicate skarn exposed in an almost continuous section in the Iris River, immediately east of the well-developed skarn in Ti-Tree Creek.

Despite its stock-like appearance at the surface, Gee (1966) suggests that the Dolcoath Granite plunges gradually westward from Dolcoath Hill to extend beneath Moina; and later, during diamond drilling at the Shepherd and Murphy mine by the Mount Lyell Mining and Railway Company, granite was intersected 200-220 m below the surface in two of the drill holes (McKibben, 1971). Furthermore, Reid (1971) also suggests that the granite continues plunging westward and occurs at relatively shallow depths beneath the Ti-Tree Creek area because of the development of magnetite skarn in the creek similar to that exposed at the Shepherd and Murphy mine.

Tertiary clay, sand and gravel, overlying the Gordon Limestone and Moina Sandstone, covers much of the low area around Lake Gairdner, and has also been recorded below the basalt in diamond drill holes along the line of the Hydro-electric Commission's Wilmot-Cethana tunnel (fig. 5, section A-B). A sub-basalt deep lead exposed in an open cut in the upper levels of the Shepherd and Murphy mine has been traced further west and north-west by drilling and seismic investigations (Collins, 1975), and a second deep lead system in which the Tertiary drainage flowed south, was defined during investigations of the Wilmot dam site by the Hydro-electric Commission.

Greybilly occurs extensively throughout the lower areas around Lake Gairdner as small isolated outcrops of sub-basaltic light grey and pink siliceous conglomerate with interbedded sandstone and grit which superficially appears similar to the Roland Conglomerate. Tertiary basalt effectively blankets much of the surrounding higher areas, and at several localities within the basalt is an agglomerate or tachylitic breccia composed of angular basalt fragments in a glassy matrix.

The dominant structure in the Moina area is a broad, north-east plunging syncline (fig. 5, section C-D) which has been terminated to the east by a NW-SE trending, near-vertical, reverse fault (the Bismuth Creek Fault). The fault is well defined in Bismuth Creek at the Shepherd and Murphy mine but is then concealed by Tertiary sediments and basalt before reappearing on the western side of the Wilmot dam, passing to the east of the drill holes on the eastern shore of Lake Gairdner (fig. 4). Although most of the folding and faulting is related to Devonian Tabberabberan orogenic movements there is evidence that some Tertiary faulting also occurred (fig. 5, section A-B).

MINERALISATION

Mineralisation in the Middlesex district occurs widely as wolframite-cassiterite-molybdenite-bismuthinite vein deposits around the Dolcoath Granite, with minor bismuth-gold, silver-lead and gold deposits (Jennings, 1965).

The most important deposit in the Moina area was at the Shepherd and Murphy mine where approximately 549 t of tin (metallic), 246 t of tungsten, and 72 t of bismuth were produced between 1893 and 1957, from an E-W trending sheeted cassiterite-wolframite-bismuthinite vein system in metamorphosed quartzite of the Moina Sandstone and metasomatised basal sections of the Gordon Limestone. The Mount Lyell Mining and Railway Company completed three diamond drill holes in the mine area to test for lateral and depth extensions of the known lodes, and whilst no significant mineralisation was encountered, the intersection of granite at relatively shallow depths significantly downgrades the potential of this deposit.

It would seem that, with the intrusion of the Dolcoath Granite in such close proximity to the Gordon Limestone and the presence of tungsten mineralisation within the immediate area, favourable conditions possibly existed for the formation of disseminated or veined scheelite mineralisation in the skarn. However, at the Shepherd and Murphy mine, Williams (1957) records a significant lack of primary scheelite mineralisation within the skarn rock, which is then attributed to most of the available calcium being taken up in garnets (grossular) and other minerals during metamorphism of the basal impure limestones prior to the introduction of the tungsten bearing solutions.

DRILLING

Three holes, with a total depth of 521 m, were drilled in the Moina area during the period November 1972-May 1973. The location of each of the three holes is indicated in Figures 3 and 4; and complete survey details are given in Table 2, which also includes details of the three holes drilled by the Mount Lyell Mining and Railway Company, at the Shepherd and Murphy mine.

To determine the depth and thickness of the metasomatic skarn near the centre of the syncline, a vertical diamond drill hole (DOM 1) was collared approximately midway between the road and the southern shore of Lake Gairdner (fig. 3) and drilled to a depth of 324.7 m. This drill hole was also expected to intersect granite at a depth of approximately 250 m below the surface, similar to that encountered beneath the Shepherd and Murphy mine. To test the magnetiferous skarn area in Ti-Tree Creek for disseminated scheelite or sulphide mineralisation and also possible associated cassiterite-wolframite vein deposits at depth, two inclined holes (DOM 2 and DOM 3) were drilled for a total of 196.4 m.

Table 2. SURVEY DETAILS OF DIAMOND DRILL HOLES IN THE MOINA AREA.

D.D.H.	ANG Coordinates	BEARING True N	BEARING Mag N	INCLINATION (at surface)	LEVEL (metres)
DOM 1	0604091268	-	-	vertical	482.8
DOM 2	0480590501	252°	239°	50°	524.0
DOM 3	0487590409	240°	227°	50°	544.4
ML 1	0731190656	188°	175°	50°	585.3
ML 2	0765890818	191°	178°	50°	563.6
ML 3	0784190447	13°	0°	50°	611.5

All holes surveyed by G. Benn, surveyor, Department of Mines.

DOM = Department of Mines drill holes; ML = Mount Lyell Mining and Railway Company drill holes. Coordinates for one yard grid reference; all locations within 100 kiloyard grid square 48, zone 7. All levels relative to H.E.C. bench mark No. 3732.

GEOLOGICAL LOGS

The geological information obtained from the drilling is given in the following summaries of the drill core logs, and is illustrated in the detailed lithological sections in Figure 6. Due to the possible presence of scheelite, the relevant sections of core containing the skarn were also examined in ultra-violet light.

D.D.H. DOM 1

Depth (m)	*Recovery (%)*	*Description*
0.0-9.1	15	Rounded pebbles and boulders of quartzite, greybilly and basalt in a light brown sandy soil.
9.1-19.8	12	Light brown clay and fine sand with thin pebble horizons.
19.8-20.9	54	Weathered limestone fragments in brown sandy clay.
20.9-81.2	82	Lithified, finely stylolitic, light grey limestone with quartz-calcite veins and patches of medium-grained recrystallised limestone. Minor pyrite occurs in the stylolites and in thin calcite veins.
81.2-134.3	100	Very fine-grained, massive, stylolitic micritic limestone; fossiliferous in part, and with irregular coarsely crystallised calcite veins and minor sulphides in the stylolites.
134.3-154.7	100	Fine-grained massive, and occasionally thinly bedded limestone, strongly veined by calcite.
154.7-157.5	100	Minor skarn development consisting of quartz, chert, hornfels and recrystallised limestone. Scattered specks of scheelite.
157.5-170.2	100	Fine-grained recrystallised limestone interbanded with hornfels.
170.2-173.0	100	Calc-silicate skarn. Fine specks of scheelite in thin near-vertical veins.
173.0-174.4	100	Silicate skarn with scattered specks of scheelite.

Depth (m)	Recovery (%)	Description
174.4-174.8	100	Grey-brown hornfels.
174.8-178.6	100	Garnetiferous calc-silicate skarn with bands of magnetite skarn at 177 m and 178 m, and minor disseminated fine scheelite.
178.6-180.5	100	Grey hornfels.
180.5-181.3	100	Fine-grained quartzite.
181.3-186.0	100	Interbanded hornfels and fine-grained quartzite intersected by thin calcite veins.
186.0-189.1	100	Massive, dark grey hornfels.
189.1-224.4	100	Massive, medium-grained quartzite with fine disseminated sulphides.
224.4-225.0	100	Light green chloritic siltstone.
225.0-227.3	100	Massive, fine-grained quartzite.
227.3-228.2	100	Light brown chloritic siltstone.
228.2-238.6	100	Massive, fine-grained quartzite with disseminated sulphides and a near-vertical quartz-calcite-fluorite vein at 230 m.
238.6-242.3	100	Massive, medium-grained quartzite.
242.3-280.5	100	Fine-grained chloritic quartzite with disseminated sulphides.
280.5-297.8	100	Chloritic quartzite with disseminated sulphides.
297.8-298.7	100	Interbanded green hornfels and quartzite.
298.7-302.1	100	Chloritic quartzite with disseminated pyrite and pyrrhotite.
302.1-302.4	100	Finely banded quartz and pyrite.
302.4-324.7	100	Fine- to medium-grained quartzite, with near-vertical quartz-calcite-fluorite-sulphide veins at 307-308 m and 310-313 m.

The skarn occurs at a depth of 170-180 m, giving it a level of 303-313 m compared with about 530 m in Ti-Tree Creek and about 570 m in Bismuth Creek. There appears to be a tailing off on either side of the skarn with interbanded hornfels and recrystallised limestone above, and interbanded hornfels and quartzites below.

Granite was not intersected, although the bottom of the drill hole is approximately 150 m below the level of the granite intersected in drill holes at the Shepherd and Murphy mine (fig. 5, section C-D). However the occurrence of quartz-calcite-fluorite veins at 230 m, 307-308 m and 310-313 m indicates a proximity to granite.

D.D.H. DOM 2

Depth (m)	Recovery (%)	Description
0.0-2.7	38	Magnetite-chlorite skarn with sulphides in veins and joints and fine disseminated grains of scheelite.
2.7-5.3	100	Massive, green calc-silicate skarn with pink-red garnetiferous patches and magnetite-quartz-sulphide veins. Scattered specks of scheelite in the skarn and in veins.
5.3-8.8	100	Magnetite-chlorite skarn with fine disseminated sulphides and scheelite.
8.8-9.3	100	Magnetite-pyrrhotite-chlorite skarn.
9.3-12.5	100	Calc-silicate skarn with patches of magnetite-chlorite skarn and magnetite-pyrite-

Depth (m)	Recovery (%)	Description
		-calcite-quartz veins. Scheelite occurs as scattered specks and in the veins.
12.5-14.8	100	Poorly developed calc-silicate skarn.
14.8-28.0	100	Massive, fine- to medium-grained quartzite with pyrite veins.
28.0-30.0	100	Interbedded siltstone and sandstone.
30.0-38.6	100	Massive, medium-grained quartzite with disseminated euhedral pyrite.
38.6-51.6	100	Chloritic quartzite and impure sandstone.
51.6-81.8	100	Fine- to medium-grained quartzite.
81.8-82.7	100	Chloritic, conglomeratic quartzite.
82.7-84.4	100	Fine- to medium-grained quartzite.
84.4-86.5	100	Fine-grained quartzite and siliceous conglomerate.
86.5-101.1	100	Fine- and medium-grained quartzite with occasional pebble horizons and pyrite veins.

D.D.H. DOM 3

Depth (m)	Recovery (%)	Description
0.0-7.1	65	Olivine basalt and tachylitic breccia.
7.1-8.5	55	Weathered basalt and skarn in a sandy soil.
8.5-9.1	100	Olivine basalt.
9.1-10.0	35	Fragments of weathered skarn and basalt in sandy soil.
10.0-14.4	100	Garnetiferous calc-silicate skarn. Fine scattered specks of scheelite.
14.4-14.7	100	Light grey hornfels.
14.7-21.4	100	Strongly garnetiferous calc-silicate skarn with magnetite patches at 17.1-17.3 m and minor very fine specks of scheelite.
21.4-23.0	100	Light green calc-silicate skarn.
23.0-25.7	100	Fine-grained quartzite.
25.7-28.8	100	Irregular bands of quartzite and chert.
28.8-39.3	100	Fine- to medium-grained chloritic quartzite.
39.3-43.6	100	Medium-grained sandstone and interbedded siltstone.
43.6-50.4	100	Medium-grained chloritic quartzite with fine disseminated pyrite.
50.4-56.8	100	Fine-grained quartzite and medium-grained sandstone.
56.8-95.3	100	Massive, fine- to medium-grained quartzite with disseminated euhedral pyrite.

Although diamond drill holes DOM 2 and DOM 3 were collared 109 m apart, parallel to the skarn-Moina Sandstone boundary (fig. 4), and drilled approximately at right angles to this boundary, there is a marked change in the composition of the skarn along the strike with a reduction in the magnetite-chlorite skarn in DOM 3 when compared with DOM 2 and a corresponding increase in garnetiferous calc-silicate skarn.

In all three drill holes, only minor amounts of very fine-grained disseminated scheelite were observed in both the magnetite-chlorite and calc-silicate skarn. Fine-grained scheelite was also observed in very thin near-vertical veins throughout the skarn, and in diamond drill hole DOM 2 up to 1-2% of scheelite was observed in magnetite-pyrite-pyrrhotite-quartz-calcite veins up to 2 cm thick, at 4.5 m, 4.7 m, 5.7 m, 9.8 m and 12.4 m.

RESULTS OF ANALYSES

A total of 34.93 m of the metasomatic skarn mineralisation at the base of the Gordon Limestone was analysed for WO_3, Sn, Bi, Cu, Au, Mo, and Fe. The results of these analyses, undertaken by the Department of Mines Laboratories, Launceston, are listed in Tables 3, 4 and 5. Sampling was conducted according to rock types (*i.e.* magnetite-chlorite skarn, or calc-silicate skarn, etc.) and, after splitting, half the core was submitted for analysis, so that each assay is representative of the entire drill core section at that depth.

Table 3. ANALYSES OF METASOMATIC SKARN FROM DIAMOND DRILL HOLE DOM 1, MOINA.

Sample Reg. No.	Depth (m)	Recovery %	Fe %	WO_3 %	Sn %	Cu %	Bi %	Mo %	Au
735422	170.20-171.50	100	3.0	<0.01	0.01	<0.01	<0.01	<0.01	Nil
735423	171.50-172.80	100	6.2	<0.01	0.02	<0.01	<0.01	<0.01	Tr.
735424	172.80-173.60	100	2.0	<0.01	<0.01	<0.01	<0.01	<0.01	Nil
735425	173.60-174.45	100	0.4	<0.01	<0.01	<0.01	<0.01	<0.01	Nil
735426	174.80-175.70	100	7.1	<0.01	0.03	<0.01	<0.01	<0.01	Nil
735427	175-70-176.80	100	7.0	<0.01	0.03	<0.01	<0.01	<0.01	Nil
735428	176.80-177.30	100	16.3	<0.01	0.03	0.01	0.13	<0.01	Tr.
735429	177.30-177.80	100	8.8	<0.01	0.02	<0.01	0.03	<0.01	Tr.
735430	177.80-178.75	100	10.7	<0.01	0.03	0.01	0.08	<0.01	Tr.

Table 4. ANALYSES OF METASOMATIC SKARN FROM DIAMOND DRILL HOLE DOM 2, MOINA

Sample Reg. No.	Depth (m)	Recovery %	Fe %	WO_3 %	Sn %	Cu %	Bi %	Mo %	Au
734294	0.00-0.40	50	32.6	0.04	0.09	0.04	0.09	<0.01	Tr.
734295	0.40-1.06	30	27.3	<0.01	0.09	0.01	0.06	<0.01	Tr.
734296	1.06-1.30	50	17.7	0.01	0.11	0.02	0.06	<0.01	Tr.
734297	1.30-2.66	35	25.7	0.02	0.07	0.04	0.16	<0.01	Tr.
734298	2.66-3.66	100	10.6	<0.01	0.06	0.01	0.02	<0.01	Tr.
734299	3.66-4.40	100	6.0	<0.01	0.05	<0.01	0.01	<0.01	Tr.
734300	4.40-4.60	100	15.7	0.12	0.04	0.05	0.07	<0.01	Tr.
734301	4.60-5.45	100	11.2	<0.01	0.12	0.01	0.04	<0.01	Tr.
734302	5.45-5.85	100	29.8	0.01	0.20	0.07	0.02	<0.01	Tr.
734303	5.85-6.85	100	31.1	<0.01	0.15	0.01	0.05	<0.01	Nil
735431	6.85-7.88	100	38.0	<0.01	0.05	0.02	0.24	<0.01	Tr.
735432	7.88-8.93	100	31.4	<0.01	0.13	0.08	0.16	<0.01	Tr.
735433	8.93-10.07	100	24.8	<0.01	0.09	0.10	0.16	<0.01	Tr.
735434	10.07-11.10	100	23.8	<0.01	0.10	0.08	0.08	<0.01	Tr.
735435	11.10-12.15	100	16.9	0.02	0.07	0.04	0.04	<0.01	Nil
735436	12.15-12.70	100	15.8	0.02	0.05	0.07	0.06	<0.01	Nil
735437	12.70-13.82	100	8.2	<0.01	0.04	0.03	0.03	<0.01	Tr.

Table 5. ANALYSES OF METASOMATIC SKARN FROM DIAMOND DRILL HOLE DOM 3, MOINA

Sample Reg. No.	Depth (m)	Recovery %	Fe %	WO_3 %	Sn %	Cu %	Bi %	Mo %	Au
735438	10.04-11.04	100	8.6	<0.01	0.03	<0.01	0.02	<0.01	Tr.
735439	11.04-11.97	100	3.7	<0.01	0.02	<0.01	0.01	<0.01	Tr.
735440	11.97-13.00	100	8.2	<0.01	0.11	<0.01	0.01	<0.01	Tr.
735441	13.00-14.02	100	5.6	<0.01	0.01	0.02	<0.01	<0.01	Nil
735442	14.02-15.00	100	6.1	<0.01	0.02	<0.01	<0.01	<0.01	Nil
735443	15.00-16.18	100	18.6	<0.01	0.04	<0.01	<0.01	<0.01	Tr.
735444	16.18-17.12	100	18.9	<0.01	0.08	<0.01	<0.01	<0.01	Tr.
735445	17.12-18.10	100	13.6	<0.01	0.04	<0.01	<0.01	<0.01	Tr.
735446	18.10-19.10	100	10.7	<0.01	0.05	<0.01	0.01	<0.01	Nil
735447	19.10-20.17	100	10.6	<0.01	0.05	<0.01	<0.01	<0.01	Tr.
735448	20.17-21.25	100	10.0	<0.01	0.07	0.01	0.02	<0.01	Nil
735449	21.25-22.95	100	4.9	<0.01	0.04	<0.01	<0.01	<0.01	Tr.

Although with the exception of Fe, all the analysed elements occur in very small quantities (particularly Au and Mo), there is a general tendency for better values to be associated with the more magnetiferous skarn in drill hole DOM 2. The section of drill core with the highest tungsten value (Sample 734300) also contained a magnetite-pyrite-pyrrhotite vein with an estimated 1-2% scheelite, when examined in ultra-violet light. As expected, the Fe values are generally low in the calc-silicate skarn and increase with increasing magnetite content to a maximum of 38% Fe (Sample 735431).

So that comparisons could be made between the skarn intersected in the drill holes and the magnetiferous skarn exposed at the Shepherd and Murphy mine, two bulk chip samples from the mine area were also analysed for the same elements. One sample was collected from the face adjacent to the main shaft and the other sample collected from the cutting excavated for the old crushing plant. The results of these analyses (Table 6) indicate similar low quantities of Sn, WO_3, Cu, Bi, Mo and Au in the skarn exposed at the mine and in the skarn intersected in the diamond drill holes. Although the tungsten analyses are recorded as WO_3, the original metal may have been bound up in either wolframite or scheelite, which may explain the relatively high 0.52% of WO_3 in Sample 736351 from the mine.

Table 6. ANALYSES OF CHIP SAMPLES FROM THE SHEPHERD AND MURPHY MINE, AND RANGES OF ANALYSES FROM THE THREE DIAMOND DRILL HOLES.

Element	SHEPHERD AND MURPHY MINE		DIAMOND DRILL HOLES		
	736350 (shaft)	736351 (crusher)	DOM 1	DOM 2	DOM 3
% Fe	30.1	17.8	0.4-16.3	6.0-38.0	3.7-18.9
% WO_3	0.07	0.52	<0.01	<0.01-0.12	<0.01
% Sn	0.21	0.20	<0.01-0.03	0.04-0.20	0.01-0.11
% Cu	<0.01	0.01	<0.01-0.01	<0.01-0.10	<0.01-0.02
% Bi	0.05	0.03	<0.01-0.13	0.02-0.24	<0.01-0.02
% Mo	Nil	0.14	<0.01	<0.01	<0.01
Au	Nil	Nil	Nil-Trace	Nil-Trace	Nil-Trace

SUMMARY AND DISCUSSION

The surface geology in the Moina area is dominated by an extensive cover of Tertiary sediments and volcanics of variable thickness, partially obscuring the underlying Ordovician sedimentary sequence and Cambrian rocks. At the base of the Ordovician system is a quartz pebble conglomerate (Roland Conglomerate) conformably overlain by a quartzite, sandstone and siltstone sequence (Moina Sandstone) which is in turn overlain by a thick limestone unit with minor calcareous siltstones (Gordon Limestone). These Ordovician rocks have been folded into a broad NE-plunging syncline, terminated to the east by the NW-SE trending Bismuth Creek Fault. On the southern limb of this fold, the basal sections of the Gordon Limestone were metamorphosed and metasomatised to a garnetiferous and magnetiferous calc-silicate skarn, during intrusion of the Devonian Dolcoath Granite which outcrops on Dolcoath Hill 5-6 km east of Moina.

The skarn is exposed at the Shepherd and Murphy mine (Bismuth Creek) as a predominantly magnetiferous skarn and in the Ti-Tree Creek area as magnetiferous and garnetiferous skarn. Rapid variations in the intensity of skarn development is reflected in the limited occurrence of minor, poorly developed calc-silicate skarn exposed in the Iris River, immediately east of Ti-Tree Creek.

The mineralisation in the Moina area is obviously associated with the Devonian granite. There are two main types of occurrence:

(1) Quartz fissure type lodes up to 1 m thick, cutting various host rocks, and containing cassiterite, wolframite, bismuthinite, and molybdenite (*e.g.* Shepherd and Murphy mine).

(2) Disseminations of sulphides (pyrite, chalcopyrite, bismuthinite, sphalerite and galena) and scheelite frequently associated with the magnetiferous skarn (*e.g.* Bismuth Creek and Ti-Tree Creek).

Six diamond drill holes have been completed in the Moina area for a total of approximately 1385.7 m of drilling. Three holes were drilled by the Department of Mines to test for disseminated mineralisation in the skarn, and possible Sn-W vein mineralisation in the Ti-Tree Creek area. A vertical hole (DOM 1) midway between Bismuth Creek and Ti-Tree Creek intersected only 10.3 m of poorly developed calc-silicate skarn at a depth of 170.2-180.5 m below the surface. This hole then continued through 144.2 m of Moina Sandstone to bottom at a depth of 324.7 m; 150 m below the level of the granite intersected beneath the Shepherd and Murphy mine. Two inclined holes (DOM 2, DOM 3), 109 m apart, in the Ti-Tree Creek area intersected 14.8 m of predominantly magnetiferous skarn and 13 m of predominantly garnetiferous skarn respectively, before continuing into Moina Sandstone for approximately 86 m and 75 m respectively; both holes failing to encounter any vein type cassiterite-wolframite mineralisation.

Analyses of the skarn intersected in the drill holes show that the metals Sn, Bi, Cu, Mo, Au and WO_3 are only present in very small proportions. There is however a slight indication of an increase in quantities of the metals associated with the more magnetiferous skarn, as reflected in the Fe values which range from 0.4-38%.

The Mount Lyell Mining and Railway Company drilled three holes at the Shepherd and Murphy mine to test for lateral and depth extensions of the known lode systems and although the drilling failed to encounter any significant mineralisation, granite was intersected in two of the drill holes at a depth of 200-220 m below the surface, indicating that the Dolcoath Granite plunges gradually westwards from Dolcoath Hill to extend beneath Moina. Furthermore, the development of magnetiferous skarn in Ti-Tree Creek (similar to that in Bismuth Creek) suggests that the granite continues west to extend beneath the Lea River at relatively shallow depths, estimated by Reid (1971) to be of the order of 300-350 m below the surface.

However the presence of only minor poorly developed calc-silicate skarn in diamond drill hole DOM 1, and in the Iris River, indicates the granite is much deeper (at least by 150 m) in these areas than in the two areas of well developed skarn at Bismuth Creek and Ti-Tree Creek. Therefore it is suggested that the granite extends westwards from Dolcoath Hill at depths greater than originally estimated (probably in excess of 500 m) and that the magnetiferous and garnetiferous skarn in Ti-Tree Creek and Bismuth Creek is due to the presence of cupola-like extensions of the main granite mass. Under these circumstances the basal sections of the Gordon Limestone, and the Moina Sandstone would have been metamorphosed by the main granitic intrusion and localised, more intense metamorphism and metasomatism associated with cupolas occurring at shallower depths and nearer the Gordon Limestone-Moina Sandstone boundary. The intrusion of such a small cupola-like body beneath the Shepherd and Murphy mine may have caused the sheeted fracture system (in association with weaknesses caused by folding) providing suitable channels for the mineralising solutions, which implies that if further cupolas can be located in the area they may be accompanied by similar mineralised fracture systems.

Since the mineralising solutions are a late stage phenomenon, Williams (1957) suggests that scheelite mineralisation will only occur where the tungsten bearing solutions actually reached the unaltered Gordon Limestone (so that calcium would have been available for the formation of scheelite). The only known locality where this may have occurred is at the Shepherd and Murphy mine where the sheeted fracture system, used as channels by the mineralising solutions, may have continued into the Gordon Limestone; in which case scheelite mineralisation may occur above the skarn. Unfortunately the skarn-limestone boundary is obscured by Tertiary basalt. The absence of scheelite in the Gordon Limestone overlying the skarn in D.D.H. DOM 1 is probably not significant in this respect as there is no evidence from the drilling that tungsten bearing solutions were within the immediate area.

CONCLUSIONS AND RECOMMENDATIONS

Exploration in the Moina area is severely hampered by the extensive cover of Tertiary sediments and volcanics to the extent that any future exploration, particularly for sheeted cassiterite-wolframite vein mineralisation similar to that at the Shepherd and Murphy mine, will almost entirely be limited to what is essentially 'blind' drilling.

The skarn horizon appears to have developed in transition beds at the base of the Gordon Limestone and the well developed magnetiferous and garnetiferous skarn in the Bismuth Creek and Ti-Tree Creek areas is probably associated with cupolas of the Dolcoath Granite which extends from Dolcoath Hill to the Lea River at depths of more than 500 m beneath the surface at Moina.

The skarn cannot be considered as a potential host rock for disseminated scheelite or disseminated Bi-Cu sulphide mineralisation. Cassiterite-wolframite vein mineralisation was not intersected in diamond drill holes in the Ti-Tree Creek area, in association with the magnetiferous skarn.

It appears that, apart from the possibility of further Sn-W vein mineralisation, the only other significant mineralisation in the Moina area could be disseminated scheelite within the limestone overlying the skarn at the Shepherd and Murphy mine. As this can only be tested by drilling, it is recommended that one diamond drill hole be collared 900 m due east of DOM 1 and drilled at an inclination of 60° on a bearing of 160° m. The hole would need to be approximately 300 m in length, to pass through the limestone and skarn into the underlying Moina Sandstone, and could also test for northern extensions of the sheeted cassiterite-wolframite vein system at the mine. A second vertical diamond drill hole, approximately 300 m long, could be located 600-700 m south of DOM 1 to test the skarn and possible associated mineralisation on the southern limb of the syncline, approximately midway between the Iris River and Bismuth Creek.

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[15 March 1974]

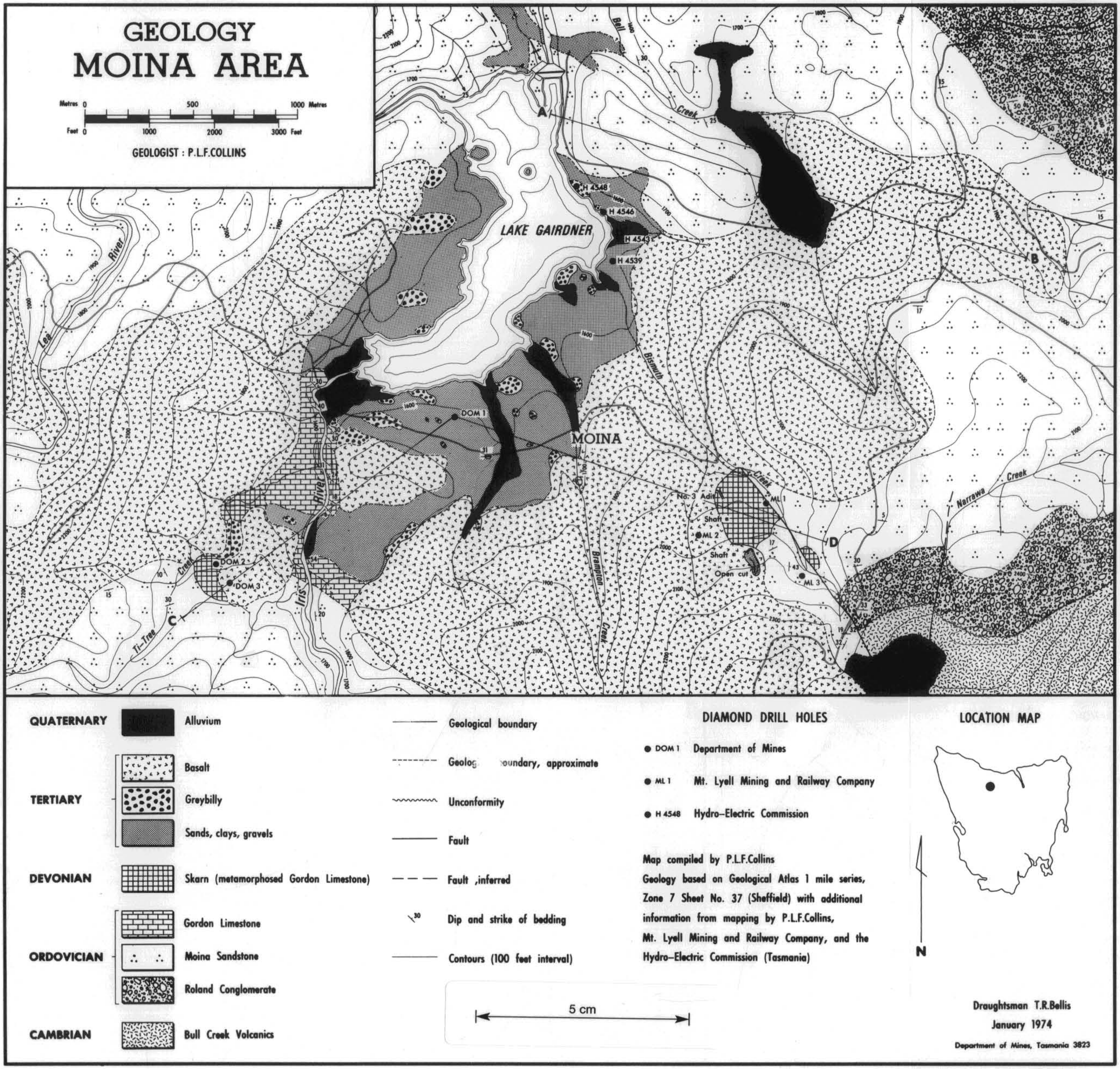
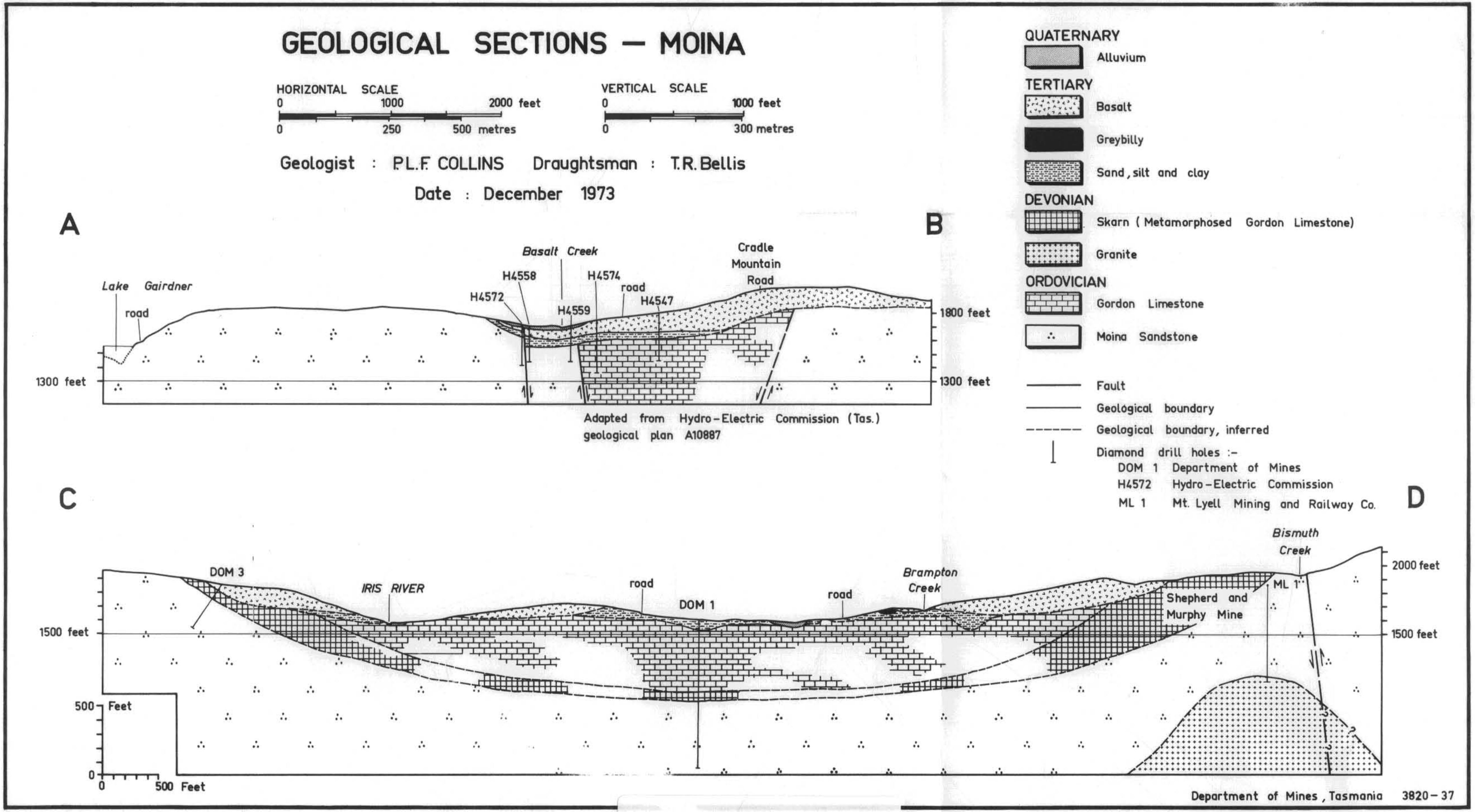


Figure 4.

TR18_17-27



GEOLOGICAL SECTIONS — MOINA
HORIZONTAL SCALE
0 1000 2000 feet
0 250 500 metres
VERTICAL SCALE
0 1000 feet
0 300 metres
Geologist : P.L.F. COLLINS Draughtsman : T.R. Bellis
Date : December 1973
A
B
Lake Gairdner
road
H4572
H4558
Basalt Creek
H4559
H4574
road
H4547
Cradle Mountain Road
1800 feet
1300 feet
1300 feet
Adapted from Hydro-Electric Commission (Tas.) geological plan A10887
QUATERNARY
Alluvium
TERTIARY
Basalt
Greybilly
Sand, silt and clay
DEVONIAN
Skarn (Metamorphosed Gordon Limestone)
Granite
ORDOVICIAN
Gordon Limestone
Moina Sandstone
Fault
Geological boundary
Geological boundary, inferred
Diamond drill holes :-
DOM 1 Department of Mines
H4572 Hydro-Electric Commission
ML 1 Mt. Lyell Mining and Railway Co.
C
D
DOM 3
IRIS RIVER
road
DOM 1
road
Brampton Creek
Bismuth Creek
ML 1
Shepherd and Murphy Mine
2000 feet
1500 feet
1500 feet
500 Feet
0
0 500 Feet
Department of Mines, Tasmania 3820 – 37
5 cm

Figure 5.

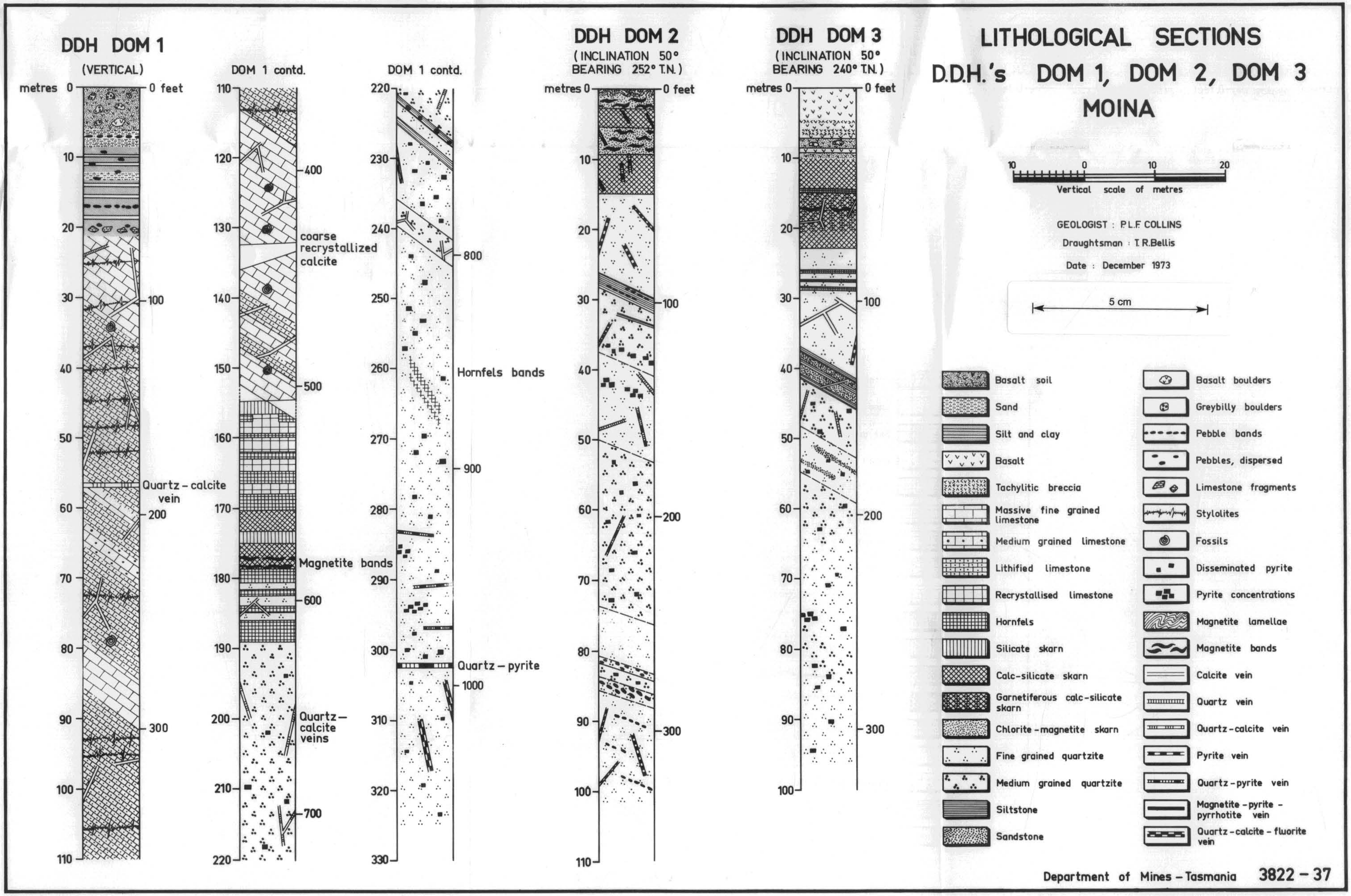


Figure 6.

TR18_17_27