PAP. & PROC. ROY. SOC. TASMANIA, 1949 (15TH SEPTEMBER, 1950)

Silurian and Devonian Stratigraphy of the Zeehan Area, Tasmania

By

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(Read 1st November, 1949)

WITH 2 TEXT FIGURES AND 3 PLATES

The renewed exploration of the Zeehan Mining Field in Western Tasmania has led to a more detailed study of the geological structure of the area, and the authors have investigated recently the Middle Palaeozoic sequence of sedimentary rocks. After spending a week on the Gordon River studying the 'Gordon River Limestone' (a key formation in West Coast stratigraphy), the limestone and succeeding formations were studied in the Zeehan area.

PHOTO-GEOLOGY

The stratigraphic work described in this paper was based on a geological map of the area prepared from aerial photographs by Professor S. Warren Carey of the University of Tasmania. He recommended that the stratigraphic studies be based on a comparatively undisturbed area south of Zeehan rather than on the very faulted Zeehan area. This suggestion was adopted and the stratigraphic succession was determined, but the extremely rough nature of the country made the work very difficult and placed limitations on the amount of palaeontological material which could be collected. This work was therefore supplemented by the study of railway cutting sections and sections in the cleared country around Zeehan.

Three great advantages accrued from the use of the photo-geological map and the aerial photographs—

1. The map provided beforehand an idea of the structure, thus making simpler the planning and execution of the field work.
2. The country is very rough, and the aerial photographs made it possible to save a great deal of time and physical effort by showing the most suitable routes for traverses.
3. In the past, difficulty has been experienced by field geologists in describing localities in rough country of this kind. References are found in the literature to such temporary features as tracks and blazed trees. However, localities can be pin-pointed from the aerial photographs, and either transferred to a map, or a reference given relative to the centre point of an officially numbered and published photograph. In Tasmania these are supplied by the Department of Lands and Surveys. An index to fossil localities will be found as Appendix B.

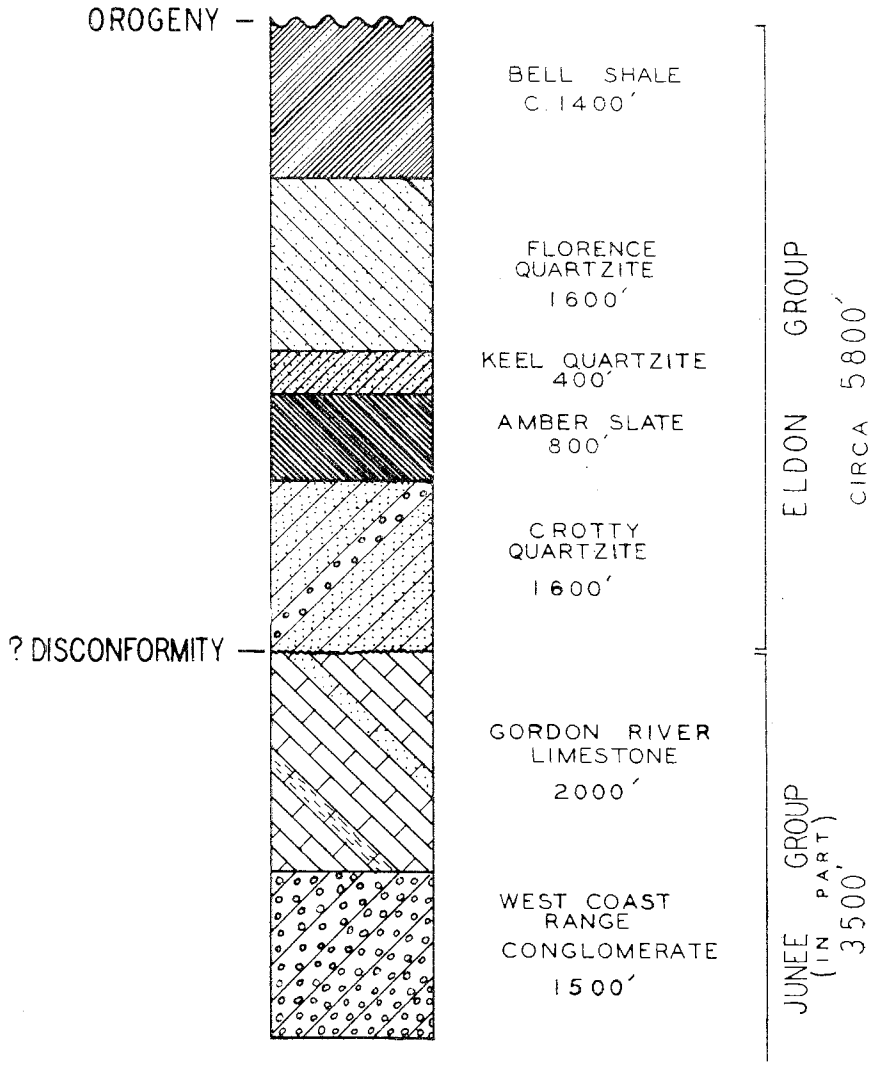

FIG. 1.—Stratigraphy and Diastrophism.

Geological Sequence

The stratigraphical succession is represented in fig. 1. This series of sedimentary rocks on the whole is a highly arenaceous one, even the limestone having sandy horizons. The strata are strongly folded, and regional metamorphism is present as a function of the competence of the beds. An average of eighteen measured dips in the Eden area gave the figure of 50°, and this was used in calculating the thicknesses of the formations. As all the dips are high, this method is not inaccurate. The average dip in the Zeehan area was 70°, this being due to the highly folded nature of that district.

In 1949 Loftus Hills and Carey put forward a tentative classification of the Silurian and Devonian rocks, which is now slightly modified (fig. 2) with their agreement as far as possible, the names already proposed have been retained, and at the same time the new code now being accepted taken into account (Glaessner, *et al.*, 1948). The name 'Drumlin' was dropped because it is the name of a geological feature, and so likely to be confusing. The new names are 'Amber', after the Amber Rivulet which crosses this formation, and 'Florence' after a ridge of that name near Zeehan (see Plates II and III) consisting of rocks of that formation. The type section for all the Eldon Group formations discussed in this paper is in the vicinity of Eden Siding (see State Map 4M) about 10 miles south of Zeehan on the Zeehan-Strahan railway. This area is uninhabited and does not provide sufficient geographical names for formational names. Eden Siding is on the Gordon River Limestone.

Present Classification	*Earlier Classification*
BELL SHALE ± 1400'	BELL SHALES
FLORENCE QUARTZITE 1600'	DRUMLIN SANDSTONES
KEEL QUARTZITE 400'	KEEL FORMATION
AMBER SLATE 800'	
CROTTY QUARTZITE 1600'	CROTTY SANDSTONES

Fig. 2.—Silurian and Devonian Formations.

JUNEE GROUP

The West Coast Range Conglomerate and the Gordon River Limestone formations have not yet been formally defined, but this is being done elsewhere and so these are not included in the Eden sequence of definitions.

West Coast Range Conglomerate

This formation constitutes some of the most prominent features of West Tasmanian geomorphology, but at the point of the section it has been planated with the rest of the formations during the development of the Henty Peneplain (Gregory, 1903). The relationship of the conglomerate to the Gordon River Limestone in this area was recognized by Waller in 1904, and was studied by the writers at an abandoned mine (loc. 77) about half a mile SSE. of Greive Siding. The spoil heaps show the presence of—

1. A quartzite which is undoubtedly the uppermost member of the West Coast Range Conglomerate formation, forming passage beds from the conglomerate into the limestone.
2. Re-crystallized limestone of a light bluish colour with some ferruginous staining.
3. Ore containing galena and sphalerite.

In the considerable changes of strike attendant upon the strong pitch of many of the folds in this area, the West Coast Range Conglomerate always remains in the same relationship with the limestone, indicating that the two formations are conformable. This was confirmed by further observations near Zeehan. The thickness of the formation shown in fig. 2 is Loftus Hills' and Carey's estimate for Mt. Zeehan (1949, p. 26).

Gordon River Limestone

In addition to the abovementioned limestone locality, this formation was studied in a ballast quarry (loc. 58) about 50 chains NE. of Greive Siding. Argillaceous and arenaceous impurities were observed in some of the beds, and some appear to contain carbonaceous material. Calcite veins are common, and pyritic inclusions occasional. Certain horizons are considerably leached, while others remain compact. The limestone is often sheared. This locality is stratigraphically low in the formation as it is near the base of the scarp formed by the West Coast Range Conglomerate formation. The limestone has a characteristic physiographic expression as a lowland, and judging by this criterion it has a thickness of the order of 2000 feet. Outcrops are difficult to obtain, but the proving of limestone at the two localities mentioned shows that its lower extent is approximately coincident with the eastern wall of the valley, and no reason suggests itself why the western wall of the valley should not likewise mark the upper extent of the limestone.

Fossils were obtained from this formation at loc. 58, but preservation was generally poor. The fossils, which were far from numerous, included tabulate corals, trepostomatous and cryptostomatous bryozoans, with very poorly preserved brachiopods and pelecypods and some well preserved ostracods. The genera identified are set out below—

Coelenterata:	*Favosites.*
Polyzoa:	*Rhinidictya.*
	Polypora.

The trepostomatous types found were difficult to identify and work is proceeding on these. The brachiopods included a strophomenid and a rhynchonellid, but insufficient details were preserved to warrant identification. *Rhinidictya* is

found at Zeehan in association with *Tetradium tasmaniense* Chapman and other fossils of Upper Ordovician age and its occurrence at Eden suggests a similar age for the limestone there. If this is true, the base of the limestone at Eden would be high in the Ordovician. More work is needed before the point can be finally resolved.

Eldon Group

The formations of this Group in the Zeehan area in order are the Crotty Quartzite (lowest), the Amber Slate, the Keel Quartzite, the Florence Quartzite, and the Bell Shale (highest). (See figs 1 and 2.) These lithological units are now formally defined and described. The quartzites are of impure types.

Crotty Quartzite

The Crotty Quartzite is hereby defined as a formation of some 1600 feet of quartzitic sedimentary rocks as mapped in Plate III, underlain conformably by the Gordon River Limestone and overlain conformably by the Amber Slate. The formation consists mostly of quartzites, but includes a thick band of quartzitic grit which in places becomes a fine conglomerate. The Crotty Quartzite is usually of a light greyish colour which weathers white at the surface. In places it has a pinkish hue which is not altogether lost on weathering and is characteristic of the lithology of the formation. The rocks are sometimes sheared, and thin milky veins are frequent. Cross-bedding is common.

This formation is a typically unfossiliferous one. Near Eden Siding poorly preserved brachiopods, lamellibranchs, crinoid stems, and tubicolar structures were recognized, but even generic determinations were difficult. As the matrix preserves so little detail, it is easy to confuse various types of tube-like structures, and the following generalisations have proved useful in the field:—

1. Tube structures at right angles to the bedding planes, straight, and unbranching are generally the tubes of marine worms. These are discussed in an accompanying palaeontological paper (Gill, 1950).
2. Tube structures parallel to the bedding planes, sometimes straight and sometimes curved, but unbranching, are generally pieces of crinoid stem. Sometimes there is enough structure preserved to make out the columnals.
3. Tube structures which are branched. These are usually polyzoa.

From experience so far it would appear that the tubicolar quartzite in the West Coast Range Conglomerate is usually (if not always) of the first type, whereas in the Crotty Quartzite all three types are present. As these two formations are so sparsely fossiliferous, such distinctions are helpful in field work. The West Coast Range Conglomerate, being older than the Ordovician Gordon River Limestone, is probably too old to have either crinoids or polyzoa.

The Crotty Quartzite constitutes the ridge at Zeehan on which the Smelters' works are built. As the ridge is bare, and is excavated in places, it provides an excellent opportunity for studying a cross-section of the formation. The majority of the strata yielded no fossils, but one highly fossiliferous band (loc. 17) was found occurring along the crest of the ridge under the median grit, and at the Smelters' sand quarry (loc. 19) large and distinctive crinoid columnals were noted. Similar columnals were noted at loc. 3. The quartzites on top of the Smelters' ridge have been strongly leached, and in some places so de-silicified as to permit of the rock being readily broken down for sand. There is a similar quarry at the south end of Manganese Hill in Crotty Quartzite.

The coarse grit band characteristic of this formation can be clearly seen on the Smelters' ridge, most of it being of remarkably open texture. The examination of fresh rock from a deep railway cutting near the 22-mile post and from mine workings, and of mineralised rock as at the Central Balstrup Mine, indicates that the grit and conglomerate contain pebbles of many different kinds of rocks and minerals, and the open texture of the leached horizons is due to the removal thence of clay, silt (siltstone pebbles were noted in the fresh rock), and soluble minerals. Mr. J. J. Jenkin of the National Museum, Melbourne, tested the percentage by volume of insoluble matter in rocks from various horizons. Fresh Crotty Quartzite from the deep railway cutting at loc. 49 showed 88 per cent insoluble matter, while specimens of the leached rock from Smelters' ridge were practically 100 per cent insoluble matter. The high rainfall of this area (90-100 inches) causes strong leaching of the surface rocks. Another lithological feature of importance is that the rocks are mixedstones, i.e., consisting of both roundstones and sharpstones, which is characteristic of rapidly eroded sediments in a geosynclinal trough.

Other results of interest from Mr. Jenkin's tests are that the sample of rock from beside the Central Balstrup Mine contained 0·57 per cent of heavy minerals, a sample of Florence Quartzite from loc. 15 contained 94 per cent insoluble matter, a sample of Amber Slate from loc. 42, 93·5 per cent, and a sample of Bell Shale from loc. 16 had 82·4 per cent.

Waterhouse (1916) described some rather unfossiliferous rocks from near Trial Harbour, on the coast west of Zeehan, in the following terms: 'The rocks are invariably very siliceous sedimentaries, white in colour, the predominating members being sandstones and grits, although sometimes coarser pebbles occur, giving the rock more the features of a conglomerate. Although hard and usually silicified, there appears to have been no crushing of the sediments. Individual particles vary in shape from angular to rounded. It is worthy of note that in many of the finer sandstones, as well as in the coarser grits, although the bulk of the rock is made up of glassy quartz, there are softer fragments which show signs of kaolinisation.

'The striking feature of the rocks is the occurrence of abundant cavities, many of which are strongly suggestive of fossil impressions, although no definite fossils were found. Some of the cavities are quite irregular in shape, and are doubtless caused by the weathering out of some of the softer constituents of the rock; others are approximately circular in plan, but of small thickness, while others again suggest the forms of brachiopods, although the impressions are not sharp. Some of the cavities are circular or slightly oval in shape, but one-quarter of an inch in diameter, and have a small circular central pillar, i.e., the cavities are cylindrical. These cavities are very suggestive of crinoid stems. Although they do not appear to be common, one loose fragment of white sandstone was obtained which showed on weathered surfaces some irregular tubular casts up to about one inch in length all lying parallel with the bedding plane of the specimen. In general form they resemble the so-called "pipe-stems' of the tubicolar sandstone which is associated with (and later than) the West Coast Range Conglomerate in various localities on the West Coast. These casts, however, are rather more indefinite than typical "pipe-stems", and lie horizontally, and not perpendicularly, with reference to the bedding planes.' The above description fits the Crotty Quartzite precisely, both in lithology and content. The cavities with the central pillar are clearly crinoid columnals. The one inch tubular casts are probably coprolitic, and are reminiscent of some found *non in situ* east of Johnston's Flat, near Zeehan, by Mr. Bruce Webb.

Amber Slate

The Amber Slate is hereby defined as a formation consisting of some 800 feet of grey slates (see Plate III), underlain conformably by the Crotty Quartzite and overlain conformably by the Keel Quartzite. There is much fine silica in these slates, which shows that they were siltstones before their regional metamorphism rather than claystones. The slates are generally highly fissile, and on weathering turn to a yellowish-brown, sometimes with pinkish and purplish hues. The formation is very uniform in its lithology.

North of Greive Siding, at the 22-mile post, the railway passes from the Gordon River Limestone of the valley into a high cutting which traverses Crotty Quartzite. Fossils were found at 460 feet and 1157 feet north of the 22-mile post. The railway then passes through Amber Slate, following this formation for about 1½ miles. Four fossil localities were discovered (locs. 38, 41, 42, 47), and at the first three of these the true dip was obtained from the lay of the fossiliferous material, viz., 57° N., 25° N., and 32° N. respectively. This shows that the beds, although now in the form of slate, are actually conformable with the underlying Crotty Quartzite.

Keel Quartzite

The Keel Quartzite is hereby defined as a formation consisting of some 400 feet of quartzite as mapped in Plate III. This formation is conformably underlain by the Amber Slate and conformably overlain by the Florence Quartzite. The rock is a grey quartzite, and quite bluish when fresh. It weathers like the other quartzites to a whitish colour.

In the railway section north of Greive Siding already partly described, Keel Quartzite was noted above the Amber Slate. Well-defined ripple marks were observed in one bed. In the railway section somewhat shaley quartzites occur at the top of the formation, and this accounts for the valley between the Keel hogbacks and the Florence ridges.

The Keel Quartzite is very poorly fossiliferous.

Florence Quartzite

The Florence Quartzite is hereby defined as a formation consisting of some 1600 feet of quartzite as mapped in Plate III. It is conformably underlain by the Keel Quartzite, and conformably overlain by the Bell Shale. The quartzite is usually light grey in colour, but not infrequently stained yellowish-brown with iron oxide. Like the other quartzites, it weathers to a whitish rock except that there is still often some of the iron stain left. This is the only formation in the Eldon Group in this area containing any quantity of iron stain, and this fact was found useful as accessory evidence in the field.

The strata of this formation are highly fossiliferous, so much so that the rock must have been a calcareous sandstone originally, and even a sandy limestone in places. All the calcareous matter is now leached away, so that the fossils are preserved in the form of casts and moulds. An enormous amount of calcium compounds must have been carried away by vadose waters.

It is to be noted that both the Florence Quartzite and the contiguous Keel Quartzite are arenite formations, but each has a very distinctive physiographic expression. The Keel Quartzite forms hogbacks—sharp, keel-like ridges—and hence the name of the Ridge from which the formation takes its name. The upper beds of this formation are physiographically weaker, so that a valley is always

formed in them, thus separating the two quartzite formations. The Florence Quartzite forms rounded ridges across which branch streams cut back, with the result that a number of drumlin-shaped eminences are formed, and hence the name originally given to this formation.

Bell Shale

The Bell Shale is hereby defined as a formation of the order of 1400 feet of siltstones, commonly with shaley fracture, and with interbedded quartzitic bands. The formation is conformably underlain by the Florence Quartzite, but is terminated above by a regional unconformity brought about by the Middle Devonian orogeny. This diastrophism is responsible for the folding and emergence of the formations described in this paper, and apparently also for the injection of the metalliferous lodes which caused mining at Zeehan to be undertaken. In the present state of our knowledge, there appears to be more diversity of lithology and faunal assemblages in the Bell Shale than in any of the other Eldon Group formations. This is probably connected with the movements which brought sedimentation to a close in this part of the Tasman Geosyncline. A hint has been given of a possible higher formation than the Bell Shale (L. Hills and Carey, 1949, p. 28) having a thickness of 'at least 3000 feet', but the field work just completed has proved that there are no beds in the type area younger than the Bell Shale.

There is considerable variation in the amount of regional metamorphism in the strata of this formation in the faulted Zeehan area, where slates occur in the proximity of large faults. In such localities the sandstones are strongly sheared, and the quartzite bands are buckled and broken. Some of the quartzitic horizons are very finely banded due not to laminated bedding but alternate fine layers of lighter and darker sediment. This feature has not been seen in any other formation of the Eldon Group.

Appendix A provides a table for the ready recognition in the field of the Eldon Group formations described above.

Permian System

Rocks of this system outcrop in railway cuttings and on the prominent hills on either side of the railway line on the Strahan side of Eden. They are faulted against formations of the Junee and Eldon Groups. The Permian rocks with their possibility of coal have received some attention from geologists in the past. Voisey (1938, p. 322) mentions them but was simply recording passages from Johnston (1891) who was the last geologist to make ground observations on them. The area occupied by the Permian was delineated by Carey in his photo-geological map. Insufficient time was available to make the definition of formations possible, and so the following are notes on outcrops studied.

At Firewood Siding (loc. 72), brown to grey micaceous sandstones outcrop. The sandstone is finely bedded, of medium grainsize and extremely micaceous, the mica being of a clear variety. Plant fragments, although present, are not common, but carbonaceous laminae are well developed, particularly in finer grained sandstones. Current bedding is present in these finer sandstones, and all are jointed, the jointing dipping to the east.

In the creek bed to the north-east of the siding (loc. 71), a grey grit is found, and this contains medium-grained fragments of quartz and argillaceous material with a few fragments of plants up to one-quarter of an inch long, surrounded by iron staining, especially in the weathered zone. White mica is again present.

A prominent homoclinal ridge can be seen further to the north-east of the siding (loc. 70), and this proved to be due to a bed of white conglomeratic grit dipping 230° at 35°. This rock, like those already described, has an argillaceous cement. It is of a glistening white colour, and is composed of poorly rounded quartz pebbles up to 5 cms. in diameter in a matrix of smaller sub-angular quartz and occasional argillaceous fragments, again with fine-grained clear micas. There is a rough alternation of pebbly and non-pebbly bands. Current bedding is very common, and in the main dips to the south but not invariably so. No fossils were found.

In the railway cuttings (locs. 73, 74, 75, 76) to the east of Firewood Siding, the main rock type is a fluvio-glacial siltstone with angular, rounded, and facetted pebbles of many rock types in a fine-grained brown matrix. The latter consists of argillaceous material with, however, an appreciable amount of quartz and occasional very fine grains of mica. The pebbles occur in irregular bands and lenses, and close to the top of the siltstone carbonaceous bands become common. The pebbles include quartz (especially near the top of the siltstone), quartzite, schists, and grey granite, one boulder of which was eight inches in diameter and markedly facetted. Fossils were found in two localities in this rock, and are sufficient to establish its Permian age, viz.—

Locality 75:

Brachiopoda	*Martiniopsis oviformis* McCoy.
	Spirifer duodecimcostata McCoy.

Locality 76:

Polyzoa	*Fenestrellina* spp.
	Polypora sp.
	Stenopora sp.
Brachiopoda	*Martiniopsis subradiata* Sowerby.
Mollusca	*Merismopteria macroptera* (Morris).
	Platyschisma oculus Sowerby.
	Conularia inornata Dana.

The matrix at loc. 76 is the rock type described above, while that at loc. 75 is much fresher and of greenish grey colour. Preservation is such that specific identification of the bryozoa was precluded.

Correlation of these strata with other Permian sequences in Tasmania is difficult. They are somewhat different from most other Permian rock types in the possession of abundant mica flakes, although these are recorded from Prider's Bronte Facies of the Marlborough Series (Prider, 1947, p. 133). The fossils are not of very great value for correlation. One of us (M.R.B.) has noticed, however, that the molluscs recorded from this locality are more common in the lower formations in the Hobart area than they are in the higher ones. These strata may be equivalent to the Granton Formation of Eastern Tasmania, but the evidence is not yet sufficient for definite correlations.

Structure and Diastrophism

The Eldon Group strata of the Zeehan area are strongly folded, with considerable pitching, by compressive forces operating in a S.W.-N.E. direction. In the comparatively undisturbed area south of Zeehan, the folds pitch to the north-west, and this strong pitching gives the beds a very sinuous outcrop (see Plate I). The bedrock is traversed by many faults of different types and amount of throw. The faulting of this area has been considered to be connected with the Middle

Devonian diastrophic and metallogenetic period (e.g., Twelvetrees and Ward, 1910, Ward, 1911, L. Hills, 1921), the ores being regarded as differentiates from the Heemskirk granite massif. However, it should be noted that—

1. The fault affecting the Permian rocks in the south of the area is definitely of later age, and
2. L. Hills and Carey (1949, p. 38) state that it is possible that the Heemskirk granite is of Lower Carboniferous age.

It would appear that there are fault systems of various ages. *A. priori* one would expect faults to be associated with the original epi-Eldon folding, with the intrusion of the doleritic sills (Edwards, 1942), and with the Tertiary faulting held responsible for some of the massive grabens of Tasmania.

We wish to record our indebtedness to Professor Carey for suggesting this area to us as one worthy of attention and to him and North Broken Hill Pty. Ltd. for making available to us their maps and aerial photographs of the area studied. These facilitated the work considerably. Help in the area was made available through the courtesy of Dr. M. D. Garretty, and Mr. B. P. Webb, B.Sc. assisted us in the field and helped us to check in the immediate vicinity of Zeehan the criteria we had established near Eden. Mr. Ramsay Ford was a willing worker with us at all times during our visit, and lightened the burden of fossils for us on many occasions. Assistance in compilation and drafting was given by Mr. Bruce Ellis.

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Appendix A

Table for Recognition of Formations in the Field

Types of Evidence	*Crotty Quartzite*	*Amber Slate*	*Keel Quartzite*	*Florence Quartzite*	*Bell Shale*
Lithology (*a*) Fresh rock	Light-grey and sometimes pinkish quartzite with mixed-stone grit to fine conglomerate of mixed rock and mineral types	Grey slates	Bluish, light-grey, and dark-grey quartzite	Light-grey and yellowish-brown quartzite	Light- or dark-grey, yellowish-brown to reddish siltstones with quartzitic horizons, some finely banded
(*b*) Weathered rock	Whitish and sometimes pinkish porous quartzite to freestone	Yellowish-brown slates sometimes with pinkish or purplish hues	Whitish porous quartzite	Whitish or sometimes yellowish-brown porous quartzite	Little alteration on weathering
(*c*) Metamorphism	Sheared in places	Fissile slates Fossils across cleavage	Sheared in places	Sheared in places	Shales become slates in major fault zones Quartzitic bands sheared, buckled, or shattered
Physiography	Rounded ridges	Low relief Tendency to dendritic stream pattern	Sharp keel-like ridges (Hogbacks)	Rounded ridges	Low relief with quartzitic bands standing out as low ridges
Palaeontology (*a*) Index fossils and assemblages	*Camarotoechia synchonena* Gill Annelid tubes Large, flat crinoid columnals with rounded sides	*?Rhenorensselaria* Ostracod zones Slender crinoid columns	No fossils yet specifically associated with this formation. Its physiographic expression is its chief characteristic	*Notoconchidium florencensis* Gill *Eatonia pleonecta* Gill Large actinopterid Masses of crinoid columnals c. ¼" diam. *Maoristrophia-Protoleptostrophia plateia* association	*Chonetes ruddockensis* Gill *Eospirifer parahentius* Gill *Leptocoelia polyspera* Gill *Meristella bellensis* Gill *Notanoplia pherista* Gill *Plectodonta bipartita* (Chapman) *Proetus curyceps* (McCoy) Crinoid columnals with scalloped margins Land plants
(*b*) Relative abundance of fossils	Poorly fossiliferous	Sparsely fossiliferous	Poorly fossiliferous	Richly fossiliferous	Richly fossiliferous

Appendix B

Index to Fossil Localities

Loc.	*Run*	*Photo*	*Dist.*	*Bearing*	*Co-ordinates*		*Notes*
			cms.		*N.*	*E.*	
1	5	21646	9·9	58	5,050	1,730	Quarry on N. bank of creek
2	,,	21644	9·3	108½	5,070	1,039	Garage quarry, Zeehan
3	,,	,,	8·4	104½	4,970	900	Quarry N. W. of hospital
4	,,	,,	9·35	118	4,980	1,270	E. side of Rotunda Hill
5	,,	21646	5·6	52	4,360	2,005	Right bank of creek, 10 yds. E. of road
6	,,	,,	6·85	29	4,210	1,557	Cutting W. side of Oceana Rd., 3 chs. S. of Main St.
7	,,	21644	1·8	73	3,950	381	Johnston's Flat
8	,,	,,	1·4	94	3,860	510	Adit on E. side of Johnston's Flat
9	,,	,,	3·5	165½	3,760	1,010	Ballast quarry on Comstock Railway
10	,,	21646	4·9	339½	3,400	1,770	Old quarry on W. side of road
11	,,	,,	5·05	336	3,340	1,790	About 415 yds. N. of Silver Bell Turn-off
12	,,	,,	5·06	335	3,270	1,770	About 408 yds. N. of Silver Bell Turn-off
13	,,	,,	5·56	323	3,030	1,790	About 258 yds. N. of Silver Bell Turn-off
14	,,	,,	6·15	316½	2,880	1,750	About 100 yds. N. of Silver Bell Turn-off
15	,,	,,	6·55	303	2,650	1,900	Silver Bell Railway Cutting
16	,,	,,	5·5	257½	2,650	2,690	Rt. bank Little Henty River
17	4	21605	9·26	125½	2,035	2,200	30 chs. N.N.W. of Smelters' Transformer Station
18	,,	,,	9·4	129	1,938	2,330	S. slope of gully
19	,,	,,	9·2	140½	1,720	2,520	Smelters' sandy quarry
20					1,806	2,700	Smelters' Railway cutting
21					1,440	3,425	Sth. bank of creeklet on flats
22					1,575	3,640	Crest of low ridge
23					1,640	3,800	Eastern side of crest of high ridge
24	3	21562	8·34	341	—2,465	1,261	On 'bridge' between ridges
25	,,	,,	7·6	335	—2,545	1,417	In small saddle
26	2	21533	11·3	98½	—2,908	787	Near top of ridge
27	,,	,,	9·8	77	—3,065	121	On spur
28	,,	,,	9·15	76½	—3,190	138	Top of ridge
29	,,	,,	8·85	78½	—3,210	173	Cliff on N. side large pool
30	,,	,,	9·3	85	—3,160	55	In whitish quartzite
31	,,	,,	8·6	77½	—3,260	147	Slope of small spur at junction of creeks
32	,,	,,	8·8	80½	—3,260	216	On sharp edge of end of spur
33	,,	,,	6·5	83½	—3,635	329	N. bank of small gully
34	,,	21530	9·7	56½	—3,705	2,665	Near bottom of gully
35	3	21562	10·25	234	—3,530	3,590	11 yds. N. of 36
36	,,	,,	10·30	235	—3,560	3,550	About 3 chs. N. of 37
37	,,	,,	10·95	241½	—3,780	3,415	Railway cutting in Keel hogback
38	2	21530	6·95	38	—4,350	2,565	4 chs. N. of 23-mile post
39	,,	21533	1·45	35	—4,590	156	Bed of small gully
40	,,	,,	1·2	30	—4,620	199	Quartzitic band across small creek
41	,,	21530	8·9	23½	—4,400	2,075	1,490 yds. from S. end cutting
42	,,	,,	8·05	30	—4,350	2,300	Near 23-mile post
43	,,	21533	2·7	335	—4,890	—69	Half-way up gully wall with N. aspect
44	,,	,,	2·35	331½	—4,890	—9	Valley wall with N. aspect

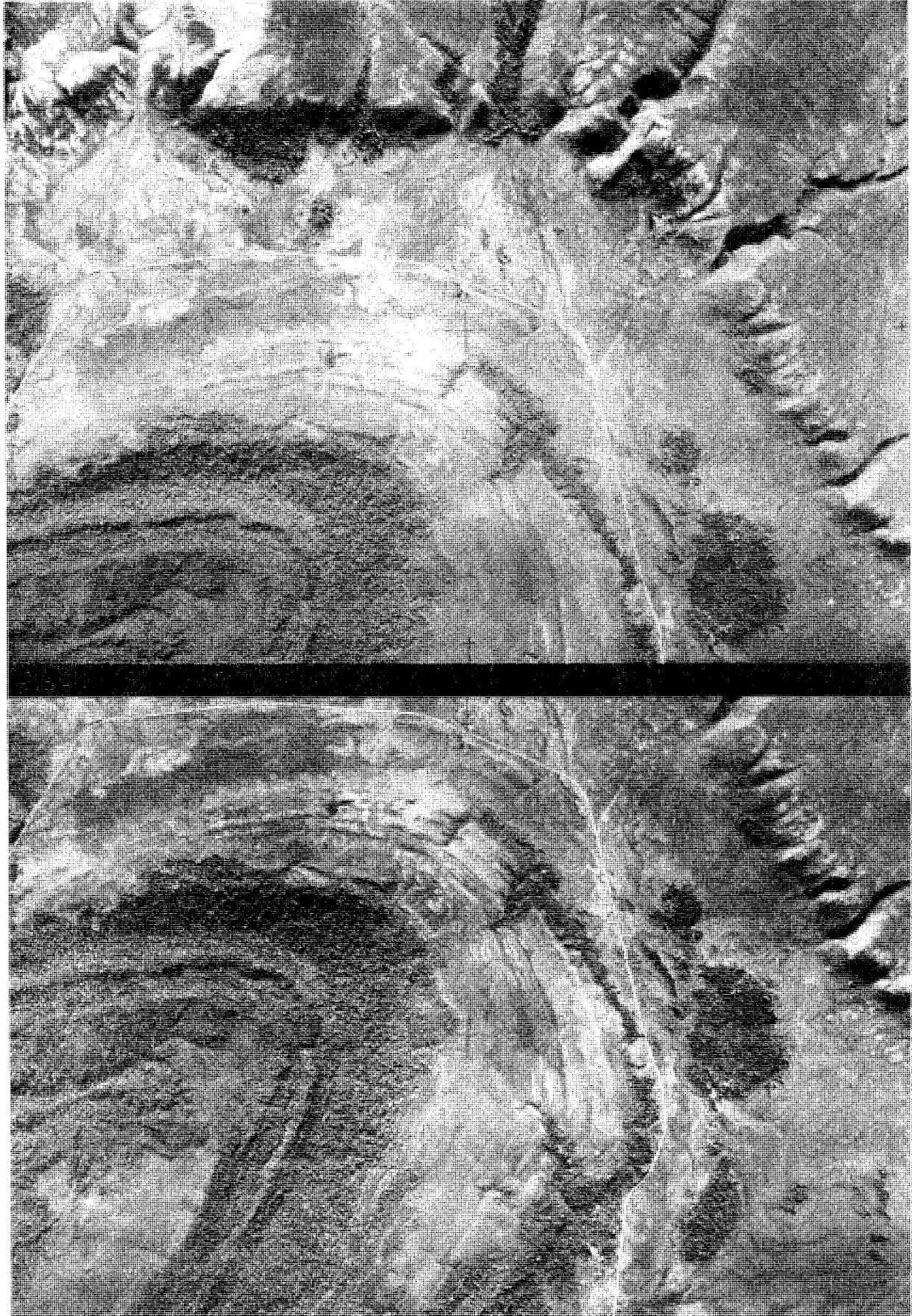
Loc.	*Run*	*Photo*	*Dist.* cms.	*Bearing*	*Co-ordinates* N.	E.	*Notes*
45	2	21533	1·95	334½	—4,850	432	Floor of small gully, hard band across creek
46	,,	,,	2·3	292½	—5,070	173	E. of 43 and lower
47	,,	21530	6·45	356½	—5,090	2,110	610 yds. from S. end cutting
48	,,	,,	6·35	340½	—5,370	2,355	370 yds. from S. end cutting
49	,,	,,	5·55	334½	—5,450	2,510	130 yds. from S. end cutting
50	,,	,,	5·1	328	—5,510	2,640	High railway cutting
51	,,	21533	8·2	306½	—5,730	—554	Tree stump on top of ridge
52	,,	,,	8·4	305½	—5,770	—554	Rock from tree stump
53	,,	,,	8·55	305	—5,800	—565	N. side of gully
54	1	23436	12·45	129½	—5,800	—510	Three-quarter-way up ridge
55	2	21530	4·65	266	—5,920	3,395	Railway cutting at bend
56	1	23436	10·35	344½	—6,240	—606	Crest of Keel hogback
57	,,	23432	7·15	57	—6,460	1,563	Floor of small creek on peneplain
58	2	21530	9·1	246½	—6,580	3,890	Quarry in limestone
59	1	23436	7·0	119	—6,560	—1,218	Top of ridge where tree uprooted
60	,,	,,	5·65	103½	—6,680	—1,546	Top of ridge where tree uprooted
61	,,	,,	3·6	117	—7,050	—1,460	On old tramway
62	,,	,,	5·8	144	—6,940	—1,060	Top of ridge
63	,,	23432	4·1	108½	—6,850	2,456	East bank of creek
64	,,	,,	4·15	120	—6,900	2,598	Head of branch creek
65	,,	,,	4·8	159½	—7,160	2,940	Top of another ridge
66	,,	,,	4·95	157½	—7,210	2,950	Top of small ridge on peneplain
67	,,	,,	5·2	160½	—7,260	3,000	Top of hill, Henty peneplain surface
68	,,	,,	5·4	166	—7,305	3,070	150 ft. further uphill from 69
69	,,	,,	5·4	170	—7,360	3,055	On hillside overlooking limestone valley
70	,,	23436	2·75	356½	—7,650	—2,105	On top of homocline
71	,,	,,	2·90	330½	—7,850	—2,040	In creek bed N.E. 72
72	,,	,,	3·70	325	—7,950	—2,120	Firewood Siding
73	,,	,,	1·4	251	—7,800	—1,580	Railway cutting
74	,,	,,	2·7	230½	—7,900	—1,295	Railway cutting
75	,,	,,	3·8	226	—8,000	—1,132	Railway cutting
76	,,	,,	5·35	223	—8,100	—908	Railway cutting
77	,,	23431	5·3	242	—8,150	3,745	Ballast quarry and mine workings

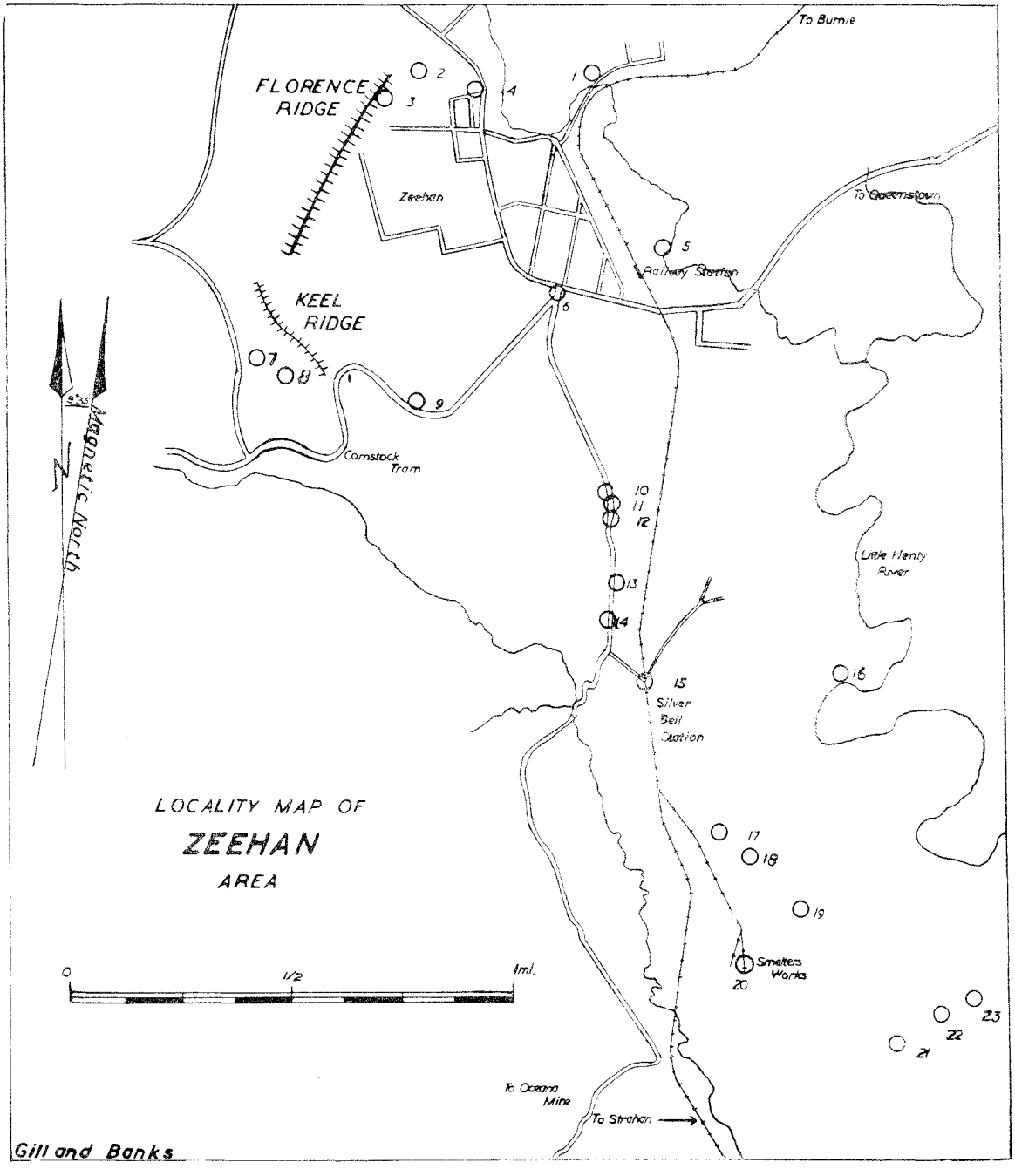
'Loc.' is locality number shown on Plates II and III.
'Run' refers to aerial survey photo runs. All runs are in the Zeehan Quadrangle.
'Distance' is measured from centre of photo quoted.
'Bearing' is taken from line joining the centre of the photo quoted and the next photo west and is measured in a clockwise sense.
'Co-ordinates' refer to Mt. Zeehan and North and East are taken as the positive directions and are measured in yards.

PLATE I

Two aerial photographs of Zeehan Run 1, nos. 23431 (top), 23432 (bottom), to show the structure near Eden. Arranged for stereoscopy; and published by courtesy of the Lands and Surveys Department, Hobart.

(NOTE.—The top of the page is east.)




To Burnie
FLORENCE RIDGE
Zeehan
To Queenstown
Railway Station
KEEL RIDGE
Comstock Tram
Little Henty River
Silver Bell Station
Smelters Works
To Oceana Mine
To Strahan
Magnetic North
LOCALITY MAP OF
ZEEHAN
AREA
0
1/2
1ml.
Gill and Banks