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GEOLOGY OF THE NOOK - GUNNS PLAINS AREA

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SUMMARY

The Precambrian rocks consist of about 1500 feet of mica and chlorite schists, quartzites, and low grade gneisses. The highest formation is a graphitic pencil shale, underlying the Dundas Group unconformably at Paloona Bridge.

The Dundas Group consists of cherts, porcellanites, tuffs and volcanic breccias interbedded with each other and with greywackes and shales. These are succeeded by a thick shale carrying a lens of spilite. These are succeeded by a coarse greywacke breccia containing limestone and chert from erosion of uplifted sediments of probably Cambrian age. This is overlain by argillites and keratophyres. The total thickness of all the defined formations is 15000 feet, but if account is made of facies changes, the total thickness of the sequence is probably about 10000 feet.

The Dundas Group was folded, uplifted, and 1800 feet of erosion occurred, after the lower Upper Cambrian. This tectonism is named the Dial Movement. In the Upper Cambrian there was renewed subsidence, and the Wilsonia Group, consisting of cherts and sandstones, was deposited.

The Tyennan and Tabberabberan folding and faulting accord with a fairly constant stress pattern, a clockwise rotational shear. Abrupt swings in strike of folded rocks appear to be due to deep-seated shears or rapid changes in thickness of the sedimentary blanket.

Mineralisation is due to the Devonian Housetop Granite, the ore feeders being Tabberabberan faults. Strong preference for greywacke conglomerates and breccias is shown by the mineralisation which is of mesothermal grade.

The Tertiary Faulting forms a network directed NNW, downthrowing east. The system is characterised by the interchange of throw between contemporaneous faults, which apparently cross one another without displacement, and folding due to rotational movement. The fault pattern is such that tasmanite and coal do not occur together in the same block. With this structural evidence of the non-contemporaneity of the coal and tasmanite the bore

records have been correlated using the coal seam as datum. the sequence obtained is consistent with the outcrops observed in the field. The total thickness is about 1300 feet, consisting of a quartzite conglomerate at the base, overlain by a sequence of pebbly mudstones and mudstones. This fo mation is named the Nook Formation, and is equivalent to the Brumby and Golden Valley Group of Western Creek, but until the correlation is proved and the seperate lithologies established in the field, there is insufficient evidence to make this correlation, the bore records being untrustworthy. The tasmanite seam occurs in a sandstone near the top of this formation. The coal measures occur in a sandstone which is probably equivalent to the Liffey sandstone, and has been so named, although the correlation is not proven.

At least three dolerite sills occur in the sequence, a basal sill intruded at the unconformity, ~~which~~ is 200 feet thick another sill above the tasmanite, and a 200 foot sill overlying the highest beds. A dyke, probably linking two sills, occurs on Bonneys Tier.

The Pre -basalt surface was the youthfully dissected exhumed Carboniferous surface, and is in process of re-exhumation. The surface has a tilt of 1 in 150 to the east, possibly due to Tertiary epeirogeny. The source of the basalts was a neck at Barrington, a neck at Upper Castra, and possibly a neck at Paloona. The rocks are tuffs, as, breccias, and chiefly olivine basalt lava. The lake sediments of Tertiary age were impounded in old valley systems by early basalt flows blocking narrow gorges.

The rivers contain erosional terraces of coarse boulder beds, which are probably derived from glacial sources in the Late Pleistocene.

LOCATION AND ACCESS

The large towns of the North-West Coast are situated on lowlands or the coastal platform less than a mile from the sea. Behind them the land rides sharply to a dissected basalt plateau. The area mapped is situated on this plateau about 5 to 10 miles from the coast. Further south the basalt plateau is bounded by the scarps of the Mt. Roland-Black Bluff mountain chain, that for convenience is referred to as the North Coast Range.

Access from the coast is good, with sealed highways from Devonport to Lower Barrington and Barrington, a sealed highway from Ulverstone to Spalford, near Sprent, and a start has been made in widening and straightening the Sprent-Upper Castra and Gawler-North Motton roads preparatory to sealing. Access east-west is hampered by the deeply incised rivers, there being only one bridge across the Wilmot River (at Alma) and two across the Forth (at Paloona ans Wilmot) south of the coast.

Numerous municipal roads, farm and timber tracks make it possible to drive within two miles of any part of the area. Progress on foot is sometimes very slow, particularly in areas of secondary regrowth skirting farmlands. Almost all the country between the Wilmot River and the Sprent-Upper Castra road is practically impassable in areas of low relief, because imported blackberries have replaced the native undergrowth, forming a blackberry jungle that has been seen 20 feet deep in the East Gawler River. The usual method of traversing is to wade down the small creeks, but where the valleys are shallow and sunlight can penetrate, the blackberries swamp the valley, so that it is necessary to cut tracks even down the creek bed. The native scrub is mainly tall bracken in areas that have been worked for timber. In the gulleys tree ferns and undershrubs with horizontal habit usually provide good travelling. On arid hillsides in siliceous rocks bauera occurs, chiefly near Paloona and on Eardley Tor. Progress on foot is slow in unsettled areas.

MAPPING TECHNIQUES

Mapping techniques in Tasmania vary widely depending upon the type of rock and the topography. In the Permian all the creeks were traversed, and rock boundaries traced by walking the outcrop where this was possible. The basalt was mapped by walking the outcrop and traversing creeks that provide xx sections through the flows. The Ordovician rocks were mapped by traverses across the strike and down the rivers, but here the strong structural control of morphology makes aerial interpretation easy. The edge of the basalt can also be interpreted by the frequent springs at the base, but it is always mecessary to check, as springs originate at times between the flows.

In the Cambrian rocks, the technique finally used is one developed by J.N.Elliston xW at Dundas and applied at Lorinna. In flat, settled country with easy access the boundaries were established by walking the outcrop, as at Moreton Road and east of Preston. Elsewhere the rivers were first carefully traversed to establish the sequence and identify lithologies. Depending upon this, traverses were made down creeks at right angles to the strike in intervening areas. The present work was hampered by abnormally wet weather which prohibited early river traverses. When the river traverses were done there was often found to be great divergences from the road traverses. For instance, the only outcrops on the road from Preston to the west Gawler River are argillites with occasional bands of arkose, but in the intervening creeks the sole outcrops are coarse cherty breccias. The same is true to a lesser extent in the Leven Gorge. The difference is due to the differing rates of chemical and mechanical erosion.

Of the Cambrian lavas, only the kxxx purple keratophyres and the spilites can be definitely recognised as such on very weathered outcrop. The spilite forms bright red, friable soil, with boulders very rarely showing. The Tertiary basalt soils invariably contain boulders of basalt.

The purple keratophyres can be specifically recognised by the occurrence of green spots from the weathered pyroxene in the otherwise structureless friable red clay. The greywacke sandstones and interbedded argillites also form a deep red friable clay but planar structures are evident and small flakes of muscovite. The coarse massive greywacke of the Sprent Formation forms a yellow spotted clay. The coarse keratophyre tuff of the Clayton Formation appears as a green structureless product with pink spots and is quite distinctive. A brown shale with large chlorite flakes was sectioned with difficulty, and is a lithic keratophyre tuff. The cherts are easily recognisable, but the associated very fine grained ashstones, claystones, and finegrained lavas cannot be seperated on weathered exposures. Mapping at Sprent had to depend on criteria such as these.

A technique somwwhat useful in country of difficult access consisted of prospecting for resistant rocks, A chert band in the keratophyres of the Braddon Creek Formation, only a few feet thick, was located by inspecting the stream gravels downstream of the ~~expected~~ outcrop. In the same way several distinctive rocks in the Wilmot Gorge were located.

TOPOGRAPHIC MAPPING

The topographic map was prepared from the 30 chain scale aerial photographs of Sheffield Quadrangle by the slotted template method. Wing points and centre points were transferred under a high magnification stereoscope. The templates were cut from used X-Ray film, and laid down on pressed hardboard. Since a field map at 20 chns. per. inch was required, the templates were enlarged by radial projection of the wing points about the centre point. The standard size slot in many cases had to be enlarged.

The detail was plotted with a Kail stereoscopic plotter, with pantograph to enlarge to 20 chain scale. This was found more suitable than a rectoplanigraph for enlargement. The instrument used proved difficult to adjust, and topographic distortion was never completely eliminated. This is most noticeable where a straight road rises a hill. The pantograph suffered from excessively worn linkages, so that plotting had to proceed always in the same direction to avoid backlash. A standard of 1/50 " was set in all the plotting. This was tested periodically by replotting an earlier pair of photographs and comparing the results.

Slotted template methods have been used by the Mines Department, the University, private companies and Government instrumentalities in Tasmania since 1945, and a large number of such maps have been produced. The present map is probably an average sample, so that the production recently of a more accurate map affords a chance to test the accuracy of the slotted template method as applied in Tasmania.

The more accurate map is a contour map of the Sheffield Quadrangle, available at the present time as section sheets at a scale of 40 chains per. inch. This map was prepared by aerial triangulation from 45 chain photographs specially flown, the detail being plotted from rectified plates with a Wild A5 (later, A8) plotter, in air conditioned rooms. Every effort has been taken to ensure accuracy, and the map is claimed to be accurate within 10 ~~yards~~ feet in position.

In order to estimate the accuracy of the slotted template map, the method outlined in the "Manual of Photogrammetry" was used. Coordinates of identifiable points were measured for both maps. The differences (northings and eastings) were squared and added, the square root of the sum being the measure of the error. The computations are tabled. 38 points were sampled at random, of which 24 occur in the eastern square when control was poor. In this area the error rises as high as 198 yards. The average over the whole map is 71.88 yards. The average for the western squares is 42.47 yards.

There are two factors responsible for the errors. It was expected that large errors would be introduced by the plotting, in which case a random spread of error would be expected. The error due to this averages 42 yards. The second source is the lack of control in the eastern corner. Seven control points were available, mostly outside the area, with none on the eastern boundary. If the errors in this region are plotted, they are radially arranged about the nearest control. The maximum error due to this cause is 150 yards. The permissable error at publication scale is 1/50", which is about 100 yards. The bulk of the map therefore complies with international standards.

The photocentres of the 45 chain Mersey photos were plotted by resection from the 30 chain centres. The latter were located on the 45 chain photos stereoscopically, using a highpowered stereoscope with one eyepiece enlarging more than the other. The mutual relationships were then established on the 45 chain photograph, and resected manually using specially prepared transparent templates. The accuracy of this method was later tested when it became necessary to bridge the 20,000 yard gap between this map and a previous map prepared by J.N. Elliston. A strain free laydown was obtained between these points and the northernmost controlled run of Elliston.

0. 007 ~~N' E' N E dN dE~~ dN^2 dE^2 ~~Sum~~ 451009 Error ~~(Yards)~~ 1/168.

~~91689 42976 91692 42990 03 14 009 196 205 143~~

TABLE

Description	N	E	N'	E'	dN	dE	dN^2	dE^2	Sum	Error
Bridge	91689	42976	91692	42990	03	14	009	196	205	143
"	5?2	902	572	. 910	00	08	·000	064	064	008
Road Junction	242	968	229	981	13	13	169	169	338	184
Bridge	085	989	070	43002	15	13	225	169	394	198
"	968	955	981	42959	13	04	169	016	185	136
Road Junction	945	750	952	751	07	01	049	001	050	071
"	842	777	850	782	08	05	064	025	089	094
"	731	757	733	760	02	03	004	009	013	036
"	643	798	635	808	08	10	064	100	164	128
"	516	774	516	784	00	10	000	100	100	010
Bridge	470	640	471	650	01	10	001	100	101	010
Road Junction	432	611	435	620	03	09	009	081	090	095
Railway Crossing	365	605	360	615	05	10	025	100	125	112
Road Junction	883	520	882	521	01	01	001	001	002	014
"	690	520	688	521	02	01	004	001	005	022
"	545	565	543	572	02	07	004	049	053	073
"	165	566	157	575	08	09	064	081	145	012
"	018	568	609	570	09	02	081	004	085	092
Road Bend	184	445	178	446	06	01	036	001	037	061
Bridge	761	344	758	347	03	03	009	009	018	042
River Bend	269	212	268	211	01	01	001	001	002	015
Road Junction	820	135	819	135	01	00	001	000	001	001
Bridge	672	117	660	122	12	05	144	025	169	013
Road Junction	965	013	961	013	04	00	016	000	016	004
Post Office	801	41455	802	41448	01	07	001	049	050	071
Road Junction	656	313	653	315	03	02	009	004	013	036
Post Office	027	204	625	202	02	02	004	004	008	028
Bridge	675	179	678	175	03	04	009	016	025	0065
"	828	708	825	708	03	00	009	000	009	003
Post Office	063	791	068	795	05	04	025	016	041	064
"	475	043	475	049 0	00	06	000	036	036	006
"	648	40347	642	40351	06	04	036	016	052	072
"	547	669	548	669	01	00	001	000	001	001
Road Junction	270	531	270	533	00	02	000	004	002	014
"	446	012	441	018	05	06	025	036	067	078
Bridge	983	770	979	772	04	02	016	004	020	045
Road Junction	390	324	387	325	63	01	009	001	010	032
"	820	148	818	144	02	04	004	016	020	045

The error is in yards. Co-ordinates are measured to five figures only, as this is the limit of accuracy with the section sheets. These coordinates are changed slightly in the published map owing to the necessity to show roads larger than actual size.

N and E refer to the slotted template map, N' and E' to the contour map.

The country between Nook and Gunns Plains is traversed by three large rivers, the Forth, Wilmot, and Leven, which have cut about 800 feet through the Pliocene(?) basalts and are now approximately at base-level in Palaeozoic rocks. These rivers arise in the Central Highlands south of the Roland-Black-Bluff mountain chain, designated herein as the North Coast Range.

The intervening country is drained by a system of small rivers with their headwaters arising well north of the range. The East and West Gawler Rivers discharge into the Leven, and Hogg Creek discharges into the Forth, but the Don River and Melrose Creek, and the Clayton River have outlets to the sea. These small rivers are youthful, with numerous waterfalls, which on Hogg Creek are over 100 feet high. In areas of soft rock these streams have locally reached maturity, based upon rock bars downstream. The Don River is base-levelled on the Bott and Denny Gorges, and Melrose Creek on the gorge at Eugenana. The West Gawler River is based on a spilite bar at Preston, and on cherts at Wilsonia. The Clayton Rivulet is based on two basalt bars, and one keratophyre bar, at Sprent. The bedrock of the mature tracts is variously Permian shales, Ordovician limestone, and Cambrian slates. In each case the meander belt is equal to the valley tract in width. The Clayton appears to be an underfit stream, which may be due to capture of the headwaters by creeks draining into the Wilmot. The river is facing capture by a small stream draining east into the Forth at Paloona. At the point of closest approach the divide is 50 feet high.

These mature tracts are covered with a thin veneer of alluvium deposited in floodtime. The deposits are mostly clays and silts. The Don at Aberdeen has 5 feet of silt overlying 2 feet of river gravel. These deposits are part of the present cycle of valley development and are therefore designated as Recent Alluvium.

The Gawler River, however, north of the junction of the east and west branches ('fork of the Gawlers') and the three large rivers,contain terraced deposits. The maximum development is on the Leven River at Warringa,where a large, well preserved terrace lies at 400 s.l.,or 150 feet above the river,just south of the caves. Portion of this was considered on soil evidence to be Crotty Sandstone(Hughes,1957)but since then a quarry has been opened and imbricate gravels revealed. (Typical localities are 4000E,9112N;4050E,9130N.) The terrace landform has been destroyed in the rest of the valley,which is filled with these gravels. Due to landsliding,the boundary between the XXXXXXXX Quaternary and Tertiary gravels is sometimes difficult to determine,but the 400 foot contour is almost certainly the top of the Quaternary gravels.

The terraced gravels on the Gawler lie about 40 feet above river level. They are almost certainly formed sympathetically with those of the Leven River,as they share a common outlet.

In the Wilmot the terraces extend from the Forth junction beyond Upper Castra,and the Forth gravels extend more than twenty miles from the mouth to Cethana. The terraces are preserved on the inside of bends,and in the lee of rock bars. At Paloona the gravels extend up to 250 s.l.,or 175' above river level,the higher portions not always present. They occur on the hill southeast of the Waterworks,and on the track to the Alma Mine. The prominent terraces are well preserved up to 40 feet above the river. The higher deposits may be earlier,protected by the lower terraces from lateral corrasion. The extensive scree preservation on terrace-defended slopes point to the efficiency of the process.

The terraces contain boulders up to one foot diameter, averaging about 6 inches. They are mostly well rounded,except for rocks derived in the immediate vicinity. Imbricate structure is a characteristic. In the Forth xxx 20 per.cent.are recognisable PreCambrian which must be derived from the area south of Lorinna, or twenty miles upstream. It is noteworthy that the granite and quartz keratophyre outcropping for six miles downstream of Lorinna are scarce in the terraces,but abundant in the modern

The Wilmot gravels are noteworthy for the absence of Precambrian boulders,basalt being the major constituent. Owen Conglomerate is abundant.The terraces are frequently covered with superficial silts up to 5 feet thick. The gravels consist therefore of resistant rocks occurring upstream,but with an abnormally high proportion of material derived from the headwaters.

Two transverse profiles were made by tacheometric survey at Paloona.These profiles show the terraces alternate across the river at 5 foot intervals.The larger terraces are commonly deepened by several feet on the side nearest the valley wall. The largest terrace at the Wilmot Forth junction has a dip of about one foot per.mile downstream.The terraces at the river junction show clearly the main characters of erosional terraces,particularly the unmatched character,and the presence of deepened back portions(Cotton,1945,p.250;von Engeln,1942,p. 242).The profile obtained about 200 yards north of Paloona Bridge,where the terraces are protected by a rock bar,has mainly unmatched,but two matched,terraces.The matching is readily explained by assuming the terraces once lay on the same side of the river,in which case a meandering course is established with the meander belt moving downstream one half wavelength before the next terrace was established.Alternatively the terrace represents a period of baselevelling.

The main question is the date of the aggradation. The nomenclature of W.R.Browne(1945,pp.viii-ix) is used for the subdivisions of the Quaternary.

Since the period of aggradation,the Forth at Paloona has cut through 40 feet(at least) of gravel and up to ten feet of chert,whereas at the Dove Bridge,Lorinna,it has cut through about twenty feet of quartzite below the varves since the Pleistocene,The amounts of erosion are of the same order.

Cotton(1945,p.214) says overloading is the chief cause of aggradation,while eustatic changes,river capture,and landslides are causes.The overloading is due to river captures,or climatic changes including glaciation.Another cause is changes in the trunk stream of which the river is an artery. The latter is a distinct possibility for the Wilmot and Gawler Rivers. Reconnaissance indicates the effect of landsliding in the Quaternary is negligible, and no large river captures have occurred. Hence the aggradation is due to eustatic changes of sealevel, or to overloading. ~~due to glaciation~~.

Von Engeln(1942,p.235), Thornbury(1954,p.149) and Mackin(1948,p.493) state that glacial action is a prime cause of aggradation. Mackin points out that the aggradation may be due as much to increase in caliber of the sediment as to increase in volume. Certainly the Precambrian pebbles are not significantly smaller than locally derived rocks, although they have travelled many times further. There is abundant evidence of glaciation in the upper reaches of the Forth, and the Wilmot and Leven also drain glaciated areas. The valley glacier of the Forth extended as far north as Lorinna, the moraines consisting largely of Precambrian rocks. The composition of the gravels indicate that material from these moraines form a large part. It is considered therefore that the aggradation either followed, or was contemporaneous with, the valley glaciation of the Forth. Lewis(1933,p.73) considers these deposits contemporaneous with the glaciation of the highlands. Maze(1945) considers terraced deposits 150 feet above the Hunter River in N.S.W. date from a Pleistocene interglacial period. Jennings (pers,comm.) postulates a similar age for terraced deposits on the Mersey River at Liena. Following the glaciation, there was a eustatic rise of sea level of 270 feet according to Browne. This would certainly have produced aggradation in these rivers. It is possible that the overloading at the time of glacial melting, and the raccompanying eustatic rise in sealevel, combined to produce the aggradation. The period of aggradation, and hence the age of the gravels, is therefore considered to be Late Pleistocene.

The age of the terraces is less definite, but may date from the Mid-Recent Interval.

TERTIARY SEDIMENTS

Terrestrial sediments occupy the floors old pre-basalt valleys and are interbedded with the flows. The largest exposed area is at Melrose, where they consist of ferruginous sandstones, sometimes with large limonite concretions up to five feet in diameter, limestone breccias with a siliceous matrix, and course river gravels or talus deposits consisting of boulders of dolerite up to 5 feet di meter, and even larger boulders of Ordovician quartzites and conglomerates. The latter occur in the valley of Melrose Creek at Paloona. Stream sediments in a Tertiary valley at Paloona consist of basalt lapilli in a clay matrix derived from volcanic ash but containing rounded quartz pebbles.

The Tertiary sediments in the bed of the old Paloona River are exposed where it crosses the Forth. On the eastern bank they consist of ferruginous bedded sandstones which have yielded a little gold. On the western bank is a deeply weathered conglomerate consisting of pebbles of Cambrian claystones in a matrix of soft red shale. Overlying this is a fine white felspathic sandstone, and the nearby imbricate gravels may be Tertary also.

Similar white sandstones occupy the floor of the basin underlying Sheffield, and are exposed at Roland and Sheffield, and in the valley of the Don River at Nook. In the Nook outcrop the beds are at least 50 feet thick, consisting of laminated silstones, felspathic, carrying abundant wood fragments and pieces of bark, which resemble modern plants in their freshness. Pieces of bark still ignite readily. The altitude of this exposure is 600 feet, which accords generally with the other outcrops and an exposure west of Lower Barrington. These beds do not outcrop further north, and it seems probable the lake owed its existence to damming of the gorge on the Paloona River by early basalt flows. This lake is named Lake Sheffield. The source of this early vulcanism was between Lower Barrington and Paloona. The sediments at Melrose were probably deposited in a similar lake. A small deposit of ferruginous sandstones containing abundant leaf impressions is interbedded with the basalt south of Moreton. The sample collected represents the total outcrop.

The deposits at Moreton Road are at least 30 feet thick, consisting of sandstones and conglomerates. These have been worked for gold. The deposits in the bed of the old river which crosses the West Gawler south of the Isandula Estate contain sandstones and gravels. The bed of the old Motton River contains river gravels, similar to deposits in the present Leven. The river was about the same size.

Younger beds at Warrings include an extensive bed of pipeclay, but which apparently overlies talus(?) deposits containing boulders of Ordovician conglomerate up to 20 feet diameter.

The Tertiary sediments are contemporaneous with the basalt. The basalt distribution at Lower Barrington shows the basalt is a long way post-faulting. The exact chronology is unknown, so the sediments are simply designated Tertiary.

TERTIARY BASALT

The tertiary volcanics consist largely of basalt,with interbedded agglomerates,ash,tuff,and vitric tuff.Pyroclastics are indicated on the accompanying maps by a small triangle. Generally the boundaries are dfficult to map due to the soil cover.It is certain that with detailed work,involving stratigraphic and petrological work on exposed sequences,a detailed picture could be compiled readily.

Any volcanic cones have been obliterated,but two necks have been found.The beck at Barrington occurs alongside the Forth River,on a palaeozoic fault.The present depth of erosion is about 600 feet below the throat.The neck at Upper Castra may occupy another palaeozoic fault.Several small dykes less than a foot in width radiate from this.The neck was surmounted by a cone consisting of dense lava with columnar jointing and aligned vesicles at the base,perhaps 100 feet thick on the west,overlain by a breccia consisting of angular blocks of pumice averaging three inches diameter,large rounded bombs with hollow or vesicular cores,up to two feet diameter,and pieces of ropy lava.This outcrops behind the Upper Castra school about half a mile from the neck.The outcrop shows linears radially disposed about the neck.The bottom flow spread out more or less horizontally over the highland to the east,but dips to the west,down under later deposits which have hackly jointing. The souce of the basalts at Preston was not located, but at Warringa are a high mesa and butte which could be remnants of an old cone.This seems unlikely. The distribution of pyroclastics at Paloona and in Hogg Creek suggests that the souce of these basalts was local,probably a neck located southeast of Paloona.

The pre-basaltic topography is discussed elsewhere.The original depth of the volcanics was up to 1200 feet at Warringa and Upper Castra, the highest remnants being at 1600 s.l. in both localities.David is recorded to have divided the basalts into'valley-filling' and'plateau-forming',but as the distiction depends upon accidents of the

Tertiary topography, is not maintained.

015 The basalts show either columnar or hackly jointing. Columnar flows are less common, and can be traced with varying certainty on this factor alone. The columnar flow from the Upper Castra neck, which has been mentioned, does not outcrop to the southwest, but can be traced north along the old Castra River till it swings east under Sprent, when the flow is covered by later deposits. The columnar flow south of the Barren Hill is in the same valley system, and may be the same one. A prominent columnar flow at the base of the sequence at Paloona Bridge is much broader in extent in the west than the east, although about the same thickness. The overlying basalts all have hackly jointing. Other columnar flows occur in the Barrington neck, at Nook and capping the hills at Barrington. These flows are generally the most resistant to weathering, and are usually prominent. The columns are almost always vertical, although some are horizontal on the hill northeast of Nook. The bulk of the Gunns Plains flows are columnar.

The basalts are all olivine basalts, no unusual varieties being noted. The rock in the Barrington Neck consists of large, anhedral, sometimes broken phenocrysts of olivine, averaging 1 mm. diameter, forming 20 per. cent. of the rock. Phenocrysts of augite constitute another 20 per. cent., and the matrix which shows strong flow structure is made up of 3/5 of tiny lathes of plagioclase, with magnetite, augite and a few crystals of iddingsite. The lowest basalt exposed at Paloona in Melrose Creek consists of 5 per. cent olivine as euhedral phenocrysts averaging 0.5mm. diameter, and up to 1.5 mm., with long thin needles of plagioclase up to 3mm. long, averaging 1.5mm. long and 0.25mm. wide. The crystals are broken and corroded, anhedral, the edges lined with round magnetite grains and with long streaks of inclusions lengthwise within the crystals. Twinning is usually simple, with the twin planes seperated by a network of magnetite needles and rounded grains, and crystals of pyr xene. The variety is labradorite($Ab_{49}An_{51}$) and forms 40 per. cent of the rock. The pyroxene is pink lathes of titanaugite forming 25 per.cent. of the rock. The crystals have zoned extinction, and irregular outlines with faces sometimes developed, and are frequently associated with a brown glass that includes magnetite. The maximum length is 1mm., the average length being 0.3mm. and width 0.1mm.

Magnetite forms the bulk of this rock, occurring in feathery growths which are disposed radially, or else as the fronds of a fern. The largest 'fronds' are 1 mm. long. The total quantity is about 40 per.cent. The glass is a bright green or yellow, faintly birefringent, occurring mainly around vesicles. The vesicles are lined with a thin layer of fibrous chalcedony, while the centre of the vesicles is filled with colourless zeolites.

A highly vesicular basalt occupies the centre of the Upper Castra Neck. Large phenocrysts ~~and veins~~ of olivine occur, and vesicles containing euhedral chabazite up to 2" diameter. The field appearance is a 'froth' occupying the neck. The level of erosion is only about 200 feet below the original throat.

The basalt at the Isandula Bridge at Preston ~~xixxx~~ consists of anhedral olivine up to 0.2 mm. diameter, comprising $20^{o}/_{o}$ of the rock, in a matrix of plagioclase lathes averaging 0.2mm. long, $20^{o}/_{o}$ euhedral magnetite, and $10^{o}/_{o}$ clear glass containing tiny rounded grains of augite averaging 0.05 mm. diameter and forming 30 per.cent of the rock.

PERMIAN SYSTEM

Permian rocks outcrop in the valley of the Don River and east of there to beyond Latrobe. This area of Permian rocks is the Mersey Coal Basin of earlier authors and was considered a distinct basin because the coal seams did not correlate with other seams known in Tasmania(Selwyn,1855,Reid,1922,p.222). Recently Ahmad(pers.comm.)has found evidence that the boundaries of the outcrop were of palaeogeographic significance in early Permian time,so the term Marsey Basin is thus valid in the sense of a Permian basin of deposition. Mapping in the Don Valley shows the present distribution of Permian rocks is structurally controlled,and the term Don Graben is used for this Tertiary structure.

The Mersey Basin is of economic importance,containing a thin but widespread seam of coal which has been mined extensively at Tugrah,Aberdeen,Tarleton,Spreyton,Dulverton and Sherwood. In the area mapped only three companies have operated. Messrs.Dean and Denny located coal outcrops in the bed of the Don River west of Aberdeen(9250N,4294E),and their shaft in the centre of the river flat struck coal at 26 feet(Selwyn,1855). Coal was mined in 1937 just south of Buster Road(9193N,4293E) by Foster and others. This occurrence is immediately opposite the old workings of the Mersey Coal Company. Gould(1861,p.9)and Reid(1922,p.227) record a borehole close to the river which passed through 7 feet of coal measures,then 243 feet through marls. Reid reports two shafts reaching the coal in 18 and 2o feet. Selwyn reports the seam was from 2'2" to 2'4" thick, with a low ash content,the coal being the best then seen in Van Diemens Land. East of the borehole a 50 foot shaft was sunk entirely in fossiliferous marls(Gould) or marls and shaley,impure limestones(Reid),but meeting no coal, Selwyn records the coal outcropping near the surface to 50 or 60 yards east of the Don River,then shows in the figure an 110 foot bore entirely in the marls without reaching coal,and further east a bore meeting the coal at 134 feet. The fault displacement is therefore about 100 feet. This fault strikes N-S,downthrowing east,and is one of the faults of the Don Graben.

The Permian stratigraphy of this area is not well known. The low topographic relief and numerous faults mean that in the field only a series of disconnecte d sections is obtained,frequently in a single lithology.The stratigraphic subdivision must therefore rest upon drillers logs. Voisey(1938) has complained that despite the economic importance of the field,and the amount of drilling done,records are scanty and no core is available.The writer has taken pains to search all available records, and has located logs that may not have been available to Voisey. Unfortunately the logs are usually recorded in such a way that identification of the lithology is difficult.The terms siltstone,sandstone, sandy mudstone,and mudstone have been applied to the same rock.A single core would be invaluable.

Voisey has correlated the logs using the assumption that the tasmanite and coal occur at the same horizon. In that he was quite justified in following Twelvetrees(1912, p.21),Reid(1924,pp.28,107;1927,p.44) and Nye and Blake(1938, p.44).These writers,largely influenced by Reid,have based this conception upon two considerations--the fact that the shale fields and the coal fields do not overlap,and a supposed conclusive outcrop at the Bott Gorge.The former is answered by the Bore No.4 of the Adelaide Oil Exploration Company at Native Plains(Reid,1924,p.84) which intersected coal at 50 feet and tasmanite at 596 feet.Twelvetrees considered this bore anomalous.Furthermore,there is now structural evid nce that the outcrop distr bution is fault controlled(Reid,while pointing out the numerous faults, still considered the boundary to be an unconformity,in which case abutting outcrops are evidence of contemporaneity) and the seperate occurrence of coal and tasmanite is due to stepped graben and horst structure.

The Bott Gorge outcrop is about 200 yards east of the mouth of the gorge(4294E,9178N)on the south bank of the Don River.Describing this,Reid(1924,p.98) says:

"In addition to the deposits of ordinary shale occurring in the central part of this(Mersey) field, a thick seam of carbonaceous shale occurs at the northern end of Bott Gorge. This shale is of particular interest in marking the transition stage between tasmanite and the xxxxxxxxx coal". In 1927(p.44) he says:

"In the bed of Don River below Bott Gorge is a thin xx seam of black coaly shale which differs in many important respects from tasmanite and apparently marks the transition stage between it and the humic-kerogenite coal of the region, for in addition to sporangia of tasmanite it contains black coaly matter derived probably from another order of plants".

Gould(1861)records this as simply a coal outcrop. Reid states the outcrop is in the bed of the river,but though three seperate visits (drought periods) have been made,the only outcrops found have been barren mudstones. One waterworn piece of shaley coal was found,but is probably derived from upstream. The collapsed mouths of two adits were found about 100 feet above the river,driven under a bed of sandstone. Excavations in a small creek between these adits failed to expose the seam. However Reid states(1924,p.99) the seam is in two bands,three to four feet thick,seperated by sandstone.

The only other tasmanite outcrop in the valley is on the western bank of Ray Creek at Nook (9152N,4302E). Here the seam underlies sandstone. Strewn on the surface were found fragments of a fissile black shale with numerous plant remains. Tasmanite was not found,and may not have been abundant. Nye(1933,p.102) says the seam was from 4 to 6 feet thick. This generally confirms Reids observations at the Bott Gorge. There is no hesitation in correlating the two outcrops,which are a fissile, carbonaceous shale or coal with tasmanite spores. There is a possibility that Dean and Denny's workings,and Foster's Mine, are in this material. Furthermore,local inhabitants report the occurrence of a 'coal seam',mentioned indirectly by Reid,in the bed of the Don River at the Lower Barrington Bridge. Available evidence points to this being a carbonaceous shale underlying the tasmanite, although it cannot be disproven to be equivalent to the tasmanite.

However, the occurrence of tasmanite spores in coal does not prove that this coal is equivalent to the major seam-it merely indicates that the tasmanite may grade laterally into a coal seam, or alternatively that the deposition of tasmanite was diluted here by the introduction of plant remains. The proof rested with Reid's interpretation of the boundary as an exhumed unconformity with small structural complications, whereas in fact the structural complications are large, with the surface of the upthroen block being an exhumed unconformity. The relatiohship of the coal to the tasmanite is therefore reinstated as a problem to be solved.

The sequence beneath the coal is variable, so reference will only be made to bores close to the area. These are the No. 1 (or No. 2) bore at Tarleton(Johnston, 1888, p. 132; Reid, 1924, p. 112) the Adelaide Oil Company's bores Nos, 6, 7, 11, at Spreyton and Tarleton(Reid, 1924, pp. 109-113) and the Alfred bore near Tarleton (Reid, 1922, p. 225). Unpublished bores from Dulverton(1934) will be used as well.

These bores are characterised by a basal conglomerate and sandstone, with marine fossils, varying between 12 and 105 feet thick. Selwyn(1855) records this as 200 feet thick in Mr. Williams shaft at Tarleton. This formation is part of the Lower Latrobe Stage of Voisey, which consists of of

"marine conglomerates, pebbly sandstones, sandstones and mudstones containing Fenestella plebeia, Stenopora tasmaniensid, Spirifer tasmaniensis. Pleurotomaria morrisiana,, and almost certainly. Eurydesma cordatum."

So far as is known, this conglomerate, the main artesian aquifer of the basin, outcrops in only one locality, southeast of Buster Road. The basal formation on the Great Bend is a lenticular tillite, which is correlated by Jennings with the Stockers Tillite of the Quamby Brook area(Wells, 1954). The conglomerate appears to be a facies variant of the Stockers Formation, since both are overlain by pebbly mudstones in the Mersey area. The formation is equivalent to the 'D' and 'E' of Twelvetrees(1912,p.49) but is not underain by any mudstones. The basal mudstones to which Twelvetrees refers overlie the tillite and overlap onto the sub-Permian hills. Mapping by the writer at Western Creek and Dairy Plains shows the tillite occurs in depressions in the limestone,overlain by Quamby and Golden Valley mudstones and and limestones,which thin rapidly onto the sub-Permian hills and the sequence becomes basal conglomerate,about 100 feet of highly fossiliferous mudstones, overlain by sandstone which is probably the Billop. In this condensed sequence the conglomerate may be equivalent in age to parts of the Quamby. Hence the conglomerate is designated a seperate formation,the Buster Road Formation,and if it is shown to be areally continuous with the the Stockers Tillite(in view of the Western Creek exposures,requiring the formation to be strongly time transgressive),this will be the Buster Road Facies of the Stockers Formation. Similar conglomerates outcrop at Flowery Gulley and at Barn Bluff.

In the type locality (4293E,9185N) the Buster Conglomerate is a conglomeratic sandstone,containing subangular pebbles avera ing one inch diameter,but up to two inches,in a matrix of felspathic sandstone. The pebbles are mainly white quartzite,but some are locally derived schist and conglomerate. Beds of highly conglomeratic rock,in some cases their base being a marked diastem,alternate with banded sandstone,pebbly sandstone,and occasional rare lenses of fossiliferous sandstone. The thickness in the type area is probably 50 feet,but elsewhere ranges betwee 20 and 200 feet.

Samples of the fossils were submitted to G.Lane for identification. He furnishes the following description:

"<u>Eurydesma cf.hobartense</u>(Johnston)1888

<u>Material</u>:Two internal moulds of left valve preserved in conglomeratic sandstone.

<u>Observations</u>: The specimens agree with published descriptions of <u>E.hobartense</u> in shell proportions,outline,and convexity. The hinge line is obtusely bent just below the

umbo, and the umbones are low, rather blunt and only moderately raised over the shell margin. The retractor muscle scars follow the general pattern of E. hobartense but are less prominent and show en echelon pattern along the anterior umbonal slope.

The specimens at hand also differ from the published material in their larger size: E. hobartense usually being about 42 mm. in length and height, the specimens here being up to 60 mm. in length and height. The specimens differ from E. cordatum in the umbo size, general outline, shape of the hinge-line, and arrangement of muscle scars.

Platyschisma cf. rotundum (Etheridge) 1872 Etheridge 1892:

Material: Numerous broken internal moulds and several external moulds in a slightly conglomeratic sandstone.

Observations: The specimens at hand differ from genera common in the Permian which are related to Platyschisma principally in abseoce of a keel on the periphery of the whorls. Both Keenia Etheridge and Hourlonia de Koninck have a gross structure similar to Platyschisma but possess keels. The surface ornamentation on specimens at hand is simple, rather weak and consists of thin, closely spaced lines, slightly sinuous and directed anteriorly. Four whorls are developed, expanding rather rapidly. The apical angle is large.

The only commonly occurring species of Platyschisma in the Permian of Australia is P. rotundum. P. oculum has been reassigned to the genus Keenia Etheridge. The specimens are therefore provisionally placed in P. rotundum. "

In addition numerous wood stems are present. The environment was marine with forests on bordering lands.

Overlying the Buster Road Conglomerate is a thick sequence of pebbly,fossiliferous mudstones,mudstones and sandstones. This formation is named the Nook Mudstone.The type locality is the bed of the Don River near the bridge at Lower Barrington.

Several hundred yards north of the bridge is an outcrop of highly fossiliferous pebbly mudstone,crowded with a very rich molluscan fauna including Eurydesma and Platyschisma, spirifers and bryozoans.This rock is also exposed at Parson's cut,at the entrance to Bott Gorge.Fossils from this have been submitted for determination.This bed appears to be the very base of the Nook Formation,although according to K.G.Brill (U.T.G.D.Excursion,1953) it is underlain by a mudstone containing plant spores.There is some little doubt that the bridge outcrop may not be a lens of Permian beneath the dolerite,rather than the downfaulted occurrence of beds overlying the dolerite.

The overlying beds are non-fossiliferous,blue mudstones, with scattered erratics including limestone pebbles.

About 50 yards north of the Don Bridge,in a bank overhanging the river,an extremely weathered outcrop of of soft, blue sandstone was found.This weathers yellow,and is without pebbles or marine fossils.It contains black laminae which appear to be plant fragments.The excavation for the new bridge abutment reveals a siltstone containing wood stems.It appears the 'coal seam' recorded here occurs in this sandstone.

Overlying this are highly conglomeratic beds,strongly resembling the Buster Road Conglomerate except that the matrix is argillaceous.Some boulders 2 feet in diameter occur.This is exposed about 100 yards east of the Lower Barrington bridge. The pebbles consist of schist and quartzite.What is probably the same conglomeratic band occurs on the eastern bank of the Don river north of the Bott Gorge.

The overlying beds are exposed in the bed of the Don river south of the Don Bridge,and in a road cutting at the Nook turnoff.The rock is a pebbly blue mudstone,with pebbles of white quartzite averaging one inch diameter.Bedding is sometimes very poorly developed,the only structure being a weak shaley parting. This weathers to a soft yellow,friable clay.

The thickness of the Nook formation is 152'6" in the No.1 D.D. at Tarleton,273 feet in the Adelaide Oil Bore No.7, 117 feet in No.6,467 feet in No.5,and more than 500 feet in No.11. The bore of the Mersey Coal Company at Buster Road indicates a thickness exceeding 243 feet. Indications in the type area are a minimum thickness of 400 feet,and a probable thickness of 350 feet to the base of the tasmanite-bearing sandstone. It will be noted that the indicated sequence of lithologies at the base of the formation,fossiliferous pebbly mudstone mudstone,carbonaceous sandstone,and pebbly mudstone,is identical with the Adelaide Oil Bore No.5 at Tarleton. This formation is equivalent to both the Brumby and Golden Valley mudstones of Western Creek.

A sandstone member,desigmated the Ray Creek Sandstone Member,occurs at least 400 feet above the base. The exact position is unknown,and it cannot be proven not to be equivalent with the Liffey Sandstone,so it is defined as a member of the Nook Formation rather than as a seperate formation. It seems fairly certain,though,that it it is succeeded by about 100 feet of mudstone,assigned to the Nook Formation,before the base of the Liffey is reached. This Ray Creek member contains a tasmanite seam at Ray Creek which is described in detail by Twelvetrees(1911,pp.92-95). The sandstone and tasmanite also outcrop near the mouth of Bott Gorge. Here the underlying mudstone is is a blue shale with occasional mica flakes,shaley parting but no bedding,and is free of pebbles. The sandstone is a dirty carbonaceous sandstone resembling lithologically the Dabool Sandstone of Western Creek. The matrix is felspathic. Twelvetrees (1911,p.54)records glendonites in the sandstone.

Twelvetrees notes that the mudstones overlying the sandstone are yellow and bluish-grey,pebbly,weathering to a buff tint. Cavities and decomposed kernels remain from weathering of the enclosed pebbles. He says:

"The upper mudstones are more clayey than sandy, and in this respect differ from similar rocks overlying the coal measures, or occurring below the tasmanite".

The tasmanite seam itself contains isolated pebbles and casts of marine shells. The tasmanite is probably about 150 feet below the overlying Liffey sandstones, which makes the total thickness of the Nook Formation 500 feet. The tasmanite -bearing sandstone, on this reconstruction, is therefore equivalent to the Billop sandstone of Western Creek.

Overlying the Nook Formation is the coal-bearing sandstones, correlated by Jennings (pers. comm.) with the Liffey Sandstones of Blackwood Creek. Johnson (1888, p. 132) and Reid (1922) give numerous sections through these sandstones, and ten bores were put through it in a boring camaign at Dulverton (Tas. Mines Dept. unpublished records, 1934). The average sequence is 40 feet of lower sandstone, a two foot coal seam, and 80 feet of upper sandstone. At Tugrah the coal occurs in mudstone underlying a 60 foot thick sandstone.

The Liffey Formation consists of interbedded shales, micaceous laminated siltstones, and thickbedded felspathic sandstone. In Fosters shafts (4294E, 9193N) the only exposure is deeply weathered blue siltstone, with abundant plant remains.

Since the earliest days of the coalfield (Selwyn, 1855) this sandstone has been considered equivalent to the Greta Coal Measures of N.S.W. Thureau (1885, p. 4) records Glossopteris browniana and Sagenopteris in the shale immediately above the coal. He records that a tasmanite seam occurs in this position, but no confirmation has been obtained.

The sequence above the coal measures is not known with any exactitude. The basal beds are fossiliferous pebbly mudstones occurring in the shaft of the Illamatha Mine, and recorded in coal creek. There was great controversy in the early days as to whether this was equivalent to the similar beds in the

Nook Formation, although the argument was not expressed in those terms, but as to whether coal occurred beneath them or not. This mudstone is overlain by a sandstone which outcrops on Buster Road near the Aberdeen turnoff, and is possibly the same as the sandstone on the Roland Highway near the Eugenana turnoff. Overlying this are beds of alternating mudstone and siltstone, outcropping in road cuttings at South Spreyton. The formation is also exposed on Kelcies Tier, where it contains a barren, shaley limestone on the tunnel for the Devonport Water Supply, and pebbly mudstones underneath.

This formation is designated, provisionally the Bonneys Tier Formation, the type locality being the slopes of Bonneys Tier near Coal Creek at South Spreyton. The thickness is at least 110 feet (Mersey Coal Co. bore) and is probably about 450 feet. On Bonneys Tier, Banks (U.T.G.D. Excursion, 1953) has measured the thickness of this formation at 500 feet. The Lucky Nook coal mine occurs high on Bonneys Tier, and may be a coal seam in this formation. Alternatively it may be the Liffey Coal seam. Until the structural problem is solved by regional mapping, it is unwise to say the formation extends up to the summit of Bonneys Tier.

Overlying the Bonneys Tier Formation is a sequence of sandstones and pebbly mudstones. The formation outcrops beneath the dolerite on Kelcies Tier, and is about 200 feet thick, but is thin or absent on Bonneys Tier. This may indicate transgression of the dolerite. This formation is named the Kelcies Tier formation, and the type locality is on Kelcies Tier near the small reservoir of on the Devonport Water Supply pipeline. A description of exposures in artificial openings is given by Burns (1956). This formation is the Pb and Pc of that paper, and also occurs downfaulted from Kelcies Tier on the Tugrah Road about one mile from the turnoff.

The basal beds ~~are~~ are conglomeratic sandstones with plant fossils, containing boulders up to 18" diameter of pyritic black quartzite and white quartzite. The carbonaceous material gives a strong smell of sulphuretted hydrogen on freshly broken surfaces. On weathered surfaces the sandstone has a black, spotted appearance, apparently due to bituminous matter. The overlying sandstone is blue-green when fresh, consisting of pebbles of quartz, black quartz, and quartzite, averaging ¼" diameter, in a quartzose matrix containing only a little clay. These seem to merge upward into brown siltstone and claystone, weathering blue and orange, and containing small quartzite pebbles.XX

The Rifle Range road at Quoiba shows about 100 feet of shale overlying a a sandstone, which may be either the Kelcies Tier sandstone, or else a sandstone band in the Bonneys Tier formation, such as the one outcropping at Tugrah in a similar position.

The Permian sequence is therefore (provisionally):

Kelcies Tier Sandstone, conglomeratic sandstone, and pebbly claystone .... 200 feet

Bonneys Tier mudstone, pebbly and fossiliferous mudstone, sandstone, interbedded sandstone and siltstone, and interbedded limestone and shale .... 450 feet

MXMMXX Liffey sandstone, laminated micaceous siltstone, shale, one 2 foot coal seam and other less persistent seams .... 120 feet

Nook pebbly and fossiliferous mudstones, and barren mudstones, containing the Ray Creek sandstone member and a tasmanite seam .... 500 feet

Buster Road conglomerate and sandstone, possibly a facies of the Stockers Formation .... 50 feet

Total thickness (approx.) 1320 feet

JUNEE GROUP

The Ordovician rocks are quite widespread,consisting of ferruginous quartzites and shales,with lenticular conglomerates,overlain by isolated patches of limestone.

On the Badger Range at Nook the basal beds are a purple quartzite conglomerate with occasional bands about 12" thick of pink quartzite. The exposed thickness is only a few hundred feet. This basal conglomerate outcrops at Barrington(4270E, 9112N)where it is a white,well sorted quartzite conglomerate with well rounded pebbles ranging from 1/8" to 1/2" diameter.

At Lower Barrington the sequence is repeated by strike faulting,but a small outcrop of the conglomerate is exposed on the western side. On the downthrown side,the pebbles are much larger,averaging 1" diameter,and the matrix is blue in colour with pebbles pink. This passes along the strike into a white,structureless quartzite,about 50 feet thick,which also forms the base of the sequence west of Melrose. The overlying rocks are flaggy bedded quartzites with thin bands of shale. A cutting on the old Melrose tramway exposes a soft friable sandstone from which indistinct brachiopods and worm casts were obtained. A road cutting about 30 chains ~~xxx~~ east of the Lower Barrington post-office contains shale with thin tubular worm burrows up to 3" long,perpendicular to the bedding.

In the Denny Gorge the basal beds in the south west are cherty breccias,with siliceous matrix,passing rapidly upwards to a quartzite conglomerate. There appear to be two conglomerate bands,the lower one about 30 feet thick. At the ~~mouth~~ entrance of the Denny Gorge two bands occur again,seperated by about 50 feet of flaggy quartzite. This quartzite contains large gastropods. The total thickness is probably less than three hundred feet,although repetition by thrusting makes estimation difficult. The ~~total thickness~~ top of the sequence is represented by a soft,laminated,buff coloured shale,containing abundant trilobites,brachiopods and pelecypods. Samples have been submitted to M.R.Banks for identification. This shale also outcrops at Paloona,where it immediately underlies the limestone. The thickness is at least 50 feet. This bed also outcrops in the Don River at Lower Barrington, underlying the limestone, and is highly fossiliferous. Similar shales underly the limestone at Chudleigh.

The basal beds on the hill east of Paloona Bridge are conglomerates with gastropod fossils. On the Precambrian hill to the north the base is a ferruginous sandstone with tiny rounded pebbles of quartzite.

The basal lithology on the Kindred Ridge is a coarse quartzite conglomerate overlain by white sandstones containing tubicolor casts, which are readily divisible into two sets, a branching set lying parallel to bedding, and a non-branching set that occur perpenicular to bedding. The first set occupy planes in the rock, the second set occupy a volume, which means the attitude of the bedding can be determined with any random section. This was particularly useful in mapping at Round Hill.

On Eardley Tor the basal bed is a thinbedded white quartzite. This is less than 40 feet above the unconformity. The overlying rock is a poorly sorted, thic ly bedded conglomerate, consisting of rounded pebbles of quartz averaging 0.2"diameter of various colours, orange and pink predominanting, in a matrix of white quartz sand. This bed is 40 feet thick. Overlying this is between 40 and 100 feet of white, thinly-bedded quartzite containing tubercles. The next lithology is only 10 feet thick, being a conglomerate containing pebbles of chlorite schist(90 per.cent) quartz-mica schist and quartzite, the rock being remarkable for the elongated prismatic shape of the fragm ents. Overlying this is 20 feet of ferruginous quartzite containing muscovite flakes. Total thickness is about 200 feet.

In the Leven Gorge the base is a quartzite conglomerate making a 60° unconformity with underlying argillites. This appears to be ~~less than 50~~ several hundred feet thick, with overlying coarse grits and sandstones. The total thickness is probably less than 500 feet.

The name Owen Conglomerate applies to the thick axial belt of quartzite conglomerates occurring on the West Coast Range and North Coast Range. This is about 1000 feet thick on Mt. Roland, thinning rapidly to about 100 feet on Tin Spur, 2 miles south of Mt. Claude, and to a measured thickness of 10 feet in the Lobster Gorge at Chudleigh, 10 miles east along the strike.

This conglomerate is overlain at Round Hill by 800 feet of quartzites, sandstones and shales containing occasional brachiopods (5-Mile Rise) and numerous tubicolor casts. The two lithologies are well differentiated, no coarse conglomerates occurring in the tubicolor sandstones, which overlap onto the Precambrian to the south.

To the north the whole of the sequence is represented by the Caroline Creek beds at Railton, which contain conglomerates, but consist mainly of sandstones and shales.

In the eastern part of the area under discussion, there is nothing comparable to the thick axial wedge of Owen Conglomerate. Simliar conglomerates exist at the base of the sequence, but are lenticular, changing along the strike to quartzites or wedging out altogether. Further, more than one conglomerate band occurs, and there is no basis for distinguishing between them. Since some of the conglomerates overly sandstones containing tubicolor casts, the definitive character of the Tubicolar Sandstone, then to name these higher conglomerates Owen Conglomerate is to contravene the Law of Superposition.

The sequence more probably represents the overlapped Tubicolar Sandstone. It is similar in lithology and relationships to the Caroline Creek Sandstone and Shale, so this name is used. The name Dial Range Conglomerate has been applied to the outcrops in the west, but this term has been used indiscriminately to include conglomerates now believed to be Cambrian.

The conglomerate beds are thickest on the Badgers and the Dial Range, which were probably slighter deeper troughs in the Tremadocian.

DUNDAS GROUP

031 The Dundas Group as defined by Elliston(1954,p.165) consists of the rocks exposed in two sections at Dundas, overlies the Precambrian unconformably and in the type area underlies Gordon Limestone. The highest formation exposed is the Misery Conglomerate which is almost identical with a breccia exposed in the Gawler River about 1 mile north of the fork of the Gawlers. It is proposed to restrict the term Dundas Group to that group of rocks occurring at Dundas, and their correlates, but which underlie (unconformably) the Wilsonia Group of probable Upper Cambrian age. The time range of the Dundas Group is therefore restricted from the whole of the Cambrian post-dating the Stichtan Orogeny(Carey and Banks,1954) to that part of the Cambrian post-dating the Stichtan Orogeny and preceding the Dial Orogeny. xxxxxxxxxxxxxxxxxxxx It is possible that there is an unconformity at the base of the Preston Breccia of the North-West Coast which would call for subdivision of the Dundas Group. This point will be discussed further.

The Dundas Group on the North-West Coast is a thick sequence of cherts, greywackes, argillites and claystones, containing an areally resticted lens of spilite which has limited interfingering cherts, argillites and claystones; and what appears to be a strongly transgressive magnafacies of intermediate volcanics of the splilite suite containing pyroclastics ranging from lutites to rudites, and numerous wedges of lava. These volcanics interfinger with cherts and clastic sediments over a wide area. The probable stratigraphic relations are shown in the diagram, which is schematic only.

It will be noted that the subdivision xxxxxxxxx into formations is somewhat indefinite in the upper part of the volcanics. This is because no definite stratigraphic markers are available, the sedimentary rocks being very similar and no fossils having been found. There is apparently cyclical repetition of the same kind observed by Elliston at Dundas. There is a strong possibility that the volcanics and cherts were uplifted into a geanticlinal zone in the Tyennan(Cambrian) orogeny,and that the overlying formations lap onto this. The sequence appears to overlap onto the Precambrian,which early in the Cambrian was the site of chert and limestone deposition which did not continue into the trough. The sequence thickens rapidly to the southwest,due to Tyennan subsidence by crustal warping or even faulting.

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PETROLOGY

Several distinctive rock types are widespread in the Cambrian, and cyclical repetition of cherts, keratophyre tuffs, and greywacke and arkose, seems to have occurred.

The cherts are blue or green in colour, coherent, with smooth feel and conchoidal fracture. Thin chips are sometimes translucent. The Dundas Group cherts are thickbedded, in beds up to 12" thick, and are finely laminated. It was possible to trace one lamina at the Paloona Bridge for 30 feet. Internally the rocks sometimes show tiny slump folds and faults with 1/10" displacement.

Specimen 17, from the West Gawler River (9198 N, 4124E) is a green sub-translucent rock with illdefined laminae about 10 mm. thick and strings of golden coloured inclusions, probably pyrite. The rock consists of tiny shreds of quartz in an irresolvable groundmass, with flakes of chlorite up to 0.5mm. diameter forming 5 per.cent of the rock.

Specimen 64, from the East Gawler River (4117E, 9147N) contains scattered quartz grains up to 0.1 mm. in a cryptocrystalline matrix of shreds of sericite, and opaque patches of leucoxene and limonite after ilmeno-magnetite. The sericite is arranged on a reticulate pattern due to shearing. This is a common feature in many of the rocks.

Specimen 14 from the Ulverstone Waterworks (9200N, 4126E) consists of about 5 per.cent tiny chips of quartz averaging 0.05 mm. diameter in a matrix of fine grained quartz containing 5 per.cent sericite, and 20 per.cent iron ore, as amorphous aggregates averaging 1mm. diameter The sericite is again arranged upon a reticulate pattern. In the field this rock occurs in beds up to two feet thick. The rock is milky white in colour, with orange spots due to the iron ore. The rock is an argillaceous chert, and is particularly common in the Alma Formation where it crosses the Wilmot River, and in the East Gawler Formation, which is probably stratigraphically equivalent.

Specimen 13 is a similar porcellanite from the

034 Paloona Waterworks(4243E,9173N). Inthe field the rock disintegrat when struck with the hammer,and is a recemented fault breccia.

The rock consists of chips of quartz averaging o.5 mm. diameter in a matrix of very fine grained quartz and sericite averaging 0.05 mm.diameter.The cementing material appears as recrystallised quartz in cracks through the rock.

A very characteristic laminated siltstone occurs throughout the sequence,in the Aitken,Copper Creek,Wilmot,and Motton formations.Specimen 10 is from the area of finest development, on Copper Creek(4216E,9143N).This contains lenses of sand,up to 1/2" thick,thinning to about 1mm.in 2" laterally.These lenses are enclosed in thin laminae of dark shale,which vary in thickness from 20" to 1mm.and are frequently contorted by contemporaneous slumping.F.Blake(pers.comm.)has found similar stuctures in silicified rocks at Cuprona.

Pyroclastic rocks are extremely abundant.The finest grained tuff recognised is specimen 22,from the West Gawler River where it overlies spilite(4091E,9104N).The rock is very soft, green in colour,with crude layers 1/2" thick defined by iron-stained partings.The rock is coherent,but very porous,and tends to slime when ground.It consists of 5 per.cent tiny chips of quartz,5 per.cent iron ore,in a matrix of tiny latheshaped crystallites which may be plagioclase.The iron ore is arranged in styliolitic bands.The rock is a fine-grained ashstone. Microstyliolites have been recorded in other tuffs by Burma and Riley(1955).

The pyroclastics of arenite and rudite grainsizes usually contain lathes of plagioclase visible in hand specimen. Specimen 35 from Nook(4287E,9119N) occurs as a band several feet thick interbedded with slates.In hand specimen the rock is green,coherent,with white ~~felspars~~ spots and quartz and rock fragments in a dark green matrix.It consists of irregular grains of quartz,ferromagnesian minerals and rock fragments,one rock being a white felspar porphyry which weathers to the white spots. One rock fragment shows graphic texture.

Specimen 41,from south of Sprent(4166E,9136N) is cream in colour with fragments of rocks and felspar crudely aligned parallel to the jointing. The rock consists of 5 per.cent muscovite, 55 per.cent cloudy broken felspars, in a structureless very weathered matrix without quartz.

Specimen 24 from Central Castra(4099E,9165N) is interbedded with the Preston Breccia. The rock is hard and massive, spheroidally weathering, and consisting of 50 per.cent felspar in a green matrix. It passes along the strike into cherty breccia. Microscopically it consists of rounded, corroded, and cracked felspars up to 3mm. long, completely sericitised, with chipped edges. The matrix is very fine grained, containing minute quartz grains and tiny felspar lathes. A very prominent fracture zone causes en echelon cracks in the rock.

Specimen 25 from south of Sprent is a very characteristic lithic tuff which contains pieces of pumice in places, and strongly resembles the Massive Pyroclastics of Rosebery. In fresh outcrop it consists sometimes of fragments of felspar porphyry in a green chloritic matrix that has been seen with boulders of slate up to 8" diameter. The matrix sometimes contains lathes of detrital plagioclase. The specimen is a vivid green colour, coherent, fine grained, with holes filled with orange limonite. It weathers to a white clay. Microscopically it is medium to coarse grained, containing rounded felspars averaging 0.5mm diameter, sometimes completely obscured by cloudy alteration. Rock fragments include slate, basalt, quartzite, and pieces of quartz. The matrix forms 50 per.cent of the rock and contains irregular masses of chlorite and brown iron ore.

Specimen 29 is from the Paloona Bridge(9177N,4235E) where it contains boulders of black slate up to 2 feet diameter. Specimen 33(4179E,9182N) and 38(9168N,4157E) is a tuff that persistently underlies the purple keratophyre of the Sprent formation. This consists of large fragments of chert and pelite up to 2"diameter, pink and green chert, and white felspar crystals in a dark, finegrained, chloritic matrix.

Specimen 15 from the West Gawler River(9198N,4124E) and in hand specimen is a coherent, red rock with irregular fracture, weathering rapidly to a red soil. The rock shows a crude alignment of black slate fragments up to 5mm. long. The matrix contains 50 per. cent large rounded felspars up to 1mm. long in a finegrained groundmass containing quartz, chlorite sericite and iron ore. The red colour is due to limonite stains.

Specimen 18 from the East Gawler River(9167N,4118E) consists of large pieces of white felspar porphyry (with pink plagioclase and a white matrix) ~~in a matrix~~ consisting of white felspar and green chlorite. The porphyry fragments have ragged felspars in a fine grained cryptocrystalline groundmass with patches of common orientation showing twinning. This pattern is common in the lavas and may be due to regrowth. The matrix of the tuff consists of euhedral or slightly rounded plagioclase averaging 2 mm. diameter in a groundmass of magnetite, intergrown chlorite, and reticulate sericite, the latter pattern due to shearing probably related to the strong axial plane cleavage of the rocks in this area.

These crystal tuffs and lithic tuffs grade into greywackes. In the field the distinguishing criterion is the presence of felspar crystals in the tuffs.

Specimen 62 from Lower Wilmot(4187E,9123N) is an unusual variety of tuff. In hand specimen it consists of cored, rounded pellets of red felspar, possibly orthoclase, within a green chloritic matrix. In the slide the large crystals are completely altered, and the cores may be tiny lathes of felspar. The matrix consists of small lathes of plagioclase in a matrix of chlorite and tiny felspar lathes. The rock is very probably a lapilli tuff.

In the field it is very difficult to distinguish the fine grained porcellanites, ashstones and interbedded fine grained lavas. The volcanics are identified by the occurrence of felspar crystals, and these not being visible in non-porphyritic lavas, it is probable that many lavas were missed. They can only be recognised where they are vesicular.

~~Specimen 65 from the East Gawler River (41XXE,91X7N) is~~

Specimen 58 from the western abutment of the Paloona Bridge is a leucocratic fine to medium grained rock, with felspars up to 4 mm. diameter and dark concentric structures. Microscopically it consists of phenocrysts of felspar, probably albite, in a very fine grained matrix of interlocking felspars. The concentric structures are vesicles filled with zeolites and green clay. Specimens 32(4118E,9172N) and 31(4180E,9149N) are similar lavas. They have a blue-grey matrix, and are highly vesicular. Specimen 63(4183E,9144N) is a blue, finegrained vesicular lava containing altered albite phenocrysts in an interlocking matrix of chlorite and felspar, containing disseminated iron ore including pyrrhotite.

These lavas are keratophyres, but the white or blue colour is very uncommon and these are merely variations of the dominant type which is very widespread, and which is described in detail.

The best known outcrop of these purple keratophyres is underneath the pumphouse building on the eastern side of the River Forth at Paloona. This outcrop contains beds of lava two to three feet thick, defined by bands of interbedded pelites up to three inches thick which dip vertically. This outcrop was considered by Twelvetrees(1909, p. 12) as an intrusive dyke, but the interbedded pelites preclude this. This rock is bedded everywhere it is encountered. At Moreton Road it is underlain by a greywacke and tuff, and this relation ~~xxxxxx~~ holds on the other side of the syncline. In the Gawler River about 1 mile north of the Fork of the Gawlers the rock has a distinct hackly jointing, and columnar jointing has been found in acid rocks of the same age at Beulah.

The rock is usually massive, but is often vesicular, with

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the vesicles arranged in aligned trains. The vesicles are commonly lined with zeolites.

In hand specimen the rock is characteristically porphyritic with phenocrysts of white(sometimes pink)felspar.and large blobs of a dark green mineral in a purple matrix. Even when badly weathered the rock is unmistakeable

This rock is the 'granophyric quartz-felspar porphyry' of Twelvetrees,but no quartz phenocrysts were observed. Slide U.T.G.D. 5378 consists of anhedral,clear(only slightly sericitised) twinned phenocrysts of albite($Ab_{91}An_{9}$) in a matrix of microlitic felspar with interstitial quartz. In some (micro-poikilitic) patches all the quartz has common orientation. Phenocrysts of penninite,apparently after augite occur with occasional grains of magnetite and veins of calcite. The whole of the matrix is stained brown. The phenocrysts average o.5mm.diameter and constitute 40 per.cent of the rock. In specimen 27,remnants of the augite occur,but most of it is replaced by penninite. The matrix is darker in colour due to more abuhdant iron,and large pieces of magnetite are present. The chlorite is iron stained. Ragged porphyroblasts of quartz occur up to 1mm.diameter,with marked undulose extinction. The vesicles are lined with growths of quartz and filled with radiating chlorite. Specimen 37Q5 from the Leven Gorge is very similar,but the plagioclase has been almost completely sericitised and chlorirised. Twelvetrees records that these rocks contain hornblende.

The rock is a chloritised augite keratphyre. The albite phenocrysts appear to be primary. Occasional ones are fractured, with the twin lamellae offset across the fracture,which has been healed with fresh albite,but cannot be traced into the groundmass. This suggests albitisation preceding solidification. Similar fractures filled with chlorite and iron ore continue through the matrix,suggesting the chloritisation is later. The characteristic purple colour may be due to the release of iron in the alteration of augite to penninite.

The phenocrysts are primary,as shown by their occurrence in pene-contemporaneous breccias,as in the keratophyre agglomerate

039 interbedded with the Preston Breccia at the Fork of the Gawlers. Scott(1954) advances petrological evidence to show these keratophyres are derived by alteration of basic igneous rocks, and mentions that at the time of writing these rocks are confined ~~each~~ to seperate structural zones to the basic igneous lavas. Field work shows that this evidence is no longer valid. In the Leven Gorge a thick belt of spilite occurs overlain by the Radfords Creek Formation which is largely purple keratophyre. The Clayton River tuffs and agglomerates contain ~~bax~~ fragments of both basalt and keratophyre. This widespread occurrence without regard to structural position is also noted in New South Wales, where they occur in both deep and shallow water deposits and in the terrestrial beds of the Kuttung Series. All the field evidence on the North-West Coast points to the keratophyres as being igneous, not metasomatic in origin, and the albite as having been present at a very early date.

Spilites occur in the Leven Gorge, and have also been recorded by Twelvetrees(1905) in the Copper Creek Formation at Alma. The Leven Gorge rocks have been described by Twelvetrees(1909, p.13) and Scott(1954, p.134). The pillow lavas described by Scott (1951) at Penguin are probably the same formation.

In the West Gawler River(4092E, 9165N) the spilite is dark green, fine grained, massive, with ramifying veins of a lighter green material through it and abundant euhedral pyrite in thin seams. They are distinguished from the Tertiary basalt by the green colour of the spilite as against blue or brown for the basalt, the massive nature of the spilite as against the hackly and columnar jointing in the basalt, and by the prescence of olivine in the basalts. Soil colours are very similar. The West Gawler outcrop is interbedded with ashstones and cherty breccias, the latter in places becoming spilite breccias(~~4102E~~, 4097E, 9178N).

Specimen 20, from the West Gawler River, and slides 37011 show augite occurring as irregular anhedra averaging 0.1mm. diameter, surrounded by rims of penninite. About 35 per.cent. of the rock is plagioclase in lathes averaging 1mm. diameter with indistinct albite twinning and showing alteration to sericite.

The refractive index which is always less than balsam would indicate that the variety is albite.

Sphene is abundant as subhedral crystals averaging 0.1mm. diameter, or as tiny round grains less than 0.05 mm. diameter, the latter being concentrated in narrow bands. Large calcite grains are common, as are angular grains of magnetite. Chlorite forms less than 5 per.cent. of the rock, and is concentrated as narrow bands. Flow structure is present.

The white veins observed on the outcrop are dark coloured veins, microscopically, of large crystals of calcite a d magnetite in a fine matrix of dark brown material. Sometimes broken fragments of pyroxene are strung out along the veins. These veins are probably due to shearing.

Specimen 21, and slide 37Q5 are similar although coarser grained and the former contains abundant chlorite and epidote.

Slide 37Q2 from the Leven Gorge is a relatively coarse, ophitic rock described by Scott(1954, p. 137) as a dolerite. There is no evidence for this occurring as dykes and sills, as claimed. Anhedral augite averaging .025mm. diameter constitutes 50 per.cent of the rock. Generally it is clear, but about 1/5 of it is altered to pleochroic green chlorite, brown hornblende, and brown iron ore, which completely replaces some crystals and is marginal to others. The pyroxenes are glomeroporphyritic, being collected together in clumps without common orientation which are penetrated by lathes of plagioclase.

The plagioclase is in long lathes averaging 0.5mm. long which are almost completely altered to sericite. Twinning is simple, with relief higher than balsam. the variety is probably oligoclase. In addition to the lathes there are irregular patches of less sericitised felspar, untwinned, with relief always less than balsam. This appears to be albite and appears as regrowths on the lathes of more calcic felspar. There is about 10 per.cent interstitial magnetite as irregular anhedra averaging 0.2mm. diameter. This rock is an albitised, sericitised dolerite, and indicates that some of the albitisation is secondary.

Slide 37Q7 from the Leven Gorge is labelled trachyte porphyry, and is described by Scott (1952) as a felspar basalt. The rock is porphyritic, consisting of larg rounded to subhedral phenocrysts of albite up to 0.6mm. diameter, but avera ing 0.2mm. The crystals cont in frequent small patches of sericite, but also inclu e augite. There is every transition from felspar crystals with a few augite fragments to large clumps of augite with a fringing rim of felspar. The felspar sometimes show crystal faces, but is usually well rounded, and extensively resorbed at the margins. Some of the felspar has been resorbed sufficiently to free the enclosed pyroxene.

The groundmass consists of lathes of albite, 0.1mm. long, which show marked flow structure in the vicinity of the phenocrysts. A common accessory is sphene, dark brown in colour, occurring as scattered anhedra with crystal faces rarely developed. Magnetite is also present. The groundmass also contains green pleochroic penninite, optically negative, with strong ultra-blue interference colours. This is often weathered to iron ore. There are some rare needles of tremolite. The amygdules are filled with large anhedra of quartz, with epidote and radiating masses of penninite.

The spilites are therefore a variegated group of rocks, and some of the albite is secondary. The interbedded tuffs and breccias point to a submarine, effusive origin, although pillow structures have not been found.

Stratigraphy

As has been mentioned, the stratigraphy is dominated by several interfingering magnafacies of chert, volcanics, and greywackes and argillites. The lenticular nature of many of the lavas makes lithological correlation difficult. The stratigraphy is therefore dependent to some extent upon the accidents of structure. Since generally outcrops are not good enough to provide rigorous structural control, the synthesis requires simultaneous solution of the stratigraphy and structure. The best that can be done in some areas is to identify formations in restricted areas and indicate what are probably their relationships over a wider area. For instance, their are no structural grounds for correlating the Alma and East Gawler Formations, and the correlation rests upon lithological data. The probable stratigraphic relations of the group are indicated schematically.

The nomenclature used for sedimentary rocks is after Condon(1949).

The lowest exposed formation is the Sprent Volcanics. This formation is defined as those rocks outcropping in the Forth River between the Paloona Waterworks building and the the first bend north of the bridge,excluding the Precambrian graphite schist on the west bank,The lowest bed is a massive quartzite containing chert fragments,and overlying the Precambrian with a 60^{o}unconformity. There is some doubt as to whether this quartzite may not be Ordovician,and this point is discussed elsewhere. Between this quartzite and the Paloona Bridge,on the western bank,occur argillites,a thin chert band,keratophyre tuff, and white keratophyre. The relations are obscure.

A small anticline strikes east-west between the Paloona Bridge and the Waterworks building. The lowest exposed formation is a green greywacke(the nomenclature of Condon,1954,will be used for sedimentary rocks) consisting predominantly of chert fragments. It contains large mud pellets,up to 3" long,1/2"wide,elongated parallel to the bedding. Sometim s there is an alternation of 2" bands of greywacke and soft shale. A conglomerate band near the base contains chert pebbles up to 1" diameter. This greywacke is about 120 feet thick,and contains a 5 foot band of laminated chert 60' above the base. At Moreton Road this basal greywacke is about 200 feet thick. Overlying this at the Paloona Bridge is red tuff,containing slate fragments of aren te size,and a boulder of greywacke about 3 feet in diameter. This tuff contains a lens of white keratophyre which is best exposed on the eastern bank.

At the same stratigraphic level,on the southern limb of the anticline is the purple keratophyre discussed elsewhere. This keratophyre outcrops against the basalt several hundred yards west,and is exposed to the north of Moreton Road. where it is underlain by a thin,lenticular band of keratophyre tuff,containing slate fragments and large felspar crystals.

This formation reaches about 500 feet thick at Moreton Road, where the keratophyre is seen to underlie conformably the claystones of the Kindred Road Formation.

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This formation reaches about 500 feet thick at Moreton Road, where the keratophyre is seen to underlie conformably the claystones of the Kindred Road Formation.

The Kindred Road Formation is defined as those rocks conformably underlying the Alma Cherts, and and exposed up the Wilmot Road from the Alma Bridge to the base of the Alma Cherts, and up the Kindred Road from the Alma Bridge to the edge of the basalt. The roeks overlying the Sprent keratophyre at Moreton Road are considered to belong to this formation.

This formation consists of pink and yellow claystones at the base, and about 1000 feet thick. The top of these are exposed just below the basalt on the Kindred Road. Overlying beds consist of about 1200 feet of micaceous felspathic greywacke and interbe bedded shales, containing at least two bands of cherts and argillites. The cherts exposed in the bed of the Forth River between the Waterworks at Paloona and the Forth-Wilmot Junction probably belong to this formation. Just south of this junction, in the Forth River, the formation contains a five foot band of limestone breccia, cemented with calcite.

The Alma Formation is defined as those rocks exposed in the bed of the Forth River from a point near 20 chains south of the Wilmot junction, to the mouth of Copper Creek. The total thickness is 1350 feet. The rocks are dominantly flaggy bedded cherts and porcellanites, with interbedded greywackes, thin bands of keratophyre tuff, and shales. Where this formation outcrops in the Wilmot River it contains two thick bands of keratophyre tuff, consisting of fragments of fine grained lava in a chloritic matrix containing chert fragments. The cherts contain thin intraformational breccias, and several different types of wavy undulations on bedding plane surfaces, which may be curreht ripples. The cherts are finely laminated, but this is only apparent on scoured outcrop. The rocks weather to a rock described by Twelvetrees as a sandstone. About 20 shains north of Haig Creek the formation contains a thick band od blue shale, about 100 feet thick. This is soft, micaceous, with bands of interlaminated original pyrite. No fossils could be found.

The Copper Creek Formation is defined as those rocks outcropping in the Forth River between the mouth of Copper Creek and a point 30 chains north,along theeriver,from the mouth of Haig Creek. This formation is also exposed in Copper Creek,and on the Wilmot Road .The ominant lithology is a laminated siltstone and shale with lenses of sandstone,which is described elsewhere. This seems to indicate instability in the deposit.onsl environment,the coarse material being introduced by periodic slumping. A green keratophyre tuff occurs near the top of this formation,owerlain by a greywacke breccia consisting mainly of chert fragments. Twelvetrees(1909)records several breccia bands,and a spilite,which could not be located but would be the uppermost bed. The total thickness is about 1200 feet.

The East Gawler River Formation is defined as those rocks occurring in the East Gawler River north of 91350N,to the juction with Camp Creek. Between the Upper Castra Neck and the MacPherson Mine,the lithology is almost entirely lithic tuff and greywacke,the rock fragments being a green chlorite schist. These rocks yave a strong axial plane cleavage striking parallel to the river. At the MacPherson mine is a thick bed of keratophyre, and northwards is a sequence of interbedded ch rts,porcellanites, kxxxtxx crystal and lithic tuffs,and greywacke,with occassional beds of keratophyre. North of 9160N the rocks are almost entirely keratophyre and a coarse keratophyre breccia,the latter exposed in the river just south of the bridge on the Sprent-Upper Castra Roas. A vesicular white keratophyre with interbedded chert and blue shale occurs in Camp Creek for several hundred yards upstream of the mouth. The rocks in the East Gawler River north of this are the same lithology as the exposed rocks further south,being mainly lithic tuffs volcanic breccias interbedded with cherts and sometimes greywackes. In the West Gawler River between the intake for the Ulverstone Water Supply and the fork of the Gawlers the sequence is well differentiated,consisting of about an hundred feet of chert overlain by porcellanite and then kxxxtxphyxx lithic tuff.

The thickness of this formation is unknown,but must exceed 2000 feet. It probably is equivalent to the Alma Cherts, and probably represents the transition between the cherts and the penecontemporaneous volcanics originating from the south or west and interfingering eastwards with the Alma Chert.

The Clayton River Formation is defined as those rocks outcropping in the cliffs on a small tributary of the Wilmot River from 9123N,4160E,to its junction with the Wilmot. This is the only fresh outcrop,being scoured by the water of the creek falling over a waterfall several hundred feet high. The formation outcrops extensively over the country east of the Clayton Rivulet. The rock is a coarse volcanic breccia and tuff,containing fragments of porphyritic and fine grained lavas,pumice,shale, quartzite,and other rocks in a chloritic matrix that contains crystals of plagioclase. Some weathered oucrops closely resemble the Massive Pyroclastics of the Rosebery area. The thickness is probably variable,but seems to be about 500 feet.

Conformably overlying the Clayton Formation is the Moreton Keratophyre. The type area is between 9137N and 9142N, at 4165E. This is a purple keratophyre strongly resembling that of the Sprent Formation. This is about 400 feet thick. On the track to the Wilmot River at 9120N,4177E,this is only about 50 feet thick and interbedded with fine grained clastics, probably porcellanites. On the southern limb of the anticline no keratophyre could be found,its place being taken by white porcellanites.

Conformably overlying the Moreton Formation is the Haig creek Formation,consisting of interbedded greywackes and shales in beds about 8 inches thick. The type area is the eastern bank of the Wilmot River between 9110 N and 9140N. A strong fracture cleavage is developed in this outcrop. At 9123 N this formation shows very strong drag folding associated with faulting. On the Wilmot Road north of Lower Wilmot what is probably the same formation is interbedded with a chert band about 50 feet thick which has a small lens of keratophyre less than 5 feet thick,and with greywacke breccias. The thickness of this formation is about 500 feet.

Overlying the Haig Creek Formation is the Wilmot Volcanics. The type area is in the bed of a small stream between 4161E,9156N, and 4176E,9152 N. This formation in the type area consists of interbedded blue shales, keratophyre tuffs, and numerous bands of purple keratophyre. Where this formation outcrops in the Wilmot River it contains a thick white vesicular keratophyre with felspar phenocrysts about 1mm. long. The formation thickens markedly east with the occurrence near Lower Wilmot of a thick lens of red felspar porphyry, which has not been seen fresh, but is probably a keratophyre tuff with interbedded purple keratophyres. This formation is missing on the southern limb of the Lower Wilmot anticline. Elsewhere the thickness exceeds 700 feet and may rise as high as 2000 feet.

Conformably overlying the Haig Creek Formation is the Jackson Creek Formation. The boundary is marked on the southern limb of the anticline by a lapilli tuff, and by the thick intercalated Wilmot Volcanics on the northern limb. The type area for the formation is the bed of Jackson Creek between 4206E and the Jukesian unconformity , where it consists od interbedded, flaggy bedded cherts and porcellanites with at least three seperate greywacke bands, and at the top a band of tuff. The formation is about 400 feet thick.

Conformably overlying this is the Eardley Tor shales and greywackes, exposed on the road at Lower Wilmot between 9116 N and 9111N. The formation is poorly exposed everywhere it has been encountered, but the highest beds are a finely laminated siltstone with the lenses of sand that have been remarked upon as persistently recurring in the sequence. The thickness is 300 feet.

Conformably overlying the Eardley Formation is the Braddon Creek Formation, defined as those rocks outcropping in Braddon Creek at Wilmot and north from there to the top of the Eardley Formation in the Wilmot River. This formation consists of greywackes at the base, with interbedded shales, overlain by a thick keratophyre breccia, similar in many respects to the Clayton Formation, which contains boulders of slate up to 8" diameter. This is overlain in Braddon Creek by ashstones, tuffs, porcellanites and occasional cherts. The thickness exceeds 1000 feet.

The overlying formation, which is not defined, is an enormously thick sequence of shales and lenticular siltstones, that outcrops almost as far south as the the bridge on the Upper Castra-Wilmot Road. This formation contains beds of greywacke breccia at Wilmot, and is probably equivalent to the West Gawler Formation at Preston.

The west Gawler Formation is defined as those rocks outcropping in the valley of the West Gawler River between 9125N, 4075E, and 9134N, 4087E. The outcrops are extremely weathered, but apparently consist entirely of interbedded claystones, shales, and cherty beds extremely diluted with argillaceous material. No volcanics have been observed. The thickness is unknown, but exceeds 1000 feet. The usual outcrops are powdery red soil. At 9148N this formation terminates upwards in a coarse breccia containing pebbles of chert up to 6" diameter, in a matrix of felspathic sandstone. This is included xxxxxx in the Preston Formation, which is defined as those rocks outcropping in the bed of a tributary of The West Gawler River between 9148N, 4085E, and 4078E. Immediately overlying the coarse basal breccia is a thin band of shale perhaps 100 feet thick, and then a very thick breccia, consisting of fragments of mainly black chert in a finer grained matrix of chert. fragments. At 9142N, 4080E, the breccia is in bands 2 to three feet thick, with fragments averaging 1/2" but up to 6" diameter, interbedded with micaceous arkoses. This arkose contains boulders of itself up to 2 feet diameter. This formation is extremely variable, and shows significant facies changes. At 4071E, 9125N, the chert fragments are pink and orange in colour as well as black, and pebbles of quartzite and mica schist occur, though rare. The matrix in places is pure white silica. Haematite also appears in the matrix. This change almost certainly indicates the introduction of siliceous material of Precambrian origin from the south.

In the West Gawler River at 9168N the formation overlies the Motton Spilite, and contains in addition to

050

chert, ~~kmmk~~ angular pebbles of spilite ,and boulders up to two feet diameter in a matrix of brecciated chert. Typically associated with the breccia in this vicinity is a hard,blue, coherent siltstone,showing the lenticular structure noted as common in the less highly indurated rocks,and also showing contemporaneous slumping.

This breccia is well exposed in the Leven Gorge, where it contains occasional lenses of spilite breccia. A very common constituent,almost characteristic,is limestone. A very similar breccia outcrops in the Gawler River at the fork of the Gawlers interbedded with a tough,blue,laminated shale with strong fracture and axial plane cleavage. Here the breccia contains keratophyre pebbles,and boulders of limestone up to 6"diameter which are mineralised at Dunc Macs Mine. The underlying rocks are cherts and volcanics considered to belong to the East Gawler Formation. It is seen therefore,that this rock is extremely variable,and reflects the character of the underlying rocks to a marked degree. Where it overlies the West Gawler argillites the matrix is clayey,as it nears the unassigned siliceous rocks of South Preston the matrix becomes siliceous, and where it overlies volcanics it contains pebbles derived therefrom. Limestone is absent in the south,but begins to appear in the formation as it approaches the north east, and becomes progressively more abundant and larger. This suggests the limestone pebbles are derived from the north-east,and could conceivably be Cambrian limestones from a shelf region. Very similar cherty breccias occur at Cuprona overlain by Cambrian rocks,and it may also outcrop on the Dial Range and at the coast. It also outcrops extensively on the Isandula Road between Wilsonia and Gawler,where it shows a very strong vertical schistosity directed NNW for several miles along the strike. This formation certainly indicates a Tyennan orogenic movement,but it is not known whether the transgression over various rock types(and onto the Precambrian at Cuprona) is basin overlap or an unconformity. However since the Motton Spilite contains bands of this breccia{

(as at 4091E,9165N) it is contemporaneous with the spilite. The occurrence of an argillite band near the base in the type area shows it was contemporaneous with the underlying West Gawler argillites,and bands of arkose in the Leven argillite probably means the breccia is an influx of coarse material due to tectonic uplift of bordering lands,probably by faulting,but deposition was more or less continuous in the basin. There is no structural discrepancy between the breccia and underlying formations.

The Motton Spilite is defined as those rocks outcropping in the West Gawler River between 4090E and 4096E. It consists predominantly of spilite,with interbedded ashstones,cherty breccias,and in the railway cuttings on the southern end of the Barren Hill,argillites,cherts,and highly indurated siltstones that are laminated and sometimes show the lenticular structure. The petrology of the spilite has been discussed elsewhere. The volcanics appear to be a lens in the West Gawler Formation, because no spilites have been found beneath the Preston Breccia further south.

The Leven argillites are defined as those rocks outcropping on the Preston-Central Castra road between the top of the Preston Formation,near 4077E,and Preston. The lithology is a soft yellow shale and siltstone with flaggy bedding or sometimes laminated,containing bands of arkose up to 1 foot thick, and occasional conglomeratic bands containing rounded chert pebbles averaging 1/4" diameter. This conformably underlies the Radfords Creek Formation,which is defined in the bed of Radfords Creek between near 9190N and the top of the hill. The bulk of this outcrop is purple keratophyre,which is extremely abundant at this end of the Dial Range,and is interbedded with argillites and siltstones.

If the correlation of the West Gawler Formation with the argillites and siltstones overlying the Braddon Creek Formation is correct,then it means the breccias at Wilmot may be equivalent to the Preston Breccia. The overlying keratophyres of the Leven Gorge are absent at Wilmot,suggesting restricted vulcanism.

The Aitken Creek Formation is defined as those rocks outcropping in the Don River north of 9113N and outcropping on the eastern bank till 9122N,4286E. At th mouth of the Don Gorge the rock is a soft,friable yellow shale,yellow on weathered outcrops but dark grey when fresh. This shale is remarkably fissile,and it is quite easy to obtain slabs up to five feet di meter and only a few inches thick. There is an alternation of very fine clay with slightly coarser bands. There is a band of keratophyre tuff about 50 feet thick exposed on the farmlands to the east,and a band of greywacke two foot thick,with dissimenated magnesite,was found in the river nearby. Some dendroid fossils and minute brachiopods were found in rocks correlated with this on the south bank of the Don River(91190N,42556E). A prelimijary examination by Mr. Banks indicates these may be Upper Cambrian in age. The formation contains at least one band of conglomerate in the type locality,of similar lithology to the overlying Bott Conglomerate. A detailed examination of the base of this band shows that it is underlain by 2'6" of shale,29" of green,micaceous, felspathic sandstone,$2^1/2$" of shale,then 10" of conglomerate with small rouhded quartz pebbles,$2^1/2$"of shale containing lenses of conglomerate,3'4" of soft green micaceous shale,$3^1/2$" of red sandstone,a minnor disconformity consisting of eroded hollows in the underlying shale filled with sandston ,and then shales and sandstones. This sequence suggests persistence of the shale environment,with periodic influxes of coarser and coarser detritus concluding with the conglomerate band.

In rocks of this formation outcropping further west in the Don River,this process accelerated,as the shales become finely laminated with alternations of clay and silt size paricles. The conglomerate bands become much more numerous,and much coarser. Some bands contain boulders equal in diameter to the width of the bed. The conglomerates are all very similar,and identical with the overlying Bott Conglom rate which must represent the culminating phase of the movements these rocksrecord.

The Bott Conglomerate is defined as the thick conglomerate occurring in the bed of Aitken Creek between Nook and the Don River. This conglomerate is about 700 feet thick, and outcrops in the Bott Gorge and near Buster Road. North of Buster Road claystone breccias considered equivaleht to this conglomerate make a 60° unconformity wiyh the Ordovician rocks. The rock is a greywacke conglomerate consisting of rounded boulders and pebbles of Precambrian rocks ranging from 1/4" to 6" diameter,aweraging about 1",and constitutung 50 per.cent.of the rockin a matrix that is sometimes schistose,due to the high proportion of flakes of green schist,and sometimes quartzose. The siliceous phases strongly resemble the Owen Conglomerate, and have been considered as such by all previous workers in the area.The conglomerate is interbedded with the underlying Cambrian formation,which is the main reason for assigning it to the Dundas Group,but the upper part could be the equivalent of the Jukes Breccia.The pebbles include quartzite, banded quartzites,dolomite,and other less common rocks such as biotite schist and possibly mineralised matter,but the bulk of the pebbles are mica and chlorite schist. ~~Microspecially(specimen~~

The rounded quartzite pebbles occurring in a poorly sorted rock like this suggests thst they are recycled,and the source is probably a Precambrian conglomerate such as outcrops on the Clark Plains road at Kindred. Microscopivally(specimen 36) the pebbles show strong shearing with the dev lopment of quartz augens.The matrix contains shreds of chlorite and rounded,anhedral quartz,with calcite in veins.

WILSONIA GROUP

The validity of this as a seperate group in the Cambrian depends upon the existence of an unconformity at the base of the group at Preston, where it overlies rocks of the Dundas Group.

On the west the chert overli s spilite, apparently conformably, the basal beds in the chert dipping east at 40°. At the southern end of the Barren Hill, the basal beds are several hundred feet of cherty breccia, consisting of rouded pebbled of banded black chert aver ging 1/2"dianeter, with bleached rims due probably to weathering before consolidation of the rock, in a matrix of fine white chert. This same breccia is exposed all along the western face of the Barren Hill, and in the small outliers south of the Barren Hill and west, in the Leven Gorge. In these localities it is not usually so well developed.

In the Leven Gorge outlier, the chert overlies purple keratophyres of the Radfords Creek Formation. At the sortheastern end of the Barren Hill it overlies arg llites of the Lev n Formation, and in the outlier to the northeast overlies Preston Breccia. In the west Gawler River the chert dips 25° to the west, consi tently through several hundred feet, and is underlain by a br ccia which overlies Leven argillites which dip at 60° west. At the southern end of the Barren Hill the coarse breccia mentioned is very lenticular and missing in places. The chert appears to dip west at 25°, but the underlying siltstones interbedded with the spilite dip ~~west~~ east at 30°.

The barren Hill is folded generally into an ~~xxx~~ syncline directed NNE, whereas the underlying rocks form an anticline directed NNW. he evidence is theref re very str ngly in favour of an unconformit between the cherts and the underlying rocks. The cherts overl at least three seperate formations, and there is strong structural discordance. An alternative hypothesis would regard t is as part of a very flat thrust sheet, but the b undary with the underlying spilite on the western side of the Barren Hill shows no evidence of this. The distribution of outliers, particularly the one in the Leven Gorge, is such that on the topo raphy alone the thrust sheet would need to be strongly folded after emplacement. In that case a closwer correspondence with the folds in the underlying rocks would be expected.

This unconformity at the base of the Wilsonia Group is named the Dial Range, or Dial Unconformity, and the Tyennan movement it represents is named the Dial Movement.

The Barren Hill Formation is a thick sequence of thihly bedded, grey cherts, at least 500 feet thick. The type locality is the Barren Hill north of Preston, specifically, in the creek between 4102E,9186N, and4096E,9187N. Almost all the sequence is represented in this outcrop, which is a high cliff. The cherts in some localities show contemporaneous slumping, but depositional structures are usually obscured by strong tectonic folding. There are two sets of drag folds at 60° in these rocks, the first set alignes NNW and with flat slickensides in some localities showing a sense of movement of upper part east. As well there are drag folds plunging steeply east, and with numerous reverse faults indicating thrusting from the north.

The Isabdula Formation consists of yellow, flaggy bedded sandstones and shales outcropping on the Preston tramway between 9184N and 9187N. The total thickness is probably only about 100 feet. The formation is pnobably conformably above the chert, but the eastern boundary is obscured by basalt, the western boundary is concealed, and ~~thx~~ in the north and south the sandstone is in faulted relation to the chert, being in a small downfaulted wedge.

Öpik(1951) has recorded lower Upper Cambrian trilobites from the underlying Leven argillite, the age of the Wilsonia Group is therefore Upper Cambrian.

PRECAMBRIAN

The only worthwhile outcrops of Precambrian rocks arein the Forth River north of Paloona Bridge. Several traverses across the highlands to the northeast met thick bauers scrub, and the only outcrops are scattered boulders of quartz-mica schist.

The highest formation is a graphite schist, with at least two intersecting schistosities, and five lineations. The rock breaks into thin splinters typical of multiply-sheared rocks (pencil shales). This formation is highly contorted, and unconformably underlies a quartzite containing black chert, which is considered to be the base of the Dundas Group.

The beds beneath the graphite schist, at 9192N, consist of contorted chlorite schist with numerous quartz veins. This is 400 feet thick, and underlain by a 10 foot band of quartzite, with lineation on the bedding plane parallel to the strike. Beneath this quartzite is a chloritic and quartz-mica schist, changing downwards into albite-mica gneiss, with albite(?) bands about 1/10" thick, and thin laminae of muscovite. Portions of this rock are a coarse biotite schist, also outcropping at Fulton Park.

Beneath this is a mica schist with interbedded pink quartzites. The quartzites increase in thickness until a quartzite with thin bands of mica schist is obtained. The two lithologies are conformable, but in a small drag fold the schistosity of the schist strikes at right angles to the quartzite. This indicates a schistosity independent of bedding, and perhaps on a large scale lithological boundaries may transgress the schistosity.

Outcrops north of this are poor, although an albite-mica gneiss occurs, with boudins 6" long and 3" wide aligned down the dip, derived from an interbedded quartzite.

The total thickness is probably 1500 feet, but this is only a small part of a sequence that includes amphibolites, garnet amphibolites, garnet-zoisite rock, and thick ~~xxxx~~ quartzites. A stretched pebble conglomerate occurs on the Clark Plains road at Kindred.

The area is notable for the strong unconformity at the Paloona Bridge,which may be in part a Tyennan fault. The Cambrian rocks,pyroclastics and cherts of the Sprent Formation occur on the eastern bank,with attitude unknown. On the western bank is the multiply sheared graphite schist ofthe Precambrian,contorted into minor folds plunging south east beneath the Cambrian rocks.

At the first bend north of the Paloona Bridge is a practically structureless quartzite,which on the western bank contains pebbles of banded black chert and unconformably overlies the Precambrian.The age of this quartzite is therefore post-Precambrian,on the two counts mentioned,and also because it contains no streaks of mica schist,which is characteristic of the Precambrian quartzites further north. The quartzite is therefore Ordovician or Cambrian.

Further north,beyond 92000N,there are many boulders of quartzite conglomerate in the river.These have migrated from a small outcrop up the hill to the west,which has been shown to overlie the Precambrian with a 70° unconformity.This is downfaulted block of the similar conglomerates occurring on the Kindred Ridge,which have been shown to underlie sandstones containing tubicolar casts.This conglomerate is therefore Ordovician.

Behind Kindred post-office,at the extreme northwestern end of the ridge,occur structureless quartzites with chert fragments identical with the Paloona Bridge quartzite,and apparently underlying the Ordovician,as boulders of mica schist were found in the intervening country.

This quartzite is therefore considered to be Cambrian, which means the Paloona Bridge structure is the Stichtan unconformity.If it should be proved that the quartzite is Ordovician,the structure is either the Stichtan unconformity or a Tyennan fault(which may be substantially the same thing) since the Ordovician is laid down across the top without displacement. This interpretation means that here the Stichtan and Jukesian unconformities combine to form the Tyennan unconformity (Carey and Banks, 1954, have defined this nomenclature) which is required on regional grounds. The alternative interpretation places the Tyennan unconformity on th hills to the north, the Stichtan unconformity at Paloona Bridge, and the junction removed by erosion. The two alternatives are not substantially different.

The Precambrian rocks at Moreton Road, in the valley of the Clayton rivulet consist of sheared quartzites, the schistosity dipping north at about 60°, and the upper part of the outcrop being structureless quartz. Some outcrops are conglomeratic. There is no real evidence for th age, it is assigned to the Precambrian because it resembles similar outcrops east of Fulton Park, at Forth, which may be Precambrian.

THE PRE - BASALT TOPOGRAPHY

The contours on the base of the basalt were prepared by projection from the boundaries. For levelling, a network of control stations was set up by barometric traverse by motor vehicle, and the altitude of the base of the basalt was determined by barometric traverses referred to the control network, using the method of Lahee(1920) to correct for diurnal variation. Contour maps became available when mapping had been almost completed, and enabled ~~mistakes~~ errors to be corrected.

With isolated sheets of basalt, two alternatives are always available in drawing contours. If there are two low points on opposite sides of the outlier, these may represent the bottom of the one stream channel. Alternatively the two high points may be the top of the same ridge, in which case there are two channels. With a group of outliers the ~~xxx~~ control is such that there is often a unique solution, but this is not the case with a single large sheet of basalt. This means that the position of the old valley must be deduced on geological grounds(e.g. by locating stream bed deposits, or identifying flows across the outlier) which gives an indication of the direction of thinning. In such cases the map can be quite subjective, merely being the quantitative expression of the geologists opinion. However the contouring process is a severe test of that opinion, and in the present instance the writer has had to remap some boundaries where it was impossible to obtain a consistent solution. For instance, it was originally thought the Castra River crossed the East Gawler near its junction with Camp Creek, but this was inconsistent with the height of the old vall y at Preston, so a lower crossing of the East Gawler was required, and eventually found. At Lower Barrington the control is so good that the ~~mapping~~ projection is accurate to 25 feet.

Features of the pre-basalt topography have been named as far as possible with names that cannot be confused with modern topographic features. Names like "Eo-Forth" have been ? old

060 avoided as far as possible,because rarely do the old and modern stream patterns coincide,and not until the whole history of the river is determined will it be possible to decide which prebasalt streams if any correspond to the Forth. Modern names are used for some Highlands which have persisted to the present,such as Bonneys Tier.

The prebasalt topography is generally a dissected plateau,the original plateau having a local relief(monadnocks) of 700 feet at Nook,500 feet at Upper Castra,and about 400 feet at Gunns Plains.The plateau level was at 900 feet at Nook,near 1100 feet at Sprent and Preston,and probably increased to 1200 feet at Riana.Plateau remnants at Nook are covered with isolated patches of dolerite representing the basal Permian sill;with gravels containing boulders of Owen conglomerate at Sprent,that the topographic reconstruction indicates were not borne by water in Tertiary time ,and may represent Permian gravels;and the old plateau at Warringa has boulders of Owen Conglomerate up to 20 feet in length,which may be talus deposits,or else Permian in age.Twevetrees(1905) records Permian rocks at the Preston Rifle Range,but the outcro could not be found. In Hallett's Quarry at Eugenana occurs a contorted ,laminated carbonaceous shale considered by K.G.Brill to be a cave infilling.This may be Permian,but could also be Tertiary.This plateau is the exhumed Carboniferous peneplain,with the overlying rocks stripped off in pre-basalt,post-faulting time.

The amount of dissection of the plateau is almost exactly comparable with the present stage of dissection of the Tertiary lava plain.Incised into the plateau were narrow,V-shaped gorges,the Paloona Gorge at Lower Barrington being 900 feet deep and about a mile across, similar to the present Forth.The rivers Paloona and Motton expanded considerably in limestone,forming valleys nearly as wide and deep as the modern Leven,and a valley at Melrose which filled up with lake sediments and has not yet been completely exhumed.

The Paloona River may have arisen beyond Staverton, and may be identical with the pre-basalt valley at Lorinna, and Moina. The river formed a wide valley beneath Sheffield, but narrowed considerably through the gorge at Lower Barrington. Near Paloona, the river expanded on limestone, then turned west to cross the present Forth near Paloona Bridge, entering the sea between Don and Ulverstone. The valley floor has an altitude of 100 feet at Paloona, and lake sediments are exposed at Nook at 600 feet, so the floor of Lake Sheffield lies somewhere between. An altitude of 400 feet was arbitrarily chosen, but may be too high.

The Alma River arose at Lower Wilmot, and ran along the same general course as the present Wilmot, joining the Paloona River at Kindred. The Castra River arose somewhere south of Upper Castra and flowed parallel to the present Camp Creek and joined the Paloona River underneath Sprent. The Motton River arose somewhere near Loyotea and flowed into Gunns Plains from Riana, forming a wide valley. It turned east at Gunns Sugarloaf and breached the palaeozoic ridge in a narrow gorge between the Barren Hill and the Dial Range, that has been exhumed by the present Leven. It continued to the east of North Motton, joining the Paloona River near its mouth, which was probably near Gawler. The drainage pattern was therefore markedly different to the modern pattern, being arborescent with the trunk outlet probably at Ulverstone, whereas the modern streams run parallel, to seperate outlets at the coast. To the east were the dolerite-capped highlands of Bonneys and Kelcies Tiers. The plateau surface was tilted, dipping east at one foot in 50 yards, which may represent Tertiary tilting or have been inherited from the Carboniferoud. The drainage responded to the tilt, the largest river (Paloona River) being in the east, against the edge of the highlands.

The basalt completely filled this area, and may even have overlapped across the top of Bonneys Tier. The massive flows at Nook are remnants of the scarp-bordering basalt.

TERTIARY FAULTING

The tertiary faults are most readily recognised in the otherwise undisturbed Permian rocks. In the Pre-Permian rocks, no Tertiary faults were definitely recognised. The East-West fault through Halletts Quarry at Eugenana may be Tertiary since the limestone is brecciated, the Devonian schistosity orientated at random, and the Permian shale appears to have been caught in the fault zone. The fault of small throw trending S-W from Eugenana throwing the limestone against the underlying fossiliferous shales may also be Tertiary in part. The normal fault duplicating the Kindred Ridge may also be Tertiary.

The Permian rocks record a multitude of faults, the drives in the Illamatha Mine showing a fault or monoclinal roll every 50 feet or so. Isolated cuttings on the Roland Highway at South Spreyton show a fault or two in every cutting. The faults are presumably normal or gravity faults, the drag dips being the only indication of throw. The fault zones are usually too weathered to yield much information. Generally the fault zones are vertical. Some indication of the throw can be obtained from the width of the shatter zone, or zone in which bedding is completely obscured. This zone is up to 30 feet wide for faults with a throw of about 400 feet, and less than a foot for throws less than 50 feet. Corresponding drag dips are thirty degrees and less than 5 degrees. Palaeogeographic evidence indicates that the faults exposed were buried a minimum of 1200 feet at the time of the faulting. The Bott Gorge Fault can be observed in a silo excavation, the Aberdeen Fault was located by Selwyn in 1855, the position of the Buster Road Fault was obtained from a single Spirifer in a road cutting, and most of the remainder were observed in the River Don.

As has been discussed, A. M. Reid and W. H. Twelvetrees were aware of the extensive faulting in the Permian rocks, but Reid advances as evidence for the contemporaneity of coal and tasmanite the fact that the outcrops are distinct, and abut . Reid also makes frequent reference to the fact that the edge of the Permi n rocks is an ancient shoreline. This conclusion

063 has never been seriously questioned. Under this hypothesis, the Permian beds in the Don Valley dip east off an exhumed peneplain, and the dips at the boundary (up to 36 degrees) are due to, presumably, differential compaction. If this dip persists for 100 yards, it implies a differential compaction of 170 feet in a Permian thickness of less than 500 feet at the Don Bridge. At Buster Road the basal conglomerate dips at 7°, for 400 yards, requiring differential compaction of 84 feet in a formation certainly less than 200 feet, and probably only 50 feet thick. Hence the dip cannot be due entirely to differential compaction. For original dip, 36° is too large.

It was therefore decided to thoroughly test the alternative hypothesis of faulting. Most of the faults can be seen, anyway. The bordering palaeozoic rocks are covered with remnants of a dolerite sill that has been shown on Bonneys Tier to be intruded at the base of the Permian, along the Carboniferous unconformity. The sill reaches 200 feet thick. The base of this sill is taken as a datum level for tha base of the Permian, and is at an altitude of 700 feet at Nook, 500 feet at Lower Barrington, 600 feet west of the Bott Gorge, and presumably at 400 feet northwest of Buster Road although the sill has been removed by erosion.

The faults form an interlocking network striking generally N.N.W., but strongly influenced by Devonian Faults. In several places the Tertiary faults break across to older structures, run along them for a little way, then break back to join the main fault system. The best example is the fault along the Don River at Lower Barrington, with the Tertiary throw opposite to the Devonian. De Sitter (1956, p. 320) describes similar features in South Limburg, and it is quite common aith such networks of normal faults. Frequently several faults will be collinear, or two faults will cross and interchange throw. No evidence of mutual displacements could be found, so the intersecting faults are contemporaneous. Further, such behaviour is an integral part of the faulting mechanism.

of vertical

Another feature is the presence of folds in the Permian rocks. The Buster Road Conglomerate is folded into a small anticline, the opposed dips being 15°, east of the Don River. The sandstones at Tugrah are folded into a broad shallow syncline, the dips being again about 15°. The possibility of transcurrent movement was therefore examined, but it seems the folding is result of tilting of fault blocks. Tilting of a fault block will locally cause compression, and the folding is probably due to this.

In order to 'solve' the network, two principles were observed. These are well understood, but not usually stated explicitly. The statements given below show that it is possible to apply them algebraically.

The first is the Principle of xxxxx the Stratigraphic Equivalence of Altitude, or the Altitude Principle. This assumes that the difference in height of two outcrops of the same beds is a measure of the throw of the intervening faults. Thus in the figure, if traverses 8 and 9 are combined, the difference in altitude of the coal outcrops is 300 feet, so the nett intervening throw is 300 feet, north side down.

The second rule is a consequence of the first. Obviously, the nett throw will be 300 feet in the example, whatever is used as the traverse path. This leads to the principle of Conservation of Throw, or the Conservation Principle. xxxx In the case of two intersecting faults, a traverse is made around the intersection, as traverse 12 of the figure. If in making such a traverse a fault is met with the far side downthrown, the throw is counted as negative, if upthrown, as positive. The Conservation Principle states that the total throw around any closed path in a fault network is zero. This principle can be used to determine unknown throws in an area where xxx say, 'n' independent traverses are possible, and 'n-1' faults unknown.

In areas with a strong regional tilt the altitude principle is invalid,but will apply if the heights of key outcrops are referred to a tilted base plane.The main difficulty in the present case concerns isolated tilted blocks and rotational faults.It will have been noted that the principles stated are analogous to Kirchoff's Laws of electronics,with altitude equivalent to voltage and fault throw to current.It may be possible to introdu ce a parameter akin to conductance to h ndle rotational faults.The method used,which is apparently satisfactory in simple cases,is to treat fault throw and tilt as homologous,the two being added together and treated as simply fault throw,in obtaining the initial solution.Correction for tilt is made l ter.

The best example of this is the tilted fault block containing the Buster Road Conglomerate.The conglomerate outcrops xxx at 200 s.l. in the river,and on the western bank up to 400 s.l.Since the thickness is probably only 50 feet this indicates a tilt of 200 feet in 400 yards,or 7 degrees, which is the observed dip.The lowest outcrop is probably 250 feet feet above the Carboniferous unconformity,since the basal dolerite sill is 200 feet thick.The unconformity is probably at 400 feet further west.A traverse between the two points,using the altitude principle,indicates that

400+250-p=200,where p is the total throw.Hence p=450 feet. If the tilt is 200 feet,then the throw on the boundary fault is 250 feet.For the purposes of the initial solution the total throw of 450 feet is used and assi ned to a hypothetical fault p.

The figure gives details of the traverse paths.The altitude principle is applied to open,and the conservation principle to closed,traverses.From these the throw on the faults id determined as algebraic expressions in terms of stratigraphic parameters,specifically,h and h',where h is the height of the tasmanite above the unconformity,and h' is the height of the coal above the tasmanite.

From traverse 1, $700+h-a=400$, therefore $a=h+300$

From traverse 2, $500+b=700$, therefore $b=200$

Closed traverse 3, $-a+c+b=0$, therefore $c=a-b$
From 1&2, $c=h+300-200=h+100$

From traverse 4, $500+d=600$, therefore $d=100$

Closed traverse 5, $-c+e-d=0$, therefore $e=c+d$
From 3&4, $e=h+100+100=h+200$

From traverse 6, $600+h-f=350$, therefore $f=h+250$

From traverse 7, $400+h'-g=400$, therefore $g=h'$

From traverse 8, $350+h'-i=400$, therefore $i=h'-50$

From traverse 9, $350+h'-j+100=100$, therefore $j=h'+350$

From closed traverse 10, $-j+k+i=0$, therefore $k=j-i$
From 8&9, $k=h'+350-h'+50=400$

From traverse 11, $400+h+h'-m=100$, therefore $m=h+h'+300$

From traverse 12, $400+n=600$, therefore $n=200$

From evidence cited, (traverse 13), $400+250-p=200$, or $p=450$

Closed traverse 14, $-q+p+n=0$, therefore $q=p+n$
From 12&13, $q=450+200=650$

Closed traverse 15, $-m+r+p=0$, therefore $r=m-p$
From 11&13, $r=h+h'+300-450=h+h'-150$

Closed traverse 16, $-t-u+r=0$, therefore $t+u=r$
From 15, $t+u=h+h'-150$

Closed traverse 17, $-q-t+s=0$, therefore $s-t=q$
From 14, $s-t=650$

Closed traverse 18, $-u-100+j+v=0$, therefore $u-v=j-100$
From 9, $u-v=h'+350-100=h'+250$

Closed traverse 19, $-s-v+f=0$, therefore $s+v=f$
From 6, $s+v=h+250$

Therefore h and h' must be such that

$t+u=h+h'-150$	(16)	$s+v=h+250$	(19)
$s-t=650$	(17)	$u+s=h+h'+500$	(20) From 16,17
$u-v=h'+250$	(18)	$v+t=h-400$	(21) From 16,18

Now h and h' are both greater than or equal to zero. Also t and s are both positive. Since v is positive, then from 18, u is also positive. Hence, from 21, h is greater than 400.

We have now four equations and four unknowns, which means that h and h' can be made any value without invalidating the network, provided h exceeds 400. It was hoped to solve for h, but app rently there are insufficiently known quantities.

Altogether there are 16 faults, with two of known throw, and eight isolated points of known altitude. Only two more facts are needed to solve the structure completely, for example the throw on e and g. New data is available on Bonneys Tier, but introduces new faults, another stratigraphic parameter (height of the top dolerite sill), and extends the area beyond the region in which stratigraphic thickness may be reasonably regarded as constant.

Bore data must therefore be relied upon. In the stratigraphic correlation, the tasmanite is considered equivalent to the carbonaceous shale in Dulverton Bore No. 10, which occurs just below the contact of the pebbly and non-pebbly mudstones of the Nook Formation. This transition occurs at 150 feet below the coal in the nearest bore, so h' is temporarily taken as 150 feet.

It has been shown that h is greater than 400 feet. An E-W section at Nook shows the fault displacement on c must exceed 300 feet, since the dolerite on the western side outcrops up to 700 s.l., and is not exposed above the surface on the eastern side of the fault, which is at 400s.l. There is some justification for the throw being made 350 feet, since the basal beds of the Nook Formation here are a conglomerate similar in some respects to the underlying Buster Road Conglomerate, and underlying sandstones contain plant remains which also occur in the Buster Formation sandstones. Near the fault the drag dip in the Permian is 30 degrees, flattening to 5° at the tasmanite outcrop. The throw due to tilt is possibly 300 feet. The small fault ~~xxxx~~ east of the Don Bridge may have a throw of 50 feet. The total throw (a minimum) is therefore 700 feet. This means the tasmanite is 600 feet above the unconformity-200 feet of dolerite, 50 feet of Buster Conglomerate, and 350 feet of Nook pebbly mudstones. Thus h is adopted at 600 feet.

The resultant ~~displacements~~ fault throws, correcting for tilt and fault rotation, are shown in the figure.

The resultant fault pattern is a stepped graben. The highest step, on the west, contains remnants of the basal dolerite sill. The reconstruction of the Pre-basalt topography shows the remnants of the Pre-Permian surface, covered with thin basalt outliers, occurs at 900 feet at Nook and 1100 feet at Sprent, 10,000 yards west. This means a slope of 1 in 150 to the east, or about 20 minutes, which may be of Tertiary origin. or due to irregularities in the surface

The second step contains the tasmanite outcrops, the bounding faults having a throw of about 800 feet. The next step east, defined by faults throwing 150 feet, contains the coal of Fosters and Sloanes Mines (the latter on Ray Creek). The centre of the graben is downthrown about 1000 feet, and is centred on the Don River, trending NNW to run out to the north against the highest step. To the south, Jennings (pers. comm.) has located a narrow down-faulted block of Permian at Stoodley, which may be the same graben.

The total Permian thickness is about 1320 feet, which is the order of the downthrow of the centre of the graben. Therefore the top dolerite sill would be expected in the centre of the graben at the same altitude as the unconformity in the west, i.e. at 600 s.l. S.J. Mayne (pers. comm.) has mapped a dolerite sill in just that position (9171N, 4307E). Faulting may be pre-dolerite

On top of Bonneys Tier the highest dolerite sill has a base at 1100 feet, so a fault downthrowing west about 500 feet must pass between this and the Don Graben which is centred on Ray Creek. Since Ray Creek lies at the foot of Bonneys Tier, it means the fault must pass along the face of the Tier. This explains the occurrence of coal on Botts 83 acre block high on ~~Kai~~ Bonneys Tier.

At Dulverton coal was mined at s.l. 200 feet. This implies that ~~Kai~~ Bonneys Tier is a horst, which explains why the coal measure sandstones outcrop at the surface just east of Aberdeen, and suggests that Kelcies Tier is part of the same horst. This horsted structure was suspected by the writer when mapping Kelcies Tier in 1956.

horst is not a verb and hence has no past participle

To the east of the Dulverton coal mines ~~is~~ are exposed Palaeozoic rocks with a thin veneer of overlapped (Nook (?) mudstones. Hughes in the Limestone Bulletin(Railton District, in press) has considered this boundary to be an unconformity, but it now seems to be a fault downthrowing west. This makes the Dulverton-Tarleton area another graben, with the horst on the east tilted east, and containing tasmanite in a downfaulted block at the Great Bend. Further east still, this Mersey horst is cut off by the great Kimberley-Moltema fault, downthrowing east, which may be the Tiers-making fault of Wells(1954).

This graben and horst structure strikes NNW, and is cut off before the coast by the Stony Rise Fault System, which trends WNW from Latrobe, downthrowing the Kelcies Tier sill from 1200 s.l. to sea-level at Mersey Bluff. This crosses the Don River south of the Bass Highway(the associated drag dips exceed 40 degrees), and joining the boundary fault of the Don Graben runs out to sea beneath the basalt of the Don Heads. This fault may be a member of a Bass Strait forming group. This fault was first recognised by Twelvetrees(1912, p. 24), who also observed the Kimberley Fault(p. 36).

There are thus two major directions of fault strike, NNW-N, and WNW-W. The NE faults of the mapped area are complementary to, and contemporaneous with, the first set. This appears to indicate a regional tension direction of NE-SW.

Similar graben and horst structures occur elsewhere in Tasmania. The best known is the Launceston basin(Carey, 1953) which is a regional graben containing horsts at Longford and the Hummocky Hills. This is bounded on the west by by the Tiers-making fault system, and on the east by a fault system of which the most prominent member outcrops at the Lilydale Falls, crosses the shoulder of Mount Arthur, outcrops at Patersonia, and bounds Ben Lomond on the western side. This fault is very prominent on the large scale ~~map~~ geological map of Tasmania. At the northern it appears to be cut off by a NE-SW fault system, parallel to the Stony Rise system, which uplifts the Asbestos Range, and ebters the sea at Port Sorell.

A simi ar fault system occurs in the Upper Derwent Valley (Carey, pers. comm.) and the Coal Resources Bulletin contains maps showing ~~fmm~~ Tertiary faults directed N-S. on the East Coast. On the West Coast at Point Hibbs, Loftus-Hills (pers. comm.) observed Permian rocks drag-dipped 60°, so this fault system is state-wide. Carey (pers. comm.) has suggested that the famous tesselated pavement at EagleHawk neck is related to this epeirogeny.

The age is uncertain, but may be Eocene. Since it occurred, the uplifted country west of the Don River was eroded down to the Palaeozoic basement and a youthful topography developed, leaving the downfaulted blocks as Tiers in the east. The basalt floods filled up the denuded area, lapping up against the fault-line scarp. Since then perhaps 400 feet of basalt has been removed and the fault-line scarp has retreated east 3000 yards, leaving the remnants as Kelcies and Bonneys Tiers.

In the Mersey area the epeirogeny certainly predates the vulcanism, but Tertiary boulder beds at Sandy Bay, faulted Tertiaries at the Rifle Range, Hobart and on the Bass Highway at Devonport indicate that the epeirogeny or vulcanism is not everywhere of the same age. No

No faulted Tertiaries on Rifle Range

STRUCTURES IN ORDOVICIAN ROCKS

Along the North Coast Range, the strike is strongly east-west, the range being an anticlinorium with the southern limb en ~~xxxx~~ echelonned folds and thrusts plunging south east. The Loogana syncline, and the syncline beneath Narrawah are aligned east-west.

The Badger Range, to the east, is a syncline plunging south at Stoodley, but after a cross fault near Nook, the northern end is a vertical hogback, the west limb of the Railton syncline. This hogback strikes north-south.

To the west, the Dial Range strikes N-S inthe Cambrian rocks, but since a question has now arisen concerning the ages of the conglomerate or conglomerates on the Dial Range, it is not certain the Ordovician rocks participate in this strike. Reconnaissance mapping by the writer shows that about two miles north of the Leven Gorge is a syncline in Ordovician conglomerate plunging steeply east but without doubt aligned east-west, and offset by at least one tear fault striking N-S. This makes a right angled unconformity with the underlying Cambrian argillites.

There is no dominant strike direction in the Ordovician rocks which are generally folded into complicated domes and basins.

The Melrose syncline is a brachysyncline elongated N-S, pitching north at a shallow angle. The western flank is exposed at Lower Barrington and Paloona township. The axial limestone is exposed at Melrose and Paloona, and again in a small outcrop near the Don Bridge at Lower Barrington. At Lower Barrington the folding is accentuated by strike faults upthrown on the northeast which may be sinistrally transcurrent. The southern end of the syncline is cut off by a NE cross fault downthrowing north, which subscribed to Tertiary movement in the opposite sense.

The eastern flank is exposed in the Denny Gorge where occur folds of small amplitude ~~pitching~~ plunging up to40° north, and recording overthrust movemmnt from the west, the thrust planes appearing out of the river hading 60° west and flattening to 30° at the top of the cliffs. This seems to be merely a nose as coal bores record limestone further east.

The syncline is cut off in the north by a cross fault with large Tertiary movement but which may also be a palaeozoic fault, north side upthrown,.

A narrow branch syncline runs NW through Kindred, plunging southeast at perhaps 10°. The resultant nose between the the Kindred and Melrose synclines is entirely underlain by Precambrian rocks, and is aligned N-S along the Forth River, plunging south at perhaps 30°. It was suggested that the Kindred Ridge is Precambrian conglomerate, but the discovery of tubercles establishes the Ordovician age. [not necessarily]

The whole synclinal zone is therefore shaped as the letter Y, and is almost certainly doubly-plunging. The deformation mechanism was parallel folding in the flaggy quartzites (en echelon tension joints and bedding plane slickensides in the appropriate sense occur), with incompetent folding and fracture cleavage in the interbedded shales, some fine examples being exposed in the Don Gorge north of Eugenana. The deformation in the limestone was wholly by shear, and except for small areas at Mole Creek, this appears to be unique in this limestone. The limestone has a very strong schistosity, with augens of calcite, remarked upon by Henderson(1957 [1937 ?], in press) and shale bands have been contorted into tear-dop folds in the B.H.P. quarry. A bedding plane exposed on the Melrose tramway shows the surface broken up by the schistosity into en echelloned steps, a pattern irreconcilable with bedding plane slip.

Eardley Tor is a cuestiform ridge in quartzites and shales on the lower plate of the (Haig) [INGRAM] Creek Fault which has overthrust the Cambrian Alma Cherts. This is actually the northern limb of the Wilmot Anticline which plunges at about 10° south east. The limb is upturned against the Haig Creek Fault, forming a marginal syncline cut off against the fault to the north-west, and crossing (Jackson) [PERRY] Creek in the south plunging south at 10° ~~xxxxxxxxxx~~ with the axial zone containing a series of minor folds. A flat thrust dipping south is present, and a dextral transcurrent fault with north-south strike.

Thrusts dipping east, and shallow folds plunging east outcrop above the Forth River. In (Jackson) PERRY Creek the beds show intense deformation, with strong axial thickening of the shales andd complete attenuation of some quartzite beds, Folding is generally by bedding plane slip, with the shales highly incompetent. On the cuesta of Eardley Tor duplication of the sequence by thrusting is possible.

This northern limb of the Wilmot Anticline swings south through the Forth Gateway, and joins the plunging nose in the vicinity of the Forth Falls, although offset by large faults. The axial region is the flat-lying beds of Wilmot Tor. The southern limb strikes east-west through Narrawah and Wilmot. This anticline seems to be aligned east-west, and is succeeded to the south by the east-west, Loonganah-Narrawah synclinal zones, then the great anticlinorium of the North Coast Range. To the west the anticlinal zone diverges, an east-west branch south of the Three Brothers and a northern brach through Sprent, the southwestern limb being related to the Gunns Plains Basin.

The Gunns Plains basin is an almost circular brachynsyncline plunging at about 5° east. The eastern end is cut off by the strong Walloa Creek Fault which upthrows east and probably has dextral transcurrent movement. The western rim shows minor folds plunging steeply southwest at Pine Creek. In the limestone the strike is east-west, with minor folds near Walloa Creek having the same strike. The axis is just north of the Gunns Plains caves where a small area of Crotty Sandstone outcrops.

In the Leven Gorge the Owen-type conglomerate is repeated by an oblique dextral transcurrent fault, so that in the road section on the south side, what appear to be two bands of conglomerate are exposed. The argillites of the Leven Formation clearly underlie ~~this~~ the lower band with unconformity. If the lower band is traced north it becomes part of the ~~xxxxx~~ eastern limb of the Gunns Plains syncline, and if the upper band is traced south it becomes the same feature. This destroys

074 the use of this sequence as proof of siliceous quartzite conglomerates in the Cambrian, making the Bott Conglomerate unique of its type. No (Dundas section shows same)

The ~~xxxxxxxxxxx~~ quartzites on Gunns Sugarloaf cross the creek to the south at a high waterfall, and disappear beneath the basalt. There the limb is cut off by a concealed fault, or alternatively there is avery tight syncline and the limb ends on the Walloa Creek Fault. The fault of the former alternative strikes northeast, and may disappear at the Barren Hill thrust system, or continue as the fault crossing the Leven at 4078 E, in which case the strike swings rapidly to north, and beyond the map, back to north-east.

The general north-south or NNW strike in the east indicate the folding stress was directed NE-SW, which is confirmed by the strike of the Haig Creek Fault near Barrington. In the west, there is the evidence of the narrow east-west syncline north of the Leven Gorge and the thrusts of the Barren Hill to show that the culminating stresses were directed from the north. Thia agrees with the movement on the Walloa Creek Fault, and the strike of the limestone at Gunns Plains. However the underlying Cambrian rocks strike north-south, the effect of the north-south compression being to produce two sets of drag folds at right angles in the argillites of the Leven Gorge and the cherts of the Barren Hill, and very probably producing strong reversals of plunge in the Leven Gorge and West Gawler River although positive documentation could not be found. The east-west compression of the Cambrian rocks may be reflected in the fact that the Gunns Plains structure closes to the north and south.

There is thus a considerable problem in the Gunns Plains area as to whether the two intersecting structural trends represent seperate orogenies, or changes in the stress field in a single orogeny, or a complex stress field due conceivably to such factors as the neighbouring ~~Rixxx~~ Housetop granite on the west and Precambrian crystallines in the northeast.

It may be noted in this connection that Hughes (1953) records that the Dial Range is cut by two strong transverse(E-W) faults,with an upthrust block between them. The polished surface on one fault plane strikes at 120°, and dips south at 75°. This fault moved the south block east, i.e. had transcurrent movement. This again,is despite the patent north-south strike of the folded Cambrians,clearly shown on the aerial photographs,and confirmed by the mapping on the coast.

STRUCTURES IN THE CAMBRIAN ROCKS

The Ordovician rocks have been shown to strike E-W south of the area, north-south (doubly plunging) in the east, and predominantly E-W at Gunns Plains, but also doubly plunging.

The folds in the Cambrian rocks fall into two groups, north-south folds of small amplitude west of Sprent and at Nook, and north west-south east folds between Sprent and Lower Wilmot.

The north-south folds have steeply dipping limbs, particularly at Nook where they form almost an isocline. Axial plane cleavage is very common particularly in the pyroclastics of the East Gawler River, the Bott Conglomerate of Aitken Creek, and the Preston Breccia and overlying pelites in the West Gawler River. This cleavage is replaced in other areas by a very strong fracture cleavage. It appears regionally that the cherty breccias and occasional overlying cherts have deformed by fracture cleavage, while the argillites have behaved incompetently. A section drawn along the West Gawler river south of the Isandula Bridge shows measurable discrepancies between the thickness of the argillites on the limbs and axial regions of the folds. The folds are usually symmetrical, but in the West Gawler River are strongly asymmetrical facing east. This asymmetry is almost certainly due to stratigraphic thinning.

The north west-south east folds are of large amplitude, and are strongly asymmetrical facing north. The asymmetry of the southern limb of the Alma Syncline was such as to lead to thrusting, and the asymmetric Lower Wilmot Anticline appears to have a thrust running up the steep limb and breaking across the crest. To the north, the amplitude of these folds decreases rapidly due to stratigraphic thinning. These folds plunge obliquely off the exposed Precambrian. Deformation was by bedding plane slip in the cherts, and by fracture cleavage and incompetent folding in the subgreywackes and argillites. The minor structures in the cherts include north-south tension joints, and a shear cleavage defined by two planes at 60°

077 which divide the bedding plane into rhombs with the short axis aligned down-dip. This is a very characteristic feature, especially on the south limb of the Alma Syncline, and has been used to locate bedding in several localities.

The transition to north-south strike can be observed in only one locality at the eastern end of the Lower Wilmot Anticline. This crosses the Wilmot River plunging 30° to the south east, but at Jackson Creek plunges gently north. The fold is thus an asymmetrical anticlinal saddle coinciding with a 45° change in trend. Accomodation was assisted by several reverse faults, linked by cross faults which are probably transcurrent and offset at least one fault in a series of echelonned steps. The structure is suggestive of a deepseated dextral transcurrent fault. It may be noted that the anticline at Paloona swings in strike at this line, and the only folds to the east belong to the north-south set.

The transition to the northwest is poorly exposed, but it appears the anticline rides up onto the Precambrian south of Sprent, with the western limb strongly sheared. About one mile north of the Fork of the Gawlers the nearest rock to the Precambrian (a cherty breccia) is very strongly sheared for over 1000 feet, and is properly described as a schist.

The Wilsonia Group is folded into a gentle (20° to 40°) north-south syncline, the structure being cut by later thrusts striking NW-SE. The eastern extension of these thrusts is unknown, but they may represent the Haig Creek Fault, which splits up at the Wilmot River into three smaller faults. The Wilsonia group syncline overlies unconformably the north-south folds, which strike underneath it and reappear on the other side. It will be noted that the syncline ovelies an anticlinal zone, which accords with Bradleys (1956, p. 110) rejuvenation mechanism in folded tracts.

This evidence shows clearly that the north-south folding predates the Wilsonia Group, and this orogenic

UC 078 movement, the Dial Range Movement, is represented by the unconformity at the base of the Wilsonia Group. This movement is a pulse of the Tyennan Orogeny of Carey and Banks(1954) and is of considerable magnitude. The north-south folds at Nook probably date in part from this movement. This Dial Movement possibly resulted in the formation of north-south folds in a north-south trending trough aligned parallel to the Dial Range, and possibly another folded trough at Nook. This movement is probably represented on the West Coast by the unconformity at the base of the Owen Conglomerate although this probably spans a longer time interval. This phase contibuted to the emergence of the Dundas Ridge of Bradley (1956, p. 116). Why?

The north-south folds of the Wilsonia Group show that this movement continued after deposition of the group, with the east-west compression maintained. The Unconformity with the Owen Conglomerate is not exposed, but this unconformity together with the Wilsonia Group and the Dial Range unconformity span the time alotted to the Jukesian Unconformity of Carey and Banks(1954, p. 265). The movement on the West Coast was not interrupted by a depositional period. (suggested by Öpik)

The north-west folds do not reflect the Dial Movement, but it probably resulted in uplift of the area they occupy.

 On the West Coast there is nothing to indicate a difference in the direction of compression in Cambrian and Devonian times,,the structures in the Cambrian rocks conforming generally,although exaggerated,with the folds in the overlying Owen Conglomerate(Bradley,1956,p.100).

There is,however,no such general agreement in the area under discussion. The Tyennan folds in the Leven Gorge strike at right angles with the east-west syncline in the Owen Conglomerate about two miles north,and at right angles to the prevailing strike at Gunns Plains. The amplitude of the north-south folds is also much smaller than the amplitude of corresponding folds in the Owen. The difference may be due to the fact that the movements were staged,whereas at Queenstown movements continued interrupted even during the deposition of the Owen Conglomerate.

The Dial Range shows north-south structures in the Owen Conglomerate(Hughes,1953),the Melrose Syncline with the sheared limestone strikes north-south parallel to the Railton syncline and the Badgers,while the Wilmot,Loongana,and Gunns Plains structures strike predominantly east-west. This swing in trend forms a roughly sigmoidal pattern,which is due either to largescale rotational movement,as postulated by Bradley (1956,p.103),or to changes in the direction of compression. A clockwise rotational movement is consistent with the tear fault at Liena(Jennings,1957) and the probably transcurrent fault between Mts.Claude and Vandyke. The Walloa Creek fault probably has dextral transcurrent movement,and also the fault along Aitken Creek. The INGRAM (Haig) Creek Fault has a minor fault that is dextrally transcurrent,and may itself become transcurrent where it swings south at the Forth Gateway. This fault is probably the one passing between the Gog Range and Mt.Roland,and a shift in this sense is not inconsistent with the structure there.

An alternative hypothesis is that the initial direction of compression was east-west,and strongest in the east. This would initiate a series of north-south folds at Railton and Melrose, and exaggerate the Tyennan folding in the Bott Conglomerate at Nook. The folds are visualised dying out to the west. As the compression direction rotated to north-south, the preformed synclines would continue to deepen but would begin to plunge. Continued shift would intoduce oblique folds on the flanks, such as the Kindred syncline and the minor folds north-east of Riana (Hughes, 1953). The major movement would occur in a north-east direction, causing the main folding at Gunns Plains, the development of the Kindred syncline, and the north-west folding in the Cambrian rocks. This explains the south-pitching minor anticlines on the northern limb of the Gunns Plains Basin which would originate at an early stage. The thrusts and associated transcurrents would arise in ~~this~~ the later stage, which would be correlated with the northwest folds of the Queenstown area. The cross structure on the Dial Range and possibly the Barren Hill thrusts, are east-west structures which may represent a culminating phase. Jennings (1956) has shown the culminating phase at Round Hill was thrusting from the north nearly contemporaneous with the ore deposition. The Linda Disturbance (Bradley, 1956, p. 74) may be a related structure, and is also mineralised.

This second hypothesis makes the deformation of the North Coast Range succeed the development of the West Coast Range. The general similarity between the structural patterns (Jennings, pers. comm.) may be due to the similar relationships between the axial belt of Owen Conglomerate and the Precambrian shield. However this similarity itself means the structures were similar in the Owen time, long predating the Devonian Orogeny. This fact, together with the structural continuity of the two areas (see Carey, 1954) makes it probable that the deformation was due not to a shifting stress field but to relatively constant rotational stress.

It is shown later that the mineralisation is related to Devonian structures. Since the source is probably the Housetop Granite, it means the granite is Devonian. The orogeny therefore concluded with the emplacement of granite.

GEOLOGICAL HISTORY

The Stichtan Orogeny at the close of the Precambrian caused the development of low grade metamorphic rocks, which at Paloona have a dominant east-west strike. Following a period of erosion, active movements began, causing subsidence of a geosyncline of unknown alignjent, but which probably deepened to the southwest. The edge of the trough may have been marked by a fault at Paloona. why

The lowest beds exposed are quatzites with chert fragments and greywckes containing chert, showing that these are not the initial sediments. Following a period of volcanic activity and deposition of fine grained clastics, the trough deepened and cherts were deposited. After the Alma Cherts, the sediments are mainly clastic with one higher chert-forming period in the (Jackson) PERRY Creek Formation. At the same time volcanic activity began in the south, the sediments advancing and retreating to interfinger with the cherts and greywackes. Slope instability may be indicated by the lenticular siltstones.

After this period, upward movements of the surrounding lands began, without increased deepening of the trough. This resulted in the erosion of earlier formed cherts and limestones, the brecciated fragments forming the Preston Formation. This movement was heralded by the effusion of basic lavas. In the east the rising land consisted of Precambrian rocks, which were deposited as the greywacke conglomerates of the Aitken and Bott Formations. This movement was followed by further vulcanism in the Leven Gorge, and culminated in the Dial Movement which folded the Dundas Group. The stress system was probably a clockwise rotation, resulting in the north-west folds in the direction of greatest compression where the basement was shallow, but where the basement was deep and frictional resistance smaller upon the higher beds, these higher beds were dragged to a north-south orientation parallelling the scission. This process may have been assisted by transcurrent movement along the basement hinges bounding the deeper zones.

After an erosional period sufficient to

remove at least 1000 feet of the Radfords Creek Formation, 083 300 feet of Leven Argillites, and 500 feet of Prestion Breccia, the trough again subsided and cherty breccias, cherts, and sandstones were deposited. The uplift probably conjinued unabated on the West Coast.

At the end of Wilsonia time another movement occurred, ~~fxidx~~ uplifting the Wilsonia Group sediments so that by the time deposition of the Owen C onglomerate began it was absent in many areas. Conglomerate was deposited in a trough near the Dial Range, but elsewhere deposition began later and the conglomerates are poorly developed. why?

The deposition of the Eldon Group was terminated by the Tabberabberan Orogeny. The forces were still operating in a clockwise rotational sense, and severely exaggerated the Tyennan folds, the movements culminating in thrusting in a NW direction which produce cross-structures on the north-south folds. The tear faults associated with this thrusting are homologous with the basement faults which seem to have developed at abrupt changes in strike, for instance in the Lower Wilmot anticline in (Jackson) PERRY Creek. The deformation in the Ordovician rocks shows that this orogeny was very latge compared to its predecessors.

After prolonged erosion, and peneplanation, subsidence of the region began again. A shallow basin was formed, into which were deposited boulders from floating ice. Periodic lowering of sealevel enabled the establishment of forests, which formed tasmanite spore beds and coal seams. T (Not tasmanite)

Dolerite

This period of sedimentation is followed by epeirogenic movejents in probably the Eocene. This uplifted the area west of the Don River, and tilted it gently east. East of the Don River the country was broken into a horst and graben structure. The uplifted block was more susceptible to erosion, just as the Western Tiers are eroding faster than the Midlands. This ultimately resulted in reversal of the topography about the fault line, leaving an exhumed plain on the west, dissected by youthful rivers, bounded by a fault-line scarp on the east.

In perhaps the Pliocene, floods of olivine basalt from necks situated on Palaeozoic faults resulted in the complete drowning of this ancient landscape. The earlier flows dammed the narrow gorge of the Paloona River, causing lakes to develop at Melrose and Sheffield. Forests were established on the shores of lake Sheffield, as indicated by wood remains in the sandstones and fossilised wood at Nook. The sedimentation was closed by first a flow of lava into the lake, then by ash showers which formed tuffs interbedded with shales at Barrington. Finally the depression marking the lake was completely filled in with later floods of basalt.

Since that time, the rivers have established themselves in narrow V-shaped gorges dissecting the lava plain. Portions of the old Carboniferous peneplain have been exhumed for a second time, but this time are covered with outliers of basalt rather than dolerite,

The cessation of the Pleistocene glaciation produced a rise in sea-level, and the release of abundant meltwater which carrying material from moraines aggraded the river valleys. A Recent emergence has resulted in the cutting of terraces in these deposits.

Modern processes are resulting in the formation of residual soils, talus slopes, and flood plain deposits.

ECONOMIC GEOLOGY

Metallic minerals occur sporadically in the area. All known occurrences are tabulated, although no new work has been done on them.

Barrington, or Alma, Copper Mine: This consists of several tunnels, shafts, and numerous pits in the valley of Copper Creek at Alma (4222E, 9142N). Accounts have been published bu Thureau (1881), Twelvetrees (1905) and Twelv trees (1909, pp. 27-32). The ore consists of chalcopyrite, native copper, pyrite, and a little malachite, with siderite, calcite, quartz, and abundant barytes. Blake (1928) investigated the barytes occurrences.

The ~~im~~ area of mineralisation is very extnsive, Copper Creek having a bed of barytes for some chains. Chalcopyrite and baryte veins outcop in the North River half a mile east (9133N, 4230E). Leases include 1405, 114M, 3326/93M, 3325/93M, 3204/93M, 2597/93M, 3203/93M, 930, 1669, 948, and baryte reward 7422M.

Previous writers refer to a strong gossan which can be followed for many chains on the surface. This is in fact, a breccia band in the Copper Creek formation, which has been extensively replaced by ore minerals. The host rocks are here folded into an asymmetrical syncline facing north, and are conformably underlain by cherts which are recorded in some drives. The ore feeder is the (Haig) INGRAM Creek Fault, which underlies the area. There is a possibility of a small ~~trech~~ fault at the synclinal axis, which would have provided a passage through the cherts. There is a strong possibility of a blanket orebody in the siltstones and breccia, and of ore in the thrust plane. Some of the barytes is of high grade, which makes this a promising prospect. A self potential survey across the syncline, and on the outcrop of the Haig Creek fault is indicated.

Lucas and Perry's Lodes: These occur in greywacké sandstones and shales assigned to the Wilmot Formation, and lie near

near the (Haig) INGRAM Creek Fault on the lower plate. The mine was not located, but is north of Lower Wilmot (near 9130N,4205E). Twelvetrees (1905, p.33) records that the ore is argentiferous manganese oxide.

Crawford's Lodes: These occur somewhere west of the Alma Bridge (near 9165N,4205E) and are described by Twelvetrees (1905, p.33). The ore is auriferous pyrite with calcite gangue, in slates of the Kindred Formation.

Galena Prospect: A shallow shaft has been sunk on the crest of a small hill at Barrington (9119N,4269E) and fragments of milky quartz showing excellent pseudomorphs of galena were found on the surface. The country rock is Bott Conglomerate. Several pits in the side of Aitken Creek are reported to have yielded tin. Several open cuts in the Denny Gorge have yielded specul r haematite and quartz.

Preston Silver Mine: This mine is described by Twelvetrees (1905, p.24) and is an open cut on the west bank of the West Gawler River near the Preston rifle range (9120N,4070E). The ore is pyrite, zinc blende, and argentiferous galena in a calcite gangue. The country rock is slate immediately underlying the Prestoh Breccia. The lease was 2459M. The country is now overgrown, and the mine could not be located. The local inhabitants ~~only~~ remember similar mineralisation being prospected about 400 yards north west, largely covered by basalt. Small pits have been sunk on a similar deposit on a tributary of the West Gawler at South Nietta (near 9100N, 4065E). The ore was chalcopyrite.

Duncan McLaren's Mine or Dunc Mac's: This consists of a shallow open cut on the eastern side of the Gawler River (9250N,4128E). The ore is disseminated pyrites replacing the matrix and limestone pebbles of a breccia correlated with the Preston Formation. A similar deposit occurs in keratophyre breccia of the same formation on the ~~wes~~ eastern bank at the fork of the Gawlers.

Coulbourn's Show: This is a deposit of ~~quartz~~ pyrite in the

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Preston Breccia at road level on the eastern side of the Leven River(9186N,4065E),with leases 3383M,Colbourn and Longshaw,described by Twelvetrees(1905,p.23)

Brown's Blow: This is a deposit of quartz with specular haematite in a calcareous slate.The country rock is probably the Preston formation.The only description is by Twelvetrees(1905,p.23) and the locality is a few hund ed yards west of Coulbourn's Show.

Radford's Reef: This occurs in argillites of the Leven Formation,and consists(Twelvetrees,1905,p.22) of pyrite, chalcopyrite,and specular haematite with abundant manganese dioxide.The outcrop is in the Leven Gorge west of the river(4062E,9183N).

Hebblethwaite's Prospect: This is a deposit of crystalline pyrites in pug,in slates of the Leven Formation,outcropping on the eastern flank of the Barren Hill.The workings are shallow costeans on the bank of the creek(4104E,9195N). The lease is 436P,C.H. and E.I.Hebblethwaite.

Walloa Creek Mine:This is described by Twelvetrees(1903, 1905 p.17),and Hughes(1953).Numerous workings occur near the junction of two large Tabberabberan faults(9198N, 4038E).The ore consists of chalcopyrite with silver and gold,pyrite,covellite,and a gangue of calcite,quartz, specular haematite,and slate.The country rock is Cambrian Breccia.The leases are 2551M,2416M,2414M,8120M,5848M, and 8842M,the last three in the name of H.J.Coulbourn.

Barytes Deposit: Ramifying veins of crystalline barytes, stained brown by surface water,and up to 18" diameter,occur on the east bank of the Wilmot River about half a mile south of the mouth of Braddon Creek,in a sharp bend convex east.The country rock is laminated siltstone with breccia bands.

Macpherson Copper Mine: This mine was not located,but probably consists of chalcopyrite and barytes in a keratophyre breccia,or slate,on the east bank of the East Gawler River at the old township of Crawford(~~XXXXX~~,9145N,4116E).

088 Similar deposits occur further upstream(9137N,4119E). A shallow pit was discovered near the site of the mine. In the river below,a micaceous bright green mineral occurs in joints in the rock. This is probably malachite,but ~~xxxx~~ has been submitted for assay for uranium.(Lease 4995M).

Pyrite Deposit:Disseminated crystalline pyrites occurs in the Motton Spilite in the West Gawler River(4090E,9165N) and in several localities in in the Leven Gorge.

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The metalliferous deposits belong to the mesothermal zone,and the source is probably the Housetop Granite which outcrops over hundreds of square miles at Riana and may directly underly the Ordovician rocks at Pine Creek. The mineralisation is closely related to that of the Dial Range. The deposits are probably zoned,as tin-tourmaline lodes occur nearer the granite(Montgomery,1895).

all in Dundas gp? why Devonian?

The occurrences are remarkable for there persistent association with the Preston Conglomerate and its correlates, the Bott Conglomerate and the Dial Range Conglomerate of Montgomery(1895). More than half the deposits occur as replacements in this rock,or as fissure fillings in associated argillites. This fact has been commented on by Montgomery(1895), Twelvetrees,and Hughes(1953). The mineralising channels are almost certainly the Devonian faults. Hughes has pointed out the likelihood of worthwhile deposits where these large faults intersect the breccia. The period of mineralisation at Round Hill postdates the faulting,which is consistent with observations in the Dial Range. The period of mineralisation is therefore Devonian,which must be the age of the Housetop Granite.

The most promising shows are the Alma and Walloa Creek mines. The abundant pyrite on the Nietta road south of Upper Castra and the other known deposits indicate that prospecting of the southern extension of the Preston Breccia may be fruitful.

<u>Alluvial Deposits</u>: Gold has been won from the Tertiary sediments of the Paloona River where it crosses the Forth. (9183N,4235E), and in Tertiaries in the Clayton Rivulet (9187N,4159E). Shafts have been sunk in similar deposits to the north-east (9193N,4177E) for diamonds, but without success. A prospector from Ulverstone periodically washes gold from the Forth River near the mouth of Copper Creek. Montgomery (1895) records that the Pleistocene gravels (terraced deposits) contain gold frequently, and rutile is reported from such deposits on the coast. The Tertiary sands at Preston contain boulders of specular haematite.

<u>Industrial Minerals</u>: A thin but widespread bed of pipeclay underlies the basalt at Warringa (4023E,9133N), and is responsible for the landsliding there.

Ochre, derived from Tertiary basalt, has been quarried at Sprent (9199N,4175E). A report was received of iron ore deposits beneath the basalt in the East Gawler River at Sprent, but could not be located. Similar deposits are economically worked at Stoodley to supply iron for Portland cement.

Limestone outcrops extensively at Gunn's Plains, where it is utilised solely for the tourist attraction of the caves. Leases were taken out, 435PM and 8W/52 in the name of A. Kimberley, and 305PM H.L. Munro. and a report on the deposits has been prepared by T.D. Hughes (1957, in press). The limestone at Melrose has been exploited in the past by several operators, including Stone and the B.H.P. Co., for smelting flux and lime. Quarries for lime and metal are at present operating, with leases 397PM, 398PM, and 378PM, in the name of H.F. Hallett. A detailed report is in press (Henderson, 1957). A small outcrop of limestone at Lower Barrington is too small for economic development.

Graphitic pencil shales outcrop in the Forth River for 15 chains north of the Paloona Bridge. An analysis shows only 5 per.cent. carbon, but the deposits are extensive, and higher grades may underly the gravels to the west. The overburden is about 15 feet,which would not preclude economic exploitation of a high grade deposit.

Coal and oil shale have been mined at several localities in the valley of the Don River. These are described by Reid (1922,1924),Thureau(1883,1884),and Twelvetrees(1912) and Selwyn(1855).

Dean and Denny's Workings: This consists of three shafts,one now filled in,near the mouth of the Denny Gorge(9200N,4294E).

Mersey Coal Company: These workings have been obliterated,but were on the east bank of the Don River south of Buster Road (4296E,9192N).

Fosters Workings: This consists of several shafts and an adit on the west bank of the Don River south of Buster Road(4294E, 9195N). The lease is 307P,5acres,in the name of M.Foster and others,and was surveyed in 1937. The dumps at the adit are strewn with coal,but no records of production have been found.

Bott Gorge Outcrop: Deposits of oil shale(or possibly coal,or both) occur near the mouth of the Bott Gorge(4295E,9177N). The workings consist of two collapsed adits.

Ray Creek Mines: These are the Ray's and Keep's prospects of Twelvetrees. Apparently only Rays outcrop was explored,by an inclined adit,but after closure of processing facilities at Latrobe the mine closed down. The workings are 1 hundred yard west of the Nook Road(4300E,9152N). Lease 4868M,A.P.Manton, and 4880,R.P.Symmons,were sympathetic leases pegged on barren country.

The coal and tasmanite are interbedded with Permian rocks,and are discussed elsewhere. The coal is exhausted in the area mapped,but reserves on Bonneys Tier will not be known until the regional mapping is complete. The seam is ecenomic for small scale operations,being sold locally as boiler fuel. The quality is good. The oil shale is not economic in view of present petroleum prices.

Cooper-Smith's Iron Formation: This was described by Twelvetrees(1905,p.48),and is located at the first bend north of the Paloona Waterworks on the right bank of the river. It is a ferruginous sandstone in the Tertiary sediments of the old bed of the Paloona River, and is economically not of value.

Engineering Materials: Fine quartz sand derived from the Bott Conglomerate occupies an extensive area at Nook. The deposit(at 4299E,9132N),is over 30' thick in places. The material contains some ferruginous matter,but is sufficiently pure for building purposes.

The Crotty Sandstone at Gunn's Plains is high grade silica,but the outcrop is restricted,and access to the coast difficult. The lease is 515PM,H.L.Dennis.

Gravel derived from the Barren Hill cherts is used extensively for road-making by the P.W.D.,the recorded lease being Silica Reward 7420M,W.J.Coulbourn and S.J.Dawson. The Devonport council is actively exploiting deposits of gravel derived from Precambrian mica schist.at Melrose.

The developed properties are working in deeply weathered zones. The favoured technique is to use a bulldozer on a steel line,the dozer pushing the gravel downhill where it is loaded into trucks with front end loaders. The dozer winches itself back up the hill on the rope. The reserves appear to be enormous at Melrose,the only limitations being topography. The Barren Hill deposits are restricted to several weathered areas. The Nook deposits are lean in a restricted area,where the clay has been fortuitously removed.

The basalts have been extensively utilised for road-making,but the only quarry within the area is a small one on the Preston-Central Castra road. In the past Municipal authorities have purchased stone stockpiled by local farmers. The Cambrian claystones are favoured near Sprent,with numerous quarries on the roadside between Sprent and Upper Castra. Superficial scree from the Kindred Formation,which probably dates from the Pleistocene,has been exploited on the Cradle Mountain Highway at Paloona. This affords a cheap suppl[y] of broken stone,but are dangerous to work in that slips into excavations are likely. The deposits are considerable,forming a shallow mantle on the sides of the Forth and Wilmot valleys but are rarely accessible.

<u>Soils</u>: The region owes the present state of development solely to the rich soils derived from the Tertiary basalt. The boundaries of the farmlands correspond closely to the boundary of the basalt in some areas, but where the Cambrian rocks are red-soil-forming, such as the Motton Spilite and the West Gawler claystones, the boundary of the fields extends for some distance away from the basalt. Keratophyres and greywacké sandstones form deep, red soils in some localities. All available basalt soil is developed, and commands high prices. The staple products are potatoes and dairy produce.

In marginal areas, the soil is derived from the weathering of scattered boulders of basalt. The farmers report that the collection of boulders from such paddocks cause a rapid deterioration in soil condition. The Preston district at Peter Jack's Road is a typical marginal area. Elsewhere the boulders are collected from the paddocks and sold, or used to fill the deep gulleys that freguently originate from springs. Some completely filled gulleys have been seen, and the farmer now works right across them, the water percolating underneath. This practice inhibits erosion.

<u>Water</u>: The annual rainfall varies between 40 and 60 inches, and so far there has been no call for water bores. Perpetual springs are available on most farms at the base of porous flows or on the outcrop of interbedded sediments. Many of these have been dammed, and the water pumped to storage with windmills. There is no doubt that if water problems arise, abundant supplies are available beneath the basalt, particularly at Lower Barrington. The lake sediments beneath the basalt there ~~xxxxxxx~~ are probably permanently saturated. Even in the driest summers the outcrop of these sediments at Paloona carries a strong spring.

Some of the country at Lower Barrington is badly drained, and is flooded in winter. This land could be drained fairly cheaply by drilling down to the underlying Tertiaries, and letting the water escape through the borehole. In view of the value of land in the district (up to £200/acre) this technique is well worth trying.

Engineering Works: Considerable trouble has been experienced with landsliding of the Tertiary basalts. The most recent disasters occurred in 1929, when large areas at Warringa slid on pipeclay, and 1956, when vitric tuffs at Paloona slid on Tertiary volcanic clays and disrupted the Devonport Water Supply. T.D.Hughes (pers. commm.) has found the slips occur whenever the seasonal rainfall exceeds 60". Generally the slips are earthflows, but huge deep deformational shears are suspected at Warringa.

Several roads in the area cross potentially, or xmxkx already, unstable ground. Slips in the Tertiary(?) gravels have blocked the road between Preston and Gunns Plains, and there is a strong possibility that a slide is developing in basalt about 400 yards from the turnoff at Preston. This slide could be disastrous in view of the high local relief. The Roland Highway at Lower Barrington crosses a slippage zone in mixed basalt and dolerite, resting on soft Permian shales. If the basalt perched on top of the hill starts moving the slide will never be controlled. A safe route is available just south of the pine plantation several hundred yards south, in solid quartzite and dolerite and affords a better grade, but would involve relocation of the bridge, and crossing the Don flood plain at its widest extent. The road between Melrose and Paloona has had two small slips onto it, and the road alongside the Forth at Paloona is constantly menaced by rockfalls from a basalt flow resting on Tertiary sandstones which are being eroded by discharging groundwater. Since the Paloona Bridge is closed to heavy traffic, a failure here would mean closing the hinterland to all traffic too heavy for Luttrells Bridge.

The valleys of the Forth, Wilmot and Leven Rivers contain excellent dam sites for hydro-electric purposes, but storage capacities are small. Damming the Sugarloaf Gorge would create a large lake at Gunns Plains. The maps of sub-basaltic topography would need to be supplemented by drilling for tunnelling purposes.

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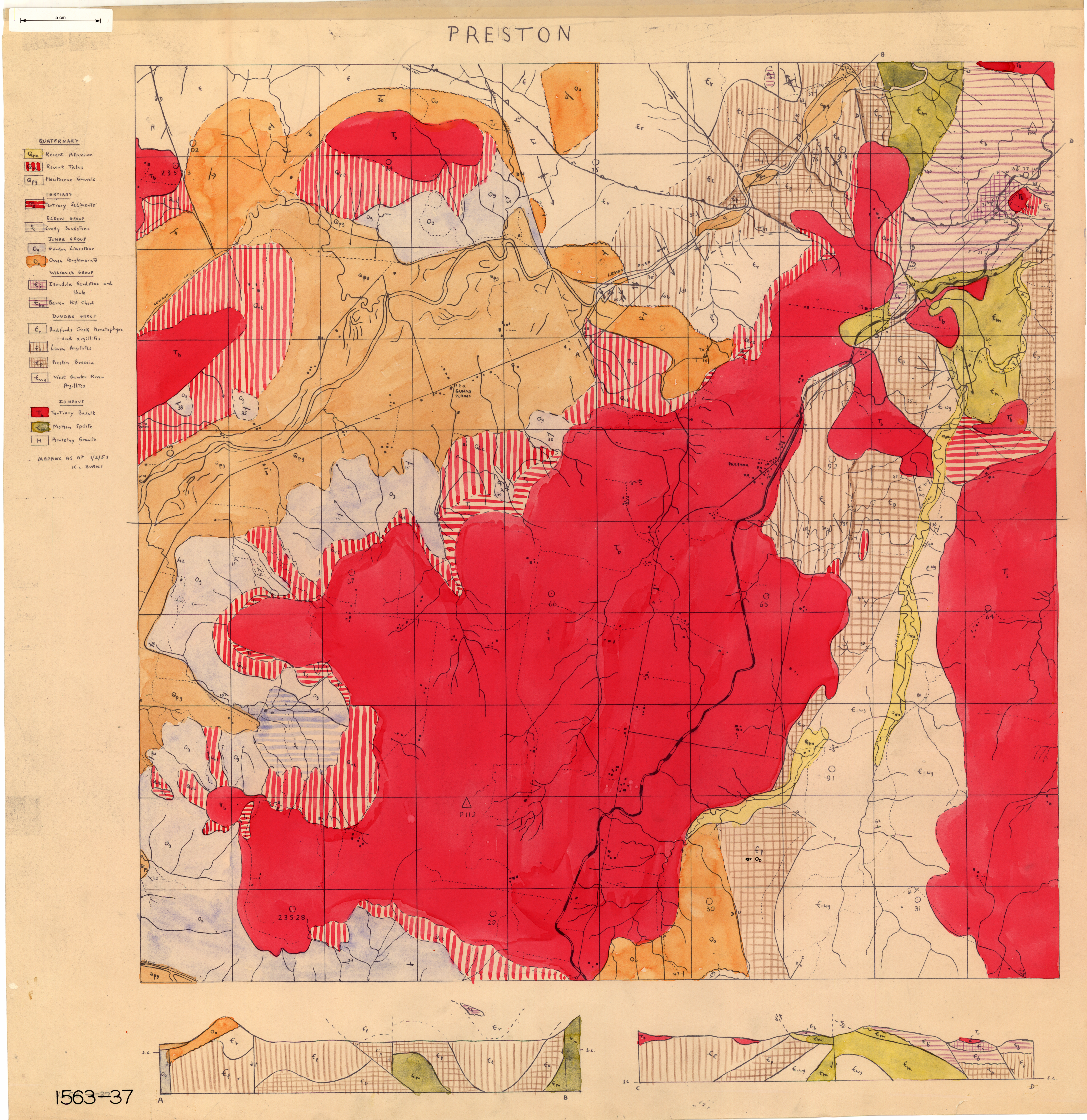
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PRESTON
QUATERNARY
Qra Recent Alluvium
Qrt Recent Talus
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TERTIARY
Ts Tertiary Sediments
ELDON GROUP
Sc Crotty Sandstone
JUNEE GROUP
Og Gordon Limestone
Oo Owen Conglomerate
WILSONIA GROUP
Ꞓi Isandula Sandstone and Shale
Ꞓba Barren Hill Chert
DUNDAS GROUP
Ꞓr Radfords Creek keratophyre and argillites
Ꞓl Leven Argillites
Ꞓp Preston Breccia
Ꞓwg West Gawler River Argillites
IGNEOUS
Tb Tertiary Basalt
Ꞓm Motton Spilite
H Housetop Granite
MAPPING AS AT 1/2/57
K. L. BURNS
LEVEN RIVER
GUNNS PLAINS
PRESTON
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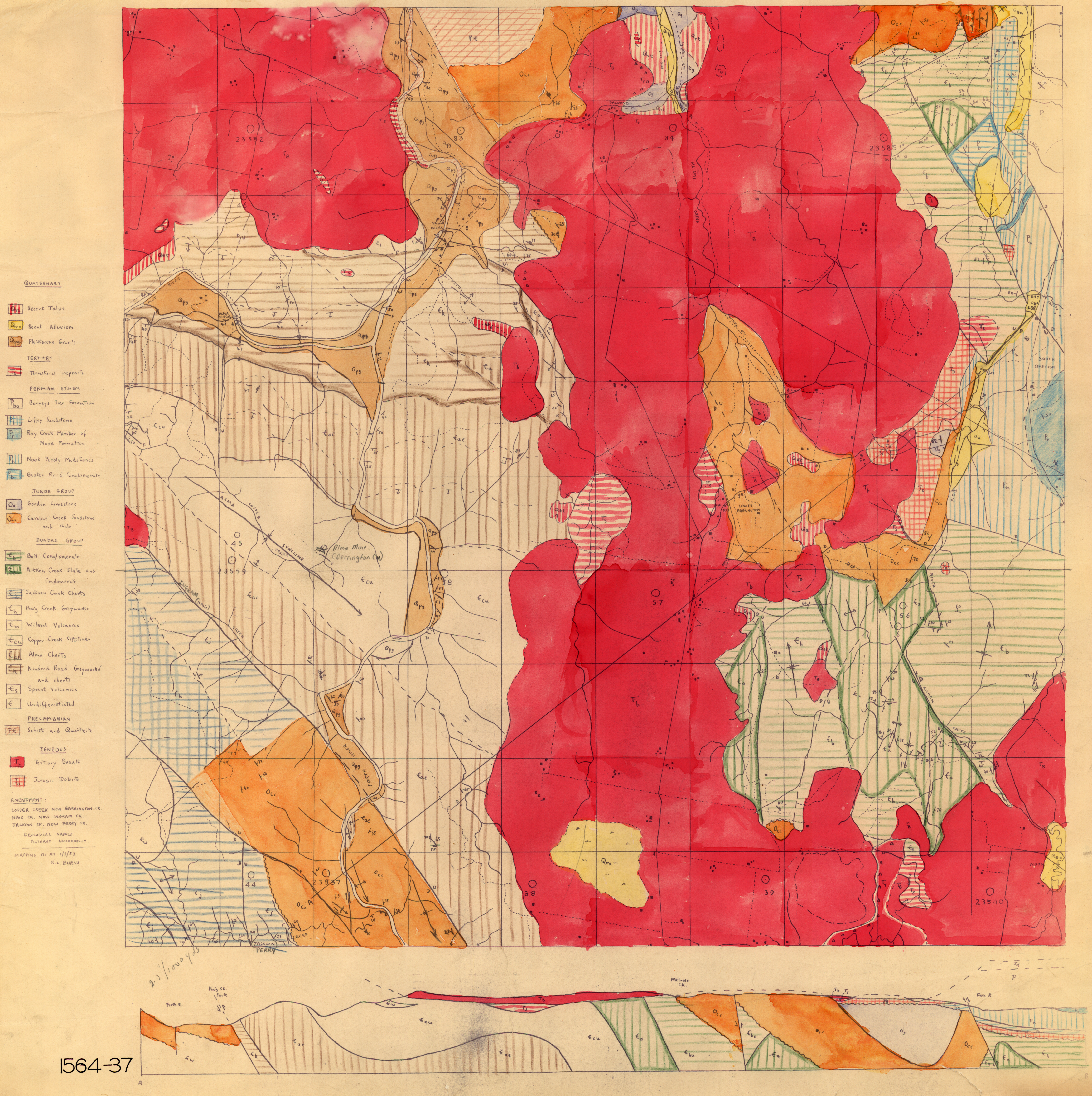
PALOONA


QUATERNARY
Qrt Recent Talus
Qra Reent Alluvium
Qpg Pleistocene Gravels
TERTIARY
Ts Terrestrial deposits
PERMIAN SYSTEM
Pbo Bonneys Tier Formation
Pl Liffey Sandstone
Pr Ray Creek Member of Nook Formation
Pn Nook Pebbly Mudstones
Pb Buster Road Conglomerate
JUNEE GROUP
Og Gordon Limestone
Occ Caroline Creek Sandstone and shale
DUNDAS GROUP
Єb Bott Conglomerate
Єa Aitken Creek Slate and Conglomerate
Єj Jackson Creek Cherts
Єh Haig Creek Greywacke
Єw Wilmot Volcanics
Єcu Copper Creek Siltstones
Єal Alma Cherts
Єk Kindred Road Greywacké and cherts
Єs Sprent Volcanics
Є Undifferentiated
PRECAMBRIAN
PЄ Schist and Quartzite
IGNEOUS
Tb Tertiary Basalt
Jd Jurassic Dolerite
AMENDMENT:
COPPER CREEK NOW BARRINGTON CK.
HAIG CK. NOW INGRAM CK.
JACKSON CK. NOW PERRY CK.
GEOLOGICAL NAMES ALTERED ACCORDINGLY.
MAPPING AS AT 1/2/57
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Alma Mine (Barrington Ck)
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23585
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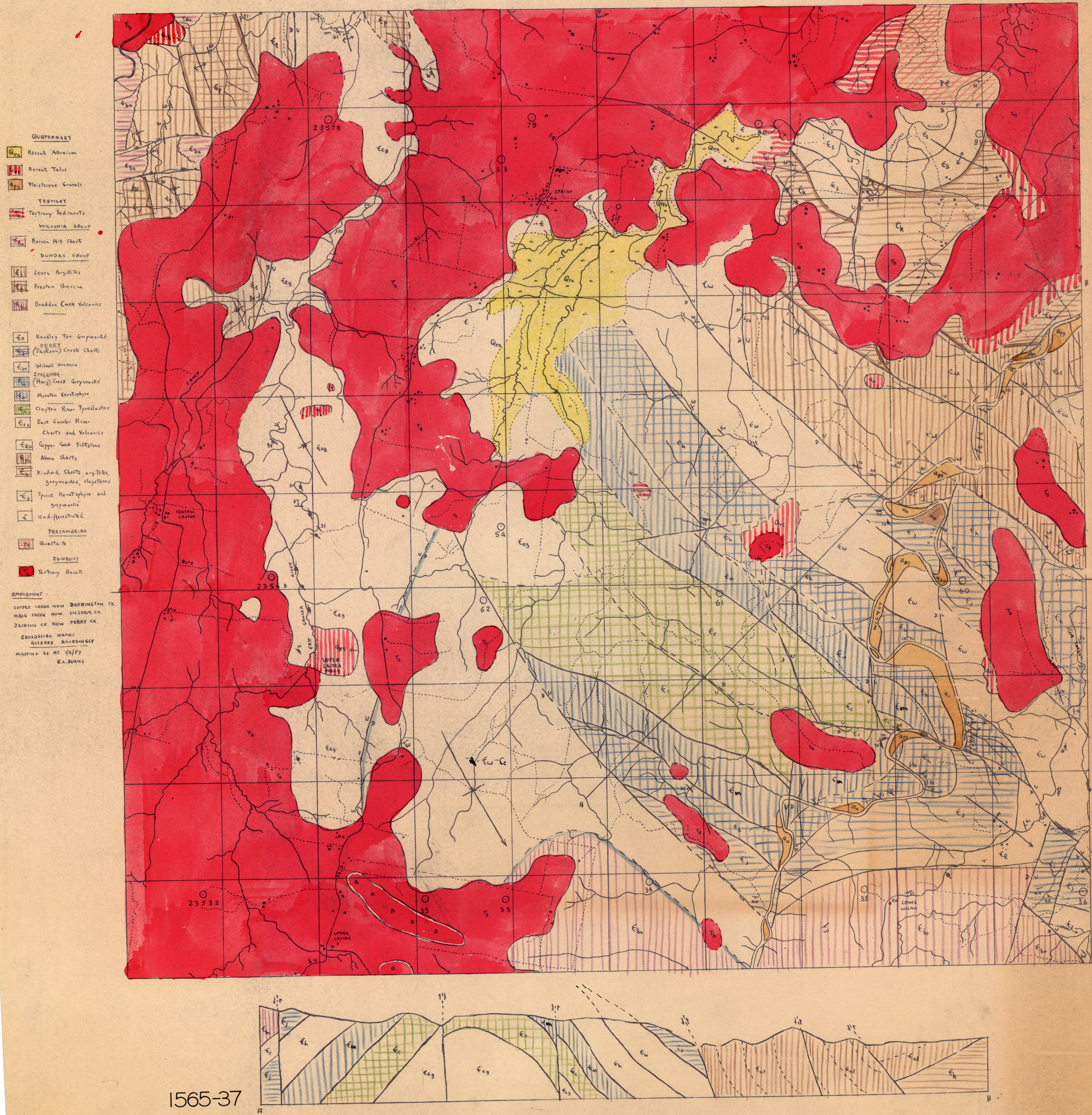

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