DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

REPT.BK.NO. 88/2

A REVIEW OF GAMBIER LIMESTONE - GEOLOGY, USES, SPECIFICATIONS AND PRODUCTION

GEOLOGICAL SURVEY

by

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MINERAL RESOURCES

JANUARY, 1988

DME.148/84

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Rept.Bk.No. 88/2
D.M.E. No. 148/84
Disk No. 149 & 155

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ABSTRACT

The Marte area, 10 km west of Mount Gambier is the largest producer of building stone in Australia. Output has averaged 20 100 tonnes of ashlars per year over the last 36 years. Massive calcarenite of the Gambier Limestone of middle Oligocene to early Miocene age, has been extensively modified by migrating groundwater which produced a thin coating of crystalline dolomite cementing bryozoal fragments. Dissolved bryozoal fragments are reprecipitated as very poorly crystalline to amorphous matrix which infills pore spaces. Although often very white, the matrix tends to be chalky and friable. The distinctive northwest alignment of the quarries is parallel to a regional joint pattern which has a strong control on the calcarenite's final texture. Jointing may be only 5 000 years old, the same age as the nearby Mount Schank volcanic activity.

Gambier Limestone has also yielded significant quantities of agricultural lime, whiting and glass-grade limestone. Although the middle 'cream limestone' has yielded most of the ashlars and whiting, the 'upper grey cherty limestone' is slightly purer and yields low iron, glass-grade limestone. Whiteness of limestone is controlled by crystallinity as well as iron content, and the 'upper grey cherty limestone' tends to be of high-purity but poorly crystalline and less white.

INTRODUCTION

Currently, Gambier Limestone yields more building stone than any other stratigraphic unit in Australia with an annual ashlar output of about 20 000 tonnes per year. In addition, Gambier Limestone provides an important source of glass-grade limestone, whiting and agricultural lime as well as a cheap, local source of road rubble. The stone has been used since colonisation; the first pastoralists in the Mount Gambier-Mount Schank area are recorded as cutting limestone blocks in 1842-1844, and a convent built of the stone in 1856 was demolished only recently in 1985.

As part of the investigation by Mineral Resources Branch of the building stones of South Australia, limestone quarries near Mount Gambier were mapped from 27 February to 7 March 1985 by D.J. Flint assisted by M.W. Flintoft (Field Assistant). Aerial photography dated 3 March 1982 was used by Photec Air Surveys Pty. Ltd. to compile a 1:5 000 base plan of quarries at Marte in August 1984. Geological data and updated quarry outlines were plotted onto the Photec base plan, which has been modified to produce a new 1:10 000 base plan. Thirty-three representative samples (7022 RS 121-153) were selected for petrographic examination by M. Farrand (Senior Geologist, Regional Geology Branch) and for chemical analysis by Australian Mineral Development Laboratories (AMDEL). Petrographic examination was used to investigate the mineralogical and petrological basis for variations in colour, grain size, texture, resistance to weathering and general suitability as a building stone. Full petrographic details are available in Farrand and Flint (1987). Quarry and sample localities are shown in Figures 1, 2 and 5. Localities of Plates are shown on Figs. 5 and 6.

Typical quarry product for detailed material testing by AMDEL was collected on 26-27 August 1985 by A.M. Pain (Principal Geologist, Extractive Materials), D.A. Young (Senior Technical Officer) and the author. Six samples (7022 RS 160-165), each consisting of about six 660x300x100 mm ashlars, were collected to provide a geographic spread and range of quarry product. Not all operating quarries were sampled.

This report reviews production of ashlars from Gambier Limestone with emphasis on the Mount Gambier area; coverage is incomplete for production of ashlars from the Tantanoola, Glencoe and Naracoorte areas. Other uses for Gambier Limestone including whiting, glass, agricultural lime, lime for mortar and road rubble are detailed. Production, geology etc. of dolomite from Gambier Limestone are not discussed in detail. Results of laboratory testing, on samples RS 160-165 by AMDEL is reported by Spry (1986) and assessed by Flint et al., (1987).

MINERAL TENURE AND PRODUCTION

Prior to 1972 nearly all production of building stone from the South East was from freehold land, with only nine Mineral Claims (MC) pegged for building stone, as detailed in Table 1. These were pegged between 1936 and 1956 in hundreds Blanche, Hindmarsh, Kongorong and MacDonnell. O'Leary quarry (Fig. 2) was repegged as MC2128 on 9 April 1987 and an Extractive Mineral Lease (EML) applied for. In 1985-86 this quarry was used as a source of road rubble for the District Council of Mount Gambier, and has been pegged so that ashlars can be cut, trial sawing was conducted during 1986. Production details of rubble and ashlars are not available.

In South Australia freehold land titles granted up to the end of 1888 included ownership of all minerals except gold and silver. All minerals were reserved to the Crown on freehold land granted after 1888, but the Mining Act restricted the right to work stone to the freehold owner. Minerals have been reserved to the Crown on all leasehold tenures issued since settlement of the State.

A new Mining Act proclaimed in 1972 resumed all privately owned minerals to the Crown. However, Section 19 provided that, for a period of 3 years commencing on 4th July 1972, on land where minerals had been resumed, a Private Mine (PM) could be proclaimed if mining operations, as defined in the Act, had been conducted in the twelve months preceeding the application for a PM. A PM so proclaimed became exempt from the provisions of the Mining Act, except for payment of royalty on extractive minerals (as defined in the Act) and no mining tenement could be granted over land contained in a PM. All freehold land owners at Marte with building stone quarries on their property applied for PMs within the three-year period. Details of PM tenure at Marte are included as Table 2; locations are shown on Fig. 3.

The Act also provided that on freehold land not subject to a Private Mine only the owner of the land can peg a MC for extractive minerals or be granted an EML.

Thus since 1972 in respect to building stone, which is classed as an extractive mineral, the following classes of land exist.

1. Land proclaimed to be a PM which is not subject to the Mining Act other than the obligation to pay royalty. However, such land is subject to the Planning Act.
2. Freehold land not proclaimed as a PM where the right to peg an EML is restricted to the freehold owner.
3. Leasehold land on which, subject to the Act, an EML can be taken out by any person holding a Miner's Right.

TABLE 1

MINERAL CLAIMS FOR ASHLARS

Tenement	Holder	Registered	Area (hectares)	Termination	Comments
HD. HINDMARSH	Section 450 (Haines Quarry)				
MC 15457	S. Haines	28.09.36	0.8		Repegged as MC 942.
MC 942	F.C. Jones	14.10.46	0.4	4.10.48	Renewed as MC 1311.
MC 1311	"	20.10.48	"	17.10.49	" " MC 1551.
MC 1551	"	14.08.50	"	7.04.52	
HD. KONGORONG	Section 497 (Near 'Old Tea Tree' ruin)				
MC 1414	H.F. Kessal	20.06.49	-	25.01.57	
MC 1517	G.F. Newton	2.02.50	0.2	1.02.51	
HD. MACDONNELL	Section 828 (Pareen Quarry)				
MC 1646	S.R. Rands	28.04.51	16	2.05.56	
HD. BLANCHE	Section 138 (Gericke Quarry)				
MC 2660	Hydrated Lime Ltd.	31.10.56	8	6.05.59	
MC 2661	" "	31.10.56	8	6.05.59	
HD. BLANCHE	Section 701 (O'Leary Quarry)				
MC 2128	L.J. Kennedy	9.04.87	7.3	-	EML applied for; proposal gazetted 17.9.87.

TABLE 2

PRIVATE MINES - MARTE AREA (hd. Blanche)

PRIVATE MINE	QUARRY	SECTION	PROCLAIMED	HOLDER
9	JARVIS	26	12.10.72	Jarvis Industries Pty. Ltd.
NOT CURRENTLY PRODUCING			27.11.80	Omya Minerals Pty. Ltd.
			22.12.81	ACI Resources Ltd.
			18.04.83	Gambier Earthmovers Pty. Ltd.
			3.09.84	White, C.G., G.B. & L.E.
14	BRUHN	136	26.10.72	Bruhn, B.H., T.B. & D.F.
15	BRUHN	136	26.10.72	Bruhn, B.H., T.B. & D.F.
115	STEETLEY	28	17.05.73	Australian Clay & Industrial Minerals
			24.09.79	Steetley Industries Ltd.
				Commercial Minerals Ltd.
125	McKAY	Block 192	14.06.73	Johnson, R.K.
	&	Allotment 1		Johnson, R.K.
	MAJOR	Block 192	27.02.85	Blackall, J. & P.M., Stafford, E.M. & J.R.
		Allotment 2		
		Block 192	29.10.85	Stafford, G.J. & B.J. & Earl, D.J. & S.J.
		Block 192	6.03.85	Gambier Earthmovers Pty. Ltd.
		Allotment 3		
132	TREFFERS	Sec.30,28,29	21.06.73	Cutting, V.A. & C.I.
		Sec.29	23.11.82	Cutting, L.V.
		Sec.30,28	21.02.85	Treffers, A. & C.A.
134	LAWSON	29	21.06.73	Garrad, H.F. NOT PRODUCING
153	FLETCHER	134	2.08.73	Pearson, K.J.
			4.05.87	Lorbar Nominees Pty. Ltd. (Bruhn)
261		135	14.11.74	Haines, M.A.
262		126,132,135	21.11.74	"
292	JENNINGS	136	11.09.75	Atkinson, R.I. & M.
			1.02.80	Little, R.L.
			20.06.83	Birrell~~, P.M.S., Walsh, M.J. & Glen, R~~.G.L.
IPS LEAGUE			9.10.84	Impact Practical Shooting League Inc.

not producing

No production data are available prior to 1924, although production is known to extend back to at least 1844. Governor Grey and G.F. Angas journeyed to the South East in 1844 and Angas wrote of the first pastoralists in the district, Messrs. Arthur:

> 'The walls of the hut, the troughs, seats and various utensils, were entirely formed of white coral: this substance, when fresh cut, is soft like salt, and easily hewn into any shape; but on exposure to the air it gradually hardens, and becomes perfectly durable.' (Angas, 1847).

Tregenza (1980) interpreted this to mean that 'from the very beginning he had learned to use Mount Gambier Stone.' Arthurs' two huts were apparently on the edge of Little Blue Lake, 5 km west-northwest of Mount Schank. Limestone blocks were probably first cut in 1842 when the Arthur brothers first arrived in the Mount Gambier area.

The oldest known building of Gambier Limestone, which stood until 1985, was the Sisters of Mercy Convent in Commercial Street East, Mount Gambier built in 1856-1857 and reputed to be the first two-storey building in the South East (Danvers Architects, 1984).

Departmental production records since 1924 are incomplete; available information is summarised in Tables 3-8. Only Gambier Limestone production is included, comprising production from throughout the South East for building stone, rubble, agricultural limestone, limestone burnt for lime and hydrated lime for building purposes as well as chemical-grade and whiting-grade limestone. Production of dolomite from Gambier Limestone is specifically excluded, as is all production from Holocene calcareous sand dunes and Quaternary Bridgewater Formation.

For many producing quarries, the quarry owner is not the operator. Production data in Table 3 are variously headed by quarry operator or owner, depending on Departmental records and are not a true indication of who worked where and when e.g. during 1973-1984 production of ashlars from PM 125 owned by R.K. Johnson was by Stafford & Blackall.

Quarry operators and owners as at 30/6/86 for all PMs in the Marte area are shown on Figure 3, along with some of the former names for the quarries. Names of other quarries in the South East area are shown on Fig. 2.

Building Stone

Records are incomplete, even after 1924, e.g. Jack (1923) described quarrying at Walter Quarry but Departmental production records commence in 1940 for that quarry. For other quarries, records are either lacking or are substantially incomplete including:

Quarry	hundred	section
- O'Leary Road	Blanche	310 & 321
- 'Bonnie-Doon'	"	203 & 238
- Edlington	"	692
- Kennedy	Gambier	1154
- Scott	"	1126
- Pareen	McDonnell	828
- Mount Salt	"	736
- name unknown	"	670

Records are unavailable for many small quarries in and near Mount Gambier which have been backfilled and built upon.

The following comments are based on available Departmental records.

Production of ashlars from Marte from 1924 to 1986 is 962 925 tonnes (Table 3). Peak production was during the building boom of the early 1950's; the highest output was 36 344 tonnes in 1953. Mobile mechanical saws able to cut ashlars *in-situ* were invented in 1950 and markedly increased production rates as follows:

1924-1950	8 500 tonnes/year
1951-1986	20 100 tonnes/year

The long-term average (1924-1986) is 15 280 tonnes/year.

TABLE 3, Part A.
PRODUCTION OF ASHLARS FROM HUNDRED OF BLANCHE, 1924-1986.

HUNDRED OF BLANCHE, SECTIONS ...

	26	28			29	29	30	121	134			136	137	138	141	144	145	192	524	UNLOCATED	
YEAR	JARVIS or KAIN & SHELTON	STEETLEY			LAWSON TREFFERS			MORRIS	FLETCHER			BRUHN		GERICKE	MAJOR	WALTER	TELFORD	MCKAY	WHITE		TOTAL Tonnes
1924								61	3066						1237			MCKAY	2187	GARRET &	6,551
1925		3997							2550						691			1335	1963	MCKINNON	10,536
1926		5318							2078						356				4709	650	13,121
1927		6431						5	1287						356				2032		10,111
1928		5255							467						305				1590		7,617
1929		7258													549				3371	96	11,274
1930		4748							111										1544		6,403
1931		1654																	1091		2,745
1932		163																	1309	183	1,655
1933		1622													142				885	406	3,055
1934		2792																	868	D.C. PORT	3,660
1935		4457													254				956	MACDONNEL	5,667
1936		3865												GERICKE	305				1858	102	6,130
1937		4592												BROTHERS	406			JOHNSON	2865		7,863
1938		6173							FLETCHER					1829	1321			3177			12,500
1939		5509							3207					2700	711	PLOENGES		3048			15,175
1940		2829												2887	610	193		1930			8,449
1941		2540							2403						229	152		1489			6,813
1942		995							914			BRUHN		GERICKE	183	61		10			2,163
1943		1329							1025			472		&	97	25					2,948
1944		1186							814					MCKINNON	494	169					2,663
1945		1951							851			914		1626		152					5,494
1946		4257							884			2032		6375		598					14,146
1947		6969							833			2306		4528		203					14,839
1948		9530	LIMESTONE						1038			719		MCKINNON & STURGESS		406		JOHNSON			11,593
1949		8135	PRODUCTS						499			1585		8636		508		1524		MOUNT	20,637
1950	PRITCHARD	13672	3223						206					5608		152	TELFORD	1910		GAMBIER	24,771
1951	BROTHERS	9063	15594						LEGGETT					5364		483	15	1219	SHAUGNESSY	QUARRIES	31,738
1952	7986		9778						305					4107		420		1219	&	7112	30,927
1953	8026		10384	KAIN &					305			5791		3101		406		1219	PLOENSES	7112	35,344
1954	9652		3595	SHELTON										1805				823	660		16,535
1955	3858		5922	13377					LIGHT &			7469		HYDRATED		CAPPERCO		1753	2286		35,165
1956	2912		3769	7620					GERICKE			6187		LIME		126		5939	1656		27,309
1957	3128		4151	4901					1219		BLACKMORE	2137		1452							17,038
1958	2778		4672	3559					2430		249	2743		1650							18,081
1959	3124		3845	4785					3853	FLETCHER		2424		129							17,760
1960	4461		3187	3302					4243	2729		1869		335							20,125

TABLE 3, Part 8.
PRODUCTION OF ASHLARS FROM HUNDRED OF BLANCHE, 1924-1986.

HUNDRED OF BLANCHE, SECTIONS ...

	26			28		29	29	30	121		134		136		137	138	141	144	145	192	524	UNLOCATED	
YEAR	JARVIS or KAIN & SHELTON			STEETLEY			LAWSON	TREFFERS	MORRIS		FLETCHER		BRUHN			GERICKE	MAJOR	WALTER	TELFORD	MCKAY	WHITE		TOTAL Tonnes
1961		3684			1483					5368	8112	163	3708			879							23,397
1962		261		1428	1524					4295	6692		3658			2949				STAFFORD			20,807
1963	JARVIS	396		3331	2032					4572	2703		3757			256				&			17,047
1964	INDUST.	736			2264					4952			2903							BLACKALL			10,855
1965	174				1437					7494			3563							1663			14,336
1966				448	1484	CORALINE				5405			2960		LIGHT					1044			11,341
1967	2056			2721	2845	INDUST.				4973			2876		BROTHERS					1169			16,645
1968	1194			4013		4288		CUTTING					2596		4369					197			16,657
1969	3859			4384	BUTLER	4023		1402		PEARSON			3556		6547					965			24,736
1970	175			2657	2288	4470		3178		2845			4630		3973					1138			25,354
1971	174		STEETLEY	2814	2939	5547		4228		3440			4907							524			24,573
1972	134		2789		1458	4938		4323		4261			3073							1244			22,220
	PRIVATE MINE 9			PRIVATE MINE 115		PRIVATE MINE 134		PM 132		PRIVATE MINE 153			PM 14 & 15							PM125			
1973	937		1811		2736	3966	LAWSON	4649		1851			6450							1458			23,858
1974			2813		1301		4200	3332		3090			4181							1827			20,744
1975			2901				3756	2816		2123			3958	ATKINSON						1145			16,699
1976			2969				3661	3779		2021			6144	153						830			19,557
1977			2925				3327	2621		1774			6044							921			17,612
1978			2800				2927	1653		2092			5255							2377			17,104
1979			1699				2223	3142		2275			7200							1934			18,473
1980			2232				3230	2931		1960			7200							2215			19,768
1981			1683				3144	1478		1401			5587							2079			15,377
1982			5278				1416	2003		776			2638							1404			13,515
1983			5029				1833	2939		1411			3653							1758			16,614
1984	BUTLER		3958				2086	3875		1493			5842							2140			19,394
1985	1022		3459				2148	—		1844			5840							2282			16,595
1986	811		702				1808	—		1838			2920							1626			9,745
SUBTOTAL	10,536	50,102	169,343	89,526	61,835	27,232	35,759	48,340	66	108,147	20,236	412	151,752	153	14,889	56,226	8,246	4,074	15	58,535	31,830	15,671	
TOTAL		60,638		320,704			62,991	48,340	66		128,795			151,905	14,889	56,226	8,246	4,074	15	58,535	31,830	15,671	962,925
	792		1082				1736	—		2758			2920							1850			11,137 – 1987
	904		1446				1964	—		3460			1460							2500			11 674 – '88
	308		1166				2255	—		4000			2920							3000			13649 – '89
	407		497				2159	260		4000			2920							3500			13743 – '90.

TABLE 3, Part C.

PRODUCTION OF ASHLARS FROM HUNDREDS OF GAMBIER, HINDMARSH, KONGORONG, MACDONNELL AND NARACOORTE, 1924 - 1986.

YEAR	GAMBIER	HINDMARSH		KONGORONG		MACDONNEL		NARACOORTE	
	359	209 & 210	335 & 450	497		736	828	28	
	TURNER	BIRD	HAINES	KESSAL	NEWTON	MOUNT SALT	PAREEN	JAMES	TOTAL Tonnes
			HAINES						
1924			81						81
1925								JAMES	0
1926								130	130
1927									0
1928									0
1929								610	610
1930									0
1931									0
1932			14					224	238
1933			6						6
1934			61						61
1935			102					711	813
1936			92					51	143
1937	TURNER		MC 15457					61	61
1938	856		222						1,078
1939		BIRD	301						301
1940		203	333						536
1941		41	176					66	283
1942		10	110						120
1943		20							20
1944									0
1945			122						122
1946		KLEM	JONES						0
1947		203	106	KESSAL					309
1948			72	MC 1414	NEWTON				72
1949			106	30	MC 1517		RANDS		136
1950			254	91	4		MC 1646		349
1951			228	41			336		605
1952				26					26
1953						MOUNT			0
1954						SALT			0
1955						QUARRY			0
1956						2158			2,158
1957						1798			1,798
1958						1669			1,669
1959-1986									0
TOTALS	856	477	2,386	188	4	5,625	336	1,853	11,725

The last time annual production reached the post-1951 average was in 1974. 1986 production of 9 705 tonnes is well below average. The last time annual production reached the post-1951 average was in 1974. Recorded 1986 production is low partly because of:

- sale of Fletcher Quarry by K. Pearson to Lorbar Nominees Pty. Ltd. (Bruhn)
- closure of Commercial Minerals plant at Marte with recommencement by Limestone Products
- production figures for Treffers are not available.

Ashlars have been mined from at least 13 localities in hundred Blanche, with additional production from six localities which cannot be located. Many sections particularly 28 & 134, contained several quarries with different operators some of whom have merged only recently, e.g. in Steetley Quarry in 1969, ashlars were being cut by Coraline Industries (Limestone Products) and Kain and Shelton (2 areas), R. Butler and Erwin Bruhn (Fig. 7).

The three most important producers are:
Steetley Quarry - 320 704 tonnes, 33% of total
Bruhn Quarries - 151 752 tonnes, 16% of total
Fletcher Quarry - 128 795 tonnes, 13% of total

Outside the Marte area an additional 11 725 tonnes of ashlars are recorded from hundreds Hindmarsh, Kongorong, MacDonnell, Naracoorte and Gambier (Table 3).

Total recorded production of ashlars from Gambier Limestone from all areas between 1924 and 1986 is 974 650 tonnes.

Total production since colonisation can be estimated from Table 3. Average production from 1924-1937 is about 6 800 tonnes/year; after 1937 production rates tend to be higher except during the years of World War II. Assuming an annual production average of 5 000 tonnes/year from 1850 to 1923, production from 1850-1923 is estimated at 370 000 tonnes. Overall total output of ashlars since colonisation is estimated at 1.3 million tonnes.

Rubble

District Councils have quarried large quantities of road rubble but only rarely are locations known. Where location is unknown and the rock type may be either Gambier Limestone or Bridgewater Formation calcarenite, production data are not included in Table 4. Production of road rubble from Gambier Limestone, as shown on Table 4, totals 1 389 028 tonnes. The figures grossly understate the importance of Gambier Limestone as a source of road rubble throughout the lower South East. Actual production must be very much higher as rubble production probably exceeds that of ashlars by a ratio of at least 10:1. For the same period, ashlar production approaches 1 000 000 tonnes. Although total tonnages mined by District Councils are known approximately, data are insufficient to determine the proportion from Gambier Limestone relative to that mined from Bridgewater Formation.

The most significant production of rubble has been from:

Telford Pit - 668 593 tonnes, 48% of the total
Bruhn Quarries - 112 205 tonnes, 8% of the total
Steetley Quarry - 109 565 tonnes, 8% of the total

The District Council of Mount Gambier operate Attiwill Pit with a production approximately matching that from Telford Pit, but rubble is obtained from a calcarenite dune of Bridgewater Formation and hence details are not shown on Table 4. Gambier Earthmovers have stopped removing rubble from Fletcher Quarry but have purchased portion of PM 125 and are now obtaining road rubble by cleaning out McKay and Major's Quarries (Plate 2).

In the near future, most production will be by Gambier Earthmovers from Telford Pit, McKay Quarry and Major Quarry. During the last 10 years, Gambier Earthmovers have averaged 36 000 tonnes/year from Telford Pit and 12 000 tonnes/year for 1985/1986 from McKay and Major Quarries.

TABLE 4, PART A.
PRODUCTION OF ROAD RUBBLE FROM GAMBIER LIMESTONE, 1924-1986

	HUNDRED OF BLANCHE														CAROLINE	KONGORONG	HINDMARSH	NARACOORTE	UNLOCATED	TOTAL Tonnes
	16	26	28	28	28	29	30	134	136	136	138	192	601	715	SEC 328,329	SEC 62,459	210	28		
YEAR		KAIN & SHELTON	KNIGHT & PRITCHARD				TREFFERS	FLETCHER	BRUHN	BRUHN	GERICKE	MCKAY	TELFORD PIT		CAROLINE			JAMES PIT		
1924			KNIGHT															JAMES		0
1925			&															& SON		0
1926			PRITCHARD															305		305
1927			823																GARRETT	823
1928																			23	23
1929																			96	96
1930																		356		356
1931																				0
1932																				0
1933																				0
1934																		305		305
1935																				0
1936																		760		760
1937	DIST. C.		44															1849		1,893
1938	MT. GAMB.		55																	55
1939	2438		179																	2,617
1940	711		356														1524	1219		3.810
1941			1048						BRUHN,AE								244	3215		4,507
1942			1678						153		GERICKE									1,861
1943			1214					FLETCHER			&					2540		4435		8,189
1944			1301					105			MCKINNON							813		2,219
1945			2746					59	BRUHN,BJ		152							5271		8,228
1946								20	30		356									406
1947			28																	28
1948			3048																	3,048
1949			2853	LIMESTONE														3356		6,709
1950			5539	PRODUCTS												936				6,535
1951	2032			8088														3556		13,676
1952																				0
1953				6076														3759		9.835
1954																				0
1955			KAIN &											QUARRY						0
1956			SHELTON					LIGHT				JOHNSON		INDUSTRIES						0
1957			2662					BROTHERS	BRUHN,BW			81		58497						61,240
1958								144	9144									3454		12,742
1959			1458						12241					11723				2718		28,140
1960			2235									8286		70232				3251		84.004

TABLE 4, PART B.
PRODUCTION OF ROAD RUBBLE FROM GAMBIER LIMESTONE, 1924-1986

	HUNDRED OF BLANCHE														CAROLINE	KONGORONG	HINDMARSH	NARACOORTE	UNLOCATED	TOTAL Tonnes
	16	26	28	28	28	29	30	134	136	136	138	192	601	715	SEC 328,329	SEC 62,469	210	28		
YEAR	KAIN & SHELTON		KNIGHT & PRITCHARD				TREFFERS	FLETCHER	BRUHN	BRUHN	GERICKE	MCKAY	TELFORD PIT		CAROLINE			JAMES PIT		
1961												152		27786				5486		33,424
1962			2680									124						3281		6,085
1963				LIMESTONE						QUARRY								4064		4,064
1964			3223	PRODUCTS						INDUSTRIES								4399		7,622
1965		JARVIS	4084	2111					225	59444		1673	GAMBIER					4572		72,109
1966		INDUSTR.	·869	1249						21556		1676	EARTHMOVERS					4267		29,617
1967		4311	6807	3414					711			19	21336					3073		39,671
1968		3336		3077								45	26434							32,892
1969				3392	AUST.		CUTTING	PEARSON				104	31255	61445						96,196
1970				4938	CLAYS &		684	308				2321	31794							40,045
1971				1522	INDUSTR.	CORALINE	304	1310	511			1172	42252							47,071
1972					MINERALS	INDUSTR.	1273	833	635			39	24020							26,800
1973					1959	102							40811							42,872
1974		JARVIS			1644		937	191	100			3575	43610							50,057
1975		INDUSTR.			2443		702	395				1613	32659							37,812
1976		4660			1305		123	436					34506							41,032
1977		796		STEETLEY	3259		400		754				58888							64,097
1978		1700		1915			239		749				41881							46,484
1979				3153				18802	1800				42608							66,393
1980				1950				23094	1800				43965							70,809
1981		GAMBIER		546				17231	1200				26491							45,768
1982		EARTHMOVERS		3693				7171	563				22234							33,661
1983		4773		3478				8395	153			GAMBIER	29864		ACI					46,663
1984		1460		2826				14268	406			EARTHMOVERS	35489		147					54,596
1985				1229								9527	29450		0					40,206
1986				1033								15020	29046		5468					50,567
TOTALS	5,181	21,035	44,930	54,025	10,610	102	4,562	92,764	31,205	81,000	508	45,427	688,593	229,683	5,615	3,536	1,768	68,264	119	1,389,028

Agricultural lime

Agricultural lime was first produced from Gambier Limestone in 1959 by Limestone Products Pty. Ltd. from Steetley Quarry. Production has been continuous since then and includes 1 561 tonnes from James' Pit in section 28 hundred Naracoorte, between 1961 and 1967 (Table 5).

Total recorded production for 1959-1986 is 80 736 tonnes of which 63 879 tonnes or 79% of the total has been produced from Steetley Quarry by Limestone Products, Aust. Clay & Industrial Minerals, Steetley Industries and Commercial Minerals.

The figures are incomplete, Gambier Earthmovers currently produce agricultural lime from Telford Pit but production is not distinguished from rubble. Agricultural lime production from Telford Pit is expected to be of similar magnitude, or greater, than the other two major producers - Commercial Minerals and ACI Resources Ltd. (ACI). ACI have produced between 1 000 and 4 000 tonnes/year of agricultural lime from Caroline since 1984.

Lime & Hydrated Lime for building purposes - mainly mortar and cement

Recorded lime production from Gambier Limestone commenced in 1924 at James Quarry near Naracoorte and ceased in 1964. Limestone from Marte, principally Steetley Quarry, was also burnt for lime and hydrated lime between 1929 and 1947.

The first significant lime production was from lime kilns burning Gambier Limestone in the Allendale area, but there is no production recorded. George Turnbull (1984, pers. comm.) who operated several lime kilns during the industry's heyday of 1950-1955 when numerous homes were built by the South Australian Housing Trust supplied the following comments.

In 1950-1953, Turnbull leased a kiln 7 km southwest of Allendale and only 2 km from Middle Point (Elliott kiln on Fig. 2) in section 673 hundred Blanche from Clarrie Jones. The kiln had been built by Alf Elliott, was wood fired and limestone was obtained from Smith Quarry, 2.5 km to the northeast.

TABLE 5

PRODUCTION OF AGRICULTURAL LIME, 1924-1986

	HD. BLANCHE		HD. CAROLINE	HD. NARACOORTE	TOTAL
	SEC. 26	SEC. 28	SEC.327-329 & 632	SEC. 28	(Tonnes)
	KAIN & SHELTON	STEETLEY	CAROLINE	JAMES	
1924-1958					
1959		698		JAMES, A. & SON	698
1960		1 190			1 190
1961		1 053		406	1 459
1962	JARVIS INDUSTRIES LTD.	907		406	1 313
1963		1 274			1 274
1964		1 563			1 563
1965	2 360	1 861		282	4 503
1966	2 996	3 823		325	7 144
1967	1 217	3 414		142	4 773
1968	977	829			1 806
1969		1 754			1 754
1970		2 122			2 122
1971		689			689
1972		AUST.CLAY & INDUSTRIAL MINERALS 562			562
1973		1 293			1 293
1974		1 984			1 984
1975		1 297			1 297
1976		1 514			1 514
1977		2 324			2 324
1978		STEETLY INDUSTRIES 4 296			4 296
1979		2 116			2 116
1980		3 580			3 580
1981		1 767			1 767
1982		7 065	A.C.I.		7 065
1983		5 211			5 211
1984		COMMERCIAL MINERALS 5 886	4 314		10 200
1985		2 067	2 280		
1986		1 740	1 152		
TOTAL	7 550	63 879	7 746	1 561	80 736

In 1953-1955, Turnbull moved to Allendale where there were two back-to-back kilns at the rear of the shop. Each kiln had an output of 30 bags/day. Fuel was a mixture of 30% wood and 70% oil, with limestone from Smith and Stafford Quarries.

In 1955-1956, Turnbull moved to Hodges Scrub (section 679, hundred MacDonnell, 7 km W of Mount Schank) and built another pair of back-to-back kilns. Both wood and limestone were collected locally. At first stone was surface-picked, then tungsten-tipped saws were used with crowbars to lever free the limestone.

Production of 9 750 tons of lime by Hydrated Lime Ltd. in 1953 and 1954 may be from County Fergusson, Yorke Peninsula not from Gambier Limestone. Hydrated Lime Ltd. held MC2260 & 2261 in section 138 hundred Blanche between 1956-1959, but Departmental records for lime production in 1953-1954 are incomplete.

Total recorded production of burnt lime for the period 1924-1984 is 23 522 tonnes.

Whiting

First recorded production of whiting-grade limestone was in 1949, with 2 141 tonnes by Limestone Products Pty. Ltd. with continuous production through to 1986 (Table 7).

Total recorded production is 224 557 tonnes, the two most significant producers have been:

Jarvis Quarry - 107 494 tonnes, 48% of the total
Steetley Quarry - 74 559 tonnes, 33% of the total

Whiting was mined at Honeysuckle Flat during 1980 and 1981; 11 334 tonnes were produced by Omya-Minerals Pty. Ltd. (Barnes, 1986). The deposit is now held by ACI and has been placed on 'care and maintenance'; labour conditions are amalgamated with Caroline.

ACI continued to obtain whiting from stockpiles at Marte after selling freehold title and PM 9 to Gambier Earthmovers in April 1983. Estimated production is included in Table 7, based on information supplied by P.D. Johnson (A.C.I. - pers. comm., 1986).

TABLE 6

PRODUCTION OF BURNT LIME, 1924-1986

YEAR	HD. BLANCHE			HD. NARACOORTE	UNLOCATED	TOTAL
	Sec. 136 BRUHN	Sec. 28 STEETLEY	Sec. 138 GERICKE	Sec.28,29 JAMES		(Tonnes)
					JAMES, A. & SON	
1924				711		711
1925				731	GARRETT,R.	731
1926				711	660	1 371
1927		KNIGHT &		635		635
1928		PRITCHARD		610	819	1 429
1929		325		635	163	1 123
1930		203		305		508
1931		78				78
1932				183		183
1933		138		203		341
1934		119		406		525
1935		120		406		526
1936		159		305		464
1937		211		610		821
1938		208		610		818
1939		102		274		376
1940		(HALZE,AC)				-
1941	BRUHN,B.J.	28				28
1942	30	30		30		90
1943		295			295	
1944		49			49	
1945	10			122		132
1946				132		132
1947		30		61		91
1948				61		61
1949						-
1950						-
1951			HYDRATED	1 118		1 118
1952			LIME LTD.	244		224
1953			5 842	152		5 994
1954			4 267	102		4 369
1955						
1956						
1957						
1958						
1959						
1960						
1961						
1962						
1963						
1964				279		279
1965-1986						
TOTALS	40	2 095	10 10	99 636	1 642	23 522

TABLE 7

PRODUCTION OF WHITING 1949-1986

YEAR	KAIN & SHELTON	STEETLEY	BRUHN	CAROLINE		HONEYSUCKLE FLAT	TOTAL
		LIMESTONE PRODUCTS PTY. LTD.					
1949		2 141					2 141
1950		5 327					5 327
1951		8 089					8 089
1952		3 437					3 437
1953		10 578					10 478
1954		10 757					10 757
1955		6 150					6 150
1956		3 289					3 289
1957		3 156					3 156
1958		3 115					3 115
1959		2 806					2 806
1950		2 809					2 809
1961		2 199					2 199
1962		2 680	BRUHN				2 680
1963	JARVIS &	2 309	75				2 384
1964	ACI	3 331	93				3 424
1965	1 096	KAIN & SHELTON					1 096
1966		592	317				909
1967	1 118		263				1 381
1968	1 435		406				1 841
1969	2 796		406				3 202
1970	3 751		423				4 174
1971	4 102						4 102
1972	4 071						4 071
1973	15 031	AUST.CLAYS	216				15 517
1974	9 006	& INDUS.					9 006
1975	3 098	MINERALS					3 098
1976	8 486	1 034					9 520
1977	8 767						8 767
1978	17 340			A.C.I.	RESOURCES		17 340
				(fine grind)	(filler)	OMYA MINERALS	
1979	11 975	STEETLEY					11 975
1980	9 264	INDUSTRIES			1 760		11 024
1981	4 370	760			4 334	11 334	9 464
1982	518						518
1983	300						300
1984	700			1 873	1 357		3 930
1985				3 955	5 685		9 680
1986				4 256	5 711		9 967
TOTAL	107 494	74 599	2 199	10 124	18 847	11 334	224 557

9705

ACI opened Caroline Quarry in 1982 to produce glass grade limestone. Whiting and filler grades are produced as byproducts but 1982-1983 production is not differentiated. Since 1984, production is classified into glass-grade, fine-grind (fibreglass filler), general-purpose filler and agricultural lime. During 1984-1986, ACI produced an average of 3 300 tonnes/year of fine-grind, fibreglass filler and 4 200 tonnes/year of general-purpose filler.

Total recorded production of whiting-grade limestone is 224 557 tonnes.

Chemical-grade limestone

Production of chemical-grade limestone was insignificant prior to opening of ACI's Caroline Quarry. First recorded production dates back to 1943 with 8 tonnes by Knight and Pritchard from Steetley Quarry. Small quantities were also produced by Limestone Products in 1959 and by Jarvis Industries in 1969, 1971 and 1978.

About 24 000 tonnes/year of chemical-grade limestone for glass manufacture have been produced from Caroline Quarry since 1982. 1982-1983 data for Caroline on Table 8 includes whiting production of 2 000 - 3 000 tonnes/year.

Total recorded production of glass-grade limestone is 134 023 tonnes of which about 92% has been produced by ACI at Caroline in the last five years.

PREVIOUS INVESTIGATIONS

Selected limestone and dolomite quarries in the Mount Gambier area were inspected by Jack (1923) who detailed quarrying methods and geology, including determinations of bulk density, water absorption by volume and the first recorded chemical analyses of samples from:

- Fletcher Quarry
- section 335 hundred Hindmarsh, a small quarry near Tantanoola.

TABLE 8

PRODUCTION OF GLASS-GRADE LIMESTONE, 1924-1986

YEAR	KAIN & SHELTON	STEETLEY	CAROLINE	TOTAL
		KNIGHT & PRITCHARD		
1943		8		8
1944		4		4
1945		722		722
1946				
1947				
1948				
1949				
1950				
1951				
1952				
1953				
1954				
1955				
1956		LIMESTONE		
1957		PRODUCTS		
1958		P/L		
1959		2 108		2 108
1960				
1961				
1962				
1963				
1964				
1965				
1966				
1967	JARVIS			
1968	INDUSTRIES			
1969	352			352
1970				
1971	635			635
1972				
1973				
1974				
1975				
1976				
1977				
1978	7 110			7 110
1979				
1980				
1981			A.C.I. RESOURCES	
1982			25 553	25 553
1983			24 011	24 011
1984			17 071	17 071
1985			27 454	27 454
1986			28 995	28 995
TOTAL	8 097	2 842	123 084	134 023

At Marte, the following quarries were inspected, geology described and stone quality noted:

- Roofs & Ceilings
- MacKay Quarry
- Major Quarry
- Walter Quarry
- White Quarry.

Quarries were again inspected in 1926 (Anonymous, 1926), a tractor, power crane and six circular saws were in use at Knight and Pritchard's Quarry. A couple of steam-driven circular saws were set up at Roofs & Ceilings Quarry but had not been used for some time. These early attempts to produce ashlars on site rather than cart two-cubic-yard blocks for cutting at building sites, were largely unsuccessful.

When inspected by Cornelius (1933), Knight and Pritchard's Quarry was the most important, mainly because of closeness to the railway siding. Blocks were loaded directly into railway trucks and railed to Victoria. A bank of five power-driven circular saws could cut material on site to any dimension below 45 cm. At that time, all cranes were worked by petrol engines. Further chemical analyses were carried out on samples from:

- Knight and Pritchard Quarry
- Fletcher Quarry
- Bruhn Quarry.

The use of milled Gambier Limestone as a substitute for imported whiting, particularly as a filler in putty, was examined by Blaskett (1941). Earlier attempts had produced a putty with low plasticity but Blaskett showed that putty prepared from finely milled, 85% less than 15 microns, Gambier Limestone had characteristics identical with putty prepared from imported whiting.

Following a proposal by the S.A. Housing Trust to re-open Pareen Quarry, Armstrong (1947) reported that the limestone was fine grained, soft and chalky and had not been quarried for many years. This material tended to fret in use and was considered inferior to ashlars cut from coarser grained, stronger limestone from Marte.

Eleven quarries were operating, employing about 100 men when inspected by Dickinson (1950 & 1951). Production was 1 340 cubic metres per week of which 70% was used locally, with the remainder railed to Adelaide, mostly as 142 x 132 x 91 cm blocks. Although gangs of powered, circular saws had been in use since at least 1926, only 25% of the output was cut into ashlars on site. Limits of outcropping limestone were mapped and reserves estimated at 2.5 million cubic metres of limestone to a depth of 2.7 m below outcrop (Dickinson, 1950 & 1951).

Alternative methods of cutting blocks, including use of wire saws and a coal cutter, were assessed by Armstrong (1950) who also reviewed mining methods and equipment. At the time, the Department of Mines considered the wire saw to have great potential. About £2 000 was spent during 1950/51 on construction and modification of a wire-saw, and conducting experiments at Mount Gambier and Adelaide. The first model was tested at the Dept. of Mines depot on 17 March 1950 and then re-erected at R.J. Nurse's depot at Norwood. First trials on cutting Gambier Limestone were conducted from 22nd to 30th March 1950. Nurse built a single-wire saw which was used to cut ashlars for the Housing Trust. The saw was then tested under quarrying conditions at the workings of Pritchard Brothers (Steetley Quarry). Two faces were cut, each 9.1 m long and 2.9 m deep. The Adelaide and Mount Gambier trials showed the cutting rate was affected by:

- speed of the wire, a speed of 380 m/min. produced the fastest cutting rate.
- quantity of sand and water used.
- grading of sand, a predominantly coarse sand produced the best result in terms of cutting speed and smoothness of face.

Wire used had a tensile strength of about 2 tonnes and a diameter of 5 mm; during testing wear on the wire reduced the diameter by about .07 mm. While the tests were in part successful, the capital cost was relatively high and quarry operators at Mount Gambier displayed little interest, preferring the mobile mechanical saws being developed at the same time by Ivan Ploenges.

A sampling program in 1952 to find suitable limestone for production of high-grade lime included shellgrit from Saint Kilda, oyster beds from Black Hill, lime sand from Wardang Island and limestone from Mount Gambier (Jackson, 1952). Only Gambier Limestone proved suitable.

Quarrying methods in Knight and Pritchard Quarry were detailed by Willington (1953), who also included total production for all quarries for the period 1938 to 1950 - 146 624 tonnes. With very few mechanical face and block saws, Pritchard Brothers were producing 190 cubic metres of ashlars per week. Some 142 x 132 x 91 cm blocks were railed to Adelaide and cut using a six-blade gang saw by Jarvis Industries Ltd. at Mile End. The plant had a capacity of 1 500 ashlars per day at a time when the building industry in Adelaide was using the equivalent of almost 2 000 ashlars per day.

Mobile mechanical saws, able to cut ashlars in situ were invented by Ivan Ploenges in 1950 and proved very successful (Anonymous, 1956), putting an end to investigations into wire-line saws.

Suitability of Gambier Limestone for production of hydrated lime was investigated by Reid (1957). Samples were tested from:

- Gericke Quarry
- Stafford Quarry.

Three samples from Gericke Quarry produced hydrated lime of very high quality and were superior to material from Stafford Quarry, and to other test specimens of Gambier Limestone from Naracoorte, and of travertine from Murray Bridge.

A parallel study examined preparation of precipitated chalk using Gambier Limestone from Gericke Quarry. Following Blaskett's (1941) recommendations, precipitated chalk was prepared by calcination, slaking, carbonation and drying. Final product contained 98.0% $CaCO_3$ and 0.96% $MgCO_3$ but was pinkish coloured presumably because of 0.17% Fe_2O_3; grain size was uniform at 1-2 microns (Madigan, 1957). The final product was classed as a suitable filler and could substitute for chalk and whiting.

The most comprehensive review of quarrying and use of Gambier Limestone was compiled by Mansfield (1961). During the building boom of the early 1950's, one third of all houses constructed by the S.A. Housing Trust in the metropolitan area were of Gambier Limestone. Forty eight mobile ashlar-cutting saws were then in use, with only three quarry operators still cutting block stone for sawing in Adelaide. Milled whiting and agricultural lime were both produced locally with finer milling of whiting, to less than 200 mesh, in Adelaide and Melbourne. Annual production figures for building stone and whiting were presented for the period 1939 to 1958. Two lime kilns at the quarries burned offcuts and produced about 250 bags of lime per week. The first recorded uniaxial compressive strength data are presented by Mansfield (1961).

Locations of building stone quarries in Gambier Limestone throughout the lower South East are listed by Johns (1963), with partial chemical analyses of samples from fourteen quarries.

Experiments on fluidised-bed calcination of Gambier Limestone were conducted by AMDEL on behalf of the S.A. Dept. of Mines (Ball, 1962-1964; Melbourne, 1964 and Ryan, 1966-1968). Unfortunately, the main impediment to exploitation was transport cost from Mount Gambier to Adelaide.

Sturmfels (1969) conducted a detailed mapping and topographic survey of Steetley Quarry for Australian Clays and Industrial Minerals Ltd. His plan is reproduced herein as Figure 7 but the text of the associated report is not available.

Six samples were collected for foraminifera determination by R.J.F. Jenkins (Adelaide University) and examined by McGowran (1970). Samples were collected from:

- Steetley Quarry
- Telford Pit.

John W. Grant Pty. Ltd. prepared a report in 1973 for Steetley Industries which included materials testing by the Snowy Mountains Hydro-Electric Authority (Appendix A). Samples were collected from Steetley Quarry and parameters determined were:

- uniaxial compressive strength
- co-efficient of linear thermal expansion
- linear expansion due to moisture absorption
- particle size changes resulting from freeze-thaw tests to simulate accelerated weathering.

Detailed laboratory investigations of South Australian building stones (Spry, 1975-1981) included the following tests on another sample from Steetley Quarry:

- uniaxial compressive strength
- modulus of rupture
- water absorption, porosity and permeability
- bulk density, absolute specific gravity
- abrasion resistance
- accelerated weathering tests
- ultrasonic velocity
- coefficient of thermal expansion
- chemical analyses
- petrography.

In recent years, operating companies have provided hand-outs summarising uses, sizes available and building techniques (Appendix B). Pamphlets include test results of:

- uniaxial compressive strength by The Readymix Group in 1978;
- likely fire resistance of non-loadbearing walls by Commonwealth Experimental Building Station.

MINING METHODS

Previous methods for mining ashlars, both block-mining style as well as mobile saws cutting ashlars in situ, are described in Jack (1923), Anonymous (1926), Cornelius (1933), Armstrong (1950), Willington (1953), Anonymous (1956) and Mansfield (1961).

The first sawing plant was erected in about 1919 by Knight and Pritchard in Steetley Quarry and consisted of a set of 6 circular saws which cut ashlars from large (2 cubic yards) blocks (Mansfield, 1959). The first attempt to cut ashlars directly in situ was in 1947 by Dudley Pritchard who adapted a logging machine by Faneco and Wohler of Ararat. This successfully enabled the vertical, longitudinal cuts to be done mechanically. The 2 cubic-yard blocks were then moved to sawing plants on site by mobile cranes, or carted direct to building sites (Mansfield, 1959).

The current mining method is essentially unchanged since the invention by Ivan Ploenges in 1950 of mobile, petrol-driven saws capable of cutting ashlars in situ and is depicted in Plates 3-7.

Similar mobile saws were invented at about the same time in New Zealand and used to cut comparable limestone at Oamaru. The N.Z. operations involved cutting 2-tonne blocks with the vertical cuts made by mobile saws. This technique was demonstrated to quarry operators in the South East by A.T. Armstrong (State Mining Engineer, S.A. Dept. Mines) in June 1952.

A direct sawing techique is also used in Western Australia on Pleistocene Tamala Limestone, a coastal aeolian dune deposit similar to Bridgewater Formation. The limestone is yellow to cream, weathers to grey hues and although dominantly calcareous, can be locally quartz rich with a quartz:shell fragment ratio of up to 1:1 (Anon., 1984). The limestone is variably indurated and mostly worked as a source of sand. Indurated bands have provided building stone for numerous buildings in the Perth-Fremantle area, particularly in the late 19th century but is now used mainly for garden walls. The current method of cutting walling stone is by using tractor-mounted saws with large blades of about 2 m diameter.

GEOLOGICAL SETTING

The following geological summary is extracted from Waterhouse (1977), Cook et al. (1977), Harris (1983), Schwebel (1983) and Sheard (1983).

Geological evolution of the South East was strongly influenced by the separation of the Australian and Antarctic continents which commenced during the Late Jurassic, about 150 million years ago. An elongate depression, the Otway Basin, formed as the two land masses drifted apart, contains sediments ranging from Late Jurassic to Middle Miocene in age.

The earliest sediments were deposited in alluvial fans, lacustrine, and fluvial floodplain environments but are only known from drillholes in the South Australian portion of the basin. Faulting synchronous with sedimentation is common, with prominent faulting of Mesozoic strata but diminished faulting of overlying Tertiary sediments. Uplift during the Middle Cretaceous led to some erosion of earlier sediments. Renewed subsidence during the Late Cretaceous, combined with fluctuating sea levels, produced a thick sequence of riverine-deltaic and shallow marine sediments. Retreat of the sea during the Late Cretaceous caused a repeat of terrestrial conditions and deposition of a sequence of arenaceous and carbonaceous sediments. Earliest Tertiary sedimentation is similar, consisting of terrestrial and marginal marine coarse sand, silt and clay. These middle Eocene sediments of Tartwaup Formation (upper part of Dilwyn Formation) are exposed at Allen's Quarry and were subsequently buried beneath the Oligocene-Miocene marine transgression which deposited the bryozoal Gambier Limestone.

The Australian continent finally separated from Antarctica about 53-55 million years ago, forming the Southern Ocean. Ocean currents sweeping around Antarctica commenced after the breakup and continued through Late Eocene and into the Oligocene (Deighton et al., 1976). This marine transgression coincided with commencement of sedimentation of Gambier Limestone in the ancestral Southern Ocean. Continued subsidence during the Oligocene and through to Middle Miocene produced widespread transgression with inundation of the Gambier Embayment, Murray Basin and much of the Padthaway Ridge. Within the Gambier Embayment extensive bryozoal colonies became the source for calcirudite, calcarenite, calcisiltite and marl of Gambier Limestone which blanket Tartwaup Formation. The base of Gambier Limestone is marked by a thin limonite cemented sand, Compton Conglomerate, which overlies Eocene sediments with angular unconformity.

The following three zones have been recognised within Gambier Limestone by Lindsay (1967) and described in detail by McGowran (1973); an

- upper grey cherty limestone,
- cream limestone
- lower grey limestone.

Gambier Limestone sedimentation was terminated during the Middle Miocene with uplift and erosion particularly along northern parts of the Gambier Embayment.

Two distinct ages of volcanic activity are evident in the South East. The older, more widespread phase of Mount Burr Range consists of fifteen volcanic centres aligned in three main zones parallel to the Burr-Gambier Lineament (Sheard, 1983). Alignment of these Pliocene-Pleistocene volcanics is similar to that of joints within Gambier Limestone throughout the lower South East (Sprigg, 1952). Volcanic ejecta were deposited on the Late Miocene erosional surface on Gambier Limestone and are in turn overlain by Pleistocene dunes of Bridgewater Formation. Drilling has shown that the volcanic field covers an area of about 110 km^2 (Sheard, 1983). Mount Burr volcanics have been dated at two million to 20 000 years B.P., using a combination of outcrop relationships, depth of weathering and pollen fossils (Dodson 1974, Marker 1975). Overlying Gambier Limestone, and broadly synchronous with Mount Burr volcanics, is sandy limestone with oyster beds, of the Miocene-Pleistocene Whalers Bluff Formation. The only outcrop of Whalers Bluff Formation is east of Mount Gambier (Fig. 1)

Following Plio-Pleistocene volcanism, tectonic uplift during the Pleistocene-Holocene and eustatic sea-level oscillations were superimposed on a coastal plain of low gradient. Twenty-one stratigraphically separable shoreline barrier dunes form thirteen distinct ranges between Robe and Naracoorte (Schwebel, 1983), with preserved shorelines, up to hundreds of kilometres in length, sub-parallel to the modern-day coast. An average tectonic uplift rate of 0.05-0.09 mm/yr throughout the Pleistocene (Schwebel, 1983) produced a general trend of increasing age of Bridgewater Formation dunes with distance from the present coastline but this trend is complicated by significant sea-level oscillations. Based on magnetic polarity data, the oldest dunes are no older than 690 000 years B.P. (Cook et al., 1977). At least one sea-level stand along the southwestern margin of Mount Burr Range produced reworking of ash and tuff beds. Another sea-level stand is marked by the shoreline barrier dune cropping out at Marte.

A second volcanic phase consists of ejecta from the Holocene Mount Gambier and Mount Schank vents which rest on partly-consolidated Bridgewater Formation (Sheard, 1983). The Mount Gambier eruption took place about 4 000 - 4 300 B.P. based on carbon-14 dating of charcoal fragments in tuff (Blackburn *et al.* 1982). Mount Schank is older with two age estimates, charcoal fragments in sand beneath tuff deposits gave a radiocarbon age of 18 100 ± 350 years B.P. (Polach *et al.*, 1978) compared to 8,700 ± 900 based on thermo-luminescence data of lava-baked sand (B. Smith, pers. comm. in Sheard 1983). Further processing of that thermo-luminescence data yielded an age of 4930 ± 540 years B.P. for Mount Schank (Smith and Prescott, 1987).

Present-day topography is karstic with Gambier Limestone beneath thin overburden of sandy soil. Dissolution of limestone, particularly along joints and bedding planes, produces a variety of sinkholes and caves, with re-precipitation forming stalactites and stalagmites. Details of the karstic topography with interpretations of its origins are presented in Marker (1975).

SITE GEOLOGY

Stratigraphy

Gambier Limestone underlies much of the Lower South East, but crops out poorly or is obscured by a veneer of sandy soil. The formation varies from only a few metres thick along the northern margin of Gambier Embayment to greater than 300 m thick along the south coast in drillholes Douglas Point 1, CAR10 and CAR11 (Fig. 18). Outcropping Gambier Limestone is generally oldest in the north and northeast and is progressively younger towards the coast though there has been only limited dating of foraminifera from outcrops or quarries.

Building stone quarries at Marte are located on outcrop of the distinctive, atypical 'middle zone' of Gambier Limestone comprising massive bryozoal calcarenite with high porosity and permeability and with very little clay and few chert or flint bands (Plate 8). Middle zone of Gambier Limestone is up to tens of metres thick and has been intersected in drillholes to the south and southwest of the main building stone quarries. Studies of foraminifera in samples from Steetley Quarry indicated a Middle Oligocene age (McGowran, 1970) i.e. about 30 million years.

Probably all the Marte quarries are within calcarenite of Middle Oligocene age. Samples from all operating quarries have been submitted to J.M. Lindsay (Principal Geologist, Biostratigraphy Branch, SADME) for foraminifera examination to confirm the hypothesis that all quarries are in 'middle zone' of Gambier Limestone.

Overlying and underlying the 'middle zone' are 'upper grey cherty limestone' and 'lower grey limestone' respectively (Lindsay, 1967). Both contain a wider variety of lithologies ranging from calcirudite to marl but with calcisiltite and glauconitic marl dominating. Massive cream calcarenite typical of 'middle zone' is also found in the 'upper zone' but is much thinner (Waterhouse, 1977). Foraminiferal examination of two calcarenite samples from Telford Pit revealed an Early Miocene age, i.e. about 20-25 million years old, (McGowran, 1970) and is part of the 'upper grey cherty limestone'. Building stone quarries south and west of Mount Schank, (e.g. Pareen, Stafford, Gums Road, Mount Salt, and possibly White's Quarry are all thought to be sited in 'upper grey cherty limestone' and calcarenite is 5-10 million years younger than calcarenite from Marte. McGowran (1970) also interpreted calcarenite at Telford Pit to represent a more open-marine facies. Samples from quarries outside the Marte area are being examined by J.M. Lindsay to elaborate stratigraphic and facies differences. Representative geological logs of all quarries mapped are included as Figs. 8-17.

The upper unit, where mined for building stone, is readily distinguished from typical calcarenite at Marte. Detailed petrographic comparisons are presented in Farrand and Flint (1987). Whereas Marte calcarenite has a medium-grained texture with uniform bryozoal debris (Plate 8), the upper unit is distinctly more bimodal (Plate 9) e.g. as at Mount Salt, Stafford and Gums Road quarries. The coarse fraction contains bryozoal fragments 10-30 mm long of a different type to the fine tubular bryozoal colonies in Marte calcarenite. The coarse debris exhibits little abrasion and is set in a very fine-grained and often amorphous matrix. Weathering of old quarry faces enhances the textural differences (Plate 9).

The upper unit also contains fine-grained, uniform calcarenite grading to calcisiltite e.g. at Pareen quarry, which has been used for ashlars. The stone has a poorly-developed dolomitic cement coating bryozoal fragments and with abundant areas of poorly crystalline to amorphous carbonate has a reputation of fretting during use.

Although flint beds are widespread throughout Gambier Limestone and crop out in the upper unit exposed along the coast from Carpenter Rocks to Port MacDonnell, the only building stone quarry mapped which contains a flint bed is Lock quarry (Fig. 2). Flint has formed as an irregular, discontinuous bed at the contact between well-bedded (above) and massive (below) calcarenite (Fig. 16). Many operators report numerous 'flint' beds that are encountered during sawing; these have been mapped and found to be only dolomite or calcite e.g. lithological log 6 from Treffers Quarry (Fig. 9). A similar conclusion was also reached by Mansfield (1959).

Unconformably overlying Gambier Limestone are well-developed, northwest-trending dune ridges and dune complexes comprising Bridgewater Formation. Gambier Limestone was eroded and reworked, contributing detritus to the dunes. These predominantly Quaternary, calcareous aeolianite dunes have been partly cemented (calcreted) and are commonly 10-15 m high. In Steetley Quarry a basal pebble bed comprising well-rounded, brown, flint pebbles developed on the seaward side and at the base of a 15-18 m high dune is well exposed in eastern quarry faces (Fig. 6, Lithological log 17, Fig. 10 and Plate 10). The pebble bed extends into Kain and Shelton Quarry. This prominent northwest-trending Bridgewater Formation dune extends through the Marte area from Steetley Quarry in the northwest, southeastwards to Fletcher Quarry (Fig. 6); hindering quarry development because of the greater thickness of overburden. The dune trends at 130°-135° TN, slightly but distinctly across the main line of Marte Quarries which trend at 145° TN.

Flint pebble conglomerates within Bridgewater Formation are also exposed on the coast southeast of Blackfellows Caves.

Grey, unconsolidated, shelly sand and silty clay 2.5 m thick with abundant, small (2-4 mm), intact gastropods are exposed in Stafford and Blackall Quarry (Lithological logs 38 and 39, Fig. 13). This sand is interpreted as a shallow-marine basal unit to the Bridgewater Formation dune, or a lateral lacustrine equivalent. No other outcrops of this sand were observed.

Overlying and masking all older units is Holocene, red-brown to grey, sandy soil which averages about one metre thick but varies from 0.2 m to 2.2 m thick (Figs 9-17). Flint pebbles and calcrete nodules are occasionally present (Plate 11). The soil is often dark grey, humus-rich and sandy near the surface but is paler grey with depth and often reddish-brown and clay-rich at the base where clay has been leached down through the soil profile (Plate 12). Iron is also leached from the soil profile into underlying Gambier Limestone.

Structure: - Bedding in Gambier Limestone

At Allen's Quarry, Dilwyn Formation dips at up to 7° to the southeast i.e. more steeply than nearby exposures of unconformably overlying Gambier Limestone and Compton Conglomerate.

Bedding in Gambier Limestone, particularly from the upper unit, is readily measurable with pronounced grainsize fluctuations particularly in Edlington Quarry. Regionally dips vary from 1-3° southeastwards to southwards, but with horizontal bedding at Telford Quarry (Fig. 5).

Bedding within massive calcarenite of the middle unit is poorly developed and in places is overprinted and obscured by dissolution planes, dolomitisation and platy calcrete. These superimposed features are all subhorizontal and not necessarily directly related to bedding, but more to surface topography and slope of present and past water tables. In some cases measured 'bedding' may be on these strongly-developed secondary features.

In the main line of quarries at Marte, calcarenite is particularly massive and bedding rarely evident (Fig. 6 and Plate 8). Occasional thin silty beds are present and have marked the lower limit to block mining in the past. These interbeds cause problems during sawing, numerous ashlars split along silty 'beds' producing extensive wastage (Plate 13). Bedding is horizontal in the central part of Steetley Quarry, but, nearby quarry operators describe the bed most favoured for ashlar production as dipping seawards (southwestwards) at 1 in 30 i.e. 2° (Fig. 6). Sturmfels (1969) mapped bedding as striking northwesterly parallel to the line of outcrop and dipping 0.75-1.25° towards the southwest (Fig. 7). Within adjacent Kain and Shelton Quarry where quarry workings parallel the topographic contours, the quarry operator described the bed most favoured for ashlar production as 'deep in the middle part of the quarry and rising and shallowing towards the southeast'. Bedding is subhorizontal and variable, but overall dip is about 1° to the southwest.

The shorter line of quarries 2 km to the east exhibits a markedly different pattern. Calcarenite is massive but grain size variations are more marked and bedding is readily measurable (Plate 14). Bedding changes from:

- dipping 2-3° southeastwards in McKay and Major Quarry to
- dipping 3° southwestwards on the southeastern end of Fletcher Quarry.

Mr K. Pearson at Fletcher Quarry reported that in the extreme northeast corner, bedding 'turns up', and there are abundant 'shakes' or faults and that area is not used for ashlar production. A dolomite 'bed' exposed just east of McKay Quarry dips more steeply, 5° to the east, but this may not represent original bedding.

Structure: - Joints

Regional trend of joints, as measured in building stone quarries is shown in Figure 5, strike varies from south-southeast to southeast. A similar pattern was recorded by Sprigg (1952) by measuring low outcropping calcrete ridges typically 5-20 cm high. These are considered to reflect unambiguously slightly-cemented or calcreted Gambier Limestone along joints, and are widespread throughout the Lower South East. A joint and lineament study over a large area of the South East by Marker (1975) also showed a well developed SE-NW joint set but N-S and

NE-SW joints were also present. This report indicates that the SE-NW set controls dissolution and reprecipitation of the limestone.

A striking feature of the Marte building stone quarries is their alignment along two parallel lines which trend 145°TN; the main Marte line of quarries is 6 km long and rarely exceeds 200 m wide (Fig. 6). This pattern is demonstrably not related to bedding or Bridgewater Formation dunes, but is controlled by the regional trend of joints within Gambier Limestone. Mount Schank is on the same lineament as the main line of quarries at Marte. Although alignment is pronounced, joints within quarry workings at Marte are not common and only ten were measured (Fig. 6 and Plate 15). These have a maximum concentration trending about 155°TN i.e. slightly across the line of workings. Although within the variation exhibited by jointing through the region, this may be due to sampling error with such a small number of readings. Joints are probably more common than observed; quarry operators report exposing more but these are mostly removed by quarrying, or covered by backfill.

Two kilometres east of McKay and Major Quarries, outcropping dolomite contains an <u>en echelon</u> joint set with the same style i.e. joints strike slightly more southerly than the line of outcrop (Fig. 5).

The age of jointing at Marte is difficult to establish. Regional faulting and jointing have probably been semicontinuous since sedimentation of Gambier Limestone. Older units in the Gambier Embayment show the same pattern with pronounced faulting of Mesozoic strata. The regional structure (fault?) at Marte, which trends at 145°TN, also apparently contains the Holocene vent of Mount Schank. If the two are synchronous, then jointing at Marte developed about 4 930 ± 540 B.P., based on thermoluminescence dating of lava-baked sands. The jointing should also have affected the poorly-consolidated Pleistocene-Holocene Bridgewater Formation; no observations during the current mapping program prove or disprove this theory.

The older Pliocene-Pleistocene volcanic centres of Mount Burr Range are also aligned in three main zones trending northwest-southeast and parallel to the Burr-Gambier Lineament (Sheard, 1983). These older volcanics, ejected prior to deposition of the Bridgewater Formation, have been variously dated at 20 000 to 2 million years B.P. (Dodson, 1974; Marker, 1975). Hence jointing at Marte may be as old as 2 million years B.P., but still considerably younger than the depositional age of about 30 million years.

The exact control that jointing has on quarry alignement has not been determined. Because quarry operators describe beds as 'turning up' along the eastern margin, particularly at Fletcher Quarry, there is the possibility that faulting in this area enhances exposure of the favourable beds for ashlars. Based on petroleum exploration and drilling of the Associated Oil Company Bore (Fig. 2) a regional fault - Knight Fault of Sprigg et al. (1951) had been interpreted 1-2 km west of Burnda roughly coincident with the eastern line of quarries. O'Driscoll (1960, p 96) doubts the existance of this fault. Probably more significant is the role that joints would have had, and still have, on groundwater movement. The high porosity of ashlars, mostly secondary porosity, coating and cementation of bryozoal fragments by crystalline dolomite and precipitation a poorly crystalline, poorly ordered, carbonate matrix of mixed composition are all groundwater features which may be controlled and promoted by joints. The original northwest-southeast oriented whaleback outcrops probably resulted from dolomitic cementation along joints giving increased resistance to weathering of the limestone.

Groundwater

Regional groundwater patterns for the Mount Gambier area are shown on Figure 18, based on data from O'Driscol (1960), Waterhouse (1977) and uncompiled recent SADME data. Of particular note is a regional high in groundwater levels near Marte based on data derived from drillholes BLA73 and BLA102. A similar pattern is evident in structure contours of the top of Dilwyn Formation (Fig. 18). Cross-section AB (Fig. 19) shows several features:

- there is a markedly elevated block of Dilwyn Formation immediately northeast of Marte quarries with a relief of 40 m on the northeastern side. This presumably tectonically uplifted block was previously referred to as 'Knight's Dome' on the basis of petroleum exploration in the 1930's. Elevations (AHD) of the top, of Dilwym Formation, based on data from water wells drilled in the Marte area, are shown on Figure 21. Although some data are considered unreliable, particularly from wells 7022-7502 and 7022-5189, the Dilwyn Formation high northeast of Marte quarries is clearly defined.

- present groundwater table has the appearance of draping over the high, with local flow northeastwards against the regional gradient.
- there is an area of dolomite outcrop, and possibly of dolomite formation in a zone where groundwater tends to pond.
- at two localities, the unconfined water table appears to be at or near the base of Gambier Limestone.

Because of the limited information available further detailed local investigations are required to confirm these observations.

The main line of quarries at Marte is located on the southwest flank of the groundwater high, where gradients are southwestwards at about 1 in 220 i.e. less than 0.25° (Fig. 20). Bedding in Gambier Limestone is also subhorizontal, generally dipping southwestwards at about 1° (Fig. 6).

The eastern line of quarries at Marte is located on the south-southeast flank of the groundwater high where gradients are much steeper i.e. 1 in 100 towards the south-southeast. Bedding in Gambier Limestone exhibits a similar pattern, dips varying from 2-3° southwestwards (regional pattern) to the local, more typical pattern of 2-3° southeastwards. As is the case for the main line of quarries bedding tends to dip in approximately the same direction as the groundwater table, but at a steeper angle.

Overall bedding tends to dip radially away from the Dilwyn Formation high, consistent with there being a shoal or exposed island of Dilwyn Formation during deposition of Gambier Limestone. As some bedding in the eastern line of quarries dips southwestwards, parallel to the regional trend, then relief was probably small, and did not persist throughout sedimentation of Gambier Limestone.

Several interpretations are possible to explain the relationship between the water table in the unconfined aquifer and the uplifted block of Dilwyn Formation.

1. Sedimentation of Gambier Limestone and Compton Conglomerate was on a relatively flat erosional surface of Dilwyn Formation prior to faulting and:
    - tectonic uplift is very recent,
    - the water table has been uplifted also and is now not in equilibrium.

The concept of very recent uplift is rejected because a relatively flat coastal plain has existed since deposition of Bridgewater Formation. The latest possible uplift would be prior to deposition of Bridgewater Formation where the oldest dunes are inferred to be no older than 690 000 years B.P. (Cook *et al*. 1977). An unstable groundwater table would not have persisted for this period in an unconfined, porous, permeable aquifer.

2. Tectonic uplift was prior to rather than after deposition of Gambier Limestone, and Gambier Limestone was deposited on a faulted irregular surface of Dilwyn Formation. A similar model has been proposed by Waterhouse (1973) and Keeling (1983) for the area near Allen's Quarry, 8 km northeast of Marte. A Dilwyn Formation shoal centred on drillholes BLA73 and BLA102, was onlapped by Gambier Limestone. The water table high is then interpreted as either:
    - a zone of present-day high recharge (F. Stadter, SADME, pers. comm. 1986) producing a perched water table,
    - a zone of discharge from the pressurised, confined aquifer of the Dilwyn Formation into the unconfined Gambier Limestone aquifer, or
    - the area of elevated Dilwyn Formation may be acting as a groundwater barrier to regional groundwater flow in the unconfined aquifer and thereby causing a mounding effect. Extensive dolomitisation of Gambier Limestone in this area (as shown on the Gambier 1:63 360 geological map) may also be contributing to the 'barrier' effect.

The pressurised aquifer may no longer be sealed because of a combination of faulting and possible erosion of a black clay confining bed at the top of Dilwyn Formation. Whether the Dilwyn Formation aquifer is discharging or being recharged depends on the hydraulic head relative to that in Gambier Limestone. If there is very little or no hydraulic head difference between the aquifers, then high recharge by rainfall is the likely explanation.

The pronounced northwest alignment of the Marte quarries is:

- not on any line related to groundwater flow (Fig. 18),
- probably related to northwesterly trend of the Dilwyn Formation high which is most likely fault controlled.

In addition, the quarries are located in a zone of past groundwater chemistry changes. To the northeast is an area of extensive dolomitisation whereas to the southwest, calcite dissolution and reprecipitation has been dominant (Cross-section AB, Fig. 19). Petrographic examination reveals a complex history of carbonate dissolution and reprecipitation. One of the critical factors in producing a strong, coherent ashlar being the presence of a thin, crystalline coating of dolomite cementing bryozoal fragments.

The area over the Dilwyn Formation high is interpreted as a zone of high recharge implying that Gambier Limestone deposited over the block has different porosity/permeability characteristics to laterally-equivalent limestone. The present model explains why there could or should be differences, but available data from cable-tool drilling of BLA73 and 102 are inadequate to determine whether lithological differences actually exist.

Regional groundwater contours have been transferred to the detailed quarry plan of the Marte area (Fig. 20). Caution is required in interpreting the data as contours are drawn from widely spaced drillholes with insufficient control. In addition, the water table will be up to 1-2 m higher under Bridgewater Formation dunes and this will distort the regional trend.

In the central part of the western line of quarries i.e. Jarvis and Steetley Quarries, water table spot heights derived from the Photec survey are consistently 3-4 m above that expected from regional groundwater contours. Possible reasons are one or several of the following:

- interpreting regional data on a local scale without adequate control
- unlocated errors in the Photec survey or AHD controls to that survey
- water in quarries is ponded and does not reflect the interpreted regional groundwater table. This is unlikely considering the high porosity and permeability of Gambier Limestone. As expected, the regional groundwater table fluctuates with seasonal rainfall, being highest in October and lowest in May but local groundwater levels in Marte quarries fluctuate inversely and are highest in about May. This suggests some form of ponding, unlikely as it seems. The fluctuating water levels allow 1-2 extra layers of ashlars to be cut during the seasonal low.
- water table is perched immediately below the quarries because of the mining i.e. removal of vegetation and topsoil leads to higher recharge of the aquifer through the quarry floor.

Extensive local recharge of the aquifer with elevation of the water table immediately below the quarry would cause possible errors in reserve determitations based on any drilling program. At Caroline, ACI found that the water table in the quarry was 1-2 m higher than that predicted from a drilling program (P.D. Johnson, ACI, pers. comm.) whereas at Marte, where the quarries are larger and have been exposed longer, the effect on the water table may be as much as 3-4 m. Further levelling of water levels in all available holes in the area and in quarries where there is permanent water, i.e. Jarvis, Steetley, Cutting and Lawson Quarries is required to confirm the perched water table.

Even if all holes are surveyed, there is probably insufficient data to predict accurately water levels in the southeastern area where none of the quarries have permanent free-standing water. For the eastern line of quarries comparison of regional groundwater contours and quarry floor spot heights suggest that the water table is from as little as 2 m to perhaps as much as 14 m below the quarry floor. At Bruhn Quarries, water table is probably about 4-7 m below the quarry floor.

Drilling

Several quarry operators have drilled within existing workings at Marte as well as exploring over a larger area but results are not recorded. S.M. Telford (pers. comm., 1984) working for Pritchard Brothers, recalls hand coring over a large area during the 1950's. The coring was by hand with a core barrel about 37 mm diameter extracting only about 300 mm of core at a time. Holes were drilled to about 6-7 m but results and locations are not recorded.

Quarry operators sought Departmental advice and assistance in early 1952 in an effort to obtain core for examination. Initial Departmental diamond drilling in March 1952 produced high drilling rates but very poor core recovery. Failure was due to the soft friable nature of the limestone and loss of drilling fluids (Armstrong, 1954). Drilling was resumed using a 300 mm (12 inch) percussion drill with the bit modified by welding on reaming wings enabling holes of 600 mm diameter to be drilled. This enabled manual down-the-hole inspection and proved much more successful and informative. Unfortunately details of the drilling are incomplete and only drillers' logs are available. Limestone was mostly described as 'coralline limestone' and undifferentiated. Available geological logs of this and subsequent drilling are included as Appendix E with locations on Figure 21. Unfortunately most of the 1952 drilling is not located any more accurately than within a particular section, i.e. 14 of the 16 holes are not accurately located.

Subsequent drilling, almost exclusively for water provides additional data. The few geological logs available are also included in Appendix E. Sturmfels (1969) drilled only one hole, BORE 19 of 9.1 m depth, which revealed that above the water table limestone was second grade either because of coarse grain size, high porosity or cream colour. First-grade limestone was only intersected below the water table.

Numerous other holes have been drilled in Steetley Quarry
i.e. 7022/033/WW 2511, 2533-2536
and 7022/003/WW 2539-2542.

Geological logs are not available for any hole which has been accurately located. WW2539, drilled for Pritchard Brothers, encountered flint knobs in the top 4.3 m but these are likely to be flint pebbles in basal Bridgewater Formation. The likely geological section is depicted in Figure 10 (Geological log 13).

Drilling north of Treffers Quarry in section 30 (WW2045) revealed 2-3 m of open, coralline limestone (calcarenite) above the water table with perhaps 5-6 m below the water table. Overlying calcarenite, is almost 6 m of soil, clay, flint and weathered limestone.

Seven drillholes (WW2512-2518), none of which are accurately located, have been drilled near Telford and Walter Quarries in section 144 (Fig. 21). The groundwater table averages about 12 m below the surface (Fig. 20). WW2512 contained creamy calcarenite down to 6-7 m and below that was a soft, white fossiliferous limestone of unknown suitability for use as ashlars. The remaining holes were less successful - five of the six holes struck flint. Quarry operators inspected these large-diameter holes but details of the limestone are not recorded.

Two logged holes (WW2528 and 2529) have been drilled on the southeastern extension of the main line of quarries southeast of Bruhn Quarries. WW2528 was drilled in 1975 and below 3 m, of soil, quartz sand and yellow stained calcarenite intersected white calcarenite with only minor silty fraction; colour is white - Munsell 5Y 8/1. This may be suitable for use as ashlars. WW2529 was drilled in 1972 and below 0.5 m, intersected bedded limestone of variable grain size as well as differing degrees of cementation. Cementation is mostly moderate to strong leading to colours of white, offwhite, cream and creamy brown. Bryozoa fragments average 2 mm but range up to 7 mm. Most of the limestone between 2 and 22 m is white to creamy white calcisiltite but may be suitable for use as ashlars.

Drillhole WW2531, in Fletcher Quarry, drilled in 1948 (56.1 m or 184 feet) is the deepest and the earliest drillhole close to Marte quarries. Logged by A.E. Knight, the top 6.1 m was described as 'coralline bed' - presumably coarse-grained, partly cemented calcarenite grading to calcirudite. The underlying 50 m was undifferentiated 'limestone' of unknown quality.

During 1986, Bruhn hand-drilled holes through the quarry floor in Fletcher Quarry under an option to purchase the quarry from K. Pearson, details are not available.

Although there are many drillholes in the Marte area few were directed at evaluating limestone for use as a building stone, only the large diameter percussion holes drilled in August 1952 yielded useful data but this was not recorded.

SPECIFICATIONS AND MATERIAL QUALITY

Road rubble

Gambier Limestone provides a cheap, reliable and local source of road rubble and is used widely throughout the Lower South East for sealed and unsealed roads. Chemical composition is not important but mineralogical impurities such as clays may be deleterious (Spry, 1974). Gambier Limestone has the following advantages:

- outcrops widely
- breaks up easily during bulldozing
- contains minor dolomitised beds and calcrete providing some aggregate
- tends to be free of clay
- rolls out easily to a flat, stable surface which does not readily go into solution during wet winters.

The main disadvantage is lack of strength but alternative materials are either not available or are considerably more expensive.

However, not all areas provide good material. Limestone from Caroline is described as puggy, that is fine grained, often wet, difficult to work and tends to go back into suspension during winter when water is ponded on roads.

Road rubble mined from areas with pronounced karstic topography and abundant clay infilled dolines would have excessive clay and is rejected. Clay-infilled dolines are abundant in many building-stone quarries and hence these rarely yield road rubble even though the ideal quarry development would be:

- soil stockpiled
- weathered Gambier Limestone removed and used as road rubble
- exposing fresh Gambier Limestone suitable for production of ashlars.

In the easterly line of building-stone quarries at Marte overburden is thinner and dolines are both less frequent and not as deep. Hence road rubble has been obtained from McKay, Major and Fletcher Quarries. Gambier Earthmovers were cleaning up McKay and Major Quarries in 1985-1986 by removing old ashlar rejects and using them for road rubble.

Agricultural Limestone

The lower South East now has many acidic soils resulting from a combination of superphosphate application, light-textured soils and high rainfall washing organic material and nutrients down through the soil profile. Superphosphate promotes faster growth leading to a buildup of organic matter which breaks down producing soil acid, causing temporary or permanent increase in acidity. The availability of many major plant nutrients (nitrogen, phosphorous, potassium, sulphur, calcium and magnesium as well as trace molybdenum) decreases as soil acidity increases (Fig. 22).

Soil acidity not only affects availability of major elements but has wider implications, including:

- below pH 5.3, legume nodulation is reduced
- seeds have a low calcium level but a high requirement which must be obtained from the soil
- lime dressings can retain large amounts of phosphorous in the surface soil causing dramatic response in pastures
- lime speeds up conversion in the soil of unavailable organic nitrogen to available inorganic nitrogen
- lime protects clovers from root-rotting organisms
- lime helps maintain the balance of soil micro-organisms.

One method of correcting soil acidity is by application of agricultural lime or limesand. However, some elements (iron, manganese, boron, copper and zinc) are more readily available under acid conditions, and heavy dressings of lime can induce deficiencies in these elements. Lime application rates vary, depending on initial pH and final pH desired, and can be up to 3 tonnes/hectare.

No formal specifications currently exist for South Australian agricultural lime though numerous deposits in several geological settings around the state yield suitable material. Table 9 shows particle size distribution, chemical analysis, neutralising value (NV) and insolubles for agricultural lime produced throughout the State. Deposits in the South East have been distinguished according to their geological setting.

Ideally, agricultural lime should have a particle size with 100% less than 0.25 mm, high surface area aids rapid solubility. Commercial Minerals did market a specialist product (CC-8 in Table 9) which was extensively screened to:

100% less than 0.25 mm with
73% less than 0.125 mm

This product is no longer available and agricultural lime from the South East typically has 27-65% of particles less than 0.25 mm. Products range from:

- Lake Leake with only 27% less than 0.25 mm, to
- Goode's Pit at Kingston with crushed calcarenite yielding 65% less than 0.25 mm.

Both are Bridgewater Formation calcarenite; unscreened Gambier Limestone yields a product with about 35-45% less than 0.25 mm. All samples contain between 22 and 72% of particles in the 0.25-1.0 mm range, the coarsest being Lake Leake.

Another factor determining the suitability, or otherwise, of limestone or limesand for agricultural use is the solubility. Field use has shown that Gambier Limestone is more soluble than Bridgewater Formation calcarenite or Holocene beach-dune lime sand. Detailed petrographic examination has shown that much of the present texture of Gambier Limestone formed by dissolution of bryozoal fragments and reprecipitation of an amorphous to poorly crystalline matrix.

TABLE 9

AGRICULTURAL LIME - PHYSICAL AND CHEMICAL CHARACTERISTICS

	Particle Size Distribution							Chemical Analysis			
	% Passing sieve sizes (mm)										
	<0.125	0.125-0.25	0.25-0.5	0.5-1	1-2	2-4	>4	Ca%	Mg%	NV%	insol.%
GAMBIER LIMESTONE											
Limestone Products (PM115)											
- crushed	19	16	25	25	9	6	0			100	
- screened	32	17	20	24	7	0	0			98	
- CC-8	73	27	0	0	0	0	0			98	
Gambier Earthmovers											
Telford Pit - PM169	21	22	20	14	9	7	7			98	
Johns (1963) - average of 20 samples								38	0.5		
Marte area (this report)-average of 25 samples								39	0.4		
QUATERNARY BRIDGEWATER FORMATION & HOLOCENE DUNES											
Lake Leake											
B.J. Teagle - ML 4883 Sec. 558 hd. Hindmarsh	6	21	67	5	1	0	0	31	0.98	81	12.6
Kingston											
J. Goode - MC 1939, 1940 Sec. 65 hd. Mt. Benson											
- uncrushed	8	32	26	9	5	5	15	32	1.2	89	7.4
- crushed	10	55	16	6	6	4	3	32	1.2	89	7.8
Henschke Industries											
PM 307 Portion Block 69 Hd. Naracoorte	17	17	24	27	14	1	0			97	
OTHER SOUTH AUSTRALIAN DEPOSITS											
Rapid Bay											
Top stockpile	17	29	24	17	13	0	0	35	0.87	90	4.3
Bottom stockpile	22	22	26	20	10	0	0	34	0.80	95	6.5
Sellicks Hill	18	2	20	15	23	22%	>2mm	25	8.4	97	5.0

Ashlars

Physical properties of many South Australian building stones, including Gambier Limestone, are currently being assessed by AMDEL. Tests include uniaxial compressive strength, modulus of rupture, water absorption, porosity, density and accelerated weathering by salt recrystallisation.

Principal nominal dimensions are 295 x 660 mm but with a large range of thicknesses depending on application. Special sizes can also be cut to order. Table 10, extracted from company handouts in Appendix B, illustrates the uses and range of sizes commonly available. Lintels for single doorways are cut 1.3 m long.

TABLE 10

SAWN GAMBIER LIMESTONE - TYPICAL SIZES AND USES

mm	inches		Ashlars/m^3	use
100	4	-	48	for normal housing,
115	4.5	-	43	building generally
125	5	-	38	
150	6	-	32	for single walls,
175	7	-	27	garages etc..
200	8	-	24	
225	9	-	21	for retaining walls, foundations etc.
250	10	-	19	for foundations,
274	11	-	17	sculpturing, etc.
300	12	-	16	

No formal specifications currently exist for Australian building limestone. Local markets dictate that top-quality or first-grade ashlars are:

- brilliant white rather than creamy
- massive
- medium and even grained
- preferably of low bulk density so that they are easier to handle.
- good coherent strength, and
- do not fret in use.

Ashlars are classified into 'seconds' or 'thirds' if creamy or yellow, excessively coarse grained or with uneven grain size. Bedded limestone shows irregular grain sizes, often with beds of different degrees of cementation and hence hardness, and would probably be rejected, or used only in foundation blocks. Coarse-grained ashlars require plastering and are not favoured as bare-facing walls.

The Mount Gambier market is oriented towards a whiter-than-white stone, even though there is probably no difference in strength between creamy yellow and white varieties. R. Butler from Jarvis Quarry produces attractive, distinctly yellow, iron-stained ashlars which are in great demand in Victoria.

Sawn blocks should be of good coherent strength otherwise corners break off excessively during handling causing high wastage. Petrographic examination reveals that many samples contain a thin, crystalline, calcitic coating on bryozoal fragments which binds the fragments and produces strong stone. Most samples contain a proportion of amorphous matrix which, although adding to the bulk density and perhaps to uniaxial compressive strength, does cause sawn blocks to be somewhat friable and prone to corners chipping. Current testing by AMDEL should further evaluate these properties.

Sawn blocks should not fret in use. Pareen Quarry has the reputation for producing limestone which frets badly although the quarry face is flat and case-hardened. In Edlington Quarry weathering has accentuated bedding with finer-grained, softer layers etched away 10-20 mm more than coarser, slightly-cemented beds which still retain the original sawn, flat surface.

The remaining two features refer to the quarry site rather than individual ashlars.

Some fine-grained limestone is described as 'puggy' - tending to clog saws during cutting. Consequently, cutting becomes more labour intensive and these quarries are abandoned in favour of areas more easily worked.

Limestone within quarries should ideally not only be massive and even grained, but free of northwest-trending joints and subhorizontal bedding plane partings. Both cause quarry development to be more difficult and somewhat haphazard.

Subhorizontal partings in particular can cause a complete layer of ashlars to be rejected as every block splits. If the layer dips at several degrees, then a second layer may also be affected. This often leads to abandonment of the quarry, at least temporarily.

Whiting

Finely milled limestone including Gambier Limestone is used extensively as cheap filler and pigment. Critical factors affecting quality are:

- chemical purity
- whiteness
- fine particle size and shape
- freedom from grit.

Deleterious impurities such as:

- quartz results in grit in the whiting, whereas
- ferric oxide results in discolouration.

Barnes (1986) provided data on characteristics of Gambier Limestone after milling where fineness and particle shape are critical. 'When milled, Gambier Limestone produces a high proportion of very fine particles, e.g. when crushed so that 99% is less than 53 μm, 40% is less than 10 μm which is much finer than other Australian whiting. Also in contrast to other crushed limestone, whiting particles are mainly sub-rounded and rounded.' Milled limestone often contains sharp, ragged particles which limits use in such applications as extruded plastics where sharp particles scratch the extruders.

Australian specification ASTM D1199-52T requires milled limestone to contain:

- minimum of 95% $CaCO_3$
- maximum of 2% moisture
- maximum of 0.35 mg NaOH/g

Whiteness of milled limestone is expressed as a percentage relative to reflection from a pure magnesia block, and ideally should be in the range 85-95%. Because of the variety of uses for whiting however, less bright whitings are still suitable for many applications. Whiteness is controlled by two factors:

- chemical purity, principally low iron
- crystallinity.

In general, whiteness is inversely proportional to iron content. In addition, the higher the degree of crystallinity in limestone, the whiter is the milled product (Barnes 1986). Typically:

- coarse, well-crystallised marble produces whiting of about 90-95% reflectivity
- partially recrystallised limestone produces whiting of about 85% reflectivity

Gambier Limestone is poorly recrystallised and produces whiting with brightness of 75-82% (Barnes, 1986). Table 11 shows the physical and chemical properties of general purpose cream/white whiting produced in 1980 by Minerals Pty. Ltd. from Jarvis Quarry; three other South Australian commercially-available whitings are also detailed in Barnes (1986).

TABLE 11

Chemical and physical properties of general purpose cream/white filler from Jarvis Quarry.

$CaCO_3$	98.47%
$MgCO_3$	0.70
SiO_2	0.53
Al_2O_3	0.16
Fe_2O_3	0.16
MnO	0.006
K_2O	0.04
TiO_2	0.01

Brightness (%) : 85.0
Oil absorption : 2.1-2.7 ml/10 g
Specific gravity : 2.68
Particle size characteristics: Max. 1% retained on 53µm sieve.

All available analyses of Gambier Limestone, some with R457 brightness determined are shown on Table 12. When compared with commercial cream/white filler, no sample reaches the required 85% brightness. However, milling often produces whiting with brightness 1-2% higher than test samples ground by mortar and pestle. Hence seven samples in this survey with a brightness greater than 82% probably match the filler produced by Minerals. These are all from the Marte area:

Sample No.	Quarry
A2550/79	Jarvis
RS 130	Steetley
RS 138	Lawson
RS 139	Lawson
RS 141	Fletcher
RS 125	Bruhn
RS 133	Stafford & Blackall

All have greater than 95% $CaCO_3$ and all contain from 0.10 to 0.17% Fe_2O_3.

Three quarries, Jarvis, Steetley and Bruhn have produced whiting. Since 1980, A.C.I. have also produced whiting-grade limestone from Caroline Quarry - as a special fine-grind, fibreglass filler as well as general-purpose filler.

Most samples produce brightness results in the range 75-82% i.e. very similar to Gambier Limestone from Honeysuckle Flat (Barnes, 1986). Lower values are attributed to samples which are:

- either partly recrystallised and with Fe_2O_3 greater than 0.10%, or
- poorly recrystallised with abundant amorphous matrix but can have Fe_2O_3 contents of only 0.09-0.13%.

In the present survey, 11 samples contain less than 0.15% Fe_2O_3 but all exhibit brightness less than 80%. Three in particular, RS150-152 from Hd. MacDonnell, contain only 0.09-0.10% Fe_2O_3 but are among the lowest in brightness at only 50-70%. High-grade low-iron limestone is not as bright as expected and this is attributed to poor crystallinity and abundance of amorphous matrix. This effect is most marked in the upper unit of Gambier Limestone. Marte quarries are in the middle unit and limestone is slightly more crystalline, but still less crystalline than Quaternary and Holocene dune sands. As expected, none of the samples with very high iron, i.e. greater than 0.3%, are of acceptable brightness.

All three samples from hundred MacDonnell are low in brightness (50-70%) and the possiblity exists that the upper unit of Gambier Limestone has a tendency to be finer grained, very poorly crystalline and will yield limestone of low brightness even when low in iron (about 0.10%).

Glass

Most manufacturers have established their own physical and chemical specifications for glass-melting 'sand'.

For chemical purity, prime requirements are low iron and consistent $Fe_2O_3+Al_2O_3$ and $CaO+MgO$ content. Typical specifications for glass-grade limestone and dolomite, Kephart and DeNapoli (1982), are:

SiO_2, Al_2O_3	± 0.5%
CaO, MgO	± 0.5%
Fe_2O_3	0.10% maximum

High-calcium limestone is considered (Kephart and DeNapoli 1982) to have:

$CaCO_3$	content of	97-99%
$MgCO_3$	" "	<2%
Fe_2O_3	limit of	0.1% maximum
SiO_2	" "	0.3-0.6% maximum

Particle size is also important but formal specifications are not well established. The trend in recent years has been to produce glass sand of finer grain size i.e. minus 30, 40 & 50 mesh products i.e. 0.3-0.6 mm (Sparks, 1982). ACI at Caroline use the 0.1-0.6 mm fraction for glass manufacture (P.D. Johnson, ACI Operations Ltd., pers. comm.). Very fine particle size results in 'dusting' in the glass furnace and loss of fines from the furnace into the regenerator and heat exchangers.

In the past, Gambier Limestone had been regarded as too fine grained for glass manufacture but specialised screening treatment at Caroline removes fine particles producing both glass-grade limestone and fines suitable as filler for fibreglass. Caroline averages 0.08-0.1% Fe_2O_3, anomalously low for Gambier Limestone (Barnes, 1986).

Available chemical analyses of Gambier Limestone are compared with the above specifications (Table 12). Seven samples from Hd. Blanche and four samples from Hd. MacDonnell apparently meet specifications, i.e.:

- Fe_2O_3 less than or equal to 0.12%
- SiO_2 less than 0.6%
- $CaCO_3$ greater than 97%

TABLE 12

CHEMICAL PROPERTIES AND BRIGHTNESS OF GAMBIER LIMESTONE

Locality	Sample No.*	Reference	CaO	MgO	SiO_2	Total iron as Fe_2O_3	Brightness (R457)	Calcite %	Dolomite %	Magnesite %	Total carbonate	Suitability as general-purpose cream/white filler	Suitability as glass-grade limestone
Hd. Blanche – 'typical'		Willington(1953)	53.9	0.72	0.90	0.48	–				98.0	No	No
Sec. 26	A2549/79	Barnes(1986)	53.2	0.59	1.34	0.28	76.9				96.0	No	No
"	A2550/79	"	53.9	0.49	0.57	0.16	83.3				96.5	Maybe	Maybe
"	RS121		54.3	0.66	1.41	0.46	74.9	95.5	3.0		98.5	No	No
"	RS122		54.9	0.59	0.88	0.26	78.3	96.5	2.5		99.0	No	No
"	RS123		54.7	0.70	0.57	0.34	66.5	96.0	3.0		99.0	No	No
"	RS148		55.3	0.75	0.69	0.12	78.0	97.0	3.0		100.0	No	Maybe
" 28		Johns(1963)	54.7	0.77	0.36	0.13	–	97.0		2.0	99.0	–	Maybe
"		"	54.7	0.70	0.42	0.18	–	97.5		1.5	99.0	–	No
"		"	54.5	0.62	0.62	0.18	–	97.0		1.5	98.5	–	No
"		"	54.3	0.67	0.84	0.30	–	97.0		1.5	98.5	–	No
"	RS127		55.1	0.61	0.56	0.14	78.5	97.0	2.5		99.5	No	Maybe
"	RS128		52.9	0.56	2.08	0.31	77.2	93.0	2.5		95.5	No	No
"	RS129		54.4	0.55	0.48	0.14	79.5	96.0	2.5		98.5	No	Maybe
"	RS130		55.0	0.52	0.53	0.15	82.0	97.0	2.5		99.5	Maybe	Maybe
"	RS131		54.7	0.64	0.95	0.23	79.3	96.0	3.0		99.0	No	No
"	RS138		55.8	0.60	0.52	0.10	82.4	98.0	2.0		100.0	Maybe	Yes
"	RS139		55.4	0.60	0.50	0.10	83.5	97.0	3.0		100.0	Maybe	Yes
"	RS140		55.3	0.63	0.50	0.10	80.0	97.0	3.0		100.0	No	Yes
" 30	RS136		53.1	0.62	1.45	0.21	73.0	93.0	3.0		96.0	No	No
"	RS137		54.7	0.69	0.71	0.19	77.2	96.0	3.0		99.0	No	No
" 134		Johns(1963)	54.5	0.77	0.64	0.16	–	97.5		1.5	99.0	–	No
"		"	52.9	1.25	0.80	0.16	–	94.5		2.5	97.0	–	No
"		"	53.1	0.81	0.88	0.17	–	95.0		1.5	96.5	–	No
"		Jack(1923)	53.1	0.75	0.88	0.59	–				96.5	–	No
"	RS141		55.7	0.61	0.32	0.10	83.0	98.0	2.0		100.0	Maybe	Yes
"	RS142		55.2	0.45	0.57	0.11	78.7	97.5	2.0		99.5	No	Yes
" 136	RS124		55.1	0.63	0.61	0.17	74.7	96.5	3.0		99.5	No	No
"	RS125		55.4	0.45	0.63	0.17	83.8	98.0	2.0		100.0	Maybe	No
"	RS126		55.9	0.53	0.75	0.20	81.0	98.0	2.0		100.0	No	No
" 138		Madigan(1957)	54.4	0.76	0.32	0.16	–	97.0		1.5	98.5	–	Maybe
"	RS147		55.1	0.79	0.60	0.13	79.6	96.5	3.5		100.0	No	Maybe
" 141		Johns(1963)	54.5	0.74	0.44	0.18	–	97.5		1.5	99.0	–	No
" 145		"	54.3	0.95	0.64	0.18	–	97.0		2.0	99.0	–	No
"	RS146		54.8	0.86	0.94	0.15	78.0	95.5	4.0		99.5	No	Maybe
" 192	RS132		55.8	0.54	0.58	0.16	79.3	98.0	2.0		100.0	No	Maybe
"	RS133		55.7	0.54	0.44	0.12	82.7	98.0	2.0		100.0	Maybe	Yes
"	RS134		52.8	0.56	2.38	0.88	68.1	93.0	2.5		95.5	No	No
"	RS135		55.7	0.53	0.38	0.11	76.5	98.0	2.0		100.0	No	Yes
" 310/321	RS149		53.8	0.97	1.29	0.22	73.9	93.5	4.5		98.0	No	No
" 524	RS145		54.5	1.04	0.77	0.17	72.8	94.5	5.0		99.5	No	No
" 526	RS153		53.4	1.18	1.23	0.18	70.3	92.5	5.5		98.0	No	No
Hd. Caroline – sec. 331		Johns(1963)	54.5	0.54	–	–	–	97.5		1.0	98.5	–	–
" 538/539	21 samples	Barnes(1986)	54.2	0.87	–	0.18$^+$	–					–	No
Hd. Hindmarsh-sec. 204		Johns(1963)	51.8	1.84	–	1.30^x	–	92.5		4.0	96.5	–	No
" 213		"	53.0	0.74	–	–	–	94.5		1.5	96.0	–	–
" 335		Jack(1923)	51.9	1.65	1.50	0.93	–	92.5		3.5	96.0	–	No
" "		Johns(1963)	54.5	0.77	0.64	0.16	–	97.5		1.5	99.0	–	Maybe
Hd. Jessie – 418		"	54.9	0.02	–	–	–	98.0		0.0	98.0	–	–
Hd. Joanna – 188		"	55.2	0.03	–	–	–	98.5		0.0	98.5	–	–
Hd. MacDonnell – 736	RS150		55.1	0.99	0.50	0.10	50.7	95.5	4.5		100.0	No	Yes
" 750		Johns(1963)	51.2	2.73	0.50	0.12	–	91.5		5.5	97.0	–	Yes
" "	RS152		51.8	3.36	0.38	0.10	68.7	84.0	15.5		99.5	No	Yes
" 828	RS151		54.0	1.91	0.43	0.09	70.7	91.5	8.5		100.0	No	Yes
Hd. Naracoorte – 28		Johns(1963)	54.9	0.50	0.44	0.24	–	98.0		1.0	99.0	–	No
– Bk 60		"	54.4	0.80	–	–	–	97.0		2.0	99.0	–	–

* All sample numbers are prefixed by 7022.

+ based on 68 samples from 8 drill holes.

TABLE 13
GLASS-GRADE LIMESTONE: SAMPLES MEETING SPECIFICATION

Hd.	Sample No.	Quarry
Blanche	138	Lawson
"	139	"
"	140	"
"	141	Fletcher
"	142	"
"	133	Stafford and Blackall
"	135	Majors
MacDonnell	150	Mount Salt
"	-	Stafford
"	152	"
"	151	Pareen

An additional eleven samples are classified as maybe meeting the less stringent specifications of:

- Fe_2O_3 of 0.13-0.16%
- SiO_2 less than 0.6%

However, all samples have higher iron content that the average of all samples from Caroline and that deposit continues to be the best source of glass-grade limestone.

All three samples tested from Lawson Quarry at the extreme northwest end of the western line of quarries are or may be of glass-grade limestone. No other sample from the main line of quarries satisfies these specifications. Coarse, porous and permeable limestone is easily stained by precipitation of iron hydroxides leached from surface soils. For all eighteen samples on the western line of quarries:

- Fe_2O_3 averages 0.20%
- SiO_2 averages 0.82%

Four widely-scattered samples from the eastern line of quarries also satisfy specifications. A high Bridgewater Formation dune cuts across this line and restricts quarry development to the west but RS 135 was collected from an abandoned quarry where:

- overburden is thin
- quarry is currently being cleaned out by Gambier Earthmovers Pty. Ltd. with old offcuts being used as road rubble
- water table is deep i.e. about 11-12 metres below natural surface.

Substantial reserves of high purity limestone could probably be established in this area.

Sampling away from Marte is restricted but four samples from widespread localities satisfy glass-grade specifications (Table 13) i.e. from Mount Salt Quarry, Pareen Quarry and Stafford Quarry. All are in the upper unit of Gambier Limestone, as are Caroline and Honeysuckle Flat deposits. This upper unit would appear to be more prospective for glass-grade limestone recognising that Caroline may be exceptional.

SUMMARY AND CONCLUSIONS

Gambier Limestone of middle Oligocene to early Miocene age has yielded ashlars from both the middle and upper units but the middle unit, cropping out at Marte is favoured because massive calcarenite is atypically up to tens of metres thick. Quarries at Marte are aligned along NW-trending joints (?faults); jointing is probably the same age as Holocene Mount Schank i.e. about 5 000 years B.P. but may be as old as the Pliocene-Pleistocene Mount Burr Volcanics.

Ashlar quarries are concentrated at Marte through a combination of:

- outcrop of the favoured middle massive calcarenite unit of Gambier Limestone.
- NW-trending joints or faults which have controlled or facilitated groundwater movement and hence carbonate dissolution and reprecipitation.
- past groundwater chemistry changes probably related to a nearby Dilwyn Formation high, and extensive dolomitisation east of Marte.

Water levels in the quarries are apparently 3-4 m higher than anticipated from regional data. Geological models include:

- ponding of water in the quarries
- local groundwater high produced by extensive recharge through the quarry floor.

The quarries at Marte are probably areas of groundwater recharge though survey and water level data are limited.

Total recorded production of ashlars from Gambier Limestone from throughout the South East between 1924 and 1986 is 974 650 tonnes. Estimated production since colonisation is 1 300 000 tonnes. Average production since invention of mobile saws in 1950 allowing ashlars to be cut in situ is 20 100 tonnes per year. 1986 production of 9 705 tonnes is well below average for the last 36 years.

Best quality building stone comprises an open fabric of coarse grained skeletal material which is coated and cemented by crystalline dolomite. Petrographic examination of thirty three specimens shows that stone quality depends on the history of corrosion, replacement and deposition of micritic carbonate subsequent to the original sedimentation of a relatively uniform limestone. Minimal corrosion of the bioclastic framework and deposition of crystalline dolomite as a thin coating of cement on grains produces a strong stone with a recognisable open fabric. Substantial corrosion of the framework and deposition of an amorphous carbonate of varied composition reduces the coherence of the stone and at worst produces a chalky ashlar which would 'fret' in use e.g. Pareen stone. The fabric is fine grained and matrix rich, with few relict fossil fragments.

Road rubble recorded as being produced from Gambier Limestone totals only 1 389 028 tonnes. This grossly understates the importance of Gambier Limestone as a cheap, local and widespread source of rubble throughout the lower South East. Production is only rarely distinguished from that from Quaternary and Holocene and calcareous, aeolian dunes. Actual production from Gambier Limestone would be at least 10 times, and possibly as much as 100 times, that recorded.

Agricultural lime has been produced since 1959 and recorded production to 1986 is 80 736 tonnes of which 79% has been produced from Steetley Quarry. Demand is high for agricultural lime as it neutralises the built-up soil acidity - a common problem throughout the South East resulting from a combination of superphosphate application, light-textured soils and high rainfall. Agricultural lime ideally should be fine grained, readily soluble and have a high neutralising value. Current production of agricultural lime is from Telford's Pit and from Steetley Quarry. At least three other sources of agricultural lime are available but Quaternary Bridgewater Formation is mined i.e. Lake Leake, Goode's Pit near Cape Jaffa and Henschke Industries' quarry at Naracoorte. Application rates depend on initial soil pH and final pH desired and can vary up to 3 tonnes/hectare for strongly acidic soils. Continued growth in agricultural lime production is foreseen.

Production of whiting-grade limestone to use as filler commenced in 1949 and has been produced continuously since. Total recorded production is 224 557 tonnes of which 81% has been produced from Jarvis and Steetley Quarries. Current production is about 7 600 tonnes/year as a by-product from Caroline Quarry where ACI mine glass-grade limestone. Average production since 1949 has been 5 000 tonnes/year with peak production in 1978 of 17 340 tonnes. Current levels of production are well below the potential of Gambier Limestone to yield a general-purpose filler. Because of a combination of 'high' iron content and poor crystallinity, typical filler produced has had an R457 brightness of around 85%, suitable only for use as a general-purpose filler. Seven samples in this survey would apparently yield acceptable general-purpose filler. Only two were from the main producing area, Jarvis and Steetley Quarries, most potential is in the southeastern area including Bruhn, Fletcher, McKay and Major Quarries. The upper unit of Gambier Limestone has a tendency to be fine grained and low in iron (about 0.10%) but will yield limestone with only low brightness (typically 50-70%) presumably because of extremely poor crystallinity.

Production of glass-grade limestone dates from 1943 but was not significant until opening of ACI's Caroline Quarry in 1982. Total production to 1986 is 134 023 tonnes of which about 92% has been produced by ACI in the last five years. Eleven samples in this survey apparently meet specifications for glass-grade limestone. Only three out of twenty samples collected from the main line of quarries are suitable, all three are from the extreme northwestern end in Lawson Quarry. Four samples from the eastern line of quarries satisfy specifications and this area has potential to supply high purity limestone. Four samples from widely separated localities near Mount Schank, Mount Salt and at Pareen confirm the 'upper grey cherty limestone' of Gambier Limestone as the most prospective for glass-grade limestone.

RECOMMENDATIONS

Water levels in and around the Marte require resurveying to provide accurate data for groundwater modelling and reserve calculations. At the moment, interpretations are hampered because of inadequate data and possible, unconfirmed, surveying errors. Regional groundwater data and limited levelling of additional bores are not consistent with spot heights from a PHOTEC survey. Accurate survey data and clarification of the discrepancy are required before any reserve estimates can be attempted.

Any reserve determination would require drilling. The cheapest and most informative technique would be by Calweld drilling with downhole inspection by geologist and/or quarry operators.

The 1986 fall in ashlar production is cause for concern if the trend continues. This decline is in part produced by a lower demand for ashlars with the fashion favouring the more expensive, clay bricks. Hence at this stage, resurveying and drilling with determination of reserves are not warranted.

Obvious targets for future quarry development are:

1) southeastwards for up to 1 km from each of the two lines of Marte quarries
2) mining between Johnson, Majors and McKay Quarries followed by expanding northwestwards past Stafford and Blackall Quarry.

Gambier Limestone has obvious potential to yield whiting suitable as a general-purpose filler. This report hs identified the southeastern end of the Marte quarries as having the most potential but that additional sampling is required, either by SADME or interested companies, to prove up a deposit.

D.J. Flint.

D.J. FLINT
SENIOR GEOLOGIST
MINERAL RESOURCES BRANCH

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APPENDIX A

REPORT BY
JOHN W. GRANT PTY. LTD.

for

STEETLEY INDUSTRIES LTD.,
1973

MOUNT GAMBIER LIMESTONE

"CORALLINE LIMESTONE"

1. INTRODUCTION

The aim of this report is to provide a full appreciation of Mount Gambier Stone and its uses to the public throughout.

(a) Description - Mount Gambier Stone is gleaming, creamy white in colour and is a very good conductor of light and heat. It is cellular in construction which makes it light in weight, a very good insulator, and gives it unique acaustic properties which is not very often obtained in other wall building materials. This stone is very easy to work with for both the tradesman and the handyman.

(b) History - Mount Gambier Limestone (Coralline Limestone) which has a calcium content of 93%, is a polyzoal marine deposit and partly chemical deposit, which has been combined together to form sedimentary layers in the earth's crust. These were laid down originally under water and later were raised to form dry land. This stone has been widely and extensively used throughout the South East of South Australia and Western districts of Victoria for over a hundred years.

2. QUARRYING OF THE STONE

(a) Location and cutting of Stone - The quarries from which this stone is cut are located around the outskirts of the city of Mount Gambier, (refer appendix 1).
Firstly the land is cleared to form a flat and level floor. Then, the top crust of the earth is cleared away, by means of bulldozers, down to the sedimentary layer of limestone. The top of the limestone is then levelled off to develop a flat level floor from which the stone ashlars can now be cut.

The stone is cut vertically by means of a power circular saw, (refer appendix 2) to the normal depth of 295mm. The saw blades used in cutting all this stone are very similar to a normal circular saw blade except for the teeth which, in this instance are tungsten tipped. After these cuts have been made vertically, another cut is made horizontally at the correct depth to a length of 660mm. and normal thickness of 100mm. (refer appendix 3) to form the ashlar. The ashlars are then manually loaded onto pallets which are stacked and stored (see appendix 4) ready for transporting onto the building site, by means of semi-trailers which help minimise handling costs.

(b) <u>Sizes</u> - The size of Mount Gambier Stone varies quite considerably according to where and how the stone is used. The normal size of a ashlar is 660mm. long x 295mm. high x 100mm. thick. This size is widely used in the housing industry as both interior walls and exterior walls. The thickness of the ashlar often varies for increased strength in factory walls or even in single-leaf wallconstructions. The thickness of the ashlar ranges anywhere between 100mm. and 300mm.

Types of stone cut and sizes are as follows:-

(1) Stone is readily used for footings in place of concrete in housing construction. The size of the stone being 600mm. x 455mm. x 200mm.

(2) Quoins can be cut and supplied to any required size. These are usually double the thickness of the standard ashlar, before being cut into an "L" shape.

(3) Lintels are also cut to the same height and thickness as a normal size ashlar to cover an opening, which does not exceed 1.5 metres.

(4) Modular sizes are also being cut from the stone tables to a size of 395mm. x 192mm. x 100mm.

All the stone is sold by cubic metre.

(c) Grades - The stone is also cut into two grades, being a first and second grade. The first grade stone has a very even texture and is snowy white in colour. This grade is used mainly for the exterior walls of houses and columns where the stone is left in its natural state. The second grade stone is not much different to the first grade except, second grade is a lot courser in texture and the colour of the stone, varies from a creamy to a bright orange. Second grade is used mainly where it is going to be covered with plaster, e.g. interior walls, or where it will not be seen e.g. dwarf walls.

3. TESTS

(a) Co-efficient of Linear Thermil Expansion - Two specimens were tested, one cut parallel to the length of a block and one parallel to its width, each of size 75mm. x 75mm. x 300mm. The Tentative Method of Test for Length Change of Drilled or Sawed specimens of Cement Mortar and Concrete was adopted with modifications to dertermine length variations corresponding to temperature changes. Co-efficient of linear thermal expansion was $3.0 \times 10^{-6}\ {}^{o}C^{-1}$ in the temperature range - 7 to +41°C.

Note:- The co-efficient of volumetric thermal expansion was not determined, this value is generally quoted in references as approximately three times the value for linear thermal expansion.

(b) Linear Expansion due to Moisture Absobtion - Two specimens prepared as described above were tested. The specimen size was 75mm. x 75mm. x 300mm. A similar test to the above was adopted with modifications to determine length changes caused by saturating the specimens with water. The change of length due to wetting by saturation under vacum and keeping the specimens submersed under water for up to 24 hours was 50×10^{-6} inch/inch. (Test temperature $20 \pm 1^{o}C$). This value was observed 4 hours after saturation, and no further expansion was observed during the subsequent 18 hours.

(c) <u>Compresive Strength</u> - (Refer Appendix 5)

4. USES

(a) <u>Foundations</u> - Ashlars are quite frequently used for footings in housing construction on good slightly reactive black soils. A building site is levelled and marked where footings are to be laid. The ashlars are then placed on top of a light sand, which is approximately 100mm. deep and butted tightly together to form a strong and rigid footing.

(b) <u>Mortar Mixes</u> - The major use of Mount Gambier Stone is for building. After the footings are laid down for a house, walls are ready to be constructed. The mortar mixed for the ashlars is usually amixture of 9 parts sand, 2 parts limil and 1 part cement. The ashlars are not wet by hosing or soaking before installation.

The first mixture to be laid on top of the footings is a damp-proof course which is most important because of the high porosity of the stone, any defects in a damp course will rapidly show up and extend over a large area. A non porite solution mixed with the mortar is most commonly used in the first two courses. Polythene membranes such as "Vixqueen", "Rencourse" and "Alcor" are also commonly used in base course.

The ashlars are then laid in position and are jointed together, being two leaves of 100mm. each with a 50mm. cavity, using double prong ties in each course and approximately each pair of ashlars.

Jointing of the stone work is based on the 100mm. stretcher - bond system. The stone, being very soft when freshly quarried, is readily cut with a hand saw and consequently makes arrangements of joints more flexible than solid units such as clay bricks or hollow concrete blocks.

(c) <u>Pointing</u> - After laying the stone with mortar and while still damp, the joints should be raked out to a depth of about 10mm. when pointing, these joints are filled flush with the wall with a mixture of Mount Gambier Stone dust, sand and limil. The exact proportions would depend on the colour of the sand in the district.

The aim is to get it as near as possible to the colour of the stone which is easily acheived with a little experimenting. It is best to point a section of the wall at a time, and, before the mixture has dried, rub it down with a small piece of clean limestone. Immediately rule the joints with a stack of carpenter's pencils and a straight edge. These pencils are made up by tapping together 4 - 5 bare pencil leads. The ruling can be done on the horizontal courses only, or on the vertical joints as well.
Another method of finishing is to seal the joint with silicone. This gives a pleasing effect if the mortar used is darker than the colour of the stone and the joint is left raked out to a depth of 10mm.
A different finish again is to leave off the pencil lines and finish the joints flush. This will have the effect of the wall appearing to be solid stone.

(d) Fixing - Through being very porous, this stone is very easy to work, e.g. fixing doors and window frames. Firstly holes 25mm. in diameter x 75mm. deep are bored into the stone with an ordinary auger bit. These holes are skewed alternatively in opposite directions, and plugged with softwood dowels. Jambs and sashes are nailed into position, making sure the nails are driven down the centres of the plugs.

Also, cupboards which are fixed to the wall, both top and bottom units, are usually screwed through the back of the cupboard into the wall by means of an ordinary steel 100mm. wood screw.
Skirting boards are also fixed to the wall by means of 100mm. wood screws at a distance of approximately 600mm centres apart.

(e) Secondary - Apart from building, Mount Gambier Stone has a number of other uses:-
Some of these are

(1) agricultural lime which is milled at the quarries.

(2) stock and poultry foods which is also milled at the quarries.

(3) ripped rubble in its crude form sent away in bulk to factories in Adelaide, Ballarat and Sydney as a base for paint.

(4) rubber industry for rubber backed linoleum.
(5) wall tiles, vegimite and calcium tablets
(6) for sculpturing throughout because of its
bulk and simplicity to work with.

5. COST

Mount Gambier Stone is much cheaper than other building materials mainly because of its simplicity to quarry, cut and transport. The price varies considerably, depending on what size, quantity and quality is required. Modular sizes and other varying sizes which differ from the normal ashlars are more expensive due to additional handling, extra sawing and excessive wastes.
The price of first grade ashlars is $13.20 per cubic metre and the second grade ashlars are about $1.20 per cubic metre less than first, at $12.00.
The cost of building with the stone is very economical, due to the rapid completion of the building. In the final stages of the building, the plumbing and electrical work is simplified. Holes are very easily bored in the walls for pipes and wiring, which saves a considerable amount of time and money.

6. SUMMARY

As can be seen from this report, Mount Gambier Stone is a very versatile and cheap building material.
It is quarried, sawn and transported in a very simple and uncomplicated way.
The stone is then separated into two grades, first and second grades, and can be sawn to varying sizes.
Has an unlimited amount of uses, ranging from building stone through to calcium tablets.
It is very easy to work with, for both the tradesman and the handyman.
It can also be noted in this report that Mount Gambier Stone has a very reasonable compresive strenth.

SNOWY MOUNTAINS HYDRO-ELECTRIC AUTHORITY
BOX 332 P.O., COOMA NORTH 4S N.S.W.
ENGINEERING LABORATORIES

REPORT OF TEST RESULTS

No. MB [illegible]

TESTING OF CORALLINE LIMESTONE FROM MT GAMBIER, S.A.

1. MATERIAL

Two blocks of coralline limestone were received from John W. Grant Pty Ltd, of Fyshwick A.C.T. on 17 January 1973.

2. REQUEST

Following verbal discussions on 17 January 1973 between Messrs J.W. Grant and A.D. Hosking the following tests were requested:

- Unconfined compressive strength tests on machined specimens in the 'as received' condition (air dry) and after 12 hours immersion in water to ASTM C2938-1971.
- Absorption (per cent) to AS A77.
- Weight per unit volume.
- Freeze Thaw Durability test, generally in accordance with S.M.A. Procedure E.6.5 to a maximum of 24 cycles.
- Coefficient of linear and volumetric thermal expansion. ASTM C341-71T was adopted with modifications as described in Table 2.
- Expansion due to moisture absorption. ASTM C341-71T was adopted with modifications as described in Table 2.

3. TEST RESULTS

The test results are listed in the attached Tables 1 and 2 and Figure 1.

4. DISPOSAL

Remnants of the test material will be stored by the Laboratory under Lab. Ref. Nos. A3003 and MMG 267 for a period of one year.

Testing Officer. A.D. Hosking

Date

epared :

ecked : E.B.

~~Engineer-in-Charge,~~
~~Scientific Services Division.~~

Chief Engineer, Engineering Services

4 Sheets Sheet 1

TABLE 1

TESTING OF CORALLINE LIMESTONE FROM MT GAMBIER S.A.

REPORT OF TESTS FOR UNCONFINED COMPRESSIVE STRENGTH - UNIT WEIGHT - ABSORPTION

LAB. REF. NO.	SPECIMEN TEST AREA mm^2	UNIT WEIGHT (DRY BASIS) kg/m^3	AVERAGE UNIT WEIGHT (DRY BASIS) kg/m^3	COMPRESSIVE STRENGTH MPa	AVERAGE COMPRESSIVE STRENGTH MPa	LAB. REF. NO.	ABSORPTION (per cent)	AVERAGE ABSORPTION (per cent)
		AS RECEIVED CONDITION - AIR DRY						
MMG 2671	4 560	1 200		4.15		MMG 2677	33.6	
MMG 2672	4 560	1 180	1 200 (75.5 lb cu ft)	3.95	4.10 (590 lbf/in^2)	MMG 2678	33.1	33.3
MMG 2673	4 560	1 240		4.20		MMG 2679	33.2	
		AFTER 12 HOURS IMMERSION						
MMG 2674	4 560	1 200		2.60				
MMG 2675	4 560	1 240	1 220 (75.5 lb cu ft)	3.00	2.85 (420 lbf/in^2)			
MMG 2676	4 560	1 200		2.95				

NOTE: Unit weight expressed to nearest 20 kg/m^3 (0.5 lb cu ft). Compressive strength to nearest 0.05 MPa (10 lbf/in^2)

Prepared by:

Checked by:

Report No. MB [illegible]

TABLE 2

TESTING OF CORALLINE LIMESTONE FROM MT GAMBIER S.A.

REPORT OF TESTS FOR COEFFICIENT OF LINEAR THERMAL EXPANSION AND LINEAR EXPANSION DUE TO MOISTURE ABSORPTION

Coefficient of Linear Thermal Expansion

Lab. Ref. No. MMG 267 10. Two specimens were tested, one cut parallel to the length of a block and one parallel to its width, each of size 3 inch x 3 inch x 12 inch. The test method described in ASTM C341-71T, Tentative Method of Test for Length Change of Drilled or Sawed specimens of Cement Mortar and Concrete was adopted with modifications to determine length variations corresponding to temperature changes. Coefficient of linear thermal expansion was 3.0 x 10^{-6} $^{o}C^{-1}$ in the temperature range - 7 to + 41°C.

Note: The coefficient of volumetric thermal expansion was not determined, this value is generally quoted in references as approximately three times the value for linear thermal expansion.

Linear Expansion due to Moisture Absorption

Lab. Ref. No. MMG 267 11. Two specimens prepared as described above were tested. The specimen size was 3 inch x 3 inch x 12 inch. The test method described in ASTM C341-71 was adopted with modifications to determine length changes caused by saturating the specimens with water. The change of length due to wetting by saturation under vacuum and keeping the specimens submersed under water for up to 24 hours was 50 x 10^{-6} inch/inch. (Test temperature 20± 1°C). This value was observed 4 hours after saturation, and no further expansion was observed during the subsequent 18 hours.

Prepared by: [illegible]

Checked by: E.B.

Report No. MB [illegible]

4 Sheets Sheet 4

ACCELERATED WEATHERING OF ROCK
FREEZE - THAW TEST

W/O ____________

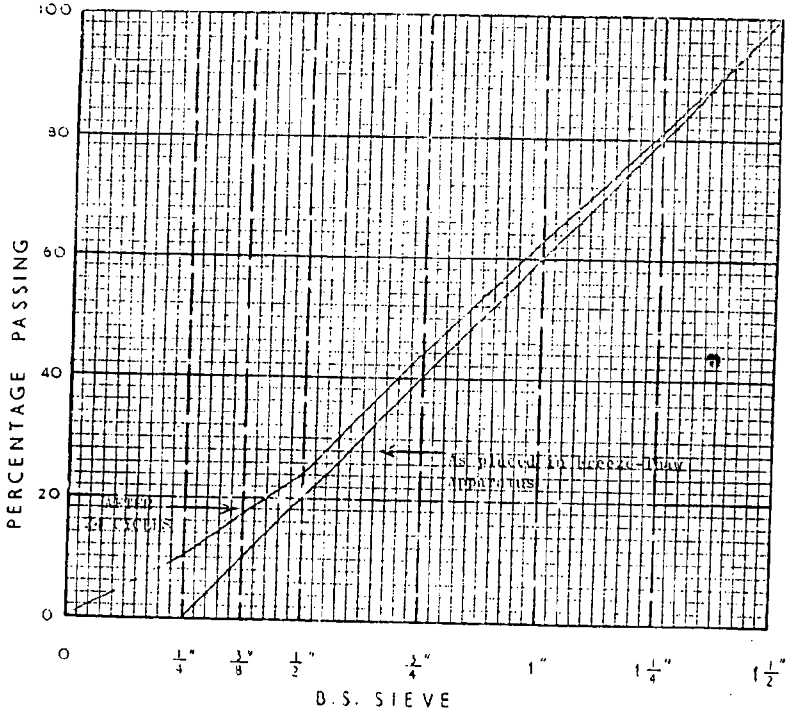
Procedure E 6·5

Tested by MB Computed by EA Checked by KMB Sample No A.3003

Date 30.1.73 Date 31.1.73 Date 31.1.73 Registration

Report No. MB [illegible]

PARTICLE SIZE DISTRIBUTION



STABILITY

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
		NUMBER OF FREEZE-THAW CYCLES						
		24						
(a)	Area between particle size distribution curves sq in	1.12						
(b)	Change in Mean Weight Diameter x 27(a) mm	1.42						
(c)	Stability Index (b) (a)	35						

Note: The principal effect of the freezing and thawing cycles was to give a slight rounding to all sharp edges. The material removed from the edges contributed largely to the final fraction passing ¼ inch. As the particles tested were obtained from sawn blocks by hand knapping, all edges were originally sharp.

S.M.A
FORM No
SS 6198
(11/64)

APPENDIX B

GENERAL INFORMATION FROM OPERATING COMPANIES ON USES, SIZES AVAILABLE, BUILDING TECHNIQUES, FIRE RATING AND COMPRESSIVE STRENGTH

COMMERCIAL MINERALS
P.O. Box 256,
Mt. Gambier, S.A. 5290
Telephone 39 9212

MOUNT GAMBIER LIMESTONE

WHAT IS IT?

Mount Gambier Limestone is a marine deposit of creamy white calcium carbonate, cellular in nature. This structure gives it excellent acoustic and insulation properties. The blocks, known as "ashlars" have been in use for 100 years, and are virtually maintenance free.

HOW IS IT USED?

Building methods are basically the same as those used with bricks, that is, stone veneer or double wall with cavity. The ashlars are sawn at the quarry and delivered direct to site. Ordinary wood working tools are used, saws, chisels, planes etc. The stone is non-abrasive. A standard sized ashlar is equivalent in area to about 10 standard bricks, and about 100 per day can be laid - a big saving in labour costs. There is also a big saving in mortar since only about 20% of the amount for equivalent brickwork is required.

WHAT CAN IT BE USED FOR?

There are many uses:-

- Multi stored buildings
- Hospitals
- Factories
- Shops
- Dwellings
- Fencing
- Pergolas
- Ornamental pillars
- Sculpturing
- Farm buildings

It is not only easy to use, it is also one of the least expensive building materials available.

SIZES AVAILABLE:

(a) Principal nominal dimension is 295 x 660 mm ($11^{5}/8$ x 26 in) in various thickness as follows:-

		Ashlars/ cu. m		
100 mm (4 in)	-	48	)	for normal housing, building generally
115 mm ($4^{1}/2$ in)	-	43	)	
125 mm (5 in)	-	38	)	
150 mm (6 in)	-	32	)	for single walls, garages etc
175 mm (7 in)	-	27	)	
200 mm (8 in)	-	24	)	
225 mm (9 in)	-	21	)	for retaining walls, foundations etc
250 mm (10 in)	-	19	)	for foundations, sculpturing, etc
275 mm (11 in)	-	17	)	
300 mm (12 in)	-	16	)	

Other sizes can be made to order for a slightly increased charge.

(b) Ashlars are available in half courses, and rock faced. Mixtures of various matching sizes can also be used, particularly in housing where it gives a most pleasing effect.

(c) Lintels:

These can be cut in limestone provided that the opening does not exceed 1.5 m (5 ft). Lintels for a single doorway are 1.3 m (4 ft 4 in), and for a double doorway, 1.65 m (6 ft 6 in). For openings larger than 1.5 m, reinforced concrete is advisable. This can be rendered to match the limestone.

(d) Corners: (Quoins)

An ashlar of double thickness is supplied and this is cut on site into an L-shape. The rebated piece can be used as an ordinary ashlar.

BUILDING TECHNIQUES:

(a) Foundations, Stumps and Bearers:

In Mount Gambier, trenches are dug, and foundation blocks set perfectly horizontal on sand. For stumps and bearers, dwarf walls with 115 mm ashlars set on solid ground are used. Wood plates 75 x 25 mm are nailed along the top, and flooring joists nailed to the plates. However, it is advisable to check with your local council for appropriate building regulations.

(b) Mortar:

A mix of 1 part Limil and 5 parts clean coarse sand. Allow 6 mm (1/4 in) joint and wet the top of each course before spreading the mortar.

(c) Damp Course:

Standard methods are satisfactory.

(d) Doors and Window Frames:

25 mm dia x 25 mm holes are drilled with an ordinary auger, skewed in opposite directions, and plugged with wooden dowels. Jambs and sashes are then nailed into position.

(e) Window Sills:

Use glazed tiles, slates or sealed stones.

(f) Chimneys and Fireplaces:

Chimneys may be built with limestone but the fireplace must be lined with brick.

(g) Cleaning Ashlars:

Before pointing the joints, the surface of the wall can be cleaned and evened by "dragging" with a tenon saw blade or similar.

(h) Pointing:

After laying the mortar, and while still damp, the joints may be raked to a depth of 6 mm, and pointed by filling the joints with a mixture of stone dust, sand and Limil, to match the colour of the ashlars.

Darker mortar can be used and the joint left raked to 6 mm

SURFACE TREATMENT:

(a) Internal Walls:

Internal walls can be plastered and painted. The natural appearance of the ashlars can be retained by coating the stone with a transparent silicone - based paint which will seal and preserve the surface.

(b) External Walls:

These are preferably left in their natural state, but can be clear rendered, if preferred, with silicone.

THE READYMIX GROUP (S.A.)
MATERIALS TESTING LABORATORIES

*** COMPRESSIVE STRENGTH OF**

1. ~~BRICKS (HALF~~/FULL)
   XXXXXXXXXXXXXXXXXXXX
2. ~~PRISMS~~ XXXXXXXXXXXXXXX
   XXXXXXXX
3. MASONRY BLOCKS
4. ~~CORES~~ (LIMESTONE)
   XXXXXX

Date Submitted: 3/7/78

Capping Method 3/16 3 PLY

Order Number:

These specimens were crushed on 3/7/78 in accordance with

~~current editions of Australian Standards.~~

Markings	Dimensions (mm)	Area (mm^2)	Load (Newtons)	Compressive Strength (Mpa)
A	150 x 151	22650	130000	5.5
B	150 x 150	22500	115000	5.0
C	150 x 150	22500	116000	5.0
D	150 x 150	22500	119000	5.5

$5.00 per block to test = $20.00

Brian Clarke

Tested By: N L Ross Date: 3/7/78

Calculated By: N L Ross Date: 3/7/78

Checked By: R C Hodge Date: 4/7/78

EBS

DEPARTMENT OF [illegible]
EXPERIMENTAL BUILDING STATIO
[illegible]

[illegible]
ES 16/10

[illegible] January 197[illegible]

(28th January 197[illegible]

LIKELY FIRE RESISTANCE OF NON-LOADBEARING WALLS OF MOUNT GAMBIER LIMESTONE

EBS conducted three pilot examinations of the likely fire endurance of 1-m x 1-m non-loadbearing wall specimens of Mount Gambier limestone.

The wall specimens were constructed of limestone blocks with nominal overall dimensions of 660 mm (26 in) x 290 mm (11½ in) and different thicknesses. The wall specimens were not rendered and were identified as follows:

Specimen No 1 (Examination No 1), nominal wall thickness = 112 mm (4⅜ in);

Specimen No 2 (Examination No 2), nominal wall thickness = 150 mm (6 in); and

Specimen No 3 (Examination No 3), nominal wall thickness = 200 mm (8 in).

Pilot examinations of the likely fire endurance of structural elements are not full-scale standard fire-resistance tests and cannot determine the level of fire resistance because of the limited size of furnace and test specimen. These pilot examinations, however, are conducted under the time-temperature conditions of the standard fire-resistance test and can indicate the fire-resisting potential of the elements examined, particularly its thermal-insulation properties at elevated temperatures and the temperatures of its unexposed surface in a standard fire-resistance test.

The results from the three pilot examinations are tabulated below:

Time (min)	Furnace Temperature as per AS 1530, Part 4-1975 (°C)	Average Temperatures on Unexposed Surface of Specimens in °C		
		Specimen No 1 (Examination No 1)	Specimen No 2 (Examination No 2)	Specimen No (Examination
0	(15 to 29)	15	29	21
15	757	16	32	23
30	843	20	34	25
45	892	44	37	26
60	927	71	44	27
75	954	80	52	28
90	978	86	60	31
105	996	102	68	35
120	1010	126	75	42
135	1027	150	82	50
137½		154*		
150	1043	174	89	57
165	1058		95	63
180	1072		107	69
195	1086		120	73
210	1098		134	77
225	1110		146	81
240	1121		158	85
255			168**	90
270			181	96
285			193	103
300	1163			111
315				118
330				124
345				132
360	1204			142***

size wall subjected to the standard fire-resistance test. The failure was due to an average temperature rise on the unexposed surface of 139°C above the initial temperature of 15°C.

** Thermal failure for specimen No 2 due to an average temperature rise on the unexposed surface of 139°C above the initial temperat of 29°C.

*** The maximum period of fire exposure in the standard fire-resistan test is 6 hours. The pilot examination was concluded shortly thereafter before a thermal failure was established.

During the pilot examinations the three non-loadbearing wall specimen retained their structural stability and did not develop fissures and cracks th could have influenced detrimentally their fire-resistive properties.

The visual examination at the end of each examination of the wall surfaces that were exposed to the fire indicated pronounced depths of chemical changes to the limestone blocks as follows:

Specimen No 1 - Average depth of 13 mm (½ in)

Specimen No 2 - Average depth of 20 mm (¾ in)

Specimen No 3 - Average depth of 28 mm (1⅛ in)

These layers of calcined limestone disintegrated during cooling of the wall specimens and fell off.

EBS intends to conduct a fourth pilot examination of the likely fire endurance of a non-loadbearing cavity wall specimen consisting of two leaves of 112-mm-thick blocks of Mount Gambier limestone. The test specimen has been constructed, but the examination is delayed because of the need for unexpected and urgent repairs to our pilot-testing facility.

Although standard fire-resistance ratings can be established only by full-scale testing to AS 1530, Part 4-1975, the information obtained from the three pilot investigations indicates that the following minimum thicknesses of unrendered walls of Mount Gambier limestone, as tested at EBS, would be probably sufficient to satisfy the thermal-insulation requirements (only) prescribed by the standard fire-resistance test:

Min. Wall Thickness (mm/in)	Expected Level of Fire Resistance (hrs)
90 mm (3½ in)	1-h
100 mm (4 in)	1½-h
110 mm (4⅜ in)	2-h
135 mm (5¼ in)	3-h
150 mm (6 in)	4-h
195 mm (7¾ in)	6-h

We consider however, that it is probably unnecessary to test all these thicknesses of wall as full-scale non-loadbearing specimens. If the thickness (20 mm) were tested successfully, we would be prepared to consider giving a formal opinion as to the likely fire-resistance ratings of thicker walls.

Although pilot testing does not provide sufficient basis for estimating the performance of loadbearing construction, it is usual either, to use figures such as those above as a basis for the selection of construction for testing, or to test construction adopted in current practice for loadbearing construction if this differs from the above. With the first approach, testing of non-loadbearing construction can sometimes be dispensed with and formal opinions on the likely ratings of non-loadbearing construction can be based on the results of tests of loadbearing construction.

Yours faithfully,

S. Rogleff.

(S. Rogleff)
for Acting Chief, EBS

MOUNT GAMBIER LIMESTONE

WHAT IS IT?

Mount Gambier Limestone is a marine deposit of creamy white calcium carbonate, cellular in nature. This structure gives it excelllent acoustic and insulation properties. The blocks, known as "ashlars" have been in use for 100 years, and virtually maintenance free.

HOW IS IT USED?

Building methods are basically the same as those used with bricks, that is, stone veneer or double wall with cavity. The ashlars are sawn at the quarry and delivered direct to site. Ordinary wood working tools are used, saws, chisels, planes etc. The stone is non-abrasive. A standard sized ashlar is equivalent in area to about 10 standard bricks, and about 100 per day can be laid - a big saving in labour costs. There is also a big saving in mortar since only about 20% of the amount for equivalent brickwork is required.

WHAT CAN IT BE USED FOR?

There are many used:-

Multi stored buildings
Hospitals
Factories
Shops
Farm Buildings
Home Units
Dwellings
Feature Walls
Fire Walls
Sculpturing

It is not only easy to use, it is also one of the least expensive building materials available.

FIRE RATING:

90 mm (3½ in)	1 hour
100 mm (4 In)	1½ hours
110 mm (4⅜ in)	2 hours
135 mm (5¼ in)	3 hours
150 mm (6 in)	4 hours
195 mm (7¾ in)	6 hours

[illegible]

MATERIALS TESTING LABORATORIES

* **COMPRESSIVE STRENGTH OF**

1. ~~BRICKS (HALF~~/FULL)
XXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
2. ~~PRISMS~~
XXXXXXXX
3. ~~MASONRY~~ BLOCKS (LIMESTONE)
4. ~~CORES~~
XXXXXX

Job & Client:

BARRIE BRUHN, P.O. BOX 412,
MT. GAMBIER. S.A. 5290

Date Submitted: 3/7/78

Capping Method 3/16 3 PLY

Order Number:

These specimens were crushed on 3/7/78 in accordance with ~~current editions of Australian Standards.~~

Markings	Dimensions (mm)	Area (mm^2)	Load (Newtons)	Compressive Strength (Mpa)
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D	150 x 150	22500	119000	5.5
$5.00 per block to test = $20.00				

Tested By: N. L. Ross Date: 3/7/78

Calculated By: N. L. Ross Date: 3/7/78

Checked By: R. C. Hodge Date: 4/7/78

* Cross out those not applicable.

T D R

BRUHN

Commercial Street West, Mount Gambier, S.A.

stal Address:
.O. Box 412
Mount Gambier, S.A. 5290

Telephone (087) 25 5333
Telex AA 80127

SIZES AVAILABLE:

(a) Principal nominal dimension is 290 x 660mm (11½ x 26in) in various thickness as follows;-

		Ashlars/ cu. m		
100 mm (4 in)	-	48	)	for normal housing,
115mm (4½ in)	-	43	)	building generally
125 mm (5 in)	-	38	)	
150 mm (6 in)	-	32	)	for single walls,
175 mm (7 in)	-	27	)	garages etc.
200 mm (8 in)	-	24	)	
225 mm (9 in)	-	21	)	for retaining walls, foundations etc.
250 mm (10)	-	19	)	for foundations,
275 (11 in)	-	17	)	sculpturing, etc.
300 mm (12 in)	-	16	)	

Other sizes can be cut to order for a slightly increased charge.

(b) Ashlars are available in half courses, and rock faced. Mixtures of various matching sizes can also be used, particularly in housing where it gives a most pleasing effect.

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These can be cut in limestone provided that the opening does not exceed 1.5 (5 ft). Lintels for a single doorway are 1.3 m (4 ft 4 in) , and for a double doorway, 1.65 m (6 ft 6 in) For openings larger than 1.5 m, reinforced concrete is advisable. This can be rendered to match the limestone.

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An ashlar of double thickness is supplied and this is cut on site into an L-shape. The rebated piece can be used as an ordinary ashlar.

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In Mount Gambier, trenches are dug, and foundation blocks set perfectly horizontal on sand. For stumps and bearers, dwarf walls with 115 mm ashlars set on solid ground are used. Wood plates 75 x 25 mm are nailed along the top, and flooring joists nailed to the plates. However, it is advisable to check with your local council for appropriate building regulations.

(b) Mortar:

A mix of 2 parts Limil and 9 parts clean coarse sand and 1 part cement. Allow 10 mm (⅜ in) joint and wet the top of each course before spreading the mortar.

(c) Damp Course:

Standard methods are satisfactory.

(d) Doors and Window Frames:

25 mm dia x 25 mm holes are drilled with an ordinary auger, skewed in opposite directions, and plugged with wooden dowels. Jambs and sashes are then nailed into position.

(e) Window Sills:

Use glazed tiles, slates or sealed stones.

(f) Chimneys and Fireplaces:

Chimneys may be built with limestone but the fireplace must be lined with brick.

(g) Cleaning Ashlars:

Before pointing the joints, the surface of the wall can be cleaned and evened by "dragging" with coarse sand paper spread over a wooden trowel.

(h) Pointing:

After laying the mortar, and while still damp, the joints may be raked to a depth of 10mm, and pointed by filling the joints with a mixture of stone dust, white sand and Limil,to match the colour of the ashlars.

Darker mortar can be used and joint left raked to 10mm.

SURFACE TREATMENT:

(a) Internal Walls:

Internal walls can be plastered and painted. But for the best effect the ashlars should be left in their natural state which retains the acoustic properties of the product.

APPENDIX C

CHEMICAL ANALYSIS, BRIGHTNESS AND XRD MINERALOGY.

AMDEL Report M6817/86 by Lyn J. Day
AMDEL Report G6330 by Michael Till

The Australian Mineral Development Laboratories

amdel

Flemington Street, Frewville.
South Australia 5063
Phone Adelaide (08) 79 1662
Telex AA82520

Please address all
correspondence to
P.O. Box 114 Eastwood
SA 5063
In reply quote:

25 September 1985

1/16/0 - M6817/86

Director General
SA Dept of Mines and Energy
PO Box 151
EASTWOOD SA 5063

Attention Mr D Flint

REPORT M6817/86

YOUR REFERENCE		Request dated 8 August 1985. (12.03.187). EX-399
TITLE		Testing of Limestone and Dolomite.
SAMPLE IDENTIFICATION	7022	RS121-RS153.
LOCALITY		Gambier Embayment of Otway Basin.
DATE RECEIVED		9 August 1985.
WORK REQUIRED		Brightness Determination and Chemical Analysis.

Investigation & Report by: Lyn J Day.
Chief, Materials Section: Philip J Parry.

for Dr William G Spencer
Manager
Mineral & Materials Sciences Division

Head Office:
Flemington Street, Frewville
South Australia 5063.
Telephone (08) 79 1662
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Thebarton, S.A.
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Melbourne, Vic.
Telephone (03) 645 3093
Perth, W.A.
Telephone (09) 325 7311
Townsville
Queensland 4814

1. INTRODUCTION AND PROCEDURE

7022

Thirty three samples labelled 'RS121'-'RS153' were submitted for brightness determination and chemical analysis.

A representative portion of each sample was milled by mortar and pestle to less than 75 micrometres for brightness determination using a Zeiss Elrepho electric reflectance photometer. Brightness quoted as at 457 nanometres using the R457 filter. Yellowness quoted is the difference between R57 and R457 values.

The samples were analysed using inductively coupled plasma atomic emission spectrometry.

2. RESULTS

The brightness determinations are given in Table 1. The chemical analyses are given in Table 2.

sj:1

TABLE 1: BRIGHTNESS DETERMINATIONS

Sample	Brightness (R457)	Yellowness (R57-R457)
7022		
RS 121	74.9	9.8
RS 122	78.3	8.8
RS 123	66.5	17.7
RS 124	74.7	10.5
RS 125	83.8	7.4
RS 126	81.0	8.8
RS 127	78.5	11.2
RS 128	77.2	10.4
RS 129	79.5	9.0
RS 130	82.0	8.0
RS 131	79.3	8.0
RS 132	79.3	8.8
RS 133	82.7	7.7
RS 134	68.1	14.9
RS 135	76.5	10.9
RS 136	73.0	9.5
RS 137	77.2	10.4
RS 138	82.4	7.6
RS 139	83.5	7.2
RS 140	80.0	8.9
RS 141	83.0	7.7
RS 142	78.7	10.3
RS 143*	51.1	19.4
RS 144	74.9	7.8
RS 145	72.8	10.5
RS 146	78.0	8.6
RS 147	79.6	7.4
RS 148	78.0	8.4
RS 149	73.9	9.0
RS 150	70.7	7.6
RS 151	70.7	7.2
RS 152	68.7	9.3
RS 153	70.3	8.5

* *Colour in sample believed to be due to organic impurities.*

TABLE 2: CHEMICAL ANALYSES

	7022 RS 121 %	RS 122 %	RS 123 %	RS 124 %	RS 125 %
SiO_2	1.41	0.88	0.57	0.61	0.63
TiO_2	0.02	0.01	<0.010	0.01	0.01
Al_2O_3	0.13	0.05	0.02	0.03	0.04
Fe_2O_3	0.46	0.26	0.34	0.17	0.17
MnO	0.01	0.01	<0.010	0.01	0.02
MgO	0.66	0.59	0.70	0.63	0.45
CaO	54.3	54.9	54.7	55.1	55.4
Na_2O	0.04	0.03	0.02	0.03	0.01
K_2O	0.06	<0.050	<0.050	<0.050	<0.050
P_2O_5	0.04	0.04	0.03	0.04	0.03
LOI	43.0	43.3	43.5	43.6	43.3
Totals	100.1	100.0	99.8	100.2	100.0

Total Fe as Fe_2O_3

TABLE 2: CHEMICAL ANALYSES

	7022 RS 126 %	RS 127 %	RS 128 %	RS 129 %	RS 130 %
SiO_2	0.75	0.56	2.08	0.48	0.53
TiO_2	<0.010	<0.010	<0.010	<0.010	<0.010
Al_2O_3	0.06	0.03	0.33	0.02	0.02
Fe_2O_3	0.20	0.14	0.31	0.14	0.15
MnO	0.01	<0.010	<0.010	<0.010	0.01
MgO	0.53	0.61	0.56	0.55	0.52
CaO	55.9	55.1	52.9	54.4	55.0
Na_2O	<0.010	0.04	0.01	0.03	0.04
K_2O	<0.050	<0.050	<0.050	<0.050	<0.050
P_2O_5	0.05	0.04	0.10	0.02	0.04
LOI	43.5	43.6	42.8	43.8	43.6
Totals	100.9	100.1	99.0	99.4	99.9

Total Fe as Fe_2O_3

TABLE 2: CHEMICAL ANALYSES

	7022				
	RS 131 %	RS 132 %	RS 133 %	RS 134 %	RS 135 %
SiO_2	0.95	0.58	0.44	2.38	0.38
TiO_2	0.02	<0.010	<0.010	0.05	0.01
Al_2O_3	0.08	0.02	0.02	0.44	0.02
Fe_2O_3	0.23	0.16	0.12	0.88	0.11
MnO	<0.010	0.01	<0.010	0.01	<0.010
MgO	0.64	0.54	0.54	0.56	0.53
CaO	54.7	55.8	55.7	52.8	55.7
Na_2O	0.03	0.02	0.03	0.19	0.04
K_2O	<0.050	<0.050	<0.050	0.20	0.06
P_2O_5	0.04	0.04	0.05	1.15	0.04
LOI	43.4	43.5	43.5	41.2	43.7
Totals	100.0	100.6	100.3	99.9	100.6

Total Fe as Fe_2O_3

TABLE 2: CHEMICAL ANALYSES

	7622 RS 136 %	RS 137 %	RS 138 %	RS 139 %	RS 140 %
SiO_2	1.45	0.71	0.52	0.50	0.50
TiO_2	0.02	0.01	<0.010	<0.010	<0.010
Al_2O_3	0.17	0.04	0.02	0.02	0.02
Fe_2O_3	0.21	0.19	0.10	0.10	0.10
MnO	<0.010	0.01	0.01	<0.010	<0.010
MgO	0.62	0.69	0.60	0.60	0.63
CaO	53.1	54.7	55.8	55.4	55.3
Na_2O	0.04	0.03	0.03	0.04	0.03
K_2O	0.11	<0.050	<0.050	<0.050	<0.050
P_2O_5	0.06	0.04	0.04	0.03	0.04
LOI	43.1	43.6	43.7	43.7	43.6
Totals	98.9	100.0	100.8	100.3	100.2

Total Fe as Fe_2O_3

TABLE 2: CHEMICAL ANALYSES

	7022				
	RS 141	RS 142	RS 143	RS 144	RS 145
	%	%	%	%	%
SiO_2	0.32	0.57	0.44	0.50	0.77
TiO_2	<0.010	<0.010	<0.010	<0.010	0.01
Al_2O_3	0.01	0.04	0.04	0.04	0.05
Fe_2O_3	0.10	0.11	0.15	0.20	0.17
MnO	<0.010	<0.010	<0.010	0.02	0.01
MgO	0.61	0.45	18.4	18.7	1.04
CaO	55.7	55.2	32.7	32.2	54.5
Na_2O	0.03	0.04	0.04	0.04	0.03
K_2O	<0.050	0.08	<0.050	<0.050	<0.050
P_2O_5	0.03	0.03	0.05	0.05	0.06
LOI	43.6	43.3	46.3	46.3	43.5
Totals:	100.3	99.8	98.1	98.0	100.1

Total Fe as Fe_2O_3

TABLE 2: CHEMICAL ANALYSES

	7022 RS 146 %	RS 147 %	RS 148 %	RS 149 %	RS 150 %
SiO_2	0.94	0.60	0.69	1.29	0.50
TiO_2	0.01	0.01	<0.010	0.01	<0.010
Al_2O_3	0.08	0.04	0.03	0.10	0.01
Fe_2O_3	0.15	0.13	0.12	0.22	0.10
MnO	<0.010	<0.010	<0.010	<0.010	<0.010
MgO	0.86	0.79	0.75	0.97	0.99
CaO	54.8	55.1	55.3	53.8	55.1
Na_2O	0.05	0.04	0.05	0.05	0.05
K_2O	0.07	0.05	0.06	0.06	<0.050
P_2O_5	0.05	0.03	0.03	0.04	0.10
LOI	43.6	43.8	43.6	43.6	43.8
Totals	100.6	100.6	100.6	100.1	100.6

Total Fe as Fe_2O_3

TABLE 2: CHEMICAL ANALYSES

	7022 RS 151 %	RS 152 %	RS 153 %
SiO_2	0.43	0.38	1.23
TiO_2	<0.010	<0.010	0.01
Al_2O_3	0.01	0.01	0.09
Fe_2O_3	0.09	0.10	0.18
MnO	<0.010	<0.010	0.01
MgO	1.91	3.36	1.18
CaO	54.0	51.8	53.4
Na_2O	0.07	0.07	0.04
K_2O	<0.050	<0.050	0.06
P_2O_5	0.13	0.09	0.06
LOI	43.9	44.3	43.6
Totals	100.5	100.0	99.9

Total Fe as Fe_2O_3

The Australian Mineral Development Laboratories

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amdel

31 May 1985

In reply quote: GS 1/16/0

Your Ref: 12/03/167 EX-350

Director General
Department of Mines & Energy
PO Box 151
EASTWOOD SA 5063

Attention: Mr. D. Flint
Mineral Resources

REPORT G 6330 PART 1

YOUR REFERENCE:	Application dated 14 May 1985
IDENTIFICATION:	7022 RS 125, 128, 134, 136
MATERIAL:	Four marl samples
LOCALITY:	Otway Basin, Gambier Embayment
DATE RECEIVED:	14 May 1985
WORK REQUIRED:	Determination of mineralogy

Investigation and Report by: Michael Till
Chief, Geological Services Section: Dr Keith J Henley

Keith Henley

for Dr William G Spencer
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MINERALOGY OF FOUR MARL SAMPLES

1. INTRODUCTION

Four marl samples were received from Mr. D. Flint of the South Australian Department of Mines and Energy with a request for determination of the clay mineralogy. However clay minerals were not detected in the bulk sample, and sedimentation and analysis of -2 μm fraction was subsequently not proceeded with.

2. PROCEDURE

The samples were analysed by X-ray powder diffractometry.

3. RESULTS

7022 RS 125

Calcite	D

7022 RS 128

Calcite	D

7022 RS 134

Calcite	D
Apatite	Tr
?K-feldspar	Tr

7022 RS 136

Calcite	D
Quartz	Tr

SEMIQUANTITATIVE ABBREVIATIONS

D = Dominant. Used for the component apparently most abundant, regardless of its probable percentage level.

Tr = Trace. Components judged to be below about 5%.

APPENDIX D

QUARRY DATA AND COMMENTS

ALLEN QUARRY PM 233

Locality: 3 km E-SE from Mount Gambier Forest Head Quarters. section 715, hundred Blanche.

Sample: -

Geological Log:

Comments: For descriptive information of the quarries exposing Dilwyn Formation, Compton Conglomerate and Gambier Limestone see Keeling (1983).

There is no record production of ashlars from the large quarry in Gambier Limestone; production is unlikely as bedding is pronounced with rapid grain size variations as well as parting along the bedding planes. Quarry does contain however, beds up to 2 m thick consisting of massive, very fine grained, partly recrystallised limestone.

ATKINS QUARRY

Locality: 3 km E of Kongorong; section 445, hundred Kongorong.

Production: None recorded.

Sample: -

Geological Logs:

Comments: Two quarries worked about 1920. Although no production is recorded, quarries produced stone for the Kongorong hall, factory, church, part of the store as well as houses in, Kongorong. Also carted to Donovan's Landing for Atkins retirement house.

Pit is now used for road rubble and has been enlarged so that no cut faces remain. Pit is now 80 x 80 x 3 m and partly rehabilitated. Northern face is 2 m high but not sawn. Calcarenite is creamy, chalky and fine grained but still contains the obviously fragmentary bryozoal texture. Joints in paddock on south side of quarry strike 141 and 144° MN.

BIRD QUARRY

Locality: Sections 209 and 210, hundred Hindmarsh; adjacent to Princes Highway 17 km SE of Millicent.

Production:	1940 - 1943	Bird	274 tonnes
	1947	Klem	203 tonnes

Sample: -

Geological Log:

Comments: Site not inspected.

BLA 131

Locality: Section 131, hundred Blanche; adjacent to Bruhn Quarries.

Production: None recorded but based on quarry dimensions may have been over 100 000 tonnes.

Sample: -

Geological Log: -

Comments: Abandoned quarry over large area, about 400 x 400 m. Reported to have been mined by block mining to a depth of 4-5 m but now backfilled so that only a shallow depresion of less than 1 m remains with low faces no more than 1 m high. Mined as single blocks to the full depth which parted along a 'soft bed'.

BLA 385

DOLOMITE

Locality: Section 385, hundred Blanche; 800 m NE of Fletcher, McKay and Major Quarries.

Sample: 7022 RS 148

Geological Log: -

Comments: Small pits to 1.5 m deep scattered over 100 m and elongate in a NE direction; mostly backfilled with dolomite rubble. Dolomite is pink to red and strongly recrystallised with a sugary, granular texture.

Production would be small; none recorded.

BLA, 386

Locality: Section 386, hundred Blanche; 800 m SE of Fletcher Quarry, and located on the same trend as the eastern line of quarries at Marte.

Production: None recorded but based on quarry dimensions, maximum possible production is about 300 tonnes.

Samples: -

Geological Logs: -

Comments: Quarry 24 x 9 x 1.5 m, is abandoned and oriented N-S parallel to adjacent road. Now partly backfilled by rubbish and ashlars. Larger area cleared - 25 x 45 m. Numerous ashlars remain in quarry. Gambier Limestone is off-white, coarse grained and very poorly cemented.

BLA 526

Locality: Section 526, hundred Blanche; 2.5 km S of Marte Railway Siding, and almost 1 km west of the main Marte line of quarries.

Production: None recorded but based on quarry dimensions, production would have been 200-300 tonnes.

Sample: 7022 RS 153.

Geological Logs: -

Comments: Small, abandoned building stone quarry. Original dimensions are not less than 11 x 7 x 2.5 m, but the quarry has been enlarged by bulldozing since March 1982. Bulldozed area now 25 x 9 x 2 m on the W-SW side of the original quarry.

Overburden is 15-20 cm of red soil. Limestone is fine grained, grading to medium but contains abundant matrix which is white and partly crystalline. Overall colour is creamy white.

BONNIE-DOON QUARRIES

Locality: Section 238, hundred Blanche; 6 km N of Blue Lake.

Alternative name: ?Hinton Quarries, ?Holdings Quarries.

Production: None recorded.

Sample: -

Geological Log: -

Comments: Two large but shallow quarries; the southern deeper quarry is 4.7 m deep. All mining was by block-mining style. As at Edlington Quarry, all rejected blocks have been removed leaving a flat grassy quarry floor.

Top 1.2 m consists of weathered limestone and minor calcrete, and was not cut. Blocks were cut from 1.2 to 4.7 m below the surface. The limestone is very similar to that exposed at Edlington Quarry i.e. abundant echinoids both intact and only partly flattened, absence of coarse echinoid spines, sponge-like bryozoal colonies and ?worm tubes. Bedding is accentuated by differential weathering. Coarse grained bands are most resistant and stand out 2-3 cm more than the fine-grained, chalkier bands which slowly fret away. The finer bands probably consist of abundant matrix similar to the amorphous to poorly crystalline matrix in many specimens from Marte. Fine-grained bands often contain secondary gypsum.

BRUHN QUARRY PM 14 & 15

Locality: Section 136, hundred Blanche; Marte area.

Production: 1943-1986 Bruhn 151 752 tonnes

Samples: 7022 RS 124-126, 161 & 162.

Geological Logs: 34-36 (Fig. 12)

Comments: Worked almost continuously by the Bruhn family since at least 1943 and this quarry has been the second largest producer of ashlars. For additional comments, see text.

CAR 327

Locality: Section 327, hundred Caroline; 4.5 km SW of Donovans Landing.

Production: None recorded

Sample: -

Geological Log: -

Comments: Building stone quarry listed within sec. 327 by Johns (1961). Quarry is alongside ACI's quarry and plant at Nelson. Site not inspected; no other data known.

CAR 331

Locality: Section 331, hundred Caroline; 3 km SW of Donovans Landing.

Production: None recorded.

Sample: -

Geological Log: -

Comments: Quarry shown by Sprigg and Cochrane (1951) and listed as a producer of building stone by Johns (1961). Site not inspected; no other data known.

CARRAILL QUARRY ML 3510 DOLOMITE

Locality: Section 202, hundred Blanche; 2 km NE of Burnda timber mills.

Sample: 7022 RS 143.

Geological Log: -

Comments: Two quarries, the smaller of which is 15 m from the E-W track and measures 10 x 10 x 2.5 m. Maximum depth on E side. Bedding is horizontal to gently east dipping. Overburden (0.4 m) on the west side of the small quarry has been stripped exposing dolomite over an area of 65 x 40 m.

The larger quarry measures 55 x 45 x 5 m; dolomite has been blasted for base course and stockpiles remain on the quarry floor. Dolomitic replacement of the limestone is extensive but variable. Bryozoal fragments evident in zones of less-extensive alteration. Massive blocks, up to 2.5 x 1.4 x 1 m tend to be pink-brown whereas poorly cemented dolomitic sandy beds tend to be orange coloured. Large brown blocks also exhibit streaks of alternating fawn and red discolouration.

Dolomite from these quarries is milled and marketed for use as fertiliser by Australian Mineral Fertilisers.

CRANLEIGH QUARRY

Locality: Section 382, hundred Blanche; 3.5 km E of Burnda Timber Mill. Located in northern portion of the section, 80 m S of the railway.

Production: None recorded but based on current quarry outline, production may have been only about 1 000 tonnes.

Sample:

Geological Log: -

Comments: Named after the property 'Cranleigh', 1 km to the west. Old abandoned quarry which has been mostly backfilled so that only a shallow depression of 30 x 30 m remains. Quarry shown on Sprigg and Cochrane (1951) and listed as a producer by Johns (1961).

EDITHVALE QUARRY

Locality: Section 381, hundred Blanche; 2 km SE of Burnda Timber Mill. Second westerly quarry may be in section 385.

Production: None recorded.

Sample: -

Geological Log: -

Comments: Named after nearby property 'Edithvale'. Two small abandoned quarries which have been mostly backfilled. Remaining quarries are 10 x 10 x 1.5 m with relict faces indicating block-mining style.

Quarries listed as producers of building stone in Johns (1961).

EDLINGTON QUARRY

Locality: Section 96 and 692, hundred Blanche; 7 km N of Blue Lake.

Production: None recorded.

Sample: -

Geological Log: -

Comments: Abandoned quarry, oriented E-W along a ridge, measures 60 x 40 x 5.5 m with face on S side of quarry. Quarry probably originally deeper but partly backfilled leaving flat grassy floor with no waste material.

Limestone is distinctly bedded but does not part along bedding planes. In addition, coarse grained beds are slightly lenticular.

Most noticeable are the very abundant echinoids and which indicate that the degree of compaction in the limestone is small. Many indicate essentially no compaction whereas the maximum compaction indicated is only 50%. Although echinoid shells are common, thick spine fragments are absent, unlike the abundant fragments at Marte.

Sponge-like bryozoal colonies are dominant; ?worm tubes to 10 mm diameter are also present.

Overall, limestone is medium to coarse grained. Surface samples exhibit secondary gypsum precipitation.

The top 3.5 m of soil and weathered limestone, containing minor calcrete was rejected. Mining was by block-mining style rather than ashlars and was from 3.5 to 5.4 m below the surface.

FERNLEIGH QUARRY

Locality: Section 726, hundred Blanche; 2.5 km E-NE of Burnda timber mills.

Production: No record production, but based on quarry dimensions, production probably exceeded 30 000 tonnes.

Sample: -

Geological Log: -

Comments: Named after nearby property 'Fernleigh Estate'. Abandoned building stone quarry which has been almost completely backfilled. Quarry originally about 200 x 100 m. Remaining faces are only 0.3 m high and 15 m long but exhibit block mining style.

FLETCHER QUARRY PM 153

Locality: Section 134, hundred Blanche; Marte area.

Alternative names: Roofs and Ceilings; Pearson

Production: Total recorded production 1924-1984 is 125,113 tonnes.

1925-1930	Roofs and Ceilings	9,559 tonnes
1939-1950	Fletcher	12,674 tonnes
1952-1953	Leggett	610 tonnes
1958-1961	Blackmore	412 tonnes
1957-	Light & Gericke	48,809 tonnes
1960-1963	Fletcher	20,236 tonnes
1970-1984	Pearson	32,813 tonnes

Quarry was also worked along the eastern boundary by Glen Height in the 1940's.

Jack Fletcher use to cart stone by horse and wagon to a railway siding 500 m east of the present Cafperco Sawmill.

Sample: 7022 RS 141, 142 & 163.

Geological Log: 50-54 (Fig. 15).

Comments: See text.

GERICKE QUARRY

Locality: Section 138, hundred Blanche; McNamara Park race circuit.

Production:

1938-1940	Gericke Brothers	7,416 tonnes
1945-1947	Gericke & McKinnon	12,529 tonnes
1949-1954	McKinnon & Sturgess	28,621 tonnes
1957-1963	Hydrated Lime	7,660 tonnes

Also worked by White; date unknown.

Sample: 7022 RS 147.

Geological Log: -

Comments: Abandoned quarry 30 x 20 x 2 m on SE side of race circuit. Other abandoned workings are now covered by the racing circuit. Calcreted joints present. Limestone is creamy white, even and fine grained, with fairly abundant matrix. Tubular bryozoal fragments are dominant but with echinoid spines and plates. Minor specks of bright pink calcite. Bivalve fragments do not exceed 1.5 mm across.

GLENCOE QUARRY

Locality: Southwest portion of section 330, hundred Young; within Glencoe township near Glencoe Wooldshed.

Production: None recorded.

Sample: -

Geological Log: -

Comments: Quarry is known to have operated at least as early as 1863 and yielded limestone for the adjacent Glencoe Woolshed. Quarry is now 100 x 60 x 3-4 m. Limestone is particularly and distinctly yellow, as evidenced in the walls of the Woolshed, and is darker yellow than any other mined Gambier Limestone. Site not inspected.

GUMS ROAD QUARRY

Locality: Section 738, hundred MacDonnell; 5 km SE of Kongorong; immediately adjacent to Gums Road, windmill and stock yards.

Production: None recorded.

Sample: -

Geological Log: -

Comments: Old abandoned quarry with block-mining style of faces; now partly used as stock yards. Quarry 30 x 15 x 2.5 m with access ramp on north end.

Calcarenite is identical with that at Mount Salt Quarry i.e. fine-grained chalky matrix but with coarse-grained intact fern-like and sponge-like bryozoal colonies. Sawn faces are relatively sharp and intact but ashlars used in the yards and sheep dip weather badly, emphasising the coarse grained fragments.

HAINES QUARRY

Locality: Section 450, hundred Hindmarsh; adjacent to Millicent-Mount Gambier highway 14 km from Millicent.

Alternative name: Jones Quarry.

Production:

1924 - 1945	Haines	1 620 tonnes
1946 - 1951	Jones	766 tonnes

Samples: -

Geological Log: -

Comments: For tenement information see Table 1. Site not inspected.

HIN 11

Locality: Section 11, hundred Hindmarsh; adjacent to and on S side of the Princes Highway, 3 km SE of The Bluff.

Production: None recorded.

Sample: -

Geological Log: -

Comments: Listed in Johns (1961) as a producer of building stone but little was discernible in 1987. Shallow surface scrapings only are evident.

HIN 333, 334 & 335

Locality: Sections 333, 334 and 335, hundred Hindmarsh; adjacent to Princess Highway 3 km NE of Tantanoola.

Production: None recorded.

Samples: -

Geological Log: -

Comments: Referred to in Johns (1963). Sites not inspected.

HIN 388

Locality: Section 388, hundred Hindmarsh; Adjacent to and on N side of the Princes Highway, 3 km SE of The Bluff.

Production: None recorded.

Sample: -

Geological Log: -

Comments: Listed in Johns (1961) as a producer of building stone but no cut faces remain. Quarry now 50 x 30 m and has probably been used as a source of road rubble for the Princes Highway. Material varies from:

- fine-grained bryozoal debris which is even-grained partly cemented and apparently without poorly-crystalline matrix, to
- very fine-grained, chalky limestone.

Colour is creamy, with lesser offwhite.

HOLLOWAY QUARRY ML 4711 DOLOMITE

Locality: Section 717, hundred Blanche, adjacent to Princes Highway.

Comments: Quarry approximately 50 m in diameter and up to 10 m deep. Recently blasted and used for road rubble and base course; no obvious signs remaining of use for building stone. Remaining dolomite blocks range up to in excess of 1 x 1 m.

Dolomite is dominantly grey to grey brown, but grades to reddish and orange-red. Large blocks tend to be grey-pinkish brown whereas dolomitic sand is yellow-orange. Dolomite replacement of limestone is highly variable, ranging from completely recrystallised granular dolomite to only slightly altered polyzoal limestone which still exhibits intact tubular bryozoa and echinoid spines. Variations in replacement i.e. texture, colour and degree are controlled by bedding.

Closely jointed, down to 10-15 cm spacing. Joints strike 145° M and dips ranging from vertical to 75° either way.

Rough faced dolomite from this quarry has been used as building stone at Princess Margaret Rose Caves Information Centre and the Mt. Gambier cheese factory office block.

Sample: 7022 RS 144

700 m to the northwest and adjacent to the Princes Highway is another quarry which has been mined recently. Quarry is elongate N-S and is 40 x 20 x 2 m with the shallow face on the E-SE side. Bedding orientation not discernible. Dolomite strongly crystalline and granular; only minor bryozoal fragments are evident. Colour relatively uniform pale brown.

About 1.5 m of platy calcrete and soil crop out above the dolomite.

JARVIS QUARRY

Locality: Section 26, hundred Blanche; in main line of Marte quarries.

Alternative names: Kain & Shelton

Production:

1952 - 1964	Pritchard Brothers	50,102 tonnes
1965 - 1973	Jarvis Industries	8,703 tonnes.

Samples: 7022 RS 40, 41, 121-123, 148 & 165.

Geological Logs: 24-33 (Fig. 11).

Comments: A.A. Shelton worked the quarry in about 1950. In the early 1950's, Kain and Shelton had a team of 32 men working for them in this quarry.

JENNINGS QUARRY

Locality: Section 137, hundred Blanche; main line of Marte quarries, SE end.

Production:

1968-1971	Light Brothers	14,889 tonnes
1976	Atkinson	153 tonnes.

Sample: -

Geological Log: -

Comments: Quarry opened prior to 1960; possibly first worked by Jack Garrad. Stafford Brothers worked the quarry from about 1960-1968; stopped when area was 'worked out' and they had worked down to a layer of flint pebbles or dolomite band. Their working level was about 3 m thick below about 2-2.5 m of overburden, weathered limestone and coarse bands.

JOHNSON QUARRY PM 125

Locality: Section 192, hundred Blanche; eastern line of Marte quarries.

Production: 1938 - 1942 Johnson 9,654 tonnes
1949 - 1956 Johnson 15,606 tonnes.

Sample: 7022 RS RS 135

Geological Logs: 44-48 (Fig. 14).

Comments: Quarry apparently opened in about 1930-1933 (D.L. Johnson, pers. comm. 1985). Currently mined by Gambier Earthmovers for road rubble.

KENNEDY ROAD QUARRY

Locality: Section 1154, hundred Gambier; NE side of town, off Kennedy Road.

Production: None recorded, but was apparently worked about 1910-1920.

Sample: -

Geological Log: -

Comments: Circular quarry 30 m across; maximum depth of 3 m on the E and N faces. No cut faces evident but quarry probably has been enlarged and used for rubble since building stone was cut.

KESSAL QUARRY

Locality: Section 497, hundred Kongorong; near 'Old Tea Tree' ruin; 4 km N of Blackfellows Caves.

Production: 1949 - 1952 MC 1414 Kessal 188 tonnes

Sample: -

Geological Log: -

Comments: Ashlars probably used for 'Old Tea Tree' homestead. Site not inspected.

KONGORONG NORTH QUARRIES

Locality: Section 452, hundred Kongorong; 2.6 km north of Kongorong. Both quarries are in the extreme NE corner of the section.

Production: None recorded.

Sample: -

Geological Log: -

Comments: Quarry is shown on Sprigg and Cochrane (1951), but very little data are known. Only two small pits remain, - both are mostly backfilled but the remaining very low faces indicate they were worked by block-mining style. Existing pits are only 8 x 5 x 0.2 m and 15 x 5 x 0.5 m. Both pits were probably sited on outcropping limestone.

LAWSON QUARRY PM 134

Locality: Section 29, hundred Blanche; NW end of Marte quarries.

Alternative name: Garrad Quarry, Cutting Quarry.

Production: Recorded production is demonstrably incomplete - starting in 1969 yet the quarry opening in about 1914.

Total recorded production is 59,035 tonnes:

1968 - 1973	27 232 tonnes	Coraline Industries
1974 - 1984	31 803 tonnes	R.M. & J. Lawson.

Samples: 7022 RS 138, 139, 140.

Geological Logs: 1-5, 7, 9 (Fig. 9).

Comments: Named after current operator, R.M. Lawson. Reportedly opened in 1914 by T.R. Walters, to build Megaw's house. Also worked by Bill Savill, Jack Garrad (1950s) and Cutting (Coraline Industries). E.M. Stafford reports that the water level in Section 29 has risen about 1.3 m in the last 5 years; 3.0 m of ashlars used to be cut from the favourable bed above the water table, but this has been reduced to 1.8 m.

LOCK QUARRIES

Locality: Section 398, hundred Blanche; 8 km SE of Marte railway siding.

Production: None recorded. Quarry dimensions suggest about 5 000 tonnes and 12 000 tonnes would have been mined from the NW and SE quarries respectively.

Sample: -

Geological Log: Fig. 16.

Comments: Two old quarries in the SW portion of sec. 398. Apparently worked about 1890-1900 and the NW quarry is older; quarry contains the inscription:

J. SHELTON
APRIL 8 1917

1. N.W. Quarry

Quarry 60 x 50 x 2 m and was mined block-style only. All cut material has been removed leaving a flat clean quarry floor. Limestone is massive and coarse-grained. Basal parts of the sawn faces are more extensively weathered and eroded where water has ponded in the quarry.

2. S.E. Quarry

Quarry is 70 x 50 x 4 m and again, has only hand-sawn faces. Bedding strikes 300°MN, dips 4°SW. For additional geological data see Figure 16.

LOUIEKIESE QUARRY

Locality: Section 119, hundred Blanche; 8 km SW of Mount Gambier.

Production: None recorded but based on quarry dimensions, maximum possible production is about 400 tonnes.

Sample: -

Geological Log: -

Comments: Quarry approximately 20 x 15 x 1 m deep and ashlars were cut in situ. Half of the quarry is 3 ashlars deep with the remainder 4 ashlars deep. Quarry floor clear and all cut ashlars have been removed.

Saws for cutting ashlars were invented in 1950/1951 and quarry is shown on Sprigg and Cochrane (1951) hence mining must have been in 1950 or 1951.

Gambier Limestone is offwhite, mostly coarse grained and with mollusc and echinoid fragments. Material tends to be soft and somewhat friable, and hence is probably poorly cemented.

MAC 670

Locality: Section 670, hundred MacDonnell; 7 km NW of Port MacDonnell and 3 km N of Middle Point. Located adjacent to and on E side of north-south track. Position approximate only.

Production: None recorded but would have been about 300 tonnes.

Sample: -

Geological Log: -

Comments: Old abandoned building stone quarry which had been mined by block-mining style. Quarry 15 x 8 x 2.5 m deep. Massive uniform texture; cut faces have remained intact with little weathering.

Probably worked at the same time as Smith Quarry, 2.5 km to the east. No blocks remain at the quarry.

MAJORS QUARRY

Locality: Sections 141 and 192, hundred Blanche.

Production: 1924-1944 Major 8 246 tonnes.

Sample: -

Geological Log: - 49 (Fig. 14).

Comments: Previously abandoned building stone quarry but now worked by Gambier Earthmovers for road rubble.

McKAY QUARRY PM 125

Locality: Section 192, hundred Blanche; Marte area.

Production:

1925 - ? 1937	McKay	1 335 tonnes
1938 - 1956	Johnson	25 260 tonnes
1985 -	Gambier Earthmovers	-

Sample: -

Geological Log: 40-43 (Fig. 14).

Comments: Previously abandoned building stone quarry but now worked by Gambier Earthmovers for road rubble.

MORRIS QUARRY

Locality: Section 121, hundred Blanche; 7 km SW of Mount Gambier and adjacent to the Mount Gambier - Carpenter Rocks road. Position approximate.

Production: Recorded production totals 66 tonnes by Morris in 1924 and 1927.

Sample: -

Geological Log: -

Comments: Quarry no longer discernible.

MOUNT SALT QUARRY

Locality: Sections 733 - 736, hundred MacDonnell, 8 km W of Mount Schank.

Production: 5 625 tonnes of ashlars produced during 1956-1958. Recorded production is probably the total production from the two quarries immediately adjacent to the bitumen road, where ashlars were cut in situ. Older quarry would have yielded about 500 tonnes, whereas the larger quarry probably may have yielded road rubble only.

Sample: 7022 RS 180

Geological Log: -

Comments: Four adjacent pits of which the largest, E pit on the N side of the road was probably for road rubble only.

1. Small pit on S side of the road: 40 x 12 x 2 m and elongate along the road. Six layers of ashlars cut. No overburden as Gambier Limestone crops out.
2. Oldest quarry, with block-mining faces is on the south side of the road near the shed. Quarry about 20 x 20 x 3 m.
3. On the N side of the road, the smaller westerly pit is solely for building stone with 5-6 layers of ashlars - about 2 m deep. Nominal 10-15 cm of overburden consisting of karstic limestone outcrop. Open quarry floor with no waste blocks remaining. Quarry floor not exactly flat and has a low-amplitude, long wavelength wave pattern.

Stone quality similar to that from Stafford Quarry. Skeletal debris is very coarse but material is dominated by very fine, amorphous to poorly-crystalline matrix. Hand specimens are friable and ashlars are likely to fret in use. Skeletal material mostly bryozoa but with echinoid fragments, foraminifera, molluscs and sponge-like growths.

O'LEARY QUARRY MC 2128

Locality: Section 701, hundred Blanche; 8 km north of Mount Gambier.

Alternative name: Kennedy Quarry (after present landowner).

Production: None recorded.

Sample: 7022 RS 176.

Geological Log: Fig. 17.

Comments: Old building stone quarry which was originally worked about 80-90 years ago; cut stone from this quarry was used in an old convent on Penola Road which is still standing today.

Old block-mining faces to 4.5 m high remain on the E-NE corner of the quarry but recent mining for road rubble has greatly enlarged the quarry. Present dimensions are about 100 x 50 x 9 m. Composite geological section of eastern quarry faces is shown on Fig. 17.

In early 1987, ashlars were cut from a bench on the S side of the quarry (sample 7022 RS 176). These are probably the first ashlars to have been cut away from the main Marte quarries since the mid 1950s.

Bedding in coarse-grained partly dolomitised calcarenite strikes 355° MN and dips 3° easterly. Remaining calcarenite bands which have been sawn are particularly massive. Calcarenite is white to offwhite, medium grained and ashlars cut in 1987 were strong and obviously partly cemented. Material quality is similar to 7022 RS 163 i.e. amongst the strongest and most durable samples of the 1985/1986 material testing program.

Dolomitised bands are discoloured also. Large blocks weighing several tonnes, obtained during mining for road rubble, are stockpiled in the E-NE corner of the pit.

Jointing in limestone is common, and strikes 142°-147°MN. The quarry operator Brian O'Connor reports joints and caves 300 - 400 m long which extend from the quarry southeastwards to the windmill.

O'LEARY ROAD QUARRY

Locality: Sections 310 and 321, hundred Blanche; NW side of town and off O'Leary Road.

Production: None recorded, but quarry known to have been worked about 1890-1920. Also once contained lime kilns.

Sample: 7022 RS 149.

Geological Log: -

Comments: Quarries originally large but are now mostly backfilled. Southern quarry (Section 321) now used as screening plant and rubbish dump. Northern quarry (Section 310) is almost completely backfilled leaving a flat grassy floor. Quarry is 90 m long and N face reaches a maximum of 2 m high in a few places. Mined by block-mining style. Overall limestone is cream coloured and massive but exhibits variable texture and grain size. Patches are coarse grained with large bryozoa and echinoid fragments. More common finer-grained zones contain amorphous to poorly crystalline matrix, within which skeletal material is extensively corroded further reducing grain size. Variable texture would be the main detrimental point for use in ashlars.

PAREEN QUARRY

Locality: Section 828, hundred MacDonnell; 4 km S-SW of Mount Schank.

Production: Production records incomplete. 336 tonnes recorded as being mined by Rands from MC 1646 in 1951. Most production predates 1950 and was by block-mining techniques.

Sample: 7022 RS 151.

Geological Log: -

Comments: Abandoned quarry 70 x 40 x 3.2 m oriented with long axis NW-SE i.e. parallel to regional joint direction. Maximum depth of 3.2 m is on N side of quarry; south face averages 2.2 m high. All mining has been by block-mining style except for one trial of cutting ashlars in situ i.e. one cut deep for a length of only 5 m.

East end of quarry now used as a dump for flint boulders.

Texture very uniform and sawn faces hold their shape well and stay flat and smooth. Bedding not evident in quarry faces. Limestone is offwhite to slightly creamy, fine and even grained. Thin-section examination reveals that matrix of amorphous ?ankerite fragmented skeletal debris and euhedral dolomite rhombs is dominant. Much of the original, coarser bioclastic material has been fragmented by dissolution producing the finer-grained, massive texture.

Ashlars from this quarry were described by quarry operators as 'puggy' i.e. chalky, and 'fret' badly in use. The 'puggy' character caused saws to clog while cutting stone. Local farmhouse and out buildings built of this stone. Although protected house walls are relatively intact, ashlars in the more exposed dairy and machinery sheds are badly fretted. However, stone from Pareen was used in the old National Bank in Mount Gambier which stood for 108 years before being bulldozed (E.M.

Stafford, 1985, pers. comm). However, it is well suited for road rubble as it packs down fast and hard producing a flat surface with a slight sheen. Quarry was worked by Snow Treloar in about 1930.

In 1947 the South Australian Housing Trust considered re-opening the quarry for Soldier Settlement housing in the area. One large block of stone had been cut earlier in 1947 but otherwise, the quarry had not been worked for many years. Stone from the quarry had been used in houses at Port MacDonnell. Quarry inspected and described by Armstrong (1947).

PLOVERS QUARRY

Locality: Section 92, hundred Young, 8 km SE of Glencoe.

Production: None recorded.

Sample: -

Geological Log: -

Comments: Named after the property 'Plovers', about 1 km to the north.

Now comprises a 30 x 30 m backfilled and overgrown quarry. May have been larger but is obscured by the backfill and surrounding area is under crop. No cut faces remain. Listed by Johns (1961) as a producer of building stone.

PORT MACDONNELL QUARRY

Locality: Section ?525, hundred MacDonnell; Outskirts of Port MacDonnell.

Production: None recorded.

Sample: -

Geological Log: -

Comments: Small quarry measuring 15 x 10 x 1 m adjacent to the Mount Gambier - Port MacDonnell road. Block-mining style used but quarry only 1 m deep and water table very shallow. Quarry partly backfilled with rubbish.

SMITH QUARRY

Locality: Section 879, hundred MacDonnell; 4.5 km W-SW of Allendale.

Alternative name: Gilmore Quarry

Production: None recorded.

Sample: -

Geological Log: -

Comments: Quarry known to have existed in 1940; at that time it was about 20 m square and had apparently started as a sheep dip cut into the limestone. Most mining was from 1947 to 1954. Worked in about 1950-1953 by Col Gilmore with blocks carted to Adelaide. Limestone also used as feed for nearby Elliott lime kilns operated by George Turnbull.

In 1953-1955, limestone was carted to kilns at the rear of the shop in Allendale also operated by G. Turnbull.

During its heyday, about 8 men worked the main part of the quarry plus another group of 5-6 men in another part of the quarry who worked on a royalty basis. Quarry reported to be about 100 m square in 1953. Deepest part of the quarry was nearly 4 m below ground level and had reached the water table - at times the quarry contained 1 m of water. A 25 mm (1 inch) centrifugal pump was used to dewater the quarry but was unsuccessful - in part because it was pumped to the surface nearby and allowed to recycle. September and October were the worst months for high water table.

Limestone was described as softer than limestone from Marte, and had a grey to offwhite colour.

Comments are derived from Eric Smith (pers. comm. 1984) and E.M. Stafford (pers. comm. 1985).

STAFFORD QUARRY

Locality: Section 478 and 750, hundred MacDonnell; 3 km W of Mount Schank.

Production: None recorded but at least one of the three quarries was block-mined, and trial ashlars were cut on the eastern end of the NE quarry.

Sample: 7022 RS 152.

Geological Log: -

Comments: This quarry was opened in about 1940. The Stafford brothers (John and Tom) worked the quarry in about 1953-1958; the ashlars would have been cut at that time. Mr E.M. (Tom) Stafford reports that these ashlars were sent to Victoria, and that ashlar rejects were trucked to Allendale and burnt for lime. At one stage, Staffords had 16 men working in the quarry.

Three adjacent quarries; the largest one, on the N side of the road and the S quarry are probably just road rubble pits. Smaller quarry to the NE is certainly an old building stone quarry which was mined block-mining style. Trial ashlars were cut on the E end of this quarry within 1.5 m of the surface. Faces average about 3 m high but are to 4.9 m high in the E-NE corner.

Abundant limestone outcrop in the area.

Limestone is similar to that at Edlington Quarry, overall being fine grained and tending towards chalky but with coarse-grained sponge-like growths and ?worm tubes. Echinoids rare.

Sample RS 152 contains only very rare complete skeletal fragments and consists mostly of partly-dolomitic, poorly-crystalline matrix. Euhedral dolomite rhombs are present. In use, stone would probably be like Pareen stone and fret.

STAFFORD AND BLACKALL QUARRY PM 125

Locality: Section 192, hundred Blanche; eastern line of quarries at Marte.

Production: 1965-1984 Stafford and Blackall 28,032 tonnes. Remaining production from Section 192 is from McKay and Major Quarries.

Samples: 7022 RS 132-134, 164.

Geological Logs: 37-39 (Fig. 13).

Comments: see text; current producer.

STEETLEY QUARRY PM 115

Alternative names: Knight and Pritchard Quarries
Pritchard Brothers Quarries
Rogers Quarry
? Garrad Quarry
Commercial Minerals Quarry.

Locality: Section 28, hundred Blanche; adjacent to Marte railway siding.

Production: These quarries have yielded 316,543 tonnes or 33% of the recorded production since 1924.

1925 - 1951	Knight & Pritchard	126,290 tonnes
1950 - 1971	Limestone Products	89,526 tonnes
1955 - 1967	Kain & Shelton	50,998 tonnes
1970 - 1974	R.L. Butler	10,837 tonnes
1972 - 1984	Steetley/Commercial	38,892 tonnes

Samples: 7022 RS 127 - 131, 160, 172.

Geological Logs: 11-23 (Fig. 10).

Comments: Now operated by B. Clark (Limestone Products); for additional comments see text.

D.J. Flint. Rept. book 88-2.

TELFORD PIT PM 169

Locality: Section 601, hundred Blanche; adjacent to Port MacDonnell road, 4 km S-SW of Blue Lake.

Production: None recorded but the quarry yields large quantities of road rubble and agricultural lime.

Sample: Samples by McGowran (1973) for examination of foraminifera.

Geological Log: -

Comments: Large quarry which in March 1985, had an eastern face 23 m high. Overburden comprises about 1 m of dark brown clayey soil; solution pipes extend down for another 1 m.

Topsoil is screened to remove calcrete, which is added to the road rubble stockpile. Remaining clayey soil is mixed 50:50 with sand and sold as loam. Loam is in high demand and carted as far as Penola.

In March 1985, plant in use consisted of a vibrating hopper with two screens at about 13 mm (½ inch) and 5 mm (3/16 inch) (Plate 16). Limestone passing the 5 mm screen is sold as agricultural lime the remainder is used as road rubble. Material is bulldozed and occasionally rolled before being fed onto the screens. Rolling significantly increases the proportion of agricultural lime product, from 50% without rolling to 75% with rolling. Agricultural lime is carted as far as Naracoorte and Dartmoor (Victoria). Road rubble from Telford Pit packs down hard and stays that way when wet.

Geology: Horizontal bedding. Diffuse bedding defined principally by grain size variations but enhanced by differential cementation. Overall, limestone is fine grained and consists of bryozoal fragments. Even very fine limestone is fragmentary rather than chalky, with a poorly crystalline matrix.

Colour offwhite to light grey but with a pale creamy tinge. Coarser bands to 1 m thick consist of coarse polyzoal fragments and are more strongly cemented; cementation is probably partly dolomitic.

Water level not reached, even at 23 m below the surface.

TELFORD QUARRY

Locality: Section 145, hundred Blanche; Marte area.

Production: 15 tonnes by Stuart Telford in 1951.

Sample: 7022 RS 146.

Geological Log:

Comments: Not to be confused with the commonly referred to Telford Pit PM 169.

Stone was also cut by Ned Light and Geraghty, before shifting to White Quarry, and subsequently Fletcher Quarry. Also see notes on Walter Quarry.

Abandoned quarry. Ashlars have been cut over a total area of about 1 300m^2 but only to an average depth of 5 ashlars (1.5 m). Overburden averages 1.2 m deep. Limestone is white, fine-grained and with some matrix but is quite coherent as it is partly recrystallised or cemented. Occasional bivalve fragments to 1 cm across. However, stone quality described as 'poor' (S.M. Telford, pers. comm. 1984).

TOLNER QUARRY

Locality: Section 325, hundred Blanche; western side of Mount Gambier.

Production: None recorded.

Sample: -

Geological Log: -

Comments: Exact locality not known, near eastern side of section 325 but quarry completely backfilled and may have been built on.

Owned or opened by 'Tritter' Tolner in 1867. Apparently, maximum size was about half a hectare, and almost 4 m deep.

TREFFERS QUARRY PM 132

Locality: 1 km NW of Marte railway siding; adjacent to Millicent - Mount Gambier railway.

Production:	1969 - 1984	Cutting	48 340 tonnes
	1985 - 1986	Treffers	N/A

Sample: 7022 RS 136 & 137

Geological Logs: Nos. 6, 8 & 10 (Fig. 9).

Comments: see text.

WALTER QUARRY

Locality: Section 144, hundred Blanche; Marte area.

Alternative name: Ploenges Quarry.

Production: Ploenges 1940-1953		3 948 tonnes
CAFPERCO 1956		126 tonnes.

Also worked by Stuart Telford, date unknown. Quarry named after Thomas Richard Walters who worked the quarry in about 1914, and who also worked in Lawson Quarry.

Sample: -

Geological Log: -

Comments: Site where Albert Ploenges was killed in about 1953-1954 when a mobile crane rolled down an incline and crushed him as he was attaching lifting hooks to raise a large block. See notes for Telford Quarry in the adjacent section as historical notes and production details are somewhat confused and mixed.

Jack Garrad also worked with Ivan Ploenges - in the interval 1940-1953.

WHITE QUARRY

Locality: Section 524, hundred Blanche; 5.7 km S-SE of Marte Railway Siding, off Barnoolut Road.

Production: Recorded production is 31,830 tonnes.

1924 - 1937	White	27 228 tonnes
1954 - 1956	Shaugnessy and Ploenges	4 602 tonnes

Also worked by Jack McKinnon some time between 1937 and 1954.

Sample: 7022 RS 145.

Geological Log: -

Comments: Abandoned quarry 110 x 65 x 6 m deep. At deepest point, 15 layers of ashlars (about 4.5 m) have been cut below 1-1.5 m of scraped overburden and karstic limestone.

Top 1 m is distinctly karstic but deep solution dolines are absent.

Quarry floor clear with all ashlars removed; only a few large blocks greater than 1 m across remain. No rejected ashlars evident.

Gambier Limestone is offwhite to creamy with slight brownish tinge, coarse grained and appears soft with little cementation. Many of the quarry faces are soft and weathered; rarer faces are smooth and hard with surface cementation.

Subhorizontal bedding evident, but exhibits distinct undulations or very broad, low ripple pattern. Grain size varies across bedding from fine and chalky to coarse grained with echinoid fragments etc. to several centimetres long.

APPENDIX E

DRILLING LOGS - MARTE AREA

BORE NO.	DEPTH		SADME	DRLLED FOR	SEC	COMMENTS
(Armstrong, 1952)	Feet	Metres	WW NO. (Prefixed by 7022)		(hd. Blanche)	
1	24	7.3	2541	Dept.; near Stafford's Quarry	28	
2	20	6.1	2542	Dept.; near E. Bruhn's Quarry	28	
3	20	6.1	2539	Pritchard Brothers	28	
4	20	6.1	-	Pritchard Brothers	28	
5	20	6.1	2534	Knight & Pritchard	28	
6	20	5.1	2535	Knight & Pritchard	28	
7	13	4.0	2540	Knight	28	
8	4	1.2	2537	B. Bruhn	136	
9	20	6.1	2538	B. Bruhn	136	Now under shed.
10	30	9.1	2513	A.H. Ploenges	144	
11	16	4.9	2536	Corralline Quarries	28	
12	34	10.4	2514	Ploenges & Telford	144	
13	8	2.4	2515	Ploenges & Telford	144	
14	6	1.8	2516	Ploenges & Telford	144	
15	12	3.7	2517	Ploenges & Telford	144	
16	14	4.3	2518	Ploenges & Telford	144	
-	30	9.1	2511	B. Bruhn	28	Water Bore
-	n/a	-	2533	Knight & Pritchard	28	Water Bore

E2

7022/003/WW 2405

LOG OF BORE

State No. 246003001 **Hundred** BLANCHE **Section** 30 **Bore No.** 01

Depth From	Depth To	Nature of Strata
0'	1'	Dark loam.
1'	6'	Brown flint and clay.
6'	18'	Hard calcite, some coraline.
18'	42'	Calcite and open grained coraline and some marl. First water cut 30' S.W. L.24'.
42'	64'	Open grained coraline and some calcite.
64'	76'	Yellow close grained coraline and some calcite.
76'	90'	Grey marl.
90'	108'	Open coraline. Second wat cut.
108'	118'	Brown clay and quartz gravel conglomerate (?could be cavity).
118'	130'	Lignitic clay and quartz gravels (brown).
130'	133'	Knight sands, some lignitic clay. S.W.L. now 20'.

Turbine pump tested with 50' shaft 7200g.p.h.
" " " " 70' " 12000 "
" " " " 90' " 18000 "

Many teeth found in slurry.

Several stick of gelignite exploded with electric detonator at 108' level by M. Pritchard.

LOGGED BY DRILLER (MAX. PRITCHARD)
1973.

Micro Film No. ....

SM-9.75 F9371

E3

7022/003/WW 2507

LOG OF BORE

ate No. 246014601 Hundred BLANCHE Section 146 Bore No. 01.

Depth From	Depth To	Nature of Strata
0'	1'6"	Sandy loam.
1'6"	4'	Red clay and brown flint pebbles.
4'	5'	Calcite.
5'	56'	Limestone, open. Slight seepage at 38'.
56'	61'	Grey marl.
61'	72'	Limestone, coraline, more water.
72'	83'	Soft close grained coraline limestone, some calcite.
83'	102'	Grey marl, or soft limestone.
102'	107'	Grey marl and black and grey flints.
107'	115'	Soft white coraline limestone.
		DRILLER'S LOG.

Micro Film No. ....

E4

7022/003/WW 2508

LOG OF BORE

State No. 246014602 Hundred BLANCHE Section 146 Bore No. 02

Depth From	Depth To	Nature of Strata
0'	6"	Chocolate loam..
6"	15'	Open coraline limestone, some calcite.
15'	22'	Hard calcite.
22'	38'	Soft coraline limestone.
38'	43'	Calcite, some coraline limestone.
43'	52'	Coraline limestone.
52'	54'	Hard white calcite.
54'	63'	Coraline limestone, some calcite.
63'	73'	Soft coraline limestone.
73'	74'	Hard calcite.
74'	83'	Soft coraline limestone.
83'	97'	Marl, some coraline limestone.
97'	100'	Grey marl, some glauconitic clay.

DRILLER'S LOG.

Micro Film No.

7022/003/WW 2509

LOG OF BORE

late No. 246014603 Hundred BLANCHE Section 146 Bore No. 03

Depth From	Depth To	Nature of Strata
0	6"	Dark sandy loam
6"	4'	yellow clay, brown flints
4	24'	yellow clay & calcite
24	38'	coraline limestone, some calcite
38	48'	marl, coraline limestone & calcite
48	67'	coraline limestone
67	70'	calcite & some coraline limestone
70	92'	marl & " "
92	103'	grey flints & " "
103	10.5'	calcite
105'	117'	soft close grained limestone with some glaucmite
17	120'	Hard gre, calcite
120	124	marl, quartz & dolomite gravels
124	128	'lignite' clay & gravels
128	130	Knight sands

Micro Film No.

Hd Blanche S: 144 BORE NO. 3 B

LOG OF BORE 7022/003/WW 2512

Depth From	Depth To	Nature of Strata
0	2'	Brown sand and gravel
2	10	Creamy yellow sandy limestone
10	20	Creamy bryozoal limestone
20	50	White soft.foss.limestone
50	60	Cream bryozoal sand
60	70	White fairly hard limestone.

END OF BORE 70'

Logged by E.O'DRISCOLL.

Micro Film No.

7022/003/WW 2513

. BLANCHE SECTION NO.144 BORE NO.C (1)

LOG OF BORE

Depth From	Depth To	Nature of Strata
0	12'	Coral limestone
12	30	Flint and limestone.
		END OF BORE 30'
		Driller's Log.

Micro Film No.

E8

7022/003/WW 2514

. BLANCHE SECTION NO. 144 BORE NO. D (1)

LOG OF BORE

Depth From	Depth To	Nature of Strata
0	34'	Coral limestone.

END OF BORE 34'

Micro Film No

7022/003/WW 2515

E9

D. BLANCHE SECTION NO.144 BORE NO. 1 (2)

LOG OF BORE

Depth From	Depth To	Nature of Strata
0	1'	Soft limestone
1	8'	Flint.

END OF BORE 8'
Log by Driller

Micro Film No.

2 OM—6.65 4244

7022/003/WW 2516

E10

. BLANCHE SECTION NO.144 BORE NO. F (3)

LOG OF BORE

Depth From	Depth To	Nature of Strata
0	1'	Soft limestone
1	6	Flint.
		END OF BORE 6' Log by Driller.

Micro Film No.

2 C/A—5.55 4244

7022/003/WW 2517

E11

BLANCHE SECTION NO. 144 BORE NO. G (4)

LOG OF BORE

Depth From	Depth To	Nature of Strata
0	3'	Limestone
3	4	Flint
4	12	Limestone

END OF BORE 12'

Log by Driller

Micro Film No.

7022/003/WW 2518

E12

BLANCHE SECTION NO. 144 BORE NO. H (6)

LOG OF BORE

Depth From	Depth To	Nature of Strata
0	3'	Limestone
3	4	Broken flint
4	14	Limestone

END OF BORE 14'
Log by Driller

Micro Film No.

2 061—6 66 4/44

7022/003/WW 2520

LOG OF BORE

State No. 20103502 Hundred BLANCHE Section 138 Bore No. 02

Depth From	Depth To	Nature of Strata
0	50cm	FOSSILIFEROUS CALCARENITE - White weakly cemented. Well preserved Bryozoa & echinoid spines to 2mm (av. 1mm)
3	9m	FOSSILIFEROUS CALCARENITE - White gading to rusty orange. Fossil fragments as for 0-50cm (Av. 0.7mm). 2%Calcisiltite - white.
~~9~~	[illegible]	3 - 6m Weakly to strongly cemented.
9	12m	FOSSILIFEROUS CALCARENITE - White, weakly cemented. Bryozoa and echinoids to 2mm (av. 0.3mm) 2% Calcisiltite - white.
12	15m	FOSSILIFEROUS CALCARENITE - White, strongly cemented with some unconsolidated material. Bryozoa, echinoids and shelly fragments common, from < 0.1mm to 3mm (av. 0.8mm)
15	18m	FOSSILIFEROUS CALCIRUDITE - White, unconsolidated. Bryozoa, shelly fragments and other fossils common. Some fragments to 23mm (Av. 2.5mm) 20% Fossiliferous Calcarenite - White strongly cemented (Av. 0.5mm)
	18m	FOSSILIFEROUS CALCARENITE - white weakly cemented Fossil fragments to 4mm (Av. 0.9mm)

LOGGED BY J. LAWSON 31/10/7.

Micro Film No.

E14

DEPARTMENT OF MINES SOUTH AUSTRALIA

7022/003/WW 2528

HYDROGEOLOGY SECTION

Temp. No. WA 35

BORE LOG

OWNER P. Siggers

Drill type
Circulation
Driller
Start
Finish

Logged by DKC
Date logged 20.11.75
Bore Diameter
DEPTH 30.5m

AMG Zone
Coords E
" N
Datum Elev
(m) Ref Pt Elev
Surface Elev

HUNDRED Blanche
SECTION 132
STATE No 246013201
Project No
Docket No
Bore Serial No

Depth to Water cut m	Depth to standing water m	SUPPLY		TOTAL DISSOLVED SOLIDS	
		litres/sec	Method of test	Milligrammes/litre	Analysis No

REMARKS Colours are as shown in "Munsell"

CASING		DEPTH m	DESCRIPTION
	1	0-0.3	Soil sandy, much (carbonaceous) organic material very dark gray 3/
	5	0.3-1.3m	Sand, quartz, mainly 0.2-0.5mm, some fine sandstone gravel. Brownish yellow 10YR 6/6.
	18	1.3-1.5m	Sand quartz (mainly 0.2mm) clayey. Yellowish brown 10 YR. 5/6
		1.5-3.0	Calcarenite (no quartz) Some bryozoal fragments ~~&~~ considerable silty material. Pale yellow, 2.5Y 8/4.
		3.0-30.5	Calcarenite numerous bryozoal fragments, Minor silty fraction. White 5Y 8/1

7022/003/WW 2529

LOG OF BORE

State No. 246013202 **Hundred** [illegible] **Section** [illegible] 1[illegible] **Bore No.** [illegible]

Depth From	Depth To	Nature of Strata
0m	0.5m	SILTY CLAY Red-brown. 10% quartz arenite 0.1-0.5m (Av. [illegible]mm) clear, sub angular sub rounded. 40% Calcarenite, bryozoal, weak to moderate cementation, off white. Organic matter.
0.5	30	CALCARENITE White, off white, cream. Cementation variable, but mainly moderate to strong. Bryozoa content varied from minor to 95%, and in size up to 7mm (Av. 2mm). 0.5-2.0 40-50% silty marl, creamy brown. 2.0-8.0 30% calcisiltite, cream-white. 8.0-16.0 50% calcisiltite, white. 16.0-22.0 -95% bryozoa, slightly silty. 22.0-24.- Calcarenite and slightly calcareous fragments yellow (right through) 20% Silty clay (?cavity infill) 26.-28.0 calcarenite weakly cemented, slightly silty 28.0-30.0 10-20% Calcisiltite.
30	36	30.0-36.0 Approx 60% Calcisiltite, pale grey. 40% Calcarenite, weakly cemented, essentially 95% bryozoal fragments to 1cm. (Av. 2mm) off white. 34.0-36.0 Slightly marly.
36	40	Approx. 50% Calcisiltite pale grey. 50% Calcarenite, weakly cemented, essentially 95% bryozoal fragments to 4mm. (Av. 1.5mm).

END OF HOLE 40m.

Logged by F.W. Aslin 20.10.72.

24-26m 30% calcisiltite, pale grey, slightly marly

Micro Film No.

7022/003/WW 2531

HD. BLANCHE SECTION NO.134 BORE NO.A

LOG OF BORE

Depth From	Depth To	Nature of Strata	
		Bryozoal limestone.	
0'	20'	Coralline bed.	
20'	184'	Limestone	Sea level at 164'.
		Dolomitic	"LOWER MIOCENE".
		"OLIGOCENE"	

Total depth of bore 184'

Copied from logs signed by
A.E. Knight, date 14.5.1947.

Micro Film No.

E17

7022/003/WW 2531

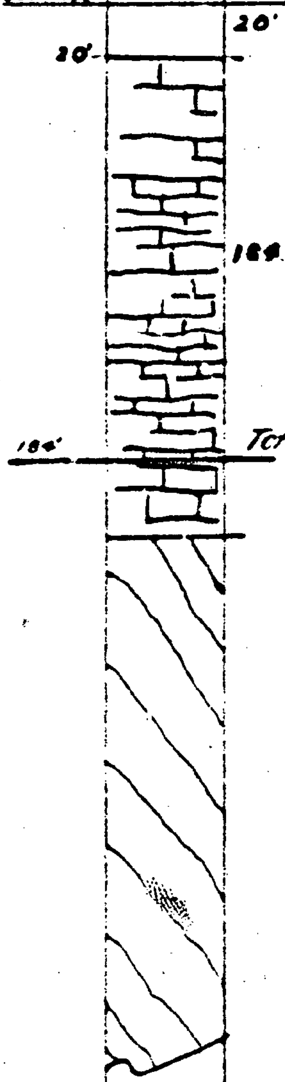
SOUTH AUSTRALIA

DEPARTMENT OF MINES

BORE Nº FLETCHERS QUARRY WATER BORE.

Direction of Bore .... Hundred of Blanche
Angle of Bore .... Section No. 134
Location

DEPTH FROM	DEPTH TO	THICKNESS	CORE	CORE RECOVERY	DESCRIPTION OF ROCK	REMARKS
ft. in.	ft. in.	ft. in.	ft. in.	%		
SURFACE					ELEVATION 100 ft.	
20'		20'			Coralline bed.	
		184			Limestone	
184'					Total depth	



Limestone. Sea Level

Lower Miocene

Dolomitic

Total depth

Division line of strata

Oligocene

Copied from logs signed A.E.Knight, dated 14-5-47

E18

7022/003/WW 2539

LOG OF BORE

State No. 246002807 **Hundred** BLANCHE **Section** 28 **Bore No.** 07

Depth From	Depth To	Nature of Strata
0'	14'	Limestone and flint knobs.
14'	20'	Limestone.

END OF BORE 20ft.
DRILLER'S LOG.

Micro Film No

E19

7022/003/WW 2540

LOG OF BORE

Depth From	Depth To	Nature of Strata
0'	5'	Soft limestone.
5'	13'	Limestone and flint.
		End of bore 13'

1 M—4.57 2630

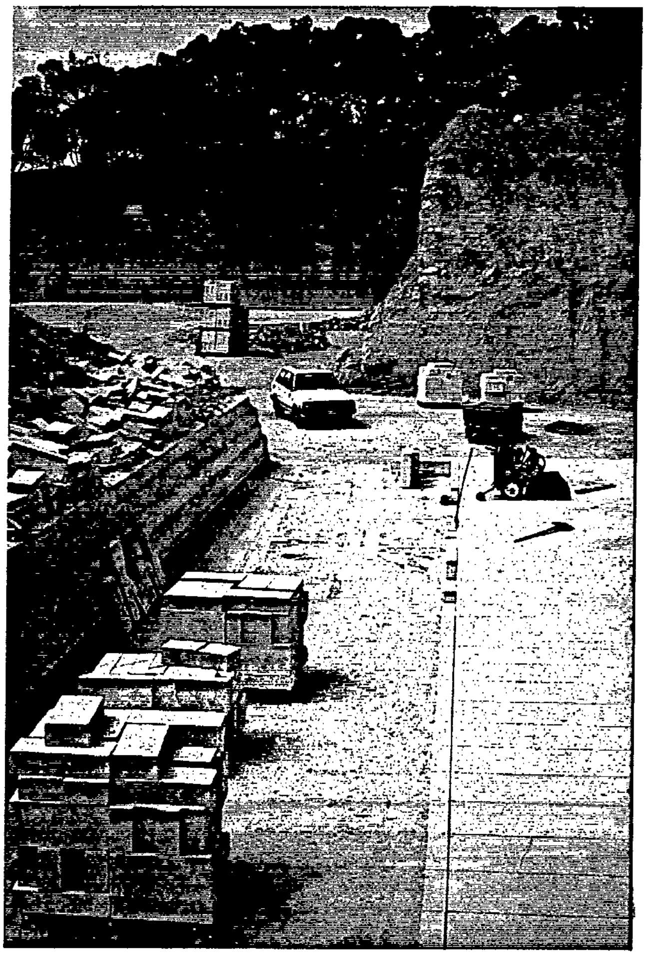


PLATE 1. Fletcher Quarry - typical operation.
Operated solely by K. Pearson until recently sold to Bruhn. Overburden of weathered and bedded Gambier Limestone, 5-6 m thick, is bulldozed and where-ever possible, used for road rubble. Ashlars are stacked to dry, whiten and harden slightly.
Slide No. 36194. 4 March, 1985.

PLATE 2. McKay Quarry - bulldozing of ashlar offcuts for road rubble.
Ashlar offcuts in abandoned McKay Quarry are bulldozed by Gambier Earthmovers and used for road rubble thus cleaning the quarry floor and opening the quarry for future sawing of ashlars.
Slide No. 36195 5 March, 1985.

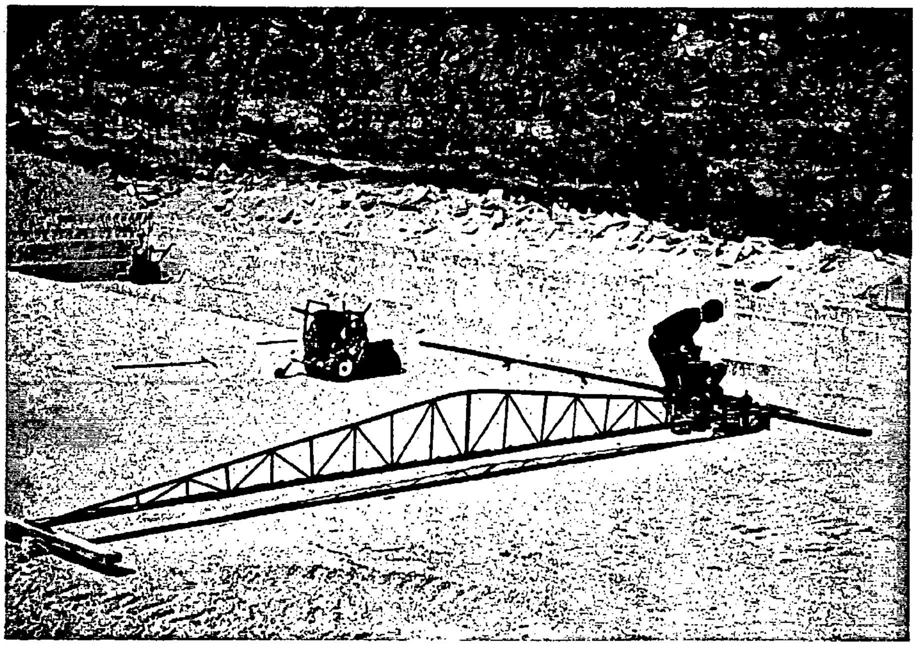


PLATE 3. Fletcher Quarry - Ashlar cutting stage 1 - Careful levelling of the site.
Quarry operators use a combination of front-end loader, fork-lift with a scraper blade attached to the forks, and an undercut saw. Guidance to levelling of the trestle and boards is simply by a spirit level. K. Pearson in Fletcher Quarry, PM 153.
Slide No. 36196 27 August, 1985.

PLATE 4. Fletcher Quarry - Ashlar cutting, stage 2. The second stage is cross-cutting with a spacing which controls the length of the ashlars. Sawn limestone powder is scraped clear to allow unimpeded progress of the saws and promoting parallel cuts.
K. Pearson in Fletcher Quarry.
Slide No. 36197 27 August, 1985.

PLATE 5. Steetley Quarry - Ashlar cutting stage 3. The third stage is undercutting which controls the height of the ashlars. Following undercutting, wedges are inserted in the undercut. Brian Clark of Limestone Products in Steetely Quarry, PM115.
Slide No. 36198 26 August, 1985.

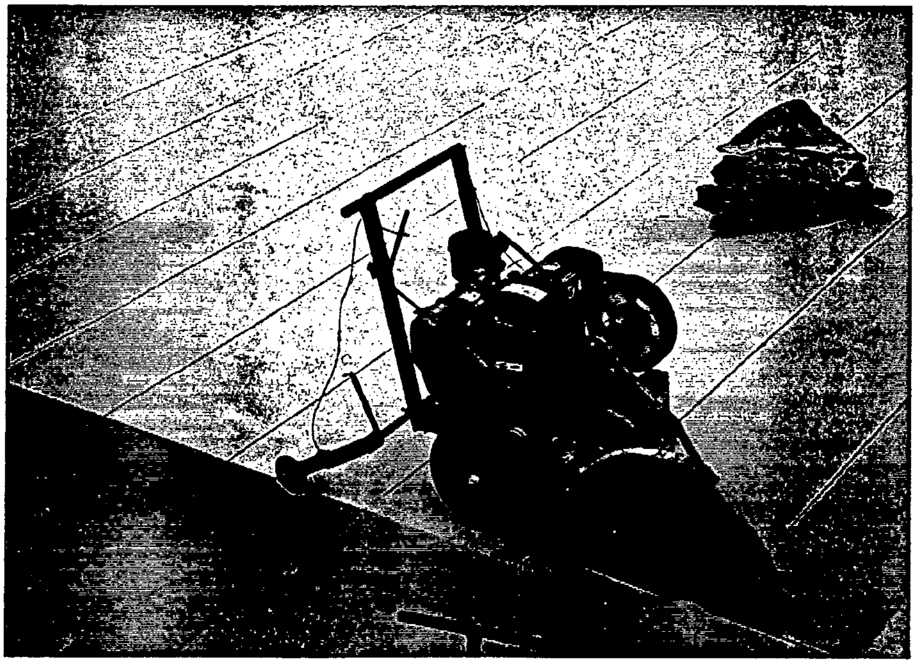
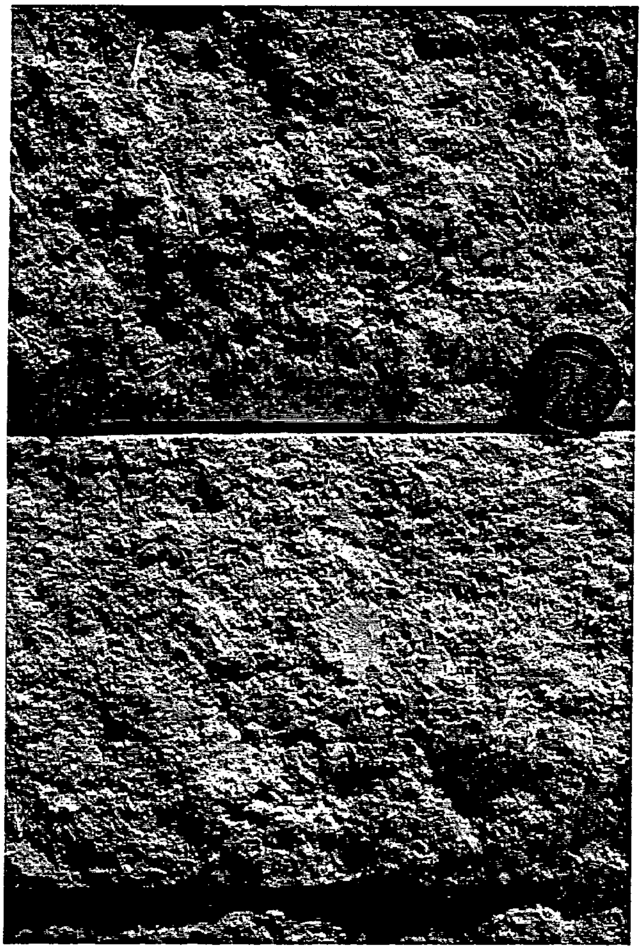


PLATE 6. Steetley Quarry - Ashlar cutting stage 4. The fourth stage is the longitudinal cutting which controls the thickness of the ashlars. Wedges prevent the ashlars from moving and breaking of a corner when the ashlar has been almost sawn free. Ashlar orientation in the ground is the same as used in walls i.e. any beding remains horizontal.
Slide No. 36199 26 August, 1985.

PLATE 7. Steetley Quarry - Ashlar cutting, stage 5 The fifth stage is removal of the wedges and stacking of the ashlars along the quarry wall and on pallets. Ashlars are often creamy and soft when wet and first sawn, but whiten, harden and lighten noticably during drying of 7-10 days. B. Clark of Limestone Products in Steetley Quarry.
Slide No. 36200 26 August, 1985.

PLATE 8. Bruhn Quarry - massive calcarenite.
Massive bryozoal calcarenite typical of the middle unit at Marte.
Massive_calcarenite is from metres to tens of metres thick with bedding rarely evident. Contains minor disseminated mollusc and echinoid fragments.
Slide No. 36201
2nd March, 1985.



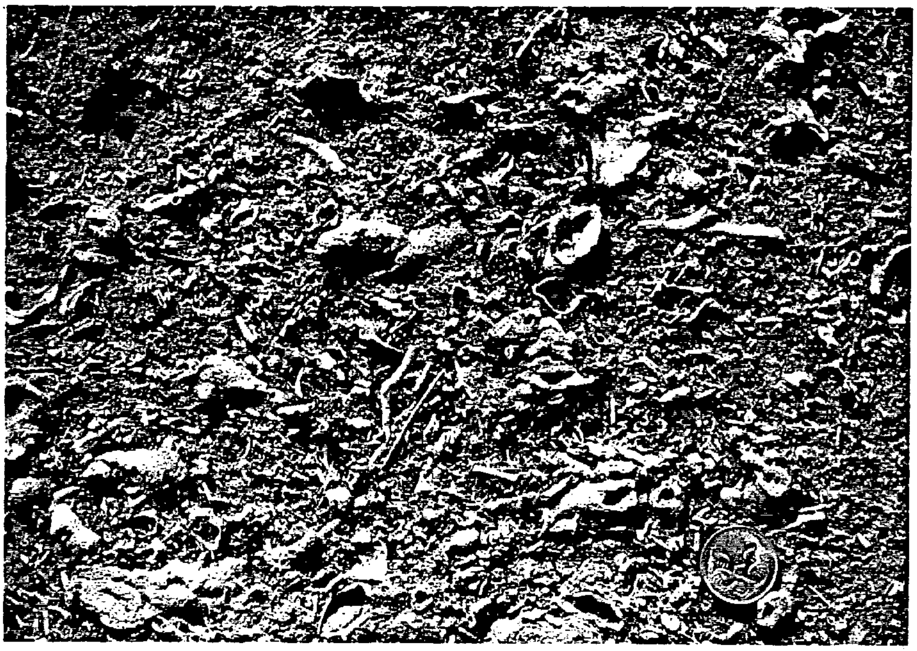


PLATE 9. Stafford Quarry - bimodal calcarenite.
Bimodal calcarenite from the upper unit which has been used for ashlars. Weathered quarry faces enhance the coarse byrozoal debris, which exhibits minimal transport and abrasion, from the very fine-grained and often partly amorphous matrix.
Slide No. 36202 6th March, 1985.

PLATE 10. Steetley Quarry - flint pebble beds in Bridgewater Formation.
Two pebble beds of flint on the seaward side of a Quaternary dune of Bridgewater Formation. Gambier Limestone (lower half of plate) is overlain by two pebble beds (Bridgewater Formation) interbedded with pale brown, silty sand. Pebble scree partly obscures Gambier Limestone. Dolines disrupt upper pebble bed. All units overlain by Holocene residual and eluvial, brown soil with abundant flint pebbles. 28 February, 1985.
Slide No. 36203

PLATE 11. Steetley Quarry - residual, flint pebbles in Holocene soil.
Holocene soil and residual, well-rounded flint pebbles (derived from nearby Bridgewater Formation dune) collapsing into and filling dolines within Gambier Limestone. Clays leached from soil and concentrated on doline margins.
Slide No. 36204
28 February, 1985.

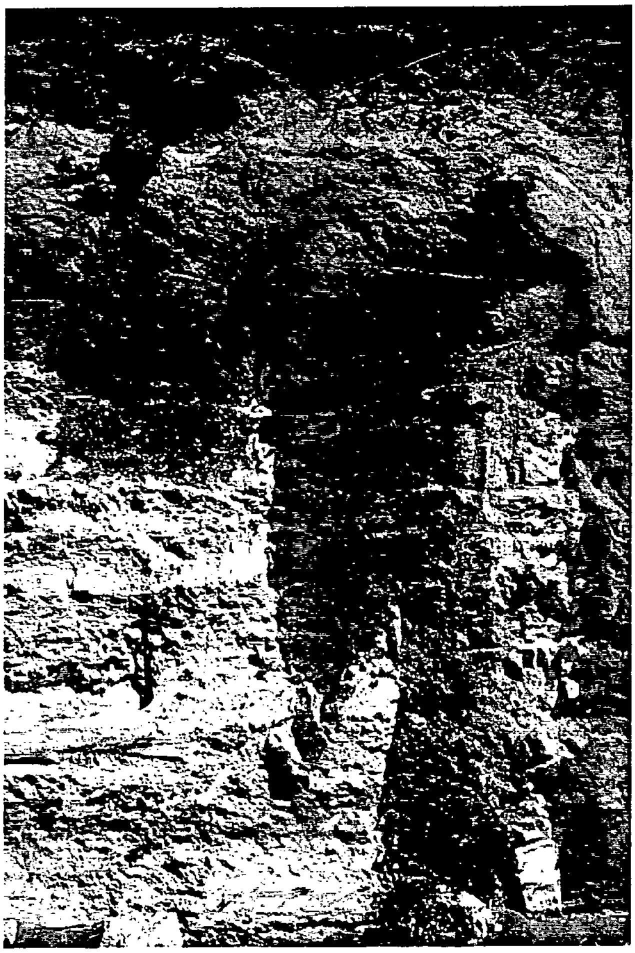


PLATE 12. Stafford and Blackall Quarry - Holocene soil infilling karstic Gambier Limestone.
Holocene soil overlying and infilling karstic dolines within Gambier Limestone; Dark grey and humus-rich at the surface, grades down through a clean and friable sand to dark brown and clay rich at the base and on the sides of dolines. Coarser, horizontal bands in Gambier Limestone are stained and partly cemented by yellow goethite.
Slide No. 36205 4 March, 1985.

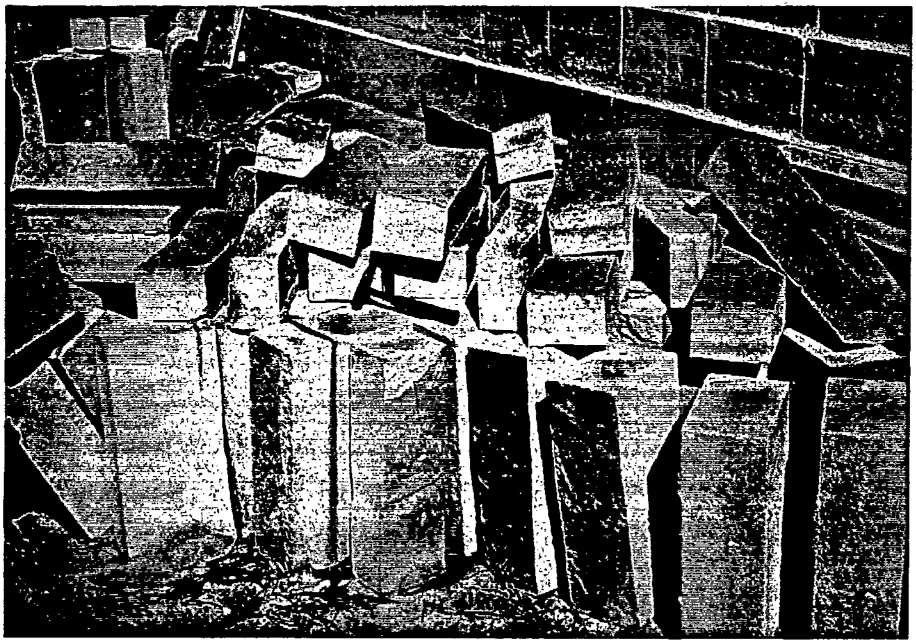


PLATE 13. Stafford and Blackall Quarry - silty beds.
Fine-grained, pale green, silty 'beds' along which ashlars readily split producing wastage. Layers are fine-grained calcite, not glauconitic marl and probably represent planes of secondary dissolution and reprecipitation; 7022 RS 134.
Slide No. 36206 4 March, 1985.

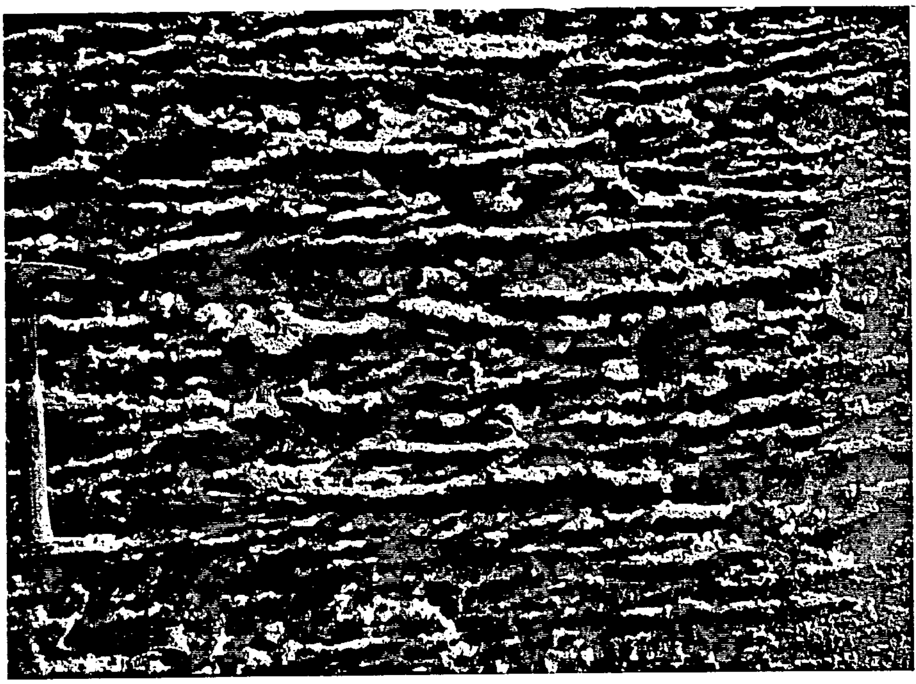


PLATE 14. McKay Quarry - bedded calcarenite.
Well-bedded calcarenite of middle unit which crops out in NW end of McKay Quarry (PM 125) and originally formed a NW-trending whaleback outcrop. Bimodal with coarser beds partly cemented and more resistant; finer-grained beds contain more abundant partly-amorphous matrix and weather and erode readily. This outcrop has been blockmined but is now bulldozed for road rubble.
Slide No. 36207. 4 March, 1985.

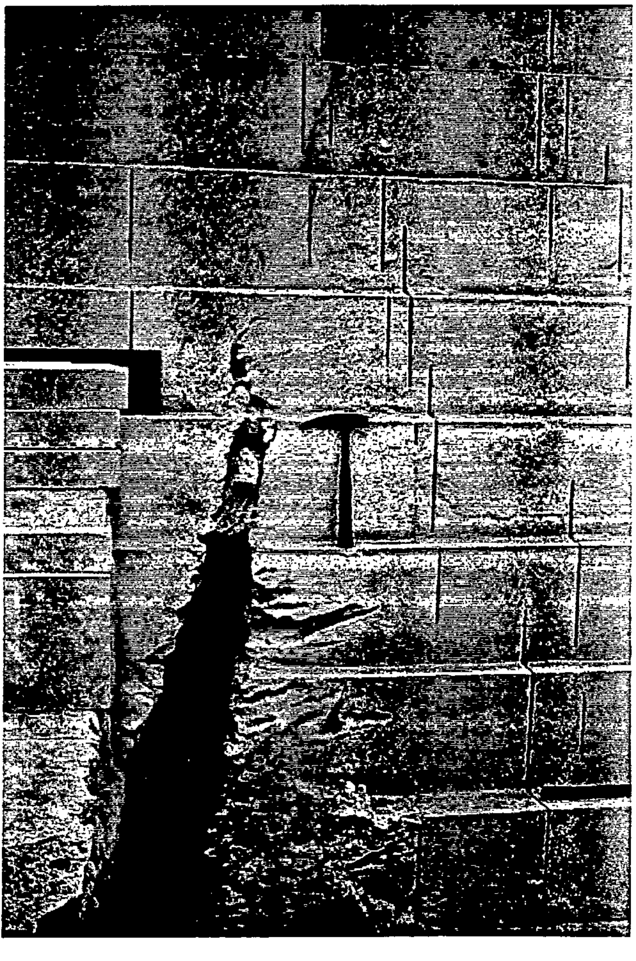


PLATE 15. Kain and Shelton Quarry - jointing and dissolution.
Dissolution occurs both down the steeply-dipping joints as well as subhorizontally along bedding planes. Joints control the NW-SE whaleback outcrops as well as the marked, narrow line of quarries. Holocene Mount Schank vent located on the same structure.
Slide No. 36208 2 March, 1985.

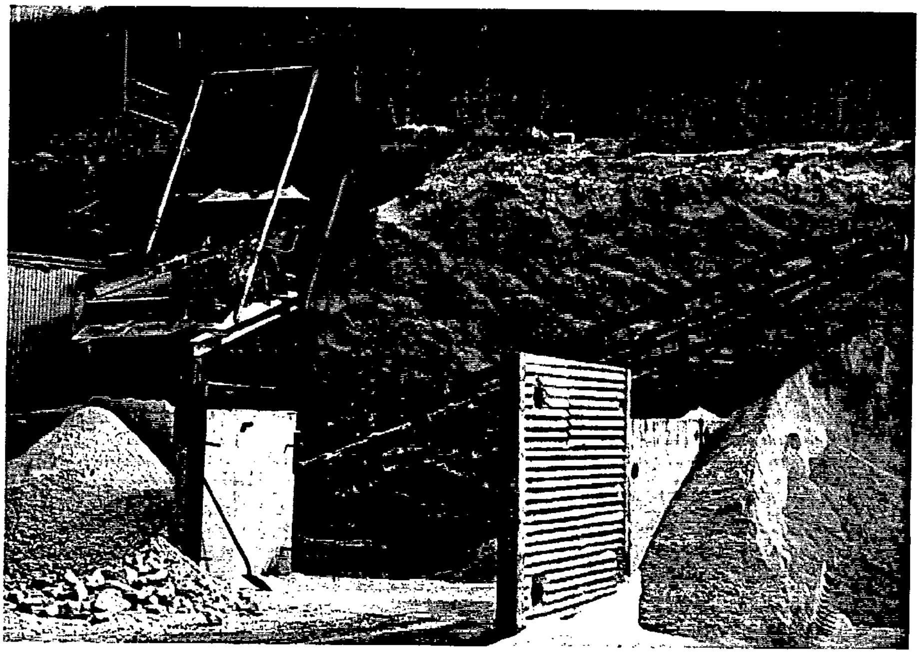


PLATE 16. Telford Pit - Gambier Earthmovers' screening plant. Bulldozed calcarenite and calcisiltite are loaded by front-end loader into the hopper. Oversize from the two screens (approx. 13 mm and 5 mm) is used as road rubble. Fines are fed to the stockpile (right) and sold as agricultural lime.
Slide No. 36209 6 March, 1985.

Primary Industry and Resources South Australia

Mineral Registration

Printed: 21/10/1999

Tenement Production

Tenement PM 115

Period 1990 / 06 .. to .. 1999 / 06

Year 1990

Period	Category	Product	Amount
06	Dimension Stone	DOLOMITE/LIMESTONE	497
06	Industrial Minerals	LIMESTONE AGRIC	4,079
		Year Total	4,576

Year 1994

Period	Category	Product	Amount
12	Dimension Stone	DOLOMITE/LIMESTONE	423
12	Industrial Minerals	LIMESTONE AGRIC	1,130
12	Quarry	RUBBLE - DOLOMITE/LIMESTONE	193
		Year Total	1,746

Year 1995

Period	Category	Product	Amount
06	Industrial Minerals	LIMESTONE AGRIC	2,304
12	Industrial Minerals	LIMESAND AGRIC	1,383
12	Quarry	RUBBLE - DOLOMITE/LIMESTONE	4,167
		Year Total	7,854

Year 1996

Period	Category	Product	Amount
06	Industrial Minerals	LIMESTONE AGRIC	2,974
12	Dimension Stone	DOLOMITE/LIMESTONE	629
12	Industrial Minerals	LIMESAND AGRIC	762
12	Quarry	RUBBLE - DOLOMITE/LIMESTONE	76
		Year Total	4,441

Year 1997

Period	Category	Product	Amount
06	Dimension Stone	DOLOMITE/LIMESTONE	385
06	Industrial Minerals	LIMESTONE AGRIC	1,722
06	Quarry	RUBBLE - DOLOMITE/LIMESTONE	96
12	Industrial Minerals	LIMESTONE	1,104
12	Quarry	RUBBLE - DOLOMITE/LIMESTONE	95
		Year Total	3,402

Year 1998

Period	Category	Product	Amount
06	Dimension Stone	DOLOMITE/LIMESTONE	268
06	Industrial Minerals	LIMESTONE	2,334
06	Quarry	RUBBLE - DOLOMITE/LIMESTONE	2,086
12	Dimension Stone	DOLOMITE/LIMESTONE	478
12	Industrial Minerals	LIMESTONE	948

Tenement Production

Tenement PM 115

Period 1990 / 06 .. to .. 1999 / 06

12	Quarry	RUBBLE - DOLOMITE/LIMESTONE	3,898
		Year Total	10,012

Year 1999

Period	Category	Product	Amount
06	Dimension Stone	DOLOMITE/LIMESTONE	63
06	Industrial Minerals	LIMESAND AGRIC	104
06	Industrial Minerals	LIMESTONE	32
06	Quarry	RUBBLE - DOLOMITE/LIMESTONE	1,420
		Year Total	1,619
		Overall Total	33,650

Mines and Energy Resources South Australia

Minerals Registration Branch

Printed: 11/5/1998

Operator Production by Category

Category: Dimension Stone

Period: 1986 / 06 .. to .. 1997 / 12

Tonnage in Excess of: 1

			Tonnage
	ARIVERUN PTY LTD PO BOX 517 RENMARK SA 5341		51,105
Holder as for operator	**LORBAR NOMINEES PL** C/- BRUHN DISTRIBUTORS PO BOX 412 MT GAMBIER SA 5290	PM 153	40,056
	ROCLA QUARRY PRODUCTS C/-AMATEK LIMITED PO BOX 38 ROSEWATER EAST SA 5013		39,569
Holder = operator Holder = operator	**STAFFORD & EARL** PO BOX 2670 MOUNT GAMBIER SA 5290	PM B 125 PM C 125	35,036
	ALBERN SLATE PTY LTD 290 MILITARY ROAD GRANGE SA 5022		28,259
	AUSTRALASIAN GRANITE PTY LTD 47 GREENHILL RD WAYVILLE SA 5034		25,987
	MARTINS GRANITE QUARRIES PL 1 LONDON ROAD MILE END SA 5031		22,547
Holder Ben Bruhn + Sons	**BRUHN DISTRIBUTORS** PO BOX 412 MT GAMBIER SA 5290	PM 14, PM 15	19,702
	FAULKNER BEVERLEY DAWN VALLEYWOOD KANMANTOO SA 5252		16,359
	GOLDFINCH PTY LTD PMB 243 NARACOORTE SA 5271		15,465
	SCHERER CONTRACTORS PL PO BOX 517 RENMARK SA 5341		13,030
Holder: R M Lawson	**LAWSON ROBERT MELVILLE** C/- J A GALPIN PO BOX 246 MT GAMBIER SA 5290	PM 132	12,956
	MINTARO SLATE QUARRIES PL PO BOX 8 MINTARO SA 5415		12,242
Holder SE Auto Club	**SOUTH EAST AUTOMOBILE CLUB** PO BOX 1551 MOUNT GAMBIER SA 5290	PM 134	12,139

Printed: 11/5/1998

Operator Production by Category

Category: Dimension Stone
Period: 1986 / 06 .. to .. 1997 / 12
Tonnage in Excess of: 1

	Tonnage
CALCA QUARRIES PL PO BOX 270 HINDMARSH SA 5007	10,585
WISTOW STONE QUARRIES PTY LTD PO BOX 95 ECHUNGA SA 5153	9,797
LEOPARDI MICHAEL JOHN 28 COX CREEK ROAD CRAFERS SA 5152	7,832
AMATEK LIMITED PO BOX 38 ROSEWATER EAST SA 5013	7,499
holder = Operator **COMMERCIAL MINERALS LIMITED** PM 115 PO BOX 74 ROSEWATER EAST SA 5013	6,329
BRANDL GOTTFRIED 3 EYRE CRES VALLEY VIEW SA 5093	5,889
DL SCOTT & SON 20 PINE ST STIRLING SA 5152	5,022
K & G CONSTRUCTIONS PTY LTD 6 MATT ST LOCKLEYS SA 5032	4,996
BASKET RANGE SANDSTONE PROD PO BOX 248 BASKET RANGE SA 5138	4,267
PHILP E W A 4/17 TROWBRIDGE AVE MITCHELL PARK SA 5043	3,222
ROBERTS DM 22-24 ST ANDREWS TCE WILLUNGA SA 5172	3,011
HAINES GJ C/- MT GAMBIER WEST POST OFF MT GAMBIER SA 5290	2,216
BORAL RESOURCES (SA) LIMITED PO BOX 37 PLYMPTON SA 5038	2,117
J & M NOMINEES PTY LTD 259 PAYNEHAM ROAD JOSLIN SA 5070	2,026
DODSLEY PTY LTD PO BOX 6325 EAST PERTH WA 6892	1,781

Operator Production by Category

Category: Dimension Stone
Period: 1986 / 06 .. to .. 1997 / 12
Tonnage in Excess of: 1

	Tonnage
GRIEVES GARY COLIN BOX 202 RENMARK SA 5341	1,670
	1,590
CALCA GRANITE PTY LTD PO BOX 10 STREAKY BAY SA 5680	1,542
DC OF COOBER PEDY PO BOX 265 COOBER PEDY SA 5723	1,372
PRYDE WILLIAM ROBERT C/- POST OFFICE SPALDING SA 5454	1,205.5
EVANS SG 67 HEATHER RD STIRLING SA 5152	972
ROWE GABRIELLE MARIE PO BOX 21 CARRIETON SA 5432	958.3
TILLEY G C/- HILLCOTT GROVE PROPRIETORS PO BOX 240 KAPUNDA SA 5373	852
TURNER GEORGE MAURICE WISANGER HILLS RSD 486 KINGSCOTE SA 5223	765
SKINNER PAUL MORTON 6/9 HERBERT AVE TORRENSVILLE SA 5031	703
GRESCH PETER C/- SPALDING SLATE & STONE PR. PO BOX 110 SPALDING SA 5454	632.5
AFFORD ELIZABETH ANN `LIZEAN' ROSEDALE 5350	624.7
WHILLAS PETER JOHN C/- PO BOX 1230 PORT LINCOLN SA 5606	533
BRANDL RUTH 3 EYRE CRES VALLEY VIEW SA 5093	444

Mines and Energy Resources South Australia
Minerals Registration Branch

Printed: 11/5/1998

Operator Production by Category

Category: Dimension Stone
Period: 1986 / 06 .. to .. 1997 / 12
Tonnage in Excess of: 1

	Tonnage
DURMAN BARRY RONALD ANDAMOOKA STATION VIA WOOMERA SA 5720	410
HURST MAX RICHARD 17 DAUNCY ST KINGSCOTE SA 5223	361
CENTOFANTI C C/- POST OFFICE BALHANNAH SA 5242	325
KENNEDY LAWRENCE JOHN BOX 1003 MOUNT GAMBIER SA 5290	302
CHIGNOLA POPPY LIA TIZIA PO BOX 113 COOBER PEDY SA 5723	240
ZWIERSEN NICOLAAS STANLEY ST AUBURN SA 5451	191
WALLING SYSTEMS PTY LTD PO BOX 306 ANGASTON SA 5353	127
DODD CONTRACTORS PTY LTD PO BOX 838 PORT LINCOLN SA 5606	80
HEIN HAYDN TREVOR PO BOX 806 MURRAY BRIDGE SA 5253	42
DC OF LE HUNTE PO BOX 6 WUDINNA SA 5652	34
CHILMAN DEAN JOHN 45 STORY AVENUE ALDINGA BEACH SA 5173	30
HUCKS DONALD R 83 VICTORIA ST PETERBOROUGH SA 5422	27
HILL WARWICK HALSE PO BOX 153 WALLAROO SA 5556	25
AURI L PO BOX 297 WILLUNGA SA 5172	21
GEMSTONE CORP OF AUST LTD PO BOX 819 BONDI JUNCTION NSW 2022	2

Operator Production by Category

Category: Dimension Stone

Period: 1986 / 06 .. to .. 1997 / 12

Tonnage in Excess of: 1

	Tonnage
EDWARDS LOLA AGNES C/- MOUNT SCHANK METALS PL PO BOX 818 MT GAMBIER SA 5290	1
Total Tonnage:	437,122.96

Production by Product

Category: Dimension Stone
Product: DOLOMITE/LIMESTONE
Period: 1986 / 06 .. to .. 1997 / 12

Year: 1987

Period	Tonnage
06	467
Year Total:	467

Company Total: 467

ARIVERUN PTY LTD
PO BOX 517
RENMARK SA 5341

Year: 1992

Period	Tonnage
06	18,995
12	16,100
Year Total:	35,095

Year: 1993

Period	Tonnage
06	16,010
Year Total:	16,010

Company Total: 51,105

BRUHN DISTRIBUTORS
PO BOX 412
MT GAMBIER SA 5290

Year: 1986

Period	Tonnage
06	1,460
12	1,460
Year Total:	2,920

Year: 1987

Period	Tonnage
06	1,460
12	1,460
Year Total:	2,920

Year: 1988

Period	Tonnage
12	1,460
Year Total:	1,460

Year: 1989

Period	Tonnage
06	1,460
12	1,460
Year Total:	2,920

Year: 1990

Period	Tonnage
06	1,460
12	1,460
Year Total:	2,920

Production by Product

Category: Dimension Stone
Product: DOLOMITE/LIMESTONE
Period: 1986 / 06 .. to .. 1997 / 12

Year: 1991

Period	Tonnage
12	1,460
Year Total:	1,460

Year: 1992

Period	Tonnage
06	1,460
12	1,460
Year Total:	2,920

Year: 1993

Period	Tonnage
06	730
Year Total:	730

Year: 1994

Period	Tonnage
06	342
12	676
Year Total:	1,018

Year: 1995

Period	Tonnage
06	142
12	230
Year Total:	372

Year: 1996

Period	Tonnage
06	62
Year Total:	62

Company Total: 19,702

COMMERCIAL MINERALS LIMITED
PO BOX 74
ROSEWATER EAST SA 5013

Year: 1986

Period	Tonnage
06	327
12	375
Year Total:	702

Year: 1987

Period	Tonnage
06	489
12	592
Year Total:	1,081

Year: 1988

Period	Tonnage
06	696
12	750
Year Total:	1,446

Year: 1989

Period	Tonnage
06	585
12	581
Year Total:	1,166

Production by Product

Category: Dimension Stone
Product: DOLOMITE/LIMESTONE
Period: 1986 / 06 .. to .. 1997 / 12

Year: 1990

Period	Tonnage
06	497
Year Total:	497

Year: 1994

Period	Tonnage
12	423
Year Total:	423

Year: 1996

Period	Tonnage
12	629
Year Total:	629

Year: 1997

Period	Tonnage
06	385
Year Total:	385

Company Total: 6,329

DC OF LE HUNTE
PO BOX 6
WUDINNA SA 5652

Year: 1991

Period	Tonnage
12	34
Year Total:	34

Company Total: 34

DL SCOTT & SON
20 PINE ST
STIRLING SA 5152

Year: 1991

Period	Tonnage
12	30
Year Total:	30

Year: 1992

Period	Tonnage
06	50
12	24
Year Total:	74

Year: 1993

Period	Tonnage
06	50
12	12
Year Total:	62

Year: 1996

Period	Tonnage
06	24
Year Total:	24

Year: 1997

Period	Tonnage
06	25

Production by Product

Category: Dimension Stone
Product: DOLOMITE/LIMESTONE
Period: 1986 / 06 .. to .. 1997 / 12

12	48
Year Total:	73

Company Total: 263

GRIEVES GARY COLIN
BOX 202
RENMARK SA 5341

Year: 1989

Period	Tonnage
06	108
Year Total:	108

Year: 1990

Period	Tonnage
06	130
Year Total:	130

Company Total: 238

HAINES GJ
C/- MT GAMBIER WEST POST OFF
MT GAMBIER SA 5290

Year: 1991

Period	Tonnage
12	197
Year Total:	197

Year: 1992

Period	Tonnage
06	207
12	198
Year Total:	405

Year: 1993

Period	Tonnage
06	122
12	142
Year Total:	264

Year: 1994

Period	Tonnage
06	182
12	128
Year Total:	310

Year: 1995

Period	Tonnage
06	191
12	198
Year Total:	389

Year: 1996

Period	Tonnage
06	136
12	199
Year Total:	335

Production by Product

Category: Dimension Stone
Product: DOLOMITE/LIMESTONE
Period: 1986 / 06 .. to .. 1997 / 12

Year: 1997

Period	Tonnage
06	229
12	87
Year Total:	316

Company Total: 2,216

KENNEDY LAWRENCE JOHN
BOX 1003
MOUNT GAMBIER SA 5290

Year: 1988

Period	Tonnage
06	302
Year Total:	302

Company Total: 302

LAWSON ROBERT MELVILLE
C/- J A GALPIN
PO BOX 246
MT GAMBIER SA 5290

Year: 1990

Period	Tonnage
12	260
Year Total:	260

Year: 1991

Period	Tonnage
06	672
12	550
Year Total:	1,222

Year: 1992

Period	Tonnage
06	994
12	623
Year Total:	1,617

Year: 1993

Period	Tonnage
06	1,007
12	803
Year Total:	1,810

Year: 1994

Period	Tonnage
06	736
12	1,006
Year Total:	1,742

Year: 1995

Period	Tonnage
06	1,300
12	1,495
Year Total:	2,795

Year: 1996

Period	Tonnage
06	714

Production by Product

Category: Dimension Stone
Product: DOLOMITE/LIMESTONE
Period: 1986 / 06 .. to .. 1997 / 12

12	890
Year Total:	1,604

Year: 1997

Period	Tonnage
06	1,055
12	851
Year Total:	1,906

Company Total: 12,956

LORBAR NOMINEES PL
C/- BRUHN DISTRIBUTORS
PO BOX 412
MT GAMBIER SA 5290

Year: 1986

Period	Tonnage
06	787
12	1,051
Year Total:	1,838

Year: 1987

Period	Tonnage
06	758
12	2,000
Year Total:	2,758

Year: 1988

Period	Tonnage
06	1,460
12	2,000
Year Total:	3,460

Year: 1989

Period	Tonnage
06	2,000
12	2,000
Year Total:	4,000

Year: 1990

Period	Tonnage
06	2,000
12	2,000
Year Total:	4,000

Year: 1991

Period	Tonnage
12	2,000
Year Total:	2,000

Year: 1992

Period	Tonnage
12	2,000
Year Total:	2,000

Year: 1993

Period	Tonnage
06	2,000
12	2,000
Year Total:	4,000

Production by Product

Category: Dimension Stone
Product: DOLOMITE/LIMESTONE
Period: 1986 / 06 .. to .. 1997 / 12

Year: 1994

Period	Tonnage
06	2,000
12	2,000
Year Total:	4,000

Year: 1995

Period	Tonnage
06	2,000
12	2,000
Year Total:	4,000

Year: 1996

Period	Tonnage
06	2,000
12	2,000
Year Total:	4,000

Year: 1997

Period	Tonnage
06	2,000
12	2,000
Year Total:	4,000

Company Total: 40,056

PHILP E W A
4/17 TROWBRIDGE AVE
MITCHELL PARK SA 5043

Year: 1986

Period	Tonnage
06	392
12	419
Year Total:	811

Year: 1987

Period	Tonnage
06	361
12	431
Year Total:	792

Year: 1988

Period	Tonnage
06	471
12	433
Year Total:	904

Year: 1989

Period	Tonnage
12	308
Year Total:	308

Year: 1990

Period	Tonnage
06	407
Year Total:	407

Company Total: 3,222

Production by Product

Category: Dimension Stone
Product: DOLOMITE/LIMESTONE
Period: 1986 / 06 .. to .. 1997 / 12

SCHERER CONTRACTORS PL
PO BOX 517
RENMARK SA 5341

Year: 1995

Period	Tonnage
06	13,030
Year Total:	13,030

Company Total: 13,030

SOUTH EAST AUTOMOBILE CLUB
PO BOX 1551
MOUNT GAMBIER SA 5290

Year: 1986

Period	Tonnage
06	760
12	1,048
Year Total:	1,808

Year: 1987

Period	Tonnage
06	920
12	816
Year Total:	1,736

Year: 1988

Period	Tonnage
06	908
12	996
Year Total:	1,904

Year: 1989

Period	Tonnage
06	1,042
12	1,213
Year Total:	2,255

Year: 1990

Period	Tonnage
06	1,319
12	840
Year Total:	2,159

Year: 1991

Period	Tonnage
06	346
12	410
Year Total:	756

Year: 1992

Period	Tonnage
06	166
12	420
Year Total:	586

Year: 1993

Period	Tonnage
06	145

Production by Product

Category: Dimension Stone
Product: DOLOMITE/LIMESTONE
Period: 1986 / 06 .. to .. 1997 / 12

12	270
Year Total:	415

Year: 1994

Period	Tonnage
06	290
12	230
Year Total:	520

Company Total: 12,139

STAFFORD & EARL
PO BOX 2670
MOUNT GAMBIER SA 5290

Year: 1986

Period	Tonnage
06	826
12	800
Year Total:	1,626

Year: 1987

Period	Tonnage
06	950
12	900
Year Total:	1,850

Year: 1988

Period	Tonnage
06	1,200
12	1,300
Year Total:	2,500

Year: 1989

Period	Tonnage
06	1,500
12	1,500
Year Total:	3,000

Year: 1990

Period	Tonnage
06	2,000
12	1,500
Year Total:	3,500

Year: 1991

Period	Tonnage
06	900
12	1,000
Year Total:	1,900

Year: 1992

Period	Tonnage
06	1,350
12	1,500
Year Total:	2,850

Year: 1993

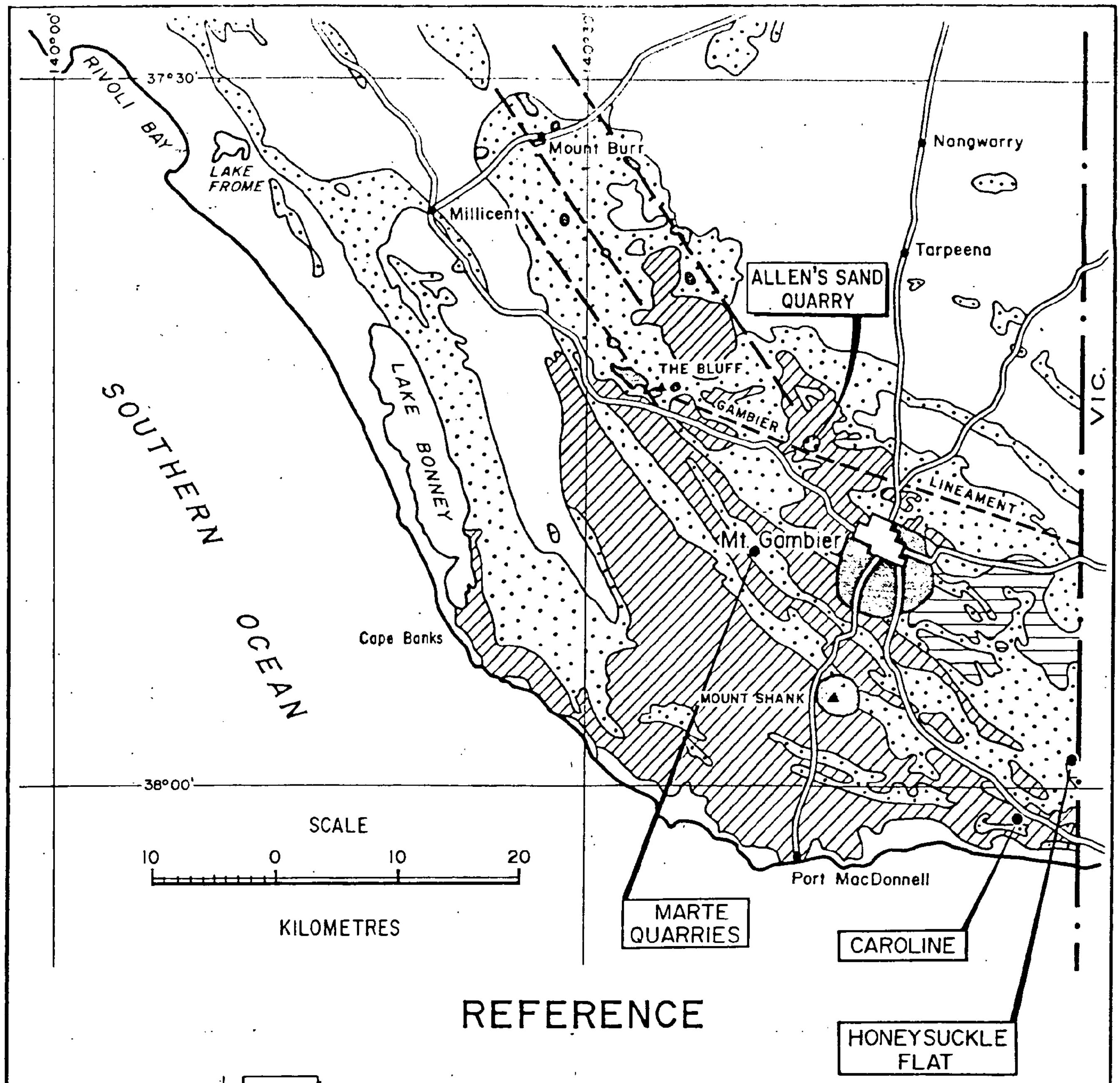
Period	Tonnage
06	1,750
12	1,645
Year Total:	3,395

Production by Product

Category: Dimension Stone
Product: DOLOMITE/LIMESTONE
Period: 1986 / 06 .. to .. 1997 / 12

Year	Period	Tonnage
Year: 1994	12	1,900
	Year Total:	1,900
Year: 1995	06	1,945
	12	2,005
	Year Total:	3,950
Year: 1996	06	1,865
	12	1,865
	Year Total:	3,730
Year: 1997	06	2,260
	12	2,575
	Year Total:	4,835

Company Total: 35,036



REFERENCE

Quaternary
- ☐ Undifferentiated deposits
- ⁘ Bridgewater Formation : calcarenite, stranded dune and beach deposits
- ☰ Whalers Bluff Formation : sandy limestone
- ░ Volcanics

Tertiary
- ▨ Gambier Limestone : pale bryzoal limestone
- ⊙ Tartwaup Fm : coarse sand, clay and silt exposed in workings at Allen's Sand Quarry

— — Inferred faults

NOTE : Modified from Rogers (1980), Keeling (1983) and Sheard (1983)

FIG. 1

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

GAMBIER LIMESTONE
REGIONAL GEOLOGY

COMPILED D.F.
DRAWN T. M.
DATE Sept '86
CHECKED
4 · 2 · 88
C D O DATE
SCALE 1:500 000
PLAN NUMBER
S18943

4217

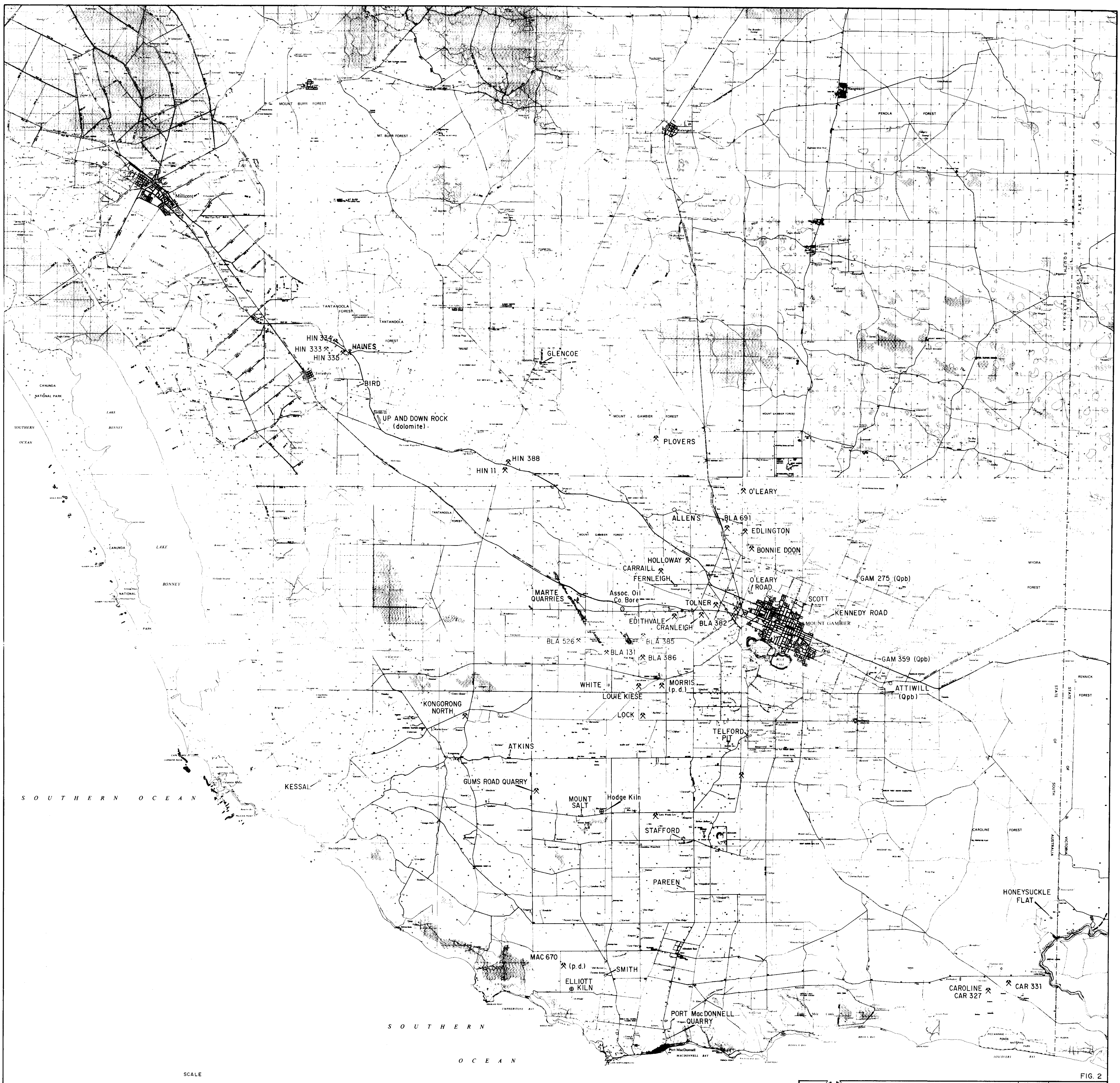


FIG. 2

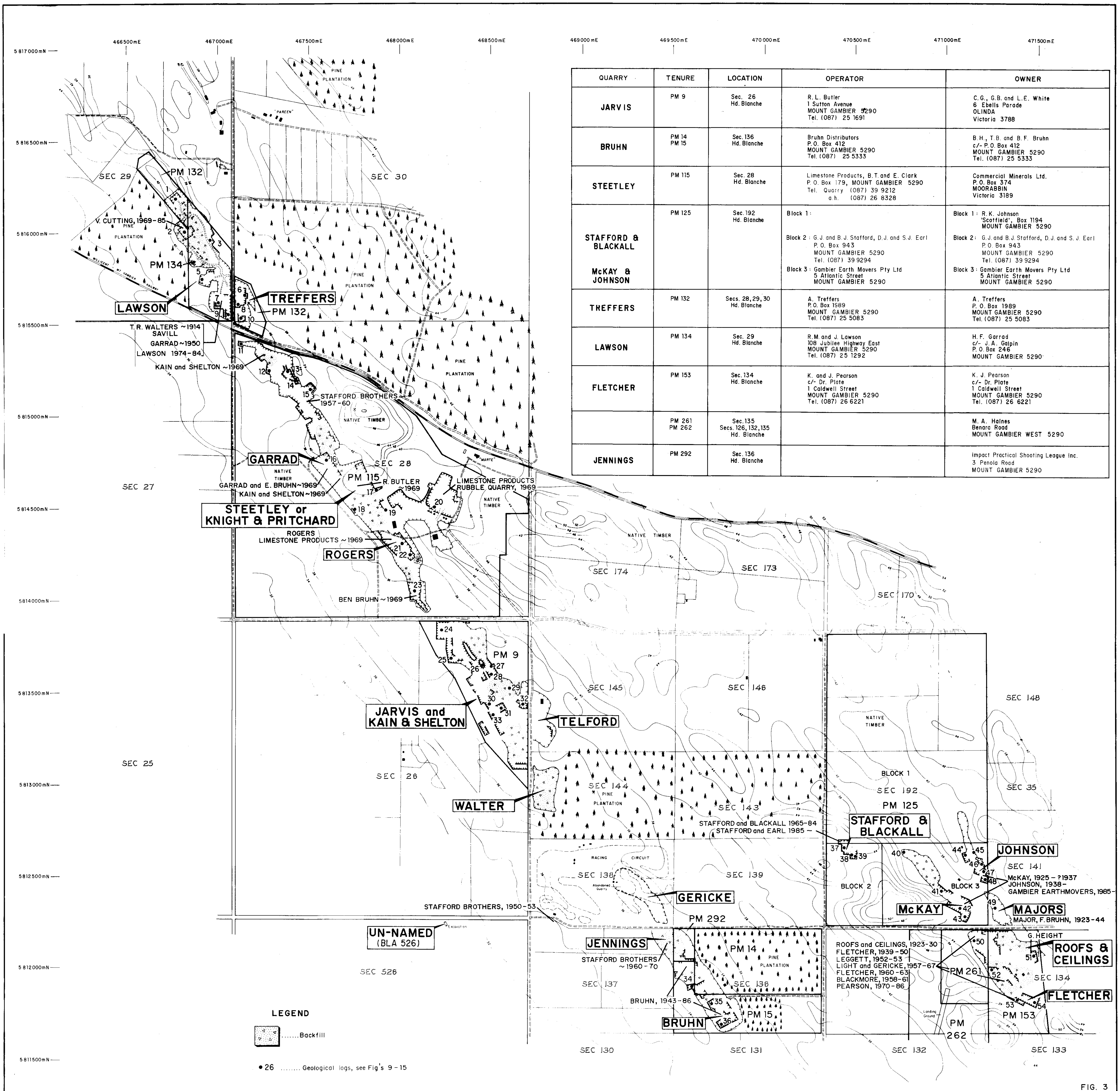
DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

GAMBIER LIMESTONE

QUARRY LOCATIONS

COMPILED D. F.	WR C.D.O. 4·2·88 DATE
DRAWN M. B.	SCALE 1: 100 000
DATE May '87	PLAN NUMBER
CHECKED	87-761

QUARRY	TENURE	LOCATION	OPERATOR	OWNER
JARVIS	PM 9	Sec. 26 Hd. Blanche	R. L. Butler 1 Sutton Avenue MOUNT GAMBIER 5290 Tel. (087) 25 1691	C. G., G. B. and L. E. White 6 Ebells Parade OLINDA Victoria 3788
BRUHN	PM 14 PM 15	Sec. 136 Hd. Blanche	Bruhn Distributors P. O. Box 412 MOUNT GAMBIER 5290 Tel. (087) 25 5333	B. H., T. B. and B. F. Bruhn c/- P. O. Box 412 MOUNT GAMBIER 5290 Tel. (087) 25 5333
STEETLEY	PM 115	Sec. 28 Hd. Blanche	Limestone Products, B. T. and E. Clark P. O. Box 179, MOUNT GAMBIER 5290 Tel. Quarry (087) 39 9212 a.h. (087) 26 8328	Commercial Minerals Ltd. P. O. Box 374 MOORABBIN Victoria 3189
STAFFORD & BLACKALL **McKAY & JOHNSON**	PM 125	Sec. 192 Hd. Blanche	Block 1 : Block 2 : G. J. and B. J. Stafford, D. J. and S. J. Earl P. O. Box 943 MOUNT GAMBIER 5290 Tel. (087) 39 9294 Block 3 : Gambier Earth Movers Pty Ltd 5 Atlantic Street MOUNT GAMBIER 5290	Block 1 : R. K. Johnson 'Scotfield', Box 1194 MOUNT GAMBIER 5290 Block 2 : G. J. and B. J. Stafford, D. J. and S. J. Earl P. O. Box 943 MOUNT GAMBIER 5290 Tel. (087) 39 9294 Block 3 : Gambier Earth Movers Pty Ltd 5 Atlantic Street MOUNT GAMBIER 5290
TREFFERS	PM 132	Secs. 28, 29, 30 Hd. Blanche	A. Treffers P. O. Box 1989 MOUNT GAMBIER 5290 Tel. (087) 25 5083	A. Treffers P. O. Box 1989 MOUNT GAMBIER 5290 Tel. (087) 25 5083
LAWSON	PM 134	Sec. 29 Hd. Blanche	R. M. and J. Lawson 108 Jubilee Highway East MOUNT GAMBIER 5290 Tel. (087) 25 1292	H. F. Garrad c/- J. A. Galpin P. O. Box 246 MOUNT GAMBIER 5290
FLETCHER	PM 153	Sec. 134 Hd. Blanche	K. and J. Pearson c/- Dr. Plate 1 Caldwell Street MOUNT GAMBIER 5290 Tel. (087) 26 6221	K. J. Pearson c/- Dr. Plate 1 Caldwell Street MOUNT GAMBIER 5290 Tel. (087) 26 6221
	PM 261 PM 262	Sec. 135 Secs. 126, 132, 135 Hd. Blanche		M. A. Haines Benara Road MOUNT GAMBIER WEST 5290
JENNINGS	PM 292	Sec. 136 Hd. Blanche		Impact Practical Shooting League Inc. 3 Penola Road MOUNT GAMBIER 5290



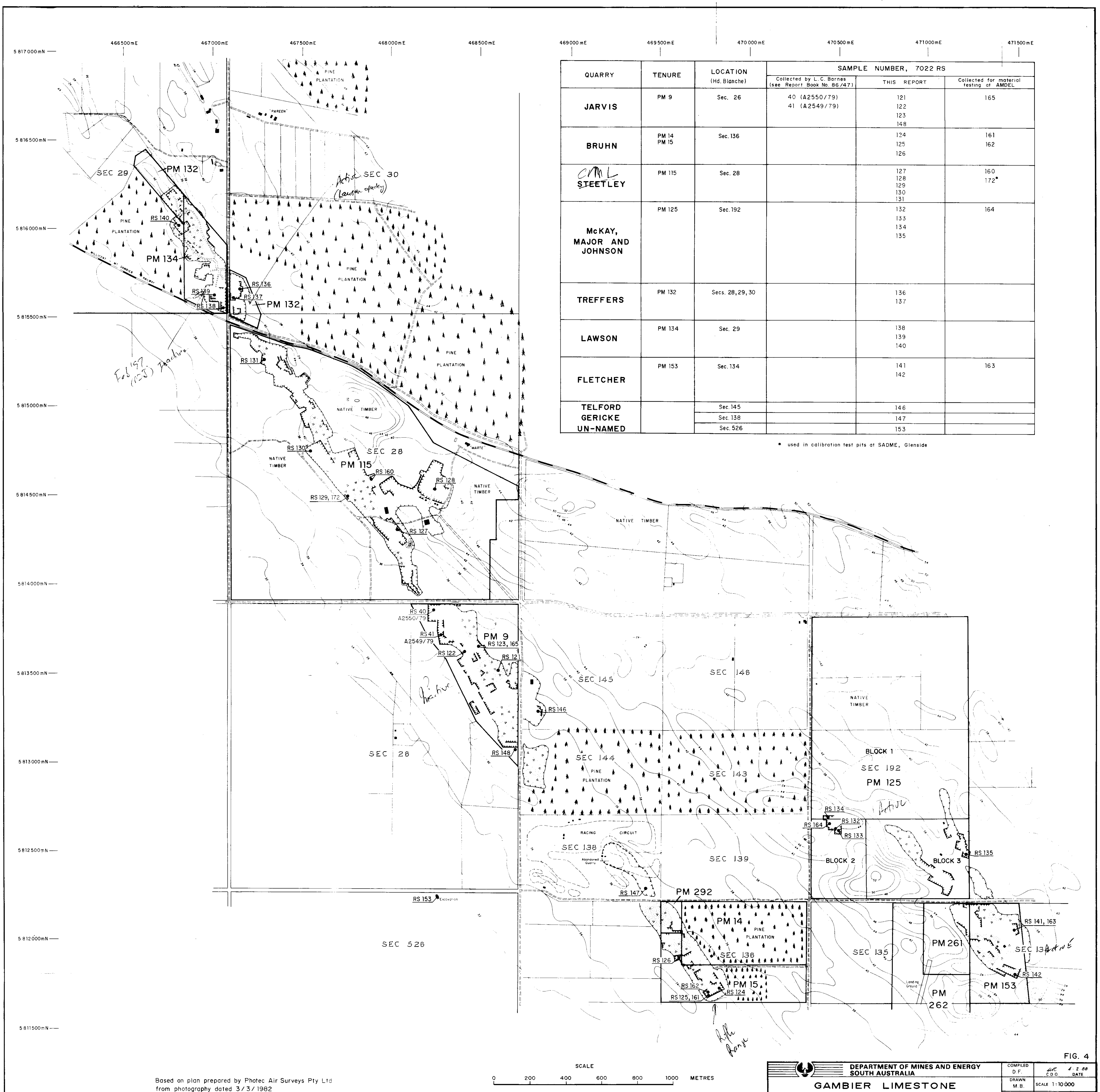
Based on plan prepared by Photec Air Surveys Pty Ltd
from photography dated 3/3/1982

FIG. 3

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

GAMBIER LIMESTONE
LOCATION OF GEOLOGICAL LOGS AND
MINING TENEMENTS AS AT 30-6-86

COMPILED D. F.	C.D.O. 4·2-88 DATE
DRAWN M. B.	SCALE 1:10 000
DATE Sept '86	PLAN NUMBER
CHECKED	86 - 570



QUARRY	TENURE	LOCATION (Hd. Blanche)	SAMPLE NUMBER, 7022 RS		
			Collected by L. C. Barnes (see Report Book No. 86/47)	THIS REPORT	Collected for material testing at AMDEL
JARVIS	PM 9	Sec. 26	40 (A2550/79) 41 (A2549/79)	121 122 123 148	165
BRUHN	PM 14 PM 15	Sec. 136		124 125 126	161 162
CML ~~STEETLEY~~	PM 115	Sec. 28		127 128 129 130 131	160 172*
McKAY, MAJOR AND JOHNSON	PM 125	Sec. 192		132 133 134 135	164
TREFFERS	PM 132	Secs. 28, 29, 30		136 137	
LAWSON	PM 134	Sec. 29		138 139 140	
FLETCHER	PM 153	Sec. 134		141 142	163
TELFORD		Sec. 145		146	
GERICKE		Sec. 138		147	
UN-NAMED		Sec. 526		153	

* used in calibration test pits at SADME, Glenside

Based on plan prepared by Photec Air Surveys Pty Ltd
from photography dated 3/3/1982

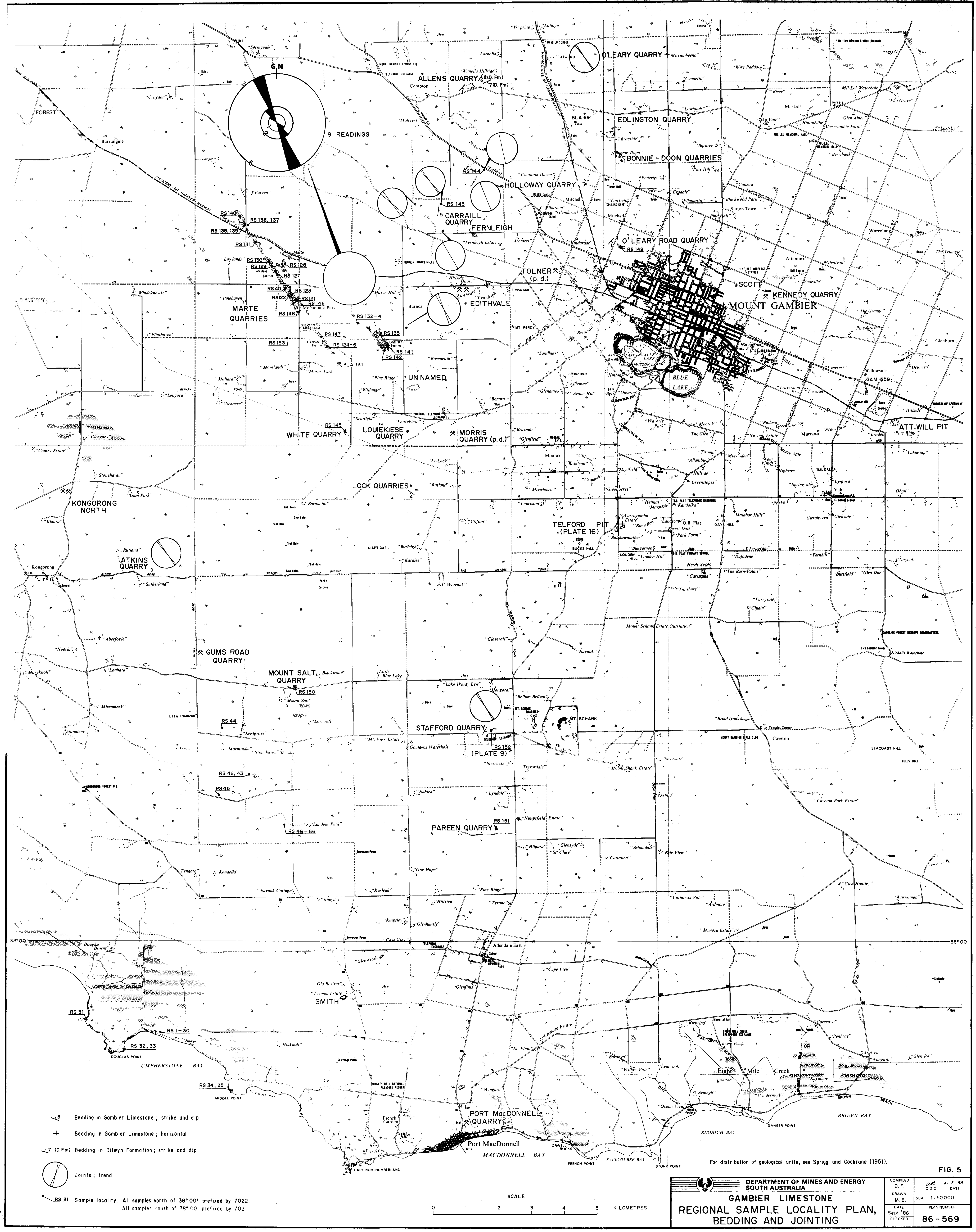
FIG. 4

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

GAMBIER LIMESTONE

MARTE AREA - SAMPLE LOCATIONS

COMPILED D.F.	C.D.O. DATE 4 · 2 · 88
DRAWN M.B.	SCALE 1:10000
DATE Sept '86	PLAN NUMBER 86-573
CHECKED	



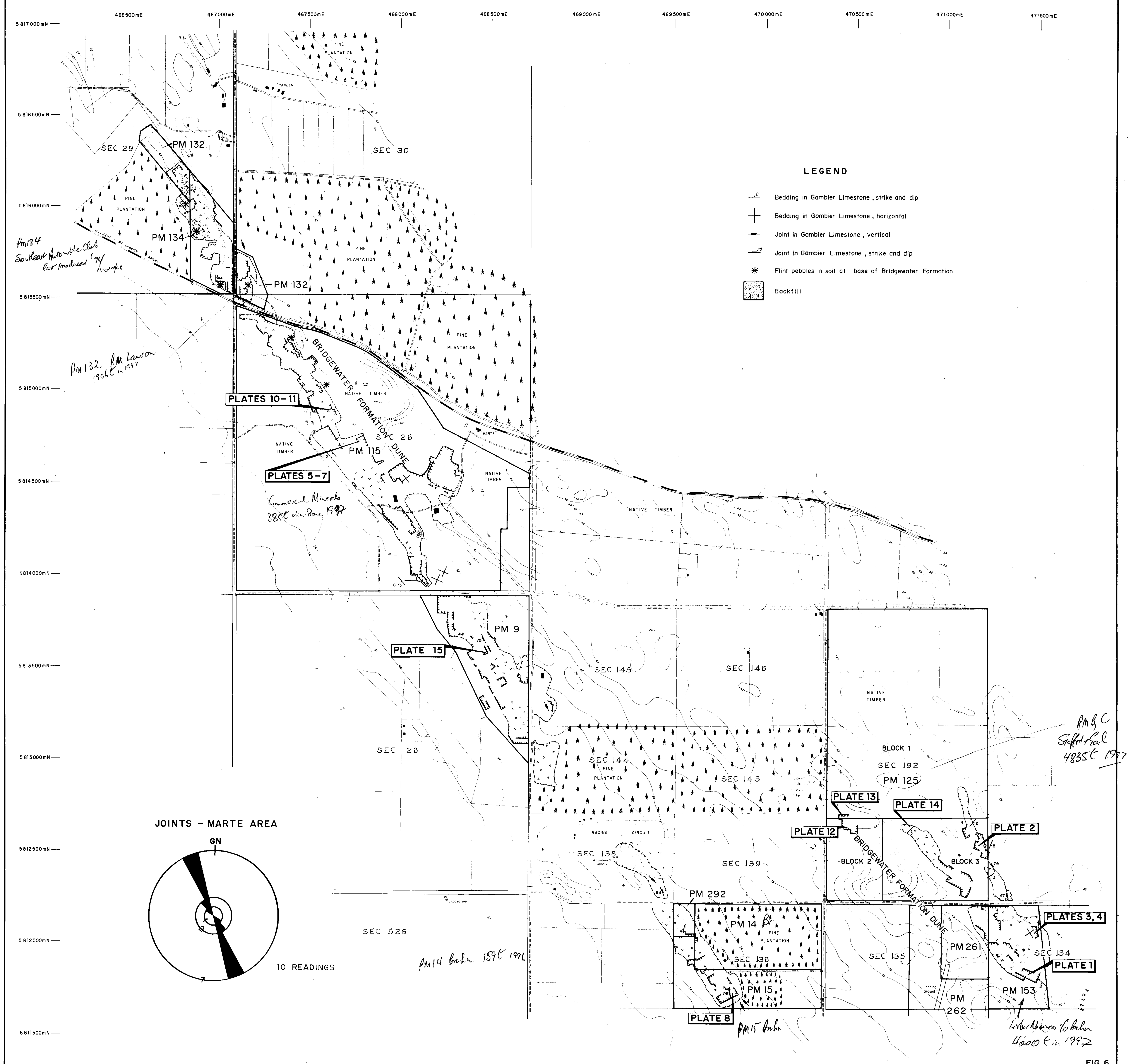
For distribution of geological units, see Sprigg and Cochrane (1951).

FIG. 5

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

GAMBIER LIMESTONE
REGIONAL SAMPLE LOCALITY PLAN, BEDDING AND JOINTING

COMPILED D. F.	*WR* C.D.O	*4. 2. 88* DATE
DRAWN M. B.	SCALE 1 : 50000	
DATE Sept '86	PLAN NUMBER	
CHECKED	86 - 569	



LEGEND

⊥2	Bedding in Gambier Limestone, strike and dip
+	Bedding in Gambier Limestone, horizontal
—	Joint in Gambier Limestone, vertical
⊥75	Joint in Gambier Limestone, strike and dip
✳	Flint pebbles in soil at base of Bridgewater Formation
▨	Backfill

Pm134
Southeast Automobile Club
last produced '94
Noted 09/98

Pm132 RM Lawson
1906t in 1997

Commercial Minerals
385t dim Stone 1997

Br

Pm14 Bahn. 159t 1996

PM15 Bahn

PM & C
Stafford + Earl
4835t 1997

Lorber Nominees to Bahn
4000 t in 1997

SCALE
0 200 400 600 800 1000 METRES

Based on plan prepared by Photec Air Surveys Pty Ltd
from photography dated 3/3/1982

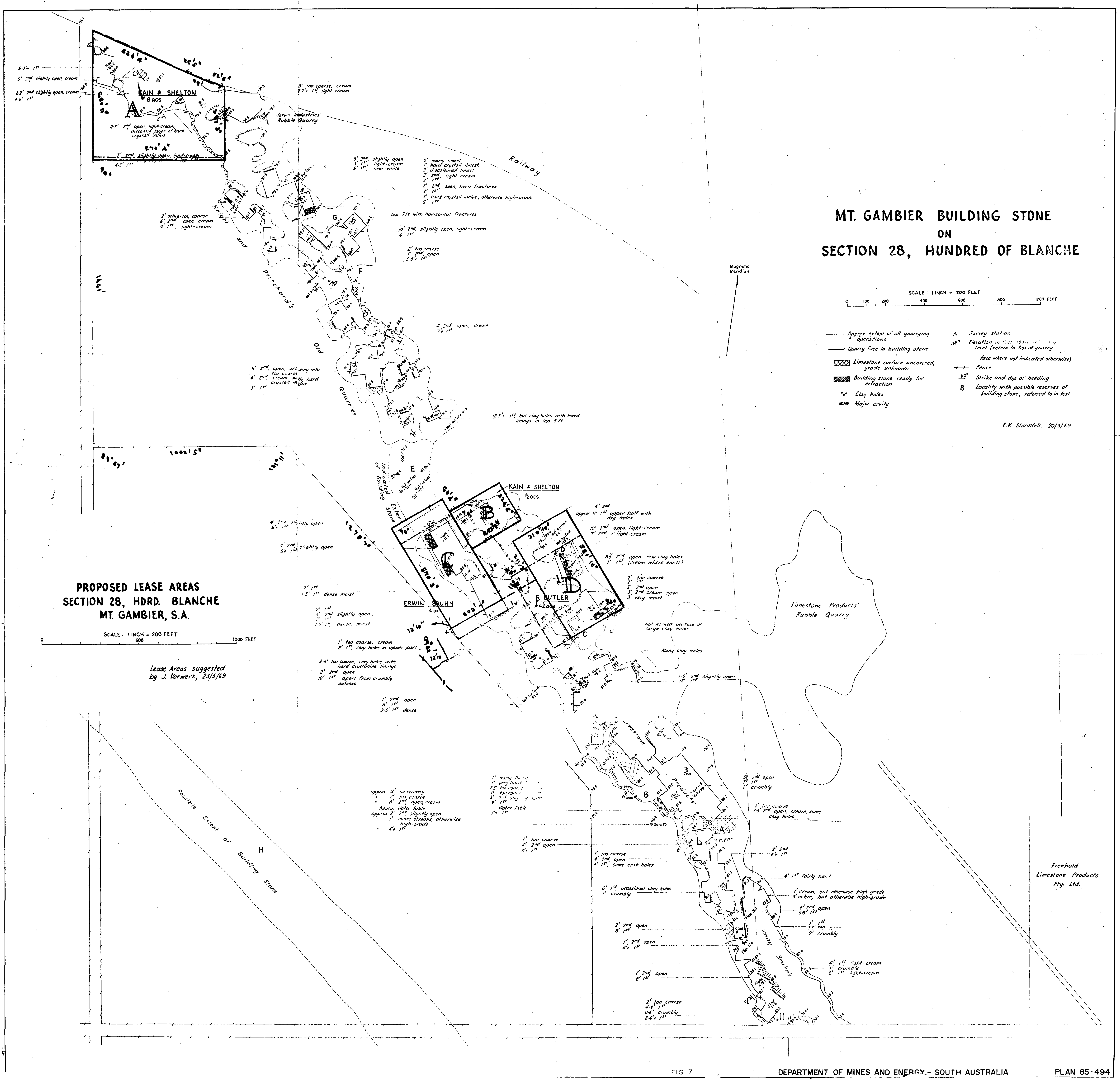
FIG. 6

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

GAMBIER LIMESTONE

MARTE AREA - BEDDING AND JOINTS

COMPILED D. F.	we C.D.O 4·2·88 DATE
DRAWN M. B.	SCALE 1:10000
DATE Sept '86	PLAN NUMBER
CHECKED	86-5



MT. GAMBIER BUILDING STONE
ON
SECTION 28, HUNDRED OF BLANCHE

SCALE : 1 INCH = 200 FEET

0 100 200 400 600 800 1000 FEET

—·—	Approx. extent of all quarrying operations	△	Survey station
——⌟	Quarry face in building stone	.88·3	Elevation in feet above arbitrary level (refers to top of quarry face where not indicated otherwise)
☒	Limestone surface uncovered, grade unknown	—+—	Fence
▩	Building stone ready for extraction	⊥2°	Strike and dip of bedding
•∘•	Clay holes	B	Locality with possible reserves of building stone, referred to in text
▨	Major cavity		

E.K. Sturmfels, 20/3/69

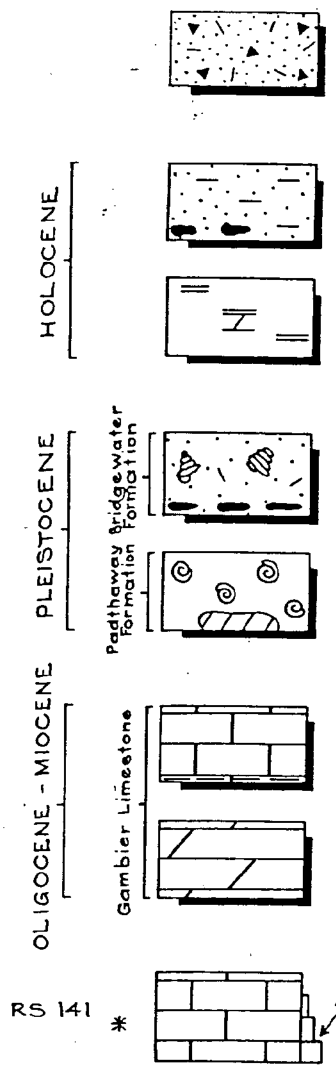
PROPOSED LEASE AREAS
SECTION 28, HDRD. BLANCHE
MT. GAMBIER, S.A.

SCALE : 1 INCH = 200 FEET

0 500 1000 FEET

Lease Areas suggested by J. Vorwerk, 23/5/69

FIG 7 DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA PLAN 85-494



BACKFILL

SOIL : Residual flint pebbles at the base.

CALCRETE (platy)

Shelly sands and silts with finely comminuted mollusc fragments. Flint pebble bed (s) at the base.

Grey shelly sand and silt; abundant intact spiral shaped molluscs; rare grey - black dolomite at base.

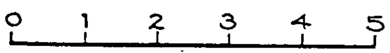
CALCARENITE, CALCISILTITE and CALCIRUDITE : Fine - grained, marly bed along which ashlars fractures.

DOLOMITE

Cut ashlars ; each either 300mm or 440mm (rare) high. Sample number and locality ; prefixed by 7022.

-------S.W.L. Static water level.

VERTICAL SCALE



METRES

Note : For location of each geological log, see Fig's. 2 and 3

FIG. 8

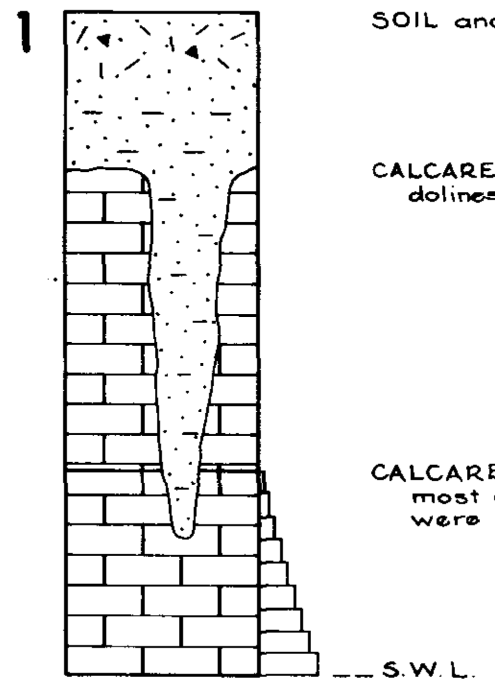
DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

GAMBIER LIMESTONE

LEGEND FOR GEOLOGICAL LOGS 1 - 54

COMPILED D. F.	C.D.O 4 · 2 · 88 DATE
DRAWN M. B.	SCALE
DATE April '87	PLAN NUMBER
CHECKED	S19538

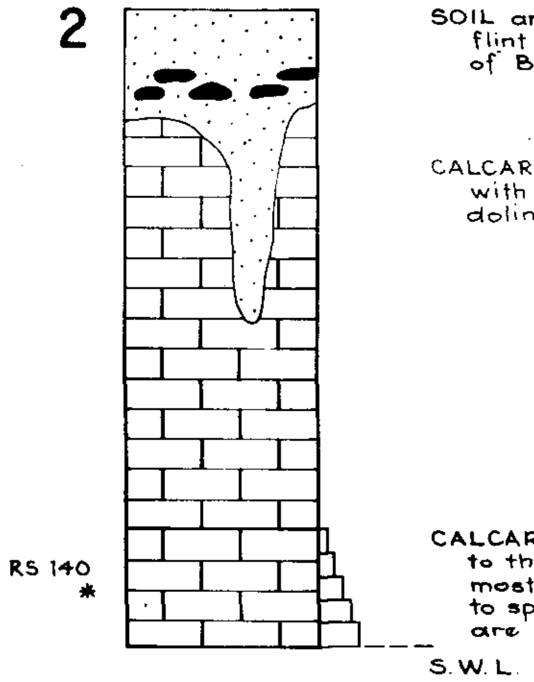
4217



SOIL and STOCKPILED OVERBURDEN

CALCARENITE : Weathered, friable and with abundant dolines extending down to at least 3rd layer of ashlars.

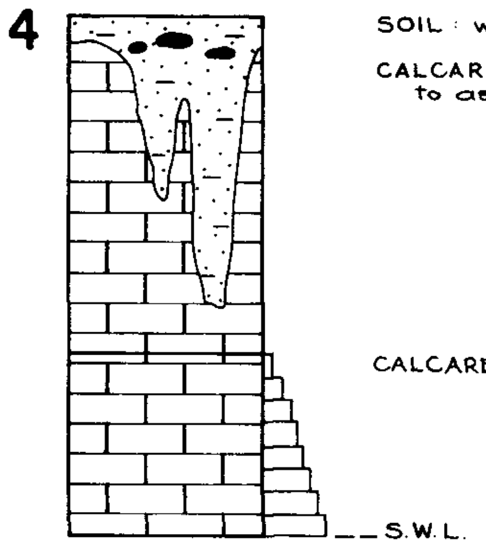
CALCARENITE : Numerous cracks in quarry faces, most of which indicate movement since ashlars were cut.



SOIL and BRIDGEWATER FORMATION : Abundant well rounded, flint pebbles which probably form part of beach deposit of Bridgewater Formation.

CALCARENITE : Weathered, friable, weakly bedded and with yellow iron stained horizontal bands. Base of dolines at 4·2m.

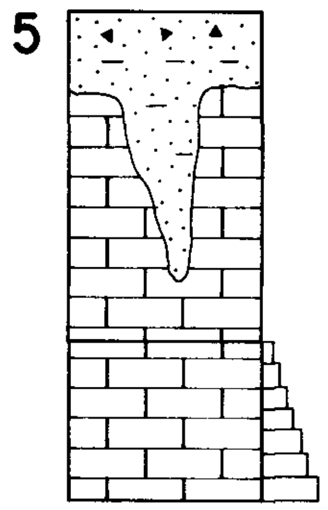
CALCARENITE : Variable texture and colour, from brilliant white to the more common cream. Open bryozoal fragments most common with crystalline cement, but material ranges to specimens with abundant amorphous matrix and hence are more friable.



SOIL : with flint pebbles.

CALCARENITE : Weathered, rubbly and with dolines down to ashlar level.

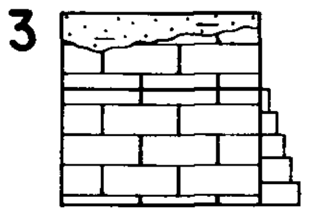
CALCARENITE



SOIL and STOCKPILED OVERBURDEN

CALCARENITE : Weathered, friable and with dolines.

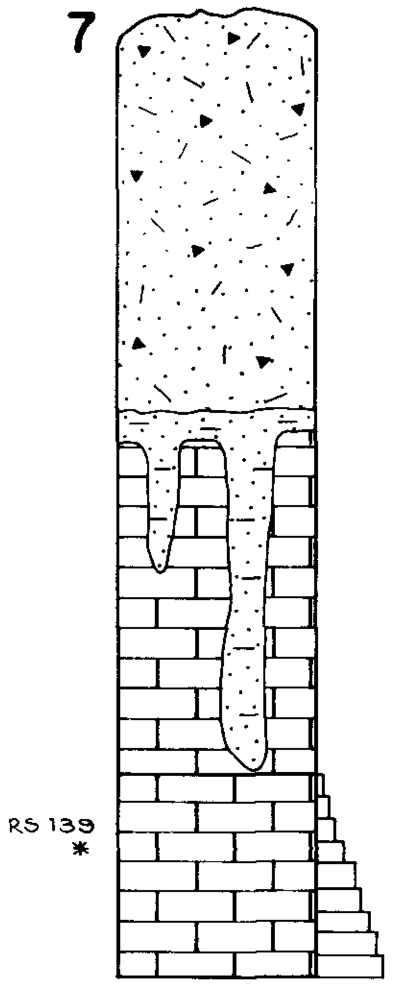
CALCARENITE



SOIL

CALCARENITE

CALCARENITE

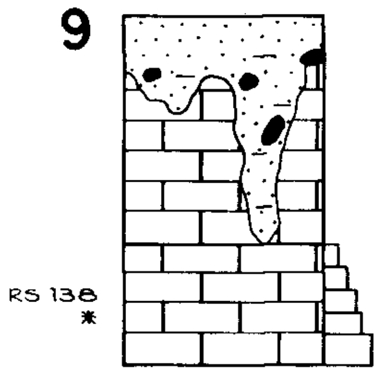


STOCKPILED OVERBURDEN

SOIL

CALCARENITE : Weathered, friable and with dolines down to ashlar level.

CALCARENITE : 1st grade white ashlars - brilliant white and consisting of an open but very well cemented framework of bryozoal fragments. Internal cavities within bryozoa filled with cement.

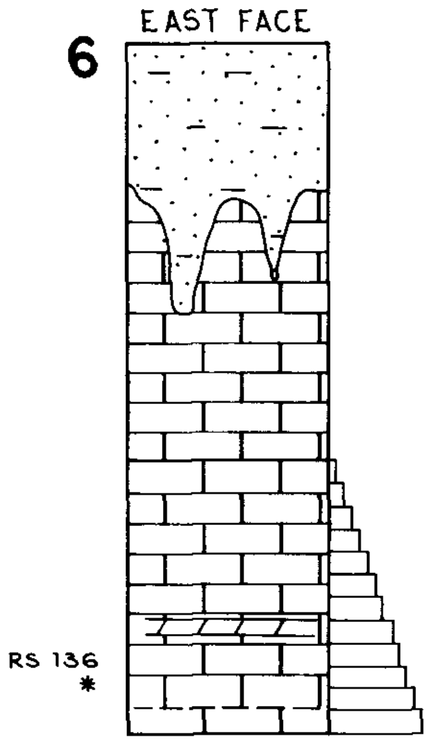


SOIL : Contains rounded pebbles of calcrete and flint.

CALCARENITE : Weathered, friable.

CALCARENITE : White to offwhite. Variable texture ranging from medium grained, even grained, cemented and without matrix to material containing more abundant amorphous matrix.

VERTICAL SCALE



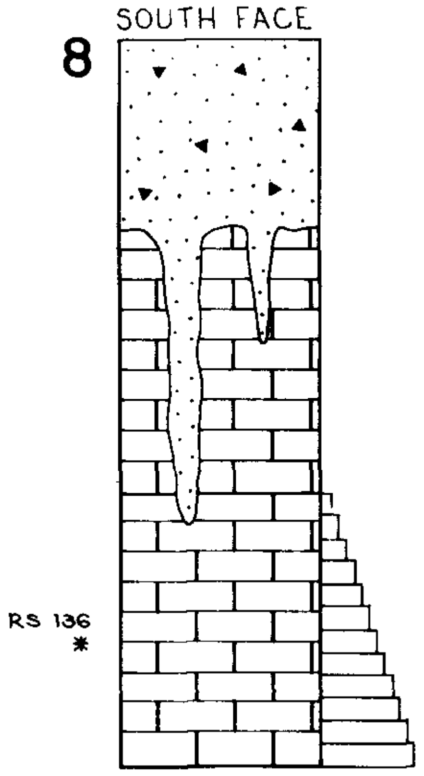
SOIL

CALCARENITE : Weathered, friable; minor platy layering.

CALCARENITE : Similar to South Face of quarry but with more abundant poorly-crystalline matrix and hence is described as more 'puggy'.

3 thin (0·5 - 3·0cm), pale tan dolomite bands over a vertical interval of 0·25m.

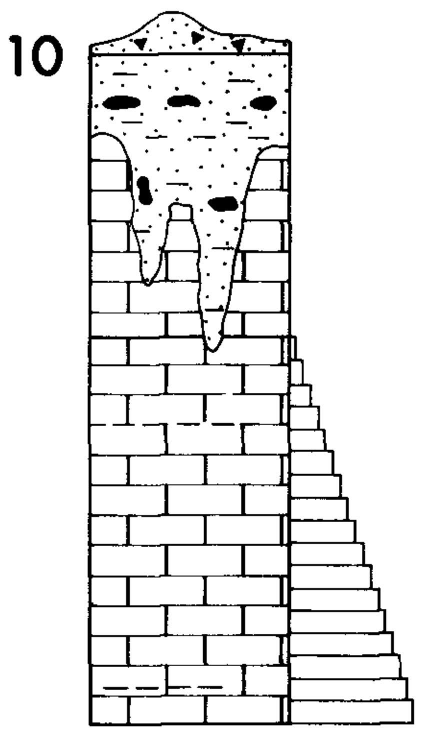
Pale green marly band along which ashlars fractures.



BACKFILL : Original soil profile at base.

CALCARENITE : Weathered, friable and with dolines through to ashlar level. Platy layering of calcrete. Dolines more common on South Face than East Face.

CALCARENITE : Medium-grained, even-grained, white to off white. Strong and coherent with slightly-dolomitic cement coating bryozoal fragments. Amorphous matrix minor and developed only in small patches.



OVERBURDEN : (to 4m high)

SOIL and minor BRIDGEWATER FORMATION : Contains flint pebbles (undifferentiated) and platy calcrete.

CALCARENITE : Weathered, friable and with dolines through to ashlar level. Bedded with pronounced grain size variations from coarse to fine; coarse bands iron stained and partly dolomitised. Fine-grained bands white and chalky.

CALCARENITE : Material quality the same as in the face immediately to the north. Ashlar rejects indicate pale green, marly bands are present, but were not mapped at any specific level in the face. Marly bands contain intact molluscs

Location of logs shown on Fig. 3 , Plan 86-570

FIG. 9

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

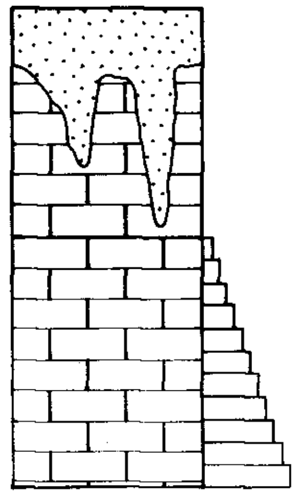
GAMBIER LIMESTONE

GEOLOGICAL LOGS 1—10
LAWSON AND TREFFERS QUARRIES

COMPILED D. F.
DRAWN M. B.
DATE April '87
CHECKED
WR C.D.O.
4.7.88 DATE
SCALE
PLAN NUMBER 87-762

4217

11

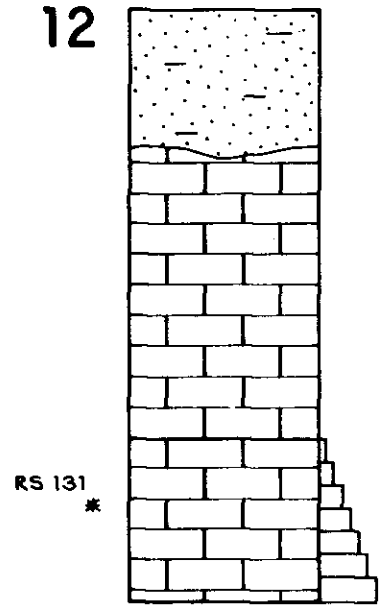


SOIL

CALCARENITE : Weathered, friable and with dolines.

CALCARENITE : Coarse grained, distinctly creamy and with variable fine grained creamy matrix. Weakly bedded.

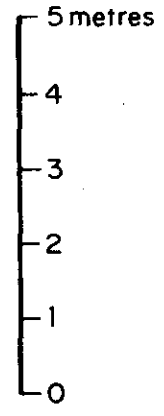
12



SOIL : Dark red brown.

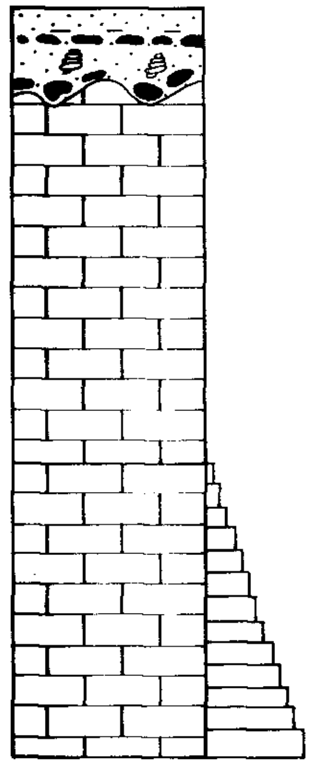
CALCARENITE : Weathered, friable.

CALCARENITE : Bryozoal with only very minor echinoid fragments. Offwhite to creamy; bryozoal fragments are distinctly whiter than the abundant creamy matrix.



VERTICAL SCALE

13



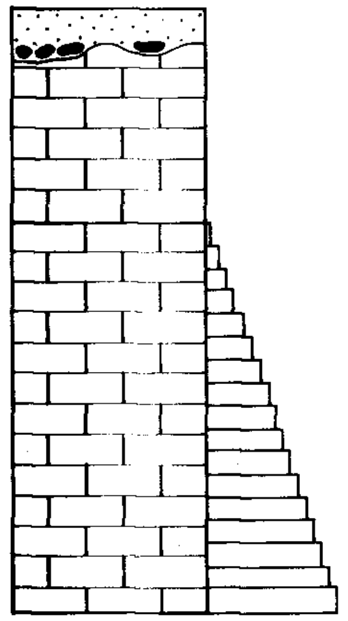
SOIL : Contains flint pebbles as surface residuals.

BRIDGEWATER FORMATION : Flint pebble beds; lower thicker band 0·6m thick and consists of very well rounded black and brown flint which is still slightly cavernous. Finely comminuted mollusc fragments between flint beds.

CALCARENITE : Weathered, friable.

CALCARENITE : Creamy, yellower near the top Coarse grained and with tubular bryozoa dominant.

14

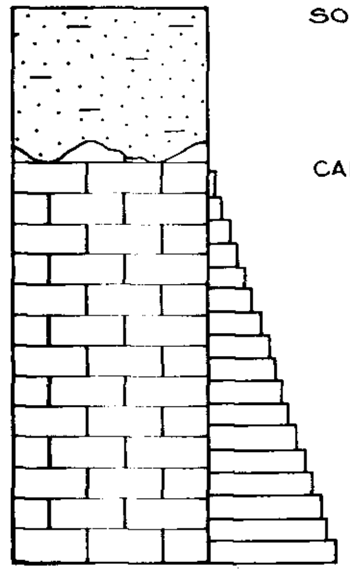


SOIL and BRIDGEWATER FORMATION : Contains well rounded flint pebbles.

CALCARENITE : Weathered, friable.

CALCARENITE : Light and porous, offwhite, dominantly tubular bryozoa.

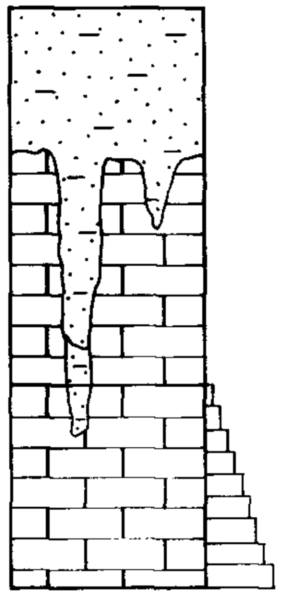
15



SOIL : Dark red and yellow-red sandy soil.

CALCARENITE : Very light and highly porous with almost no matrix, bryozoa cemented producing strong coherent ashlars. Creamy. Ashlars cut from upper levels which are stained and usually rejected as too crumbly.

16

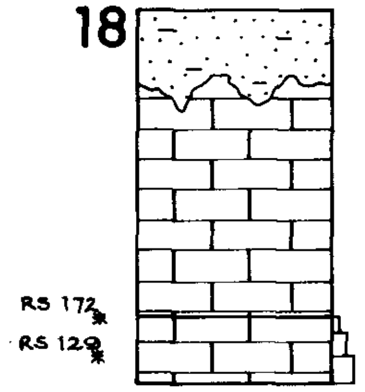


SOIL and BRIDGEWATER FORMATION : (undifferentiated).

CALCARENITE : Weathered, crumbly.

CALCARENITE : White, medium grained, high porosity, coherent with crystalline cement coating bryozoal fragments.

18

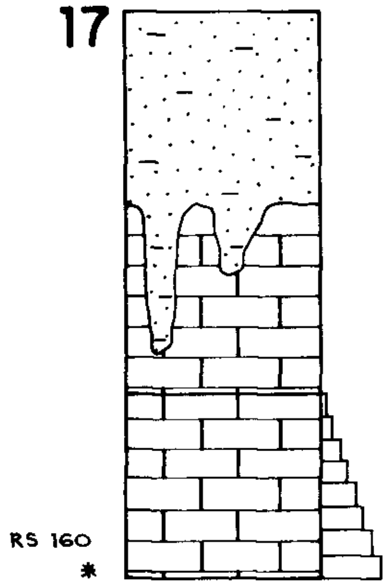


SOIL

CALCARENITE : Weathered, crumbly.

CALCARENITE : Brilliant white, highly porous with absence of amorphous matrix and with minor but well crystalline cement coating tubular bryozoal fragments.

17

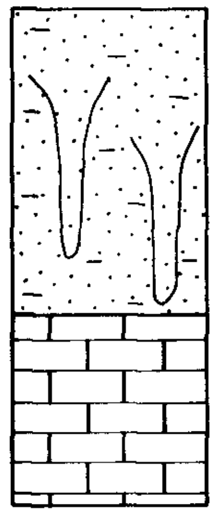


SOIL and BRIDGEWATER FORMATION : (undifferentiated).

CALCARENITE : Weathered, crumbly and with abundant infilled dolines.

CALCARENITE : Medium to coarse grained, creamy, distinctly porous and very light, dominantly tubular bryozoa.

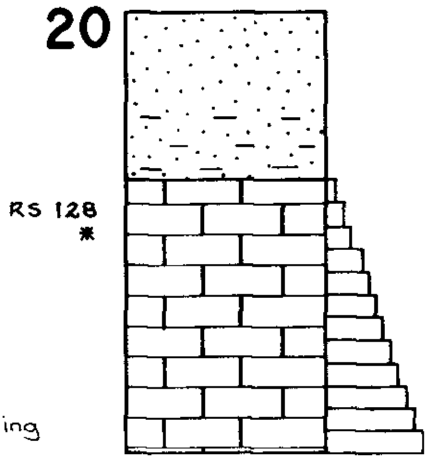
19



SOIL and BRIDGEWATER FORMATION : (undifferentiated).

CALCARENITE : Creamy, coarse grained and with abundant tubular bryozoa.

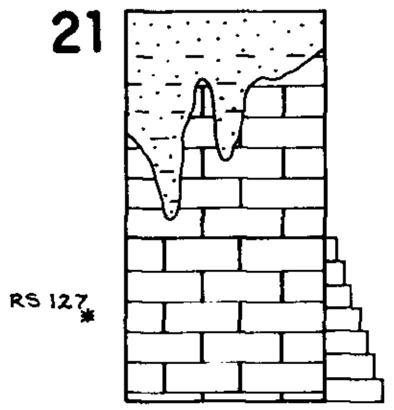
20



SOIL and BRIDGEWATER FORMATION : (undifferentiated).

CALCISILTITE : Fine grained with abundant poorly-crystalline matrix yielding material with low coherence. Bryozoa extensively corroded; echinoid plates and spines minor. Creamy. Low porosity. Quarry now only used as a source of agricultural lime but has been used for ashlars.

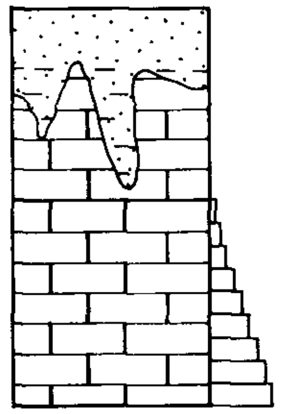
21



SOIL and BRIDGEWATER FORMATION : (undifferentiated).

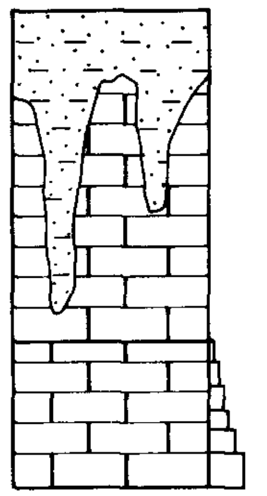
CALCARENITE : Creamy, tubules dominating, abundant large echinoid fragments, fine grained and cemented.

22



CALCARENITE : Medium to coarse-grained, offwhite to creamy, long tubular bryozoa dominant, high porosity.

23



CALCARENITE : Medium grained, long tubular bryozoa, minor pink calcite within echinoid spines and replacing molluscs. Poorly cemented.

Location of logs shown on Fig. 3, Plan 86-570

FIG. 10

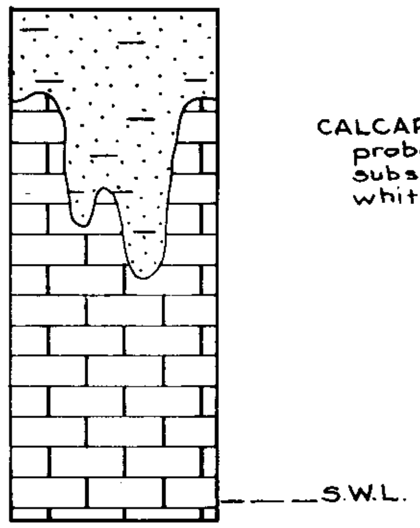
DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

GAMBIER LIMESTONE
GEOLOGICAL LOGS 11-23
STEETLEY QUARRY

COMPILED D. F.
DRAWN M. B.
DATE April '87
CHECKED
C.D.O. DATE 4 · 2 · 88
SCALE
PLAN NUMBER 87-763

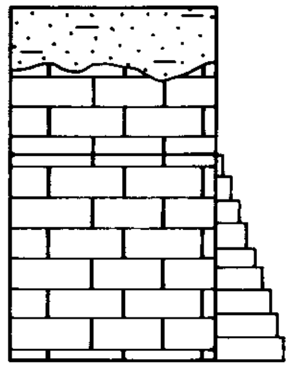
4217

24



CALCARENITE : Dolines down to at least 3·5m. Quarry probably originally used for building stone but subsequently mined by Jarvis Industries for whiting, removing all cut faces.

25



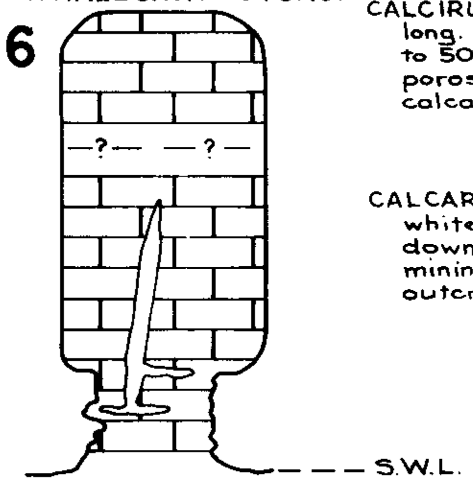
SOIL :

CALCARENITE :

CALCARENITE : Quarry mined by Jarvis Industries for whiting; most ashlar faces have been removed.

WHALEBACK OUTCROP

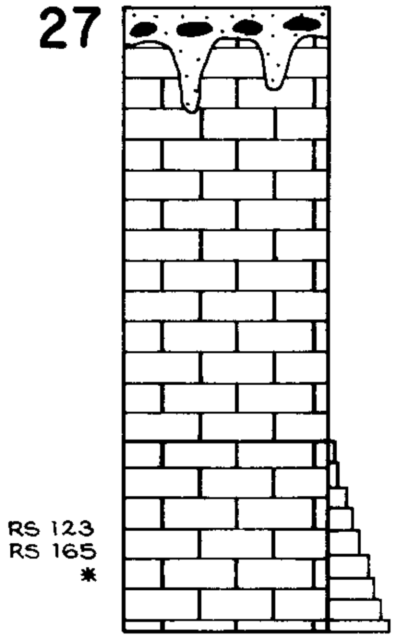
26



CALCIRUDITE : Coarse tubular bryozoa with fragments to 7mm long. Abundant intact mollusc and echinoid; echinoid spines to 50mm. No fine-grained matrix hence very high porosity. Base weakly bedded and grades into underlying calcarenite.

CALCARENITE : Similar to geological logs 30 and 31 but whiter. Pronounced NW trending joint with dissolution down joint and out along bedding planes. Block mining to depths of 4·7 - 6·0m. Southern part of the outcrop cut for ashlars in 1985/86.

27

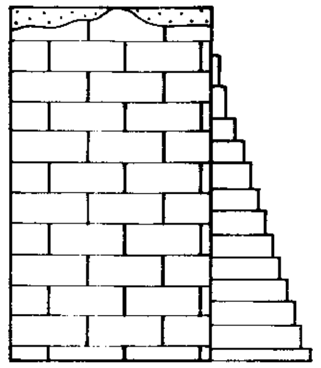


SOIL : With abundant flint pebbles. Dark red and iron-rich.

CALCARENITE : Weathered. Bedded with alternating coarse-grained, yellow iron-stained beds and whiter, fine-grained chalky bands. Overall, distinctly creamy and iron-stained.

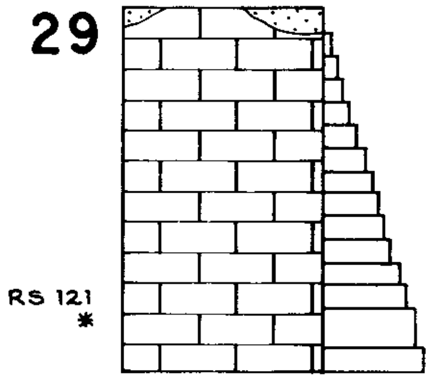
CALCARENITE : Distinctly creamy yellow - even when dry. Variable texture with areas of very fine detritus as well as poorly crystalline matrix. Cement is patchily developed but is a distinctive yellow and not only coats the fenestrate bryozoa, but also infills interstices.

28



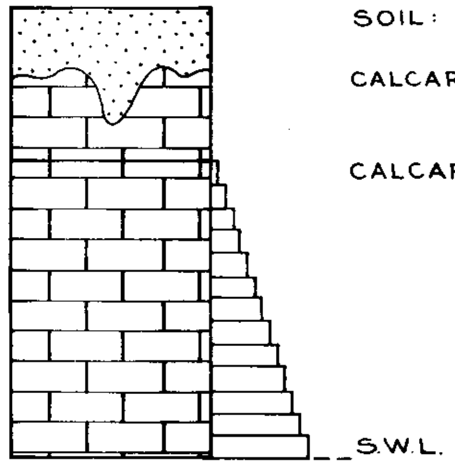
CALCARENITE : Weakly developed bedding.

29



CALCARENITE : Distinctly creamy when wet but dries white. Bryozoa are reticulate and fragments are coated with a yellow, micritic cement.

30

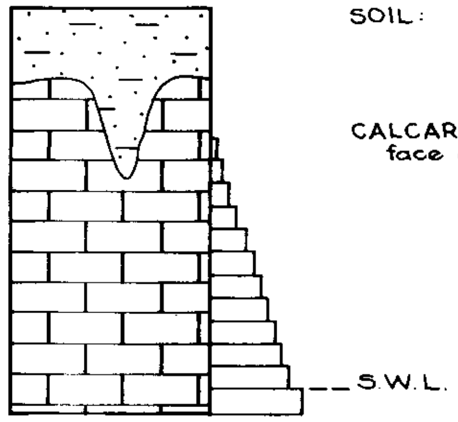


SOIL :

CALCARENITE :

CALCARENITE :

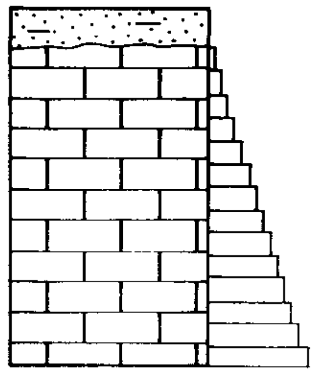
31



SOIL :

CALCARENITE : Block mining style along North face of quarry.

32

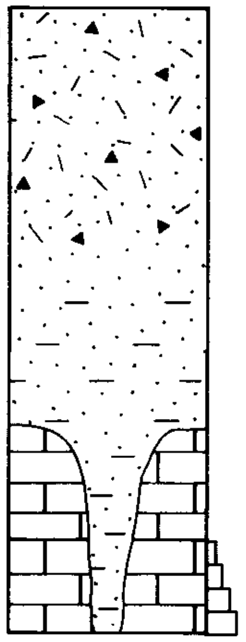


SOIL :

CALCARENITE :

Base close to S.W.L.

33

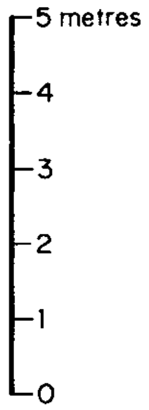


STOCKPILED OVERBURDEN (west side of quarry).

SOIL :

CALCARENITE :

CALCARENITE : Offwhite, grading to creamy. Medium grained with interlocking bryozoal fragments. Open porous texture with few fines.



VERTICAL SCALE

Location of logs shown on Fig. 3, Plan 86-570

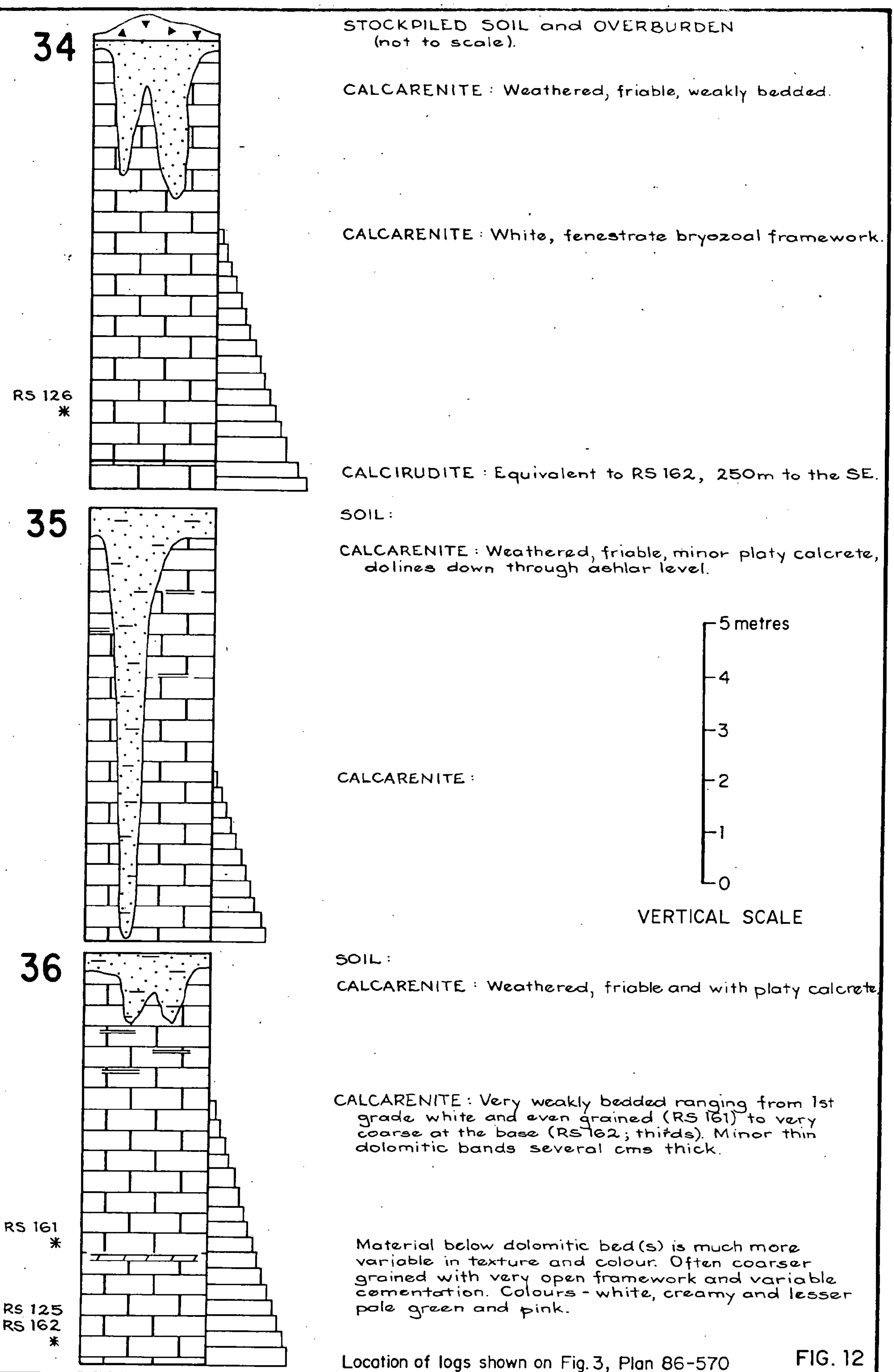
FIG. 11

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

GAMBIER LIMESTONE
GEOLOGICAL LOGS 24-33
KAIN AND SHELTON QUARRY

COMPILED D. F.
DRAWN M. B.
DATE April '87
CHECKED
C.D.O. 4·2·88 DATE
SCALE
PLAN NUMBER 87-764

4217



34

STOCKPILED SOIL and OVERBURDEN (not to scale).

CALCARENITE : Weathered, friable, weakly bedded.

CALCARENITE : White, fenestrate bryozoal framework.

CALCIRUDITE : Equivalent to RS 162, 250m to the SE.

35

SOIL :

CALCARENITE : Weathered, friable, minor platy calcrete, dolines down through aehlar level.

CALCARENITE :

36

SOIL :

CALCARENITE : Weathered, friable and with platy calcrete.

CALCARENITE : Very weakly bedded ranging from 1st grade white and even grained (RS 161) to very coarse at the base (RS 162 ; thirds). Minor thin dolomitic bands several cms thick.

Material below dolomitic bed(s) is much more variable in texture and colour. Often coarser grained with very open framework and variable cementation. Colours - white, creamy and lesser pale green and pink.

Location of logs shown on Fig. 3, Plan 86-570

FIG. 12

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

GAMBIER LIMESTONE
GEOLOGICAL LOGS 34-36
BRUHN QUARRY

COMPILED D. F.	C.D.O. 4 · 2 · 88 DATE	
DRAWN M. B.	SCALE	
DATE April '87	PLAN NUMBER S19539	
CHECKED		

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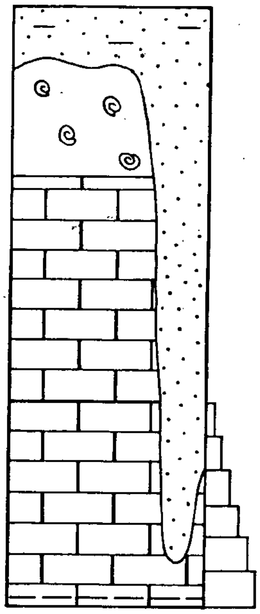
37



SOIL :

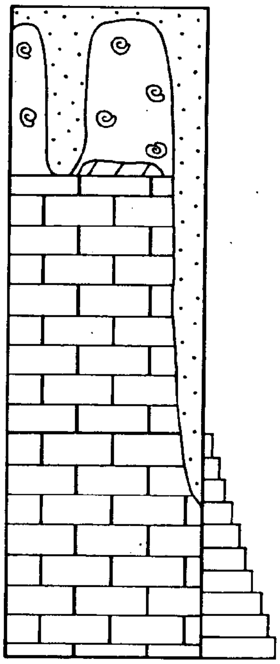
PADTHAWAY FORMATION : Grey, silty clay with minor intact mollusce to 4mm across.

CALCARENITE : Weathered, friable and weakly bedded. Dolines through to quarry face.

CALCARENITE : White, fine-grained with abundant matrix. Probably poorly cemented hence ashlars cut were 440mm high. Basal layer parts along a pale green-yellow marly limestone bed about 5cm thick consisting of alternating white calcisiltite and green-yellow marl bands.

WEST FACE

38

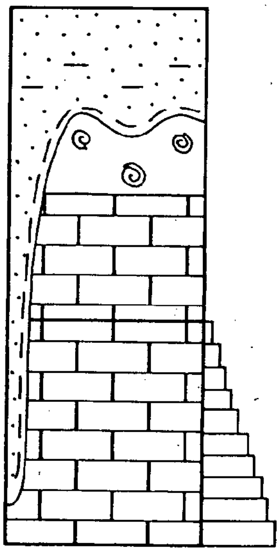


PADTHAWAY FORMATION : Abundant intact spiral-shaped molluscs to 4mm across in grey to grey brown shelly sand. Rare dark grey dolomite boulders at base.

CALCARENITE : Weathered, friable and weakly bedded with broad coarse-grained bands which are iron stained yellow and more indurated.

CALCARENITE : White and fine-grained with tendency for abundant matrix. However, crystalline cement still present. Overall is distinctly fine-grained with smaller pores but is still of low bulk density.

39



SOIL : Black and humus-rich at the surface, grading down through light brown cleaner sand to dark red, clayey soil at the base. Clay concentrated on margins of dolines; clay-rich band 0·3 - 0·5 m thick.

PADTHAWAY FORMATION : Grey shelly sand with abundant intact molluscs.

CALCARENITE : Weathered, friable and bedded with diffuse coarse-grained beds to 10cm thick which are porous, iron stained yellow and cemented.

CALCARENITE : White and fine-grained with tendency for abundant matrix but is still well cemented.

[1 metre

Location of logs shown on Fig. 3, Plan 86-570

FIG. 13

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

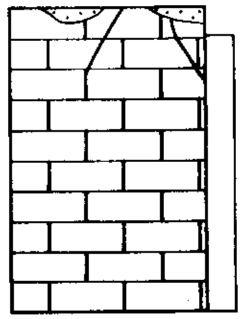
GAMBIER LIMESTONE

GEOLOGICAL LOGS 37-39
STAFFORD AND BLACKALL QUARRY

COMPILED D. F.	C.D.O. DATE 4·2·88
DRAWN M. B.	SCALE
DATE April '87	PLAN NUMBER
CHECKED	S19540

4217

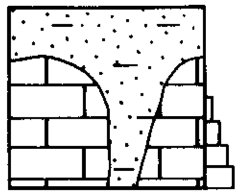
40



OUTCROPPING CALCARENITE

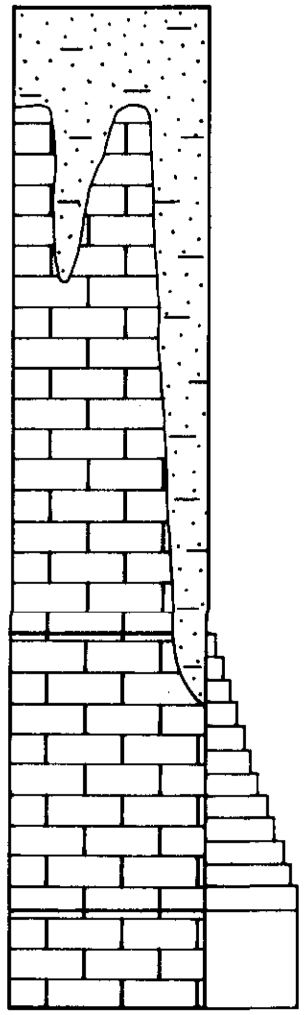
CALCARENITE : Grades to calcirudite. Parts distinctly bedded and very coarse grained with echinoderm spines to 70mm long; long spines very common. Creamy and with fine-grained matrix partially infilling pores. Selected sawn faces exhibit pronounced differential weathering along bedding planes. Calcreted near surface joints. Block mining style only; probably parts along a basal marly bed ; single block for depth of quarry.

41



CALCARENITE : Grades to calcisiltite. Very fine bryozoal fragments without an interlocking framework ; matrix abundant and material partly friable. Creamy with irregular colour mottling. Basal cut exposes a pale green, marly bed along which ashlars part.

42



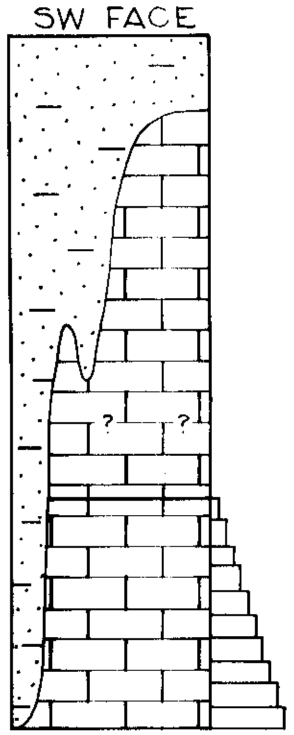
SOIL : Black and humus rich at the surface, browner with depth and dark red, clay rich at the base.

CALCARENITE : Weathered, friable, weakly bedded.

CALCARENITE : Faces mostly covered by scree.

CALCARENITE : Bulldozed for rubble.

43

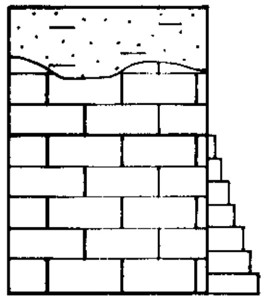


SOIL : Grey and humus-rich at the surface, grading down through fawn to light orange brown at the base.

CALCIRUDITE and CALCARENITE : Coarse-grained with abundant echinoderm plates and spines. Creamy yellow.

CALCARENITE :

44

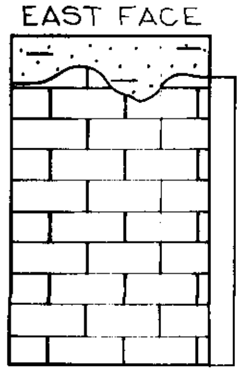


SOIL :

CALCARENITE : Weathered.

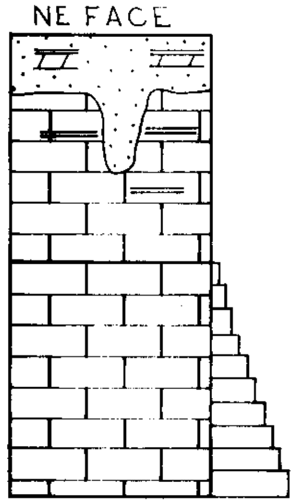
CALCARENITE : West side has ashlar cuts whereas East exhibits block mining style only. Numerous large (> 1m) blocks remain on East side and in quarry floor.

45



CALCARENITE : Common 10-20mm thick pale green, marly beds. In between, calcarenite is medium grained, has an open framework of bryozoa but also contains abundant matrix. Block mining style only; single block for depth of quarry.

46

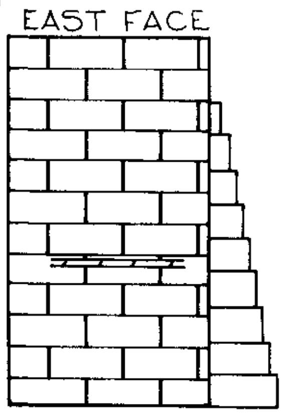


SOIL : With platy calcrete.

CALCARENITE : Weathered with minor platy calcrete.

CALCARENITE :

47



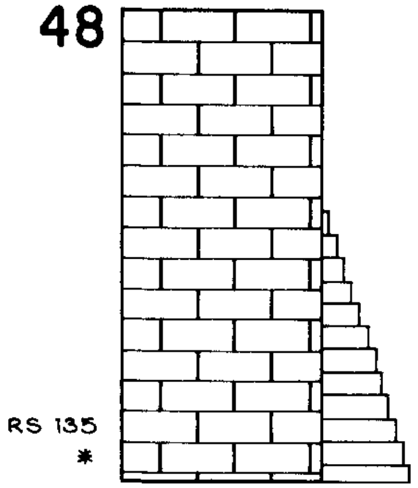
CALCARENITE : Weathered, partly friable; outcropping.

CALCARENITE : Fine to medium grained, poor interlocking tubular texture, and with fine grained matrix.

Pale grey-fawn dolomite bed dips 5° towards the east.

Tall ashlars - each 440mm high.

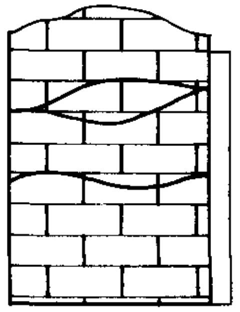
48



CALCARENITE : Outcropping; weathered and friable.

CALCARENITE : Distinct creamy yellow. Towards the base, calcarenite is medium to coarse grained with an open framework of bryozoa as well as some finely fragmented material. Fragments bound by a matrix which is patchily developed and varies from crystalline to amorphous.

49



CALCARENITE : Fine to medium grained, weakly bedded. Secondary calcite seams - wavy, lenticular and branching patterns.

Block mining style only; single block for depth of quarry.

VERTICAL SCALE

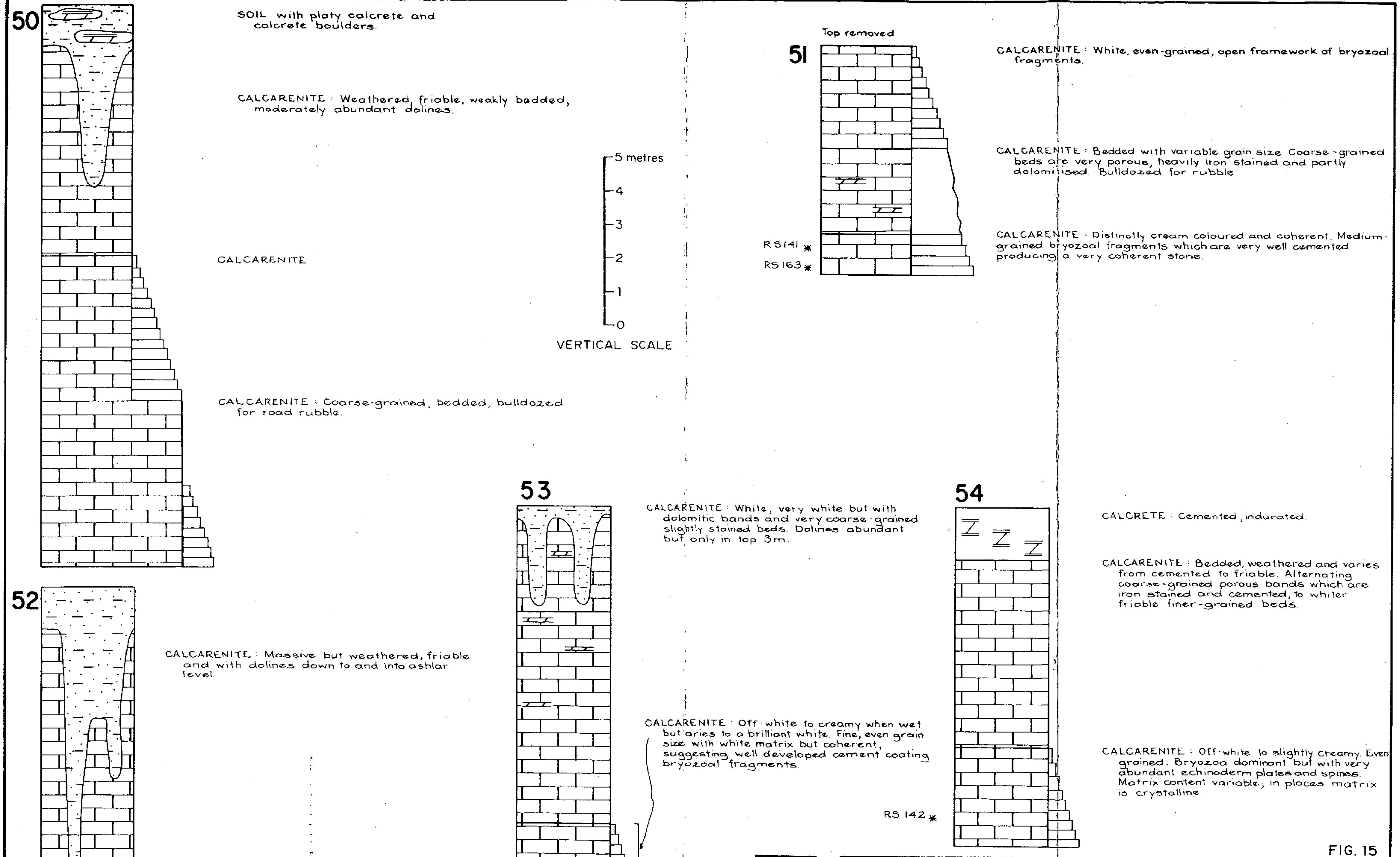
Location of logs shown on Fig. 3, Plan 86-570

FIG. 14

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

GAMBIER LIMESTONE
GEOLOGICAL LOGS 40-49
MCKAY, MAJORS AND JOHNSON QUARRIES

COMPILED D. F.	C.D.O. RC	DATE 4 · 2 · 88
DRAWN M. B.	SCALE	
DATE April '87	PLAN NUMBER 87-765	
CHECKED		



50

SOIL with platy calcrete and calcrete boulders.

CALCARENITE : Weathered, friable, weakly bedded, moderately abundant dolines.

CALCARENITE

CALCARENITE : Coarse-grained, bedded, bulldozed for road rubble.

51

CALCARENITE : White, even-grained, open framework of bryozoal fragments.

CALCARENITE : Bedded with variable grain size. Coarse-grained beds are very porous, heavily iron stained and partly dolomitised. Bulldozed for rubble.

CALCARENITE : Distinctly cream coloured and coherent. Medium-grained bryozoal fragments which are very well cemented producing a very coherent stone.

52

CALCARENITE : Massive but weathered, friable and with dolines down to and into ashlar level.

53

CALCARENITE : White, very white but with dolomitic bands and very coarse-grained slightly stained beds. Dolines abundant but only in top 3m.

CALCARENITE : Off-white to creamy when wet but dries to a brilliant white. Fine, even grain size with white matrix but coherent, suggesting well developed cement coating bryozoal fragments.

54

CALCRETE : Cemented, indurated.

CALCARENITE : Bedded, weathered and varies from cemented to friable. Alternating coarse-grained porous bands which are iron stained and cemented, to whiter friable finer-grained beds.

CALCARENITE : Off-white to slightly creamy. Even grained. Bryozoa dominant but with very abundant echinoderm plates and spines. Matrix content variable, in places matrix is crystalline.

Location of sections shown on Fig. 3, Plan 86-570

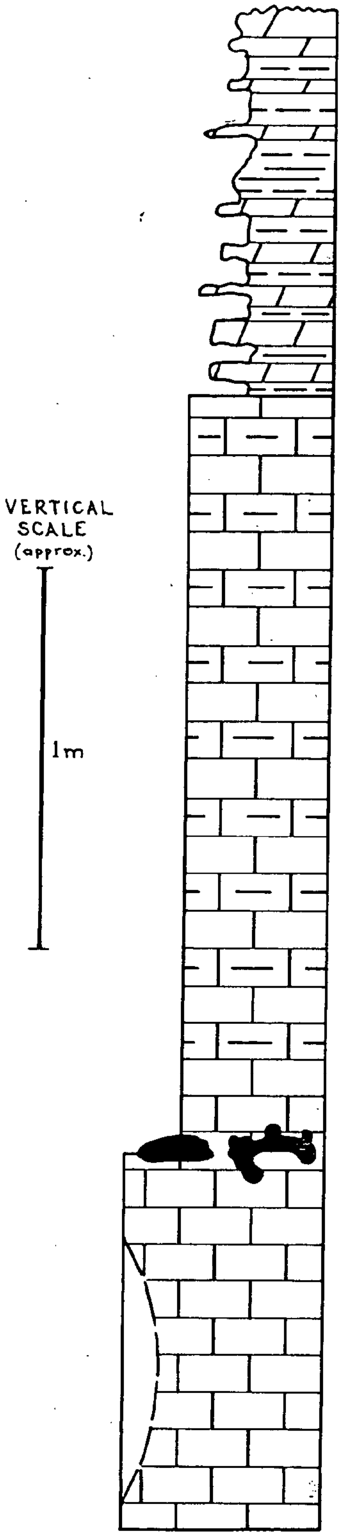
FIG. 15

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

GAMBIER LIMESTONE
GEOLOGICAL LOGS 50-54
FLETCHER QUARRY

COMPILED D.F.	UK 4·2·88 C D O DATE	
DRAWN M. B.	SCALE	
DATE April '87	PLAN NUMBER	
CHECKED	87-766	

4217



CALCRETED GAMBIER LIMESTONE : Platy and rubbly.

CALCARENITE (GAMBIER LIMESTONE) : Distinctly bedded and contrasts with massive calcarenite below flint bed. Calcarenite is identical with material at Mount Salt Quarry, ie. contains abundant intact (but slightly flattened) echinoids as well as large sponge-like polyzoal colonies and tubular growths. Matrix is fine grained and contrasts with the very coarse, more intact debris. Matrix grain size is slightly finer than in the underlying calcarenite.

FLINT : Nodules and irregular concretions of brown-black flint to 15cm across; irregular shapes and holey. Two large rounded boulders outside the quarry are 1·5 x 0·5 x 0·5m and 1·5x 1·5x 0·6m and probably were mined from this bed. Bed not flat and planar but with vertical differences of up to 20cm.

CALCARENITE (GAMBIER LIMESTONE) : Distinctly massive but with bedding evident. Consists of medium grained bryozoal fragments with abundant echinoid plates but always as small fragments. Texture is more obviously fragmentary and of more uniform grain size. Sponge-like polyzoal growths rare. Lower sawn face is more deeply eroded, predominantly by stock.

Location of section shown on Fig. 2, Plan 87-761

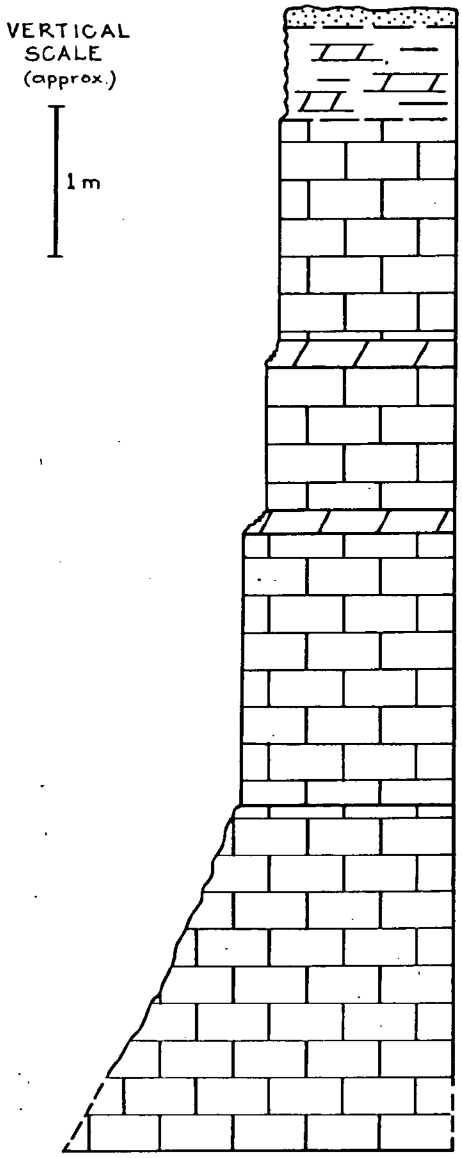
FIG. 16

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

GAMBIER LIMESTONE

GEOLOGICAL SECTION – LOCK QUARRY

COMPILED D. F.	C.D.O	4-2-88 DATE
DRAWN M. B.	SCALE	
DATE April '87	PLAN NUMBER S19541	
CHECKED		



SOIL AND WEATHERED GAMBIER LIMESTONE

CALCARENITE : as below.

DOLOMITE : Originally very coarsed grained calcarenite but now partly dolomitised and stained. Still contains readily recognisable bryozoa and is highly porous. These beds formed the base to each layer of block mining.

CALCARENITE

DOLOMITE : as above.

CALCARENITE : Old block faces remain flat and stable with very little erosion and indicate good quality, durable stone. Calcarenite is massive and medium grained. Texture obviously bryozoal and fragmentary with tubular and fern like colonies. Present bed being quarried (1987) is well cemented and strong. Also contains thin pink and yellow calcite replacing echinoid plates and spines.

CALCARENITE : Bulldozed for road rubble.

Location of section shown on Fig. 2, Plan 87-761

FIG. 17

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

GAMBIER LIMESTONE

GEOLOGICAL SECTION – O'LEARY QUARRY

COMPILED D. F.	C.D.O. DATE	2·2·88
DRAWN M. B.	SCALE	
DATE April '87	PLAN NUMBER	
CHECKED	S19542	

3634

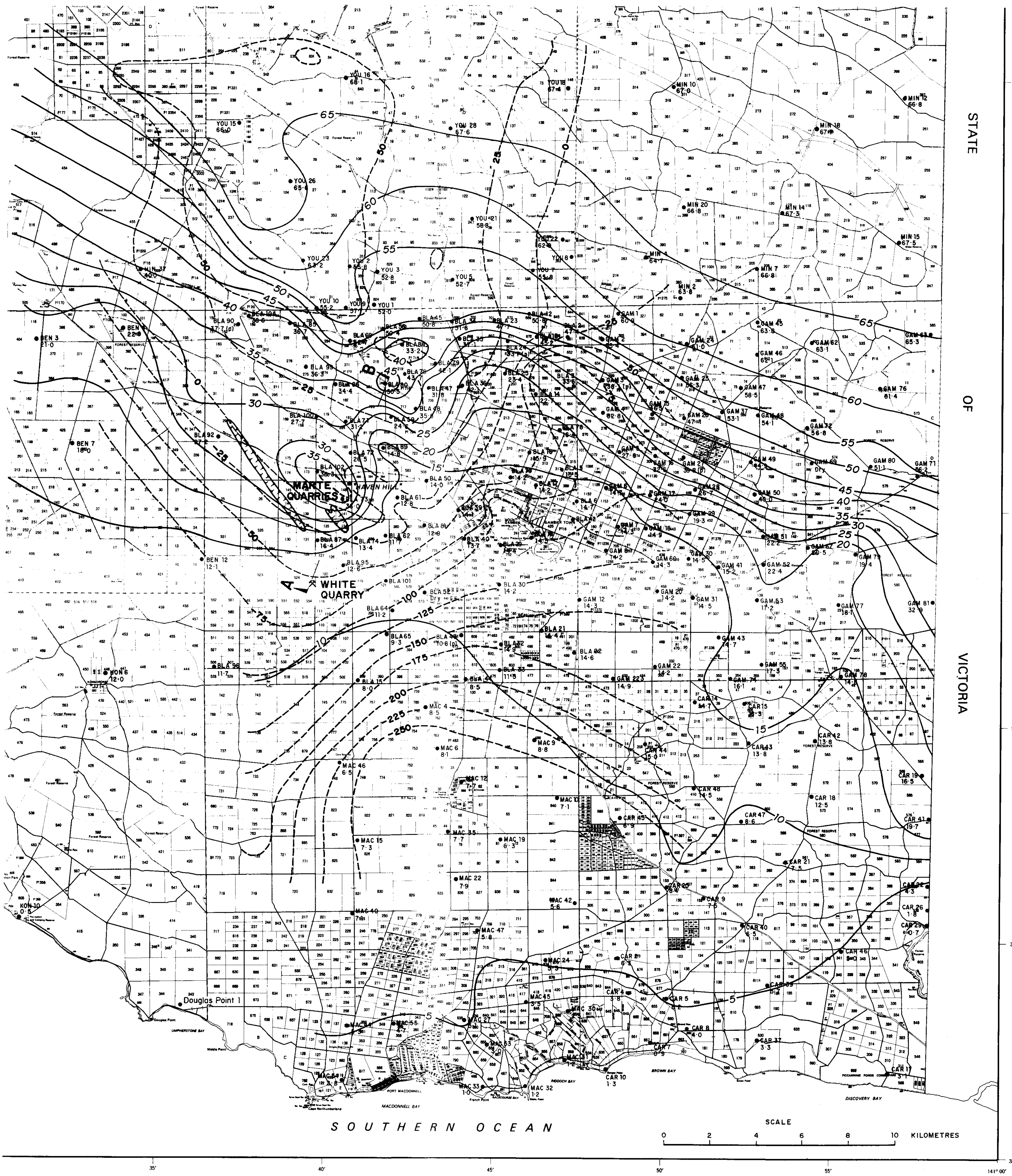


FIG. 18

—50— Structure contour (m, A.H.D.)
Top of Dilwyn Formation

—10— Water Table contour (m, A.H.D.)
Unconfined aquifer

● BLA 90 Observation Well and Number

37·7 Elevation of Water Table (m, A.H.D.)

(p) Influenced by pumping

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

GAMBIER LIMESTONE

REGIONAL CONTOURS OF TOP OF DILWYN FORMATION
AND WATER TABLE CONTOURS, MAY 1982

COMPILED D. F.	UR 4.2.88 C D O DATE	
DRAWN M.B.	SCALE 1: 100 000	
DATE April '87	PLAN NUMBER	
CHECKED	87-767	

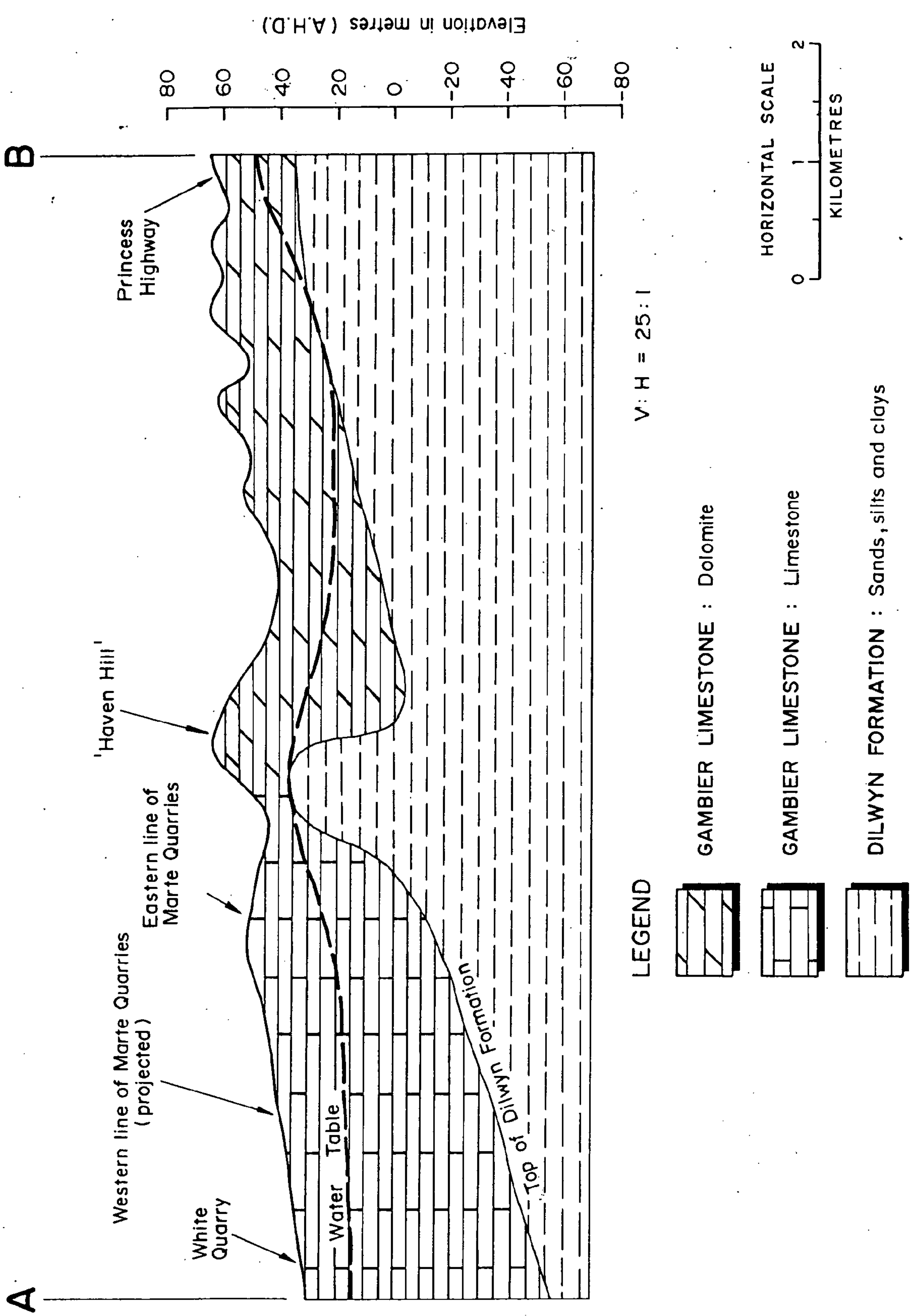


FIG.19

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

GAMBIER LIMESTONE

CROSS SECTION A-B

COMPILED D. F.
UR 4·2·88
C.D.O. DATE
DRAWN T. M.
SCALE As shown
DATE Sept '86
CHECKED
PLAN NUMBER
S18944

14217

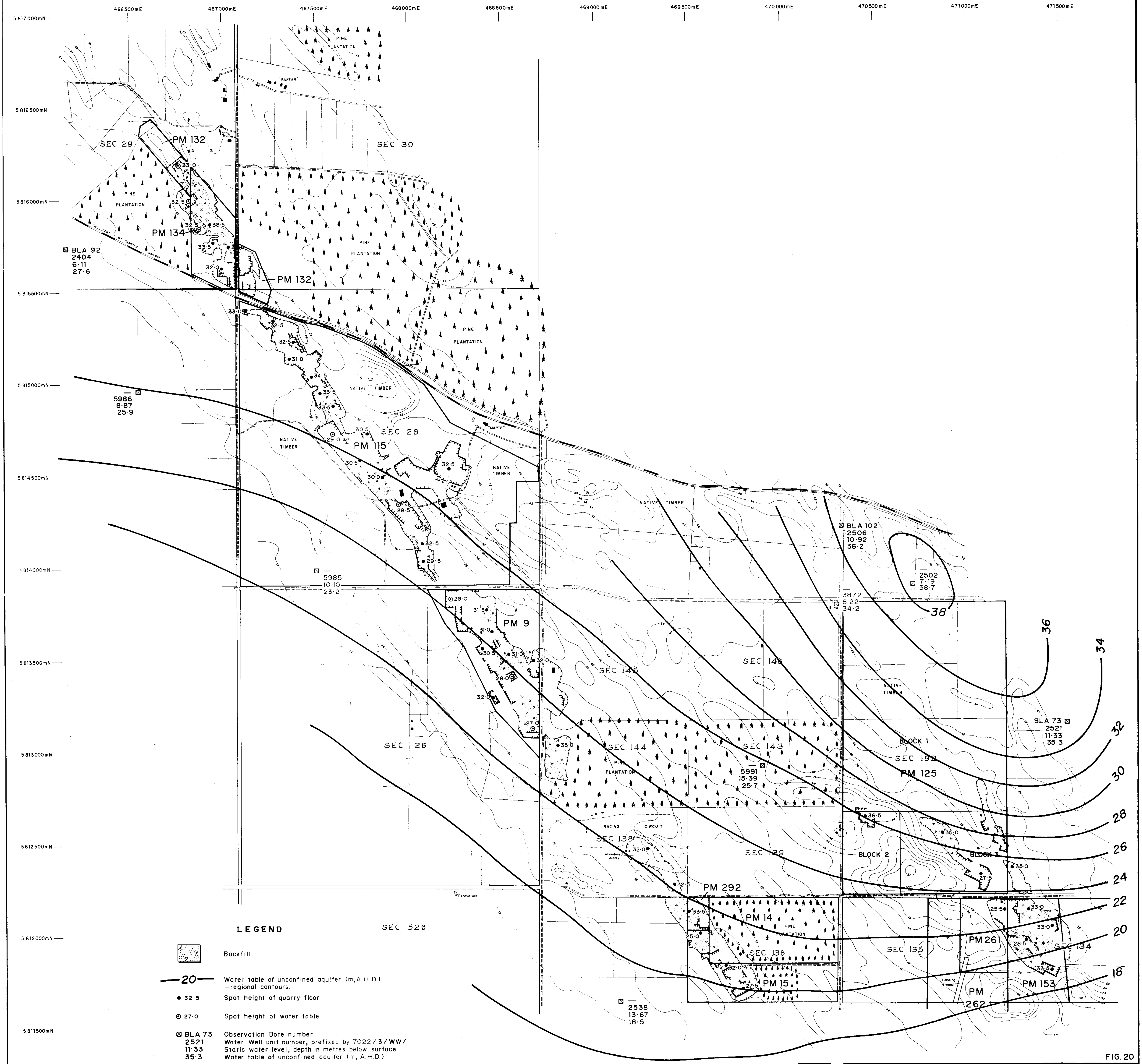


FIG. 20

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

'GAMBIER LIMESTONE

MARTE AREA - GROUNDWATER LEVELS

COMPILED D. F.	~~~~ 4·2·88 C.G.O. DATE	
DRAWN M. B.	SCALE 1:10 000	
DATE Sept '86	PLAN NUMBER 86 - 574	
CHECKED		

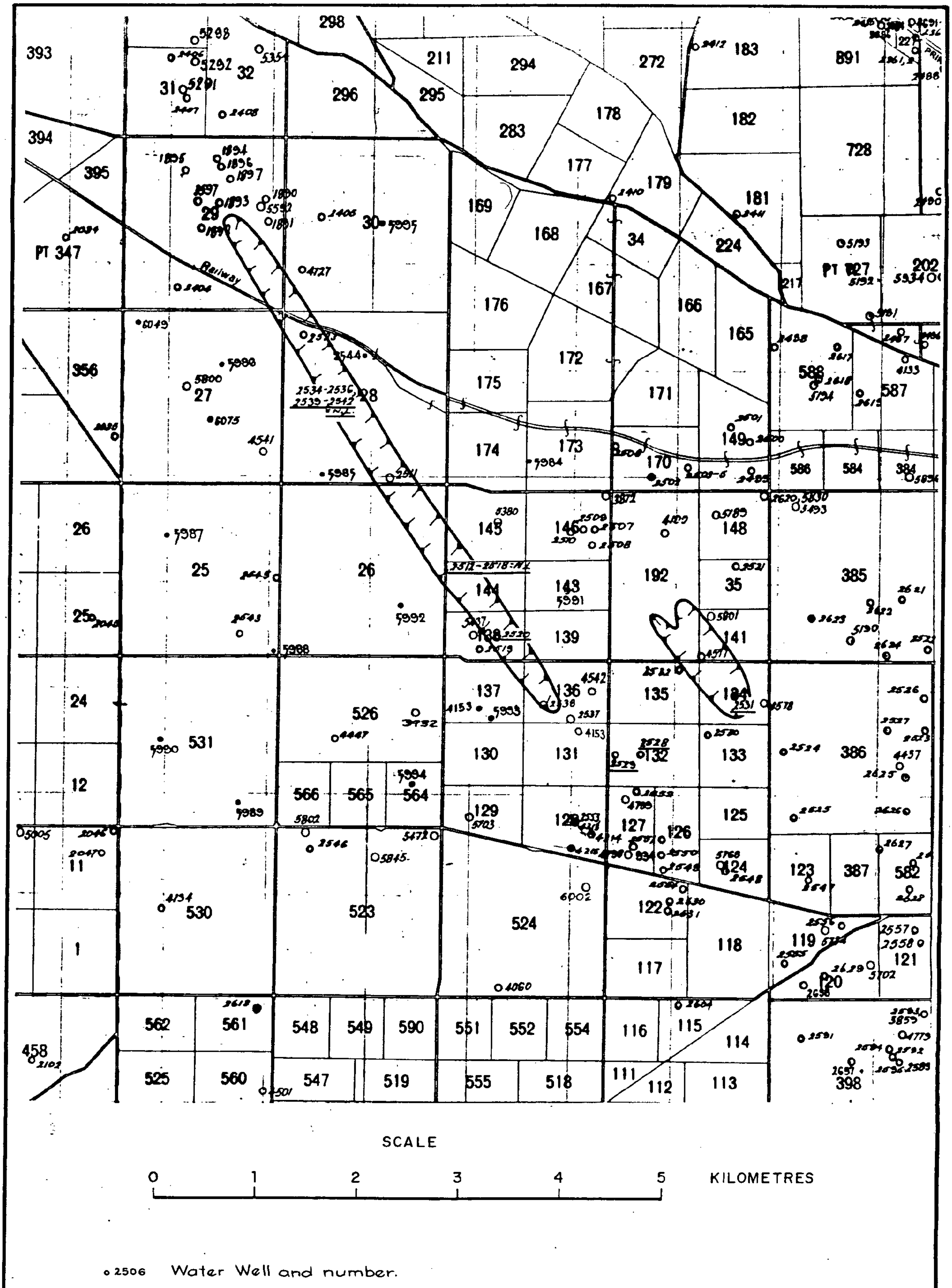


FIG. 21

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

GAMBIER LIMESTONE
MARTE AREA

LOCATION OF WATER WELLS AND PERCUSSION DRILL HOLES

COMPILED D. F.
DRAWN M. B.
DATE April '87
CHECKED

C.D.O. DATE 4 · 2 · 88

SCALE 1 : 50 000

PLAN NUMBER S19543

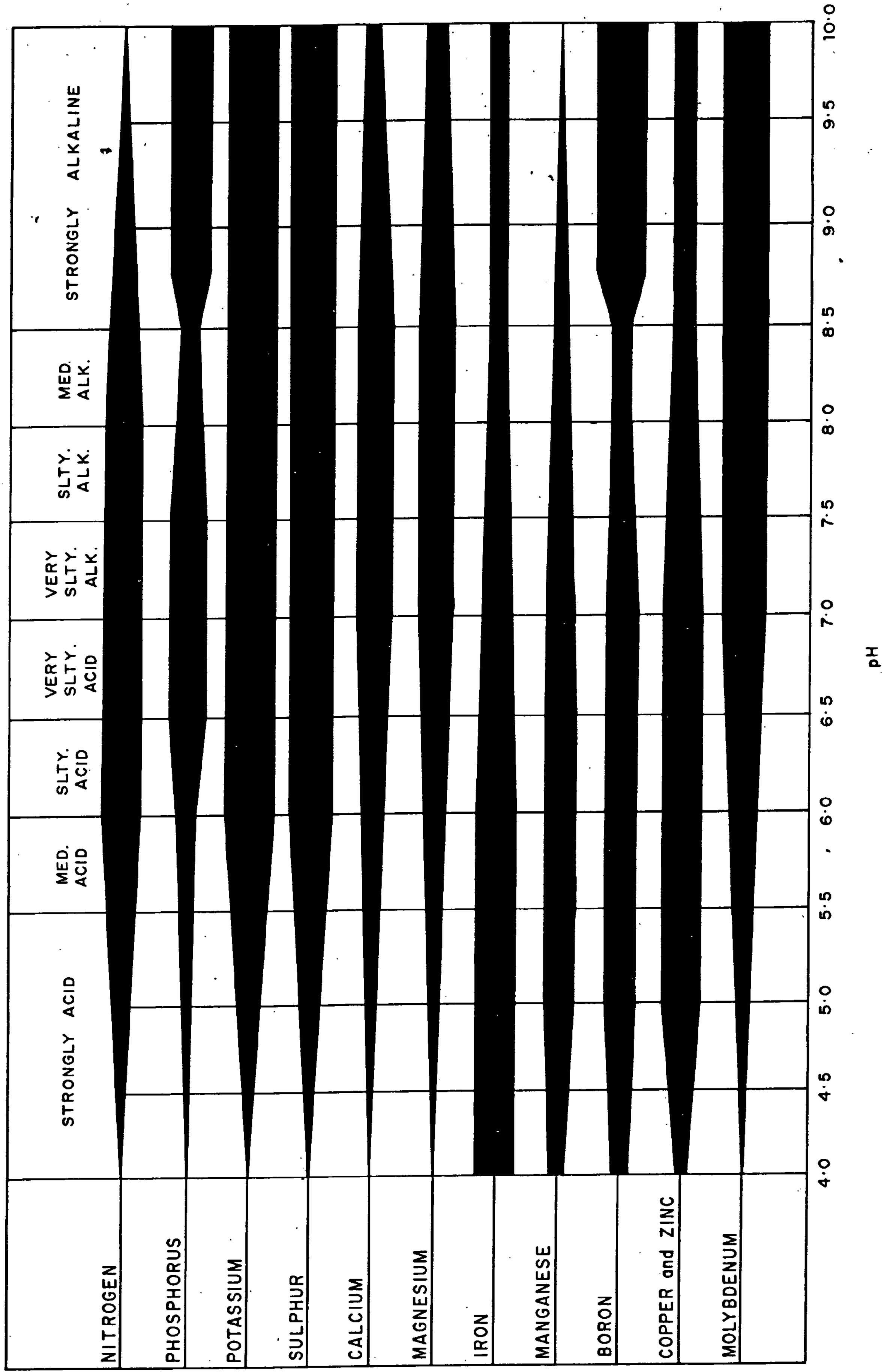


FIG. 22

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

GAMBIER LIMESTONE

SOIL ACIDITY AND EFFECT ON AVAILABILITY OF PLANT NUTRIENTS

COMPILED D. F.	C.D.O 4 · 2 · 88 DATE
DRAWN M. B.	SCALE
DATE Sept '86	PLAN NUMBER
CHECKED	S18945

- 4217