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BUILDING STONE INVESTIGATIONS  
VISIT TO SYDNEY, GOSFORD, MUDGEES AND WOMBEYAN

by

W.J. Perry.

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BUILDING STONE INVESTIGATION

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SUMMARY

Methods of quarrying and milling in New South Wales are outlined for the commonly used building stones-sandstone, granite and marble. Brief mention is made of the manner of weathering observed in these stones in certain Sydney buildings. A list prepared by Mr. R. O. Chalmers, of New South Wales building stones most used in Sydney is attached.

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## INTRODUCTION

Several quarries and stone yards in New South Wales were visited during the period 6th to 11th September 1959, for the purpose of studying general methods of quarrying and milling of the commonly used building stones. Visits were paid to stoneyards in Sydney and to quarries at Sydney, in the Gosford and Mudgee areas and at Wombeyan.

Attached is a list of New South Wales building stones most used in Sydney; it was prepared by Mr. R. O. Chalmers, Curator of Minerals at the Australian Museum, to whom thanks are due for his assistance during the writer's stay in Sydney.

### 1. SANDSTONE

#### (a) Quarrying

Quarries at Bondi, Gosford and Piles' Creek were visited.

Bondi The Bondi quarry is of the side-hill type; no overburden remains at the present time, but originally there was probably 20 feet or so of unsuitable sandstone. The freestone bed is 30 feet thick and lies horizontally. It is creamy yellow and the only blemishes are widely spaced sub-circular stains, probably of iron oxide, the origin of which is not known.

The quarrying method is to blast the overburden and strip it off with mechanical shovel or bulldozer. A channel cut is then made in the freestone parallel to the face, and other channel cuts are made at right angles intersecting the first cut, the distance apart being determined by the size of blocks required. Individual blocks are freed from the floor by drilling closely-spaced holes almost horizontally at the base of each block, inserting wedges, and striking the wedges in turn with a sledge hammer thus splitting the rock. Blocks are lifted by a crane on to a truck for transport to the stone yards where milling is carried out.

A channelling machine consists of a pneumatic drill mounted on a frame, with four wheels, which travels back and forth on a track. The drill operates with a reciprocating motion like a jack-hammer but more slowly. As it is operating, the drill is moved by hand along the frame and the frame can be moved along the track, and a cut is gradually made. The cut is started with a 3 inch star bit, and the bit is changed every 12 to 15 inches of depth, the size being reduced slightly each time. At Bondi, the rate of cutting a channel 6 feet deep is about 30 feet per day.

Gosford. At the main Gosford quarry, a side-hill type, a face 50 feet high has been developed; above this is a bench ranging in width from 15 to about 100 feet, and above the bench is another 35 to 40 feet face of usable stone. The overburden is about 30 to 80 feet thick. The colour of the freestone ranges from grey to pale brown. Bedding is sub-horizontal and in places is slightly undulating.

The method of quarrying is similar to that described for Bondi; three cranes each of about 5 tons capacity are used to hoist blocks.

Channelling rate for a 5 ft. cut was given as 12 to 15 feet per day, with an average of 60 ft. per week. The milling equipment for producing dimension stone is housed at the quarry. Stone for monumental use is trucked to the old No. 1 quarry on the opposite side of the hill and processed there.

Piles Creek This quarry started off as a side-hill type, but has developed into a pit. Drainage when necessary is by pump into Piles Creek. Bedding is horizontal. The sandstone is fine-grained and light brown and is irregularly patterned by thin bands of dark brown iron oxide staining. Veins of limonite up to  $\frac{1}{2}$  inch wide occur in places, and cause difficulty in quarrying because the stone tends to break along them instead of rectangularly.

The overburden, a cross-bedded sandstone, ranges in thickness from  $3\frac{1}{2}$  to 20 feet. Below this, the freestone bed is about 25 feet thick. Boring of the overburden to place explosives is stopped 6 to 12 inches above the top of the sound bed, and care is taken to limit the charge so as not to affect the freestone. Blocks of freestone are obtained by channelling and wedging, as previously described.

The quarry is equipped with a guy derrick, with a mast 130 feet high and a 115 foot jib, capable of handling 7 tons at a distance of 100 feet. Its maximum capacity is 12 tons. There are also two cranes of about 5 tons capacity. Two gang saws at the quarry are used for cutting flagging; masonry stone is transported in block form to the main Gosford quarry for processing.

A new quarry in similar sandstone has been opened recently at Somersby, a few miles west of Piles Creek.

#### (b) Milling methods

The quarry block is lifted from the transporting vehicle by crane and placed on the gang car - a low truck mounted on rails. This is run in beneath the gang saw and locked in position. Gang saws consist of a series of mild steel blades set in parallel position in a frame which is given a back and forward motion by a long arm attached to a crank. Blocks of the width required can be cut by setting the position of the blades within the frame. A slurry of sand and water is fed to the blades, which then cut through the stone at the rate of up to 1 ft. per hour.

The sand runs into a trough below the saw and a pump returns it to a box above the saw from which it is distributed to the blades by short lengths of hose.

A typical gang saw at Piles Creek quarry is equipped with 3 electric motors; a  $17\frac{1}{2}$  H.P. one for the reciprocating motion, a 7 H.P. one for the pump and a 3 H.P. for the rise and fall of the blades.

Blocks 2'6" to 2'8" deep are sawn into flagging 2" thick, and it is found that the blades last for about 30 blocks. The steel gradually wears away and after 15 blocks or so the blades are turned over.

Slabs for masonry are usually squared up with a diamond circular saw; depth of cut may be up to 12". At Gosford Quarry one circular saw is mounted so that the blade traverses across the stone, which remains stationary. The blade can be made to rise and fall and to cut at an angle, in much the same way as a radial arm saw used in woodwork.

Planers are usually used for shaping cornices and mouldings. At Loveridge and Hudson's quarry at Lewisham, in Sydney, a block of sandstone is supported on a trolley and the toothed blade of the planer passes back and forth along the edge of the stone, removing a fraction of an inch at each stroke, until the required depth cut is made. Cutting by the gang saw leaves a rough surface and if a smooth surface is required, as for example with most masonry blocks, the stone is subjected to the process of rubbing.

The block is placed on a trolley and fixed under a moveable rotating grinding head fitted with renewable carborundum pieces. This head is guided by hand over the block; water is added at the same time.

Finished or partly finished blocks are commonly handled with rubber slings to avoid marking them. Alternatively, shallow holes may be made by the mason in each end of a slab where they will not show, and hooks fitting into the holes are used for lifting.

Another alternative is the 'scissors' method in which a shallow hole is cut in the back of the stone; one 'blade' of the scissors has a hook which fits into the hole in the stone and the other 'blade' has a flat face which bears on a piece of lead or similar material to protect the surface.

The fabrication of dimension stone for buildings involves preparing detailed drawings of all stones used and at Gosford Quarries, for example, galvanized iron templates are used as a pattern for stones with curved faces that have to be cut by hand. Each stone is identified by a number.

Transport from mill to building project is by road; rail is not normally used because costly packing of stone would be necessary, and because hoisting facilities are not available.

- (c) Structures at Canberra in which the various sandstones have been used.

<u>Gosford Grey</u>	:	Administrative Building
(Gosford quarries)		Patents Office
		King George V memorial in front of Parliament House

(Gosford quarries)	American War Memorial - base
(Wondabyne quarry)	Australian War Memorial.
<u>File's Creek</u> (with brown bands)	Memorial Bible House, Canberra Roman Catholic Seminary, Goulburn Rd, Canberra.
<u>Bondi</u>	St. Andrews Church.

## 2. GRANITE

### (a) Quarrying

One quarry - Cooyal - in the Mudgee area was visited. It was not being worked at the time.

The terrain here is remarkable for large tors of pink granite; a group of these tors is the site of the Cooyal quarry.

A diesel-powered compressor supplies air to jack hammers and drills; instead of channelling as with sandstone, closely spaced holes are drilled in a line and the intervening rock chiselled away ('broached'). The broken fragments produced in the broaching are blown out of the drill-holes with compressed air. To free blocks at the bottom, breaks are made by drilling horizontal holes and wedging.

Two cranes powered by old car engines are used to lift stone onto trucks for transport to stone yards in Sydney.

Other granite quarries near Sodwalls and Tarana west of Lithgow are similar to that at Cooyal.

### (b) Milling

Loveridge and Hudson's stone-yard at Lewisham, Sydney was visited. This is a well-equipped yard that handles mainly granite. It has 3 overhead rail-mounted cranes and a wealth of other machinery including gang saws, diamond circular saws, lathe, planes and polishing equipment. Quarry stone comes in blocks of about 3 tons weight which are stored at the yard and used as required.

Gang saws are used to saw the granite into slabs: steel shot is the abrasive which together with water is fed to the blades continuously; the rate of cutting is about 2 inches an hour. Used shot is collected in a sump below the saw and mechanically returned to a box above the blades for redistribution.

Squaring up of blocks is done with a diamond circular saw. The blade is about 30 inches in diameter and costs £300.

The polishing of granite is done in three stages:- Sawn blocks are placed on a flat bed with their upper surfaces horizontal. First a power-driven rotating grooved metal head is guided by hand over the surfaces, steel shot being used as an abrasive. This is known as shotting.

In the next stage grinding with carborundum powder is carried out in the same manner, starting with grade F and finishing with FFF.

In the 3rd stage a power-driven buffing pad using oxide of tin (putty powder) is guided over the surfaces.

The rate of polishing, i.e., for the whole process, is about 1 sq. foot per hour, which to some extent explains the high price for polished granite. The retail price per sq. foot for granite 2" thick is about £4.

Shaping of blocks, e.g., curved surfaces, is usually done with pneumatic tools; these are guided by hand, but the compressed air supplies the impact. Columns are cut on a lathe, after being roughly shaped. The rough column is mounted on the lathe and a steel disc free to rotate on an axis at 45° to the lathe axis is moved slowly along the length of the column which is turning in the lathe. As the disc moves along it chips off high spots and gradually produces a true cylinder. Granite rollers for crushing cocoa beans for the chocolate-making industry were being turned at the time of my visit.

(c) Structures in which granite has been used

Cooyal ("Regent Red") : Admin. Building,  
Canberra.  
Sodwalls ("Rob Roy") : Maritime Services Board,  
Circ. Quay, Sydney.

### 3. MARBLE

(a) Quarrying

Quarries near Mudgee and at Wombeyan Caves were visited.

In the Mudgee area the quarry visited is 9 miles south-east of the town, a short distance west of the Mudgee-Windeyer Road. (Por. 56, Par. Broombee, County Wellington.) The rock quarried is a fine-grained limestone, known in the trade as "Mudgee puce and gold". It comes from one of several lenses within a sequence of Silurian rocks about 2,500 feet thick comprising "conglomerates and slates, with tuffs, breccias and andesitic flows" (David, 1950, p.200). The particular lens being quarried has a length of  $\frac{3}{4}$  mile along the north-westerly strike, and a width of outcrop ranging from 200 feet to  $\frac{1}{4}$  mile.



A face 20 feet high was developed in the quarry, which is of the side-hill type; a rather dark grey limestone is exposed and it is not being worked at present, but a new pit has been started 50 feet further up the hill to obtain limestone of a lighter colour, currently in demand. The strike is about north-north-west locally and the limestone dips steeply towards the west. Outcrops are limited to low rounded masses of limestone protruding from the soil, and the choice of site for a quarry seems to depend on finding the most massive outcrop of limestone of the desired colour. The usual system of drilling, broaching and wedging is employed to obtain blocks. A wooden tripod or a pair of 'shear legs' equipped with a pulley system, is employed for lifting, the power being supplied by a truck.

Quarry blocks are sent to stone yards in Sydney by road.

According to Young (1879), the limestone of the Wombeyan district is in "a belt about 1 mile wide and  $2\frac{1}{2}$  miles long. It is situated in the midst of altered sedimentary and igneous rocks, and .....has been altered into a highly crystalline marble, nearly all trace of fossils being obliterated." It is part of a sequence of Silurian rocks.

There are several small quarries in the area, the largest being at the foot of the hill near the Caves Reserve where a face of about 40 feet has been developed. Here a medium-grained cream marble, with pale brown veining, is obtained. Colours available in other quarries are white and pale blue-grey. Variation in colour within a short distance is commonly experienced both at Wombeyan and Mudgee.

As at the Mudgee quarry, a pair of shear legs made from stout logs and equipped with a pulley system is used for lifting blocks onto a truck for transport to Sydney. A diesel-powered compressor supplies air to pneumatic drills. This type of equipment is readily moved from one locality to another, as the market for different colours demands.

#### (b) Milling

Melocco Bros. yard at Annandale, Sydney, was visited. Large numbers of blocks of Italian and local marble are stored. The process of obtaining polished slabs from quarry blocks is as follows:

1. The blocks are cut into slabs of the desired thickness on the gang saw and squared up on a circular saw.
2. Each slab is placed on a 'float' - a flat steel wheel 12 ft in diameter mounted on a vertical axis, like a laboratory lap on a large scale. Sand is the abrasive and the slab is prevented from rotating with the float by a pair of wooden beams along a diameter.
3. The slab is then placed on a flat bed, and a power-driven grinding head fitted with carborundum

pads is guided over it by hand. Water is added to the surface at the same time.

4. The grinding head is replaced by a buffing pad, and a preliminary buffing using fine emery powder and oxalic acid is given, followed by the final buffing with oxide of tin and salt of sorrel. (Sodium or potassium hydrogen oxalate.)

Marble slabs are cut not less than  $\frac{3}{4}$ " thick.

(c) Structures in which marble has been used

Wombeyan	: Flooring of entrance, Admin. Building
	Many buildings in Sydney, e.g., G.P.O. extension Pitt St., steps and floor of foyer, Town Hall.
Mudgee Puce & Gold	Commonwealth Bank head office Sydney, Pitt St., entrance.

An excellent imitation of marble can be seen in the pillars in the main banking chamber of the Commonwealth Bank Head Office in Sydney. These look exactly like green marble, but are made by a process called 'scagliola', in which finely ground gypsum mixed with glue forms the substratum to which marble dust is added while it is still soft. Finally the work is polished.

### Weathering

A brief inspection of some of the City buildings was made to gain some idea of the durability of the various stones that have been used.

No weathering was noticed in any of the hard stones such as the granites, or Bowral trachyte. The marbles in most buildings are used inside and are unaffected. An example of colour fading was seen on Beard Watson's building at 363 George St, where the 'Mudgee Green' marble has been exposed to the sun and weather; the colour has faded to grey.

A small amount of scaling was seen in the sandstone of the Lands Department Building in Loftus St. This has been standing for about 80 years and is built probably of Pyrmont "Yellow Block", in common with many of the city buildings erected at this time.

The front of the sandstone building opposite the Geological Survey in Loftus Street was affected by weathering to the extent that in places it was necessary to clean up the surface recently with a pneumatic hammering tool which removed the loose material. The weathering was apparently due partly to a faulty guttering which had allowed water to drain down part of the building for many years.

The sandstone railings outside the Australian Museum in William Street show scaling particularly under the overhanging part of the posts. They are probably about 100 years old.

About ten years ago steps of Bondi sandstone were laid at one entrance to the Australian Museum. Though there is little sign of wear, cracks have developed near the edge of the treads and it appears likely that within a few years pieces may break off.

#### REFERENCES

- DAVID, T.W.E., (Ed. W.R. Browne), 1950 - The Geology of the Commonwealth of Australia. Arnold, London.
- YOUNG, L.H., 1879 - Ann. Rep. Dep. Min., 227.

APPENDIX

LIST OF N.S.W. BUILDING STONES MOST USED IN SYDNEY

by

R.O. Chalmers, Curator of Minerals, Australian Museum

TRADE NAME	BRIEF DESCRIPTION	LOCATION	BUILDINGS WHERE USED
ROB ROY RED	Coarse grained pink granite	7 miles S. of Sodwalls	26 O'Connell St. Maritime Services Board, Circular Quay. 12-14 O'Connell St. 1 Bligh St. 80-82 Pitt St.
ANAREL RUSSET	Medium grained pink granite	4 miles S.W. of Sodwalls.	Grace Bldg. cnr. King and York Sts. Water Board Bldg., Pitt St.
REGENT RED	Coarse grained pink granite	Cooyal, 13 mls. N. of Mudgee	Commonwealth Bank, cnr. Market and George Sts.
MORUYA	Coarse grey granite	2 mls. E. of Moruya.	G.P.O. Columns. Pylons, Harbour Bridge.
URALLA	Medium grained grey granite	1 ml. W. of Uralla	Bank of N.S.W. cnr. George and Wynyard Sts. Govt. Insurance Bldg., Elizabeth St. T. and G. Bldg., Elizabeth St.
BOWRAL TRACHYTE	Fine grained grey micro- syenite	Mount Gibralt- tar, Bowral	Head Office, Commonwealth Bank, Martin Place. Head Office, Commercial Banking Co. of Sydney, George St. National Mutual Life Association, George St. Australia and New Zealand Bank, cnr George St. and Martin Place.
	Green porphyry	Bookham	QANTAS Bldg., Hunter & Elizabeth St.
ADELONG BLACK GRANITE	Black gabbro	Adelong	do.

TRADE NAME	BRIEF DESCRIPTION	LOCATION	BUILDINGS WHERE USED
	Sandstone	Localities in the Sydney district too numerous to mention. Notably Pyrmont, Maroubra, and Bondi.	The majority of sandstone used in Sydney buildings, particularly the older ones, come from these quarries.
	Sandstone (yellow)	Wondabyne, Woy Woy district	Prudential Assurance, cnr. Martin Place and Elizabeth St.
	Sandstone (white)	"	Farmer's store
		"	Gowing's store
		"	David Jones' main store
		"	Commonwealth Bank cnr. George and Market Sts.
	Sandstone (white)	Pile's Crk., 3½ mls. W. of Gosford	Phoenix Insurance, Bridge St.
	Sandstone (with brown bands)	"	Nearly all the small bank premises in the city area erected in the period 1954-1959.
	Sandstone (white)	Gosford	QANTAS Bldg.
	Sandstone (white, bleached by phosphoric acid treatment of yellow sandstone).	Bondi	Port Line Bldg., Young St.
WOMBELYAN, DARK AND LIGHT	Marble medium grained, saccharoidal, pale cream to fawn, slightly mottled with golden veins.	Wombelyan Caves, 32 mls. N. of Goulburn.	Vestibules of Water Board Bldg., Pitt St., A.W.A. Bldg., York St.  Post Office Box Hall, G.P.O. extension, Pitt St.  Tasman Map, entrance to the Public Library.  Map of Australia, floor of Interstate Booking Hall, Central Railway Station.  Numerous alters in Catholic Churches.

TRADE NAME	BRIEF DESCRIPTION	MARBLE LOCATION	BUILDINGS WHERE USED
CUDGEGONG IVORY	Ivory with veins of gold	2½ mls. S.E. of Cudgegong	Vestibule 149 Castle- reagh St., Safe Deposit Commonwealth Savings Bank Head Office, Martin Pl.
CUDGEGONG "BLUE BALL"	As above with circular patches of bluish-grey	As above	Vestibule Govt. Insurance Bldg., Elizabeth St. Safe Deposit, Head Office Bank of N.S.W. George St.
BORENORE RED	Uniform deep red, crinoidal and streaked with white	11 miles W. of Orange	Commonwealth Savings Bank, Head Office, Martin Place Panelling on stairway leading from Castlereagh Street entrance to main banking hall and as architraves and skirting on lift fronts.
BORENORE KING EDWARD	Mottled pale grey and pink, crinoidal	11 miles W. of Orange	Bank of N.S.W., 228 Pitt St.
CALEULA, LIGHT	Pink, purplish and green streaks in cream to white groundmass	16 mls. N.N.W. of Orange	Elizabeth St. Lift Fronts, Head Office, Commonwealth Savings Bank. Head Office, Commercial Banking Co. Sydney.  Pitt St. entrance Anthony Horderns.
CALEULA DARK (USUALLY BRECCIAT- ED)	As above, purplish patches predominating some markedly brecciated	As above	Entrance Bank of N.S.W. Pitt & O'Connell Sts. Branch.
MUDGE GREEN	Delicately mottled pale grey & green groundmass veined with dark green and white	4 miles N.W. of Mudgee. Portions 39 40 & 53 Parish Munna, County Wellington.	Pilasters in Banking Chamber, Commonwealth Savings Bank, Head Office. Front of Beard Watson's
MUDGE PUCE & GOLD (LIGHT)	Light grey with delicate tracery of gold threads	9 miles S.E. of Mudgee	Vestibule and banking chamber, Head Office, Rural Bank.  Pitt St. entrance Head Office Commonwealth Bank.

TRADE NAME	BRIEF DESCRIPTION	LOCATION	BUILDINGS WHERE USED
MUDGE PUCE & GOLD (DARK)	Dark grey with streaks of golden argillaceous material	9 mls. S.E. of Mudgee. 10 ch. west of Mudgee-Windeyer Rd. Portion 56 Parish Broombee County Wellington	Exterior of Grace Building, York & King Sts.
YASS BLACK	Pure black, or black with an occasional white vein	13 mls. S.S.W. of Yass.	Panelling in vestibule Invincible Fire and General Insurance Co., Ltd. 66 King St.
BRINGELLET WHITE	Massive, off- white, veins of greenish talcose material, crinoids, cephalopod, & coral fossils present	5½ mls. W. of Luckley	Head Office, Commonwealth Bank vestibule, Bank of N.S.W., cnr. King & Castlereagh Sts.
COW FLAT, WHITE	White streaks in off-white, may be traversed by talcose veins.	6 mls. S. of George's Plains Rail- way Station.	Anzac War Memorial, Hyde Park.