the particles does not apper to be stable, for when the clinker—as the burnt material is technically called—is reduced to powder, and water added, a re-arrangement of the molecules takes place; the water enters into chemical combination, and the phenomenon called setting is exhibited. The intensity of the setting varies with the chemical composition of the cement, and also with the temperature at which it has been burnt.

The raw materials for a cement must be thoroughly mixed together, so that the particles of lime and silicate may be in contact throughout the mass, which is a condition favourable to their union. Limestone may be reduced to a powder in two ways, first by grinding or pounding, secondly by burning and slaking. The latter forms the most effectual means of reduction, as the crystals are thereby broken up. The adoption of either method will largely depend upon the physical structure of the limestone, its location with regard to the clay, and fuel and facilities for carriage; also to the form in which the silicate of alumina is obtainable. When the powders have been thoroughly mixed sufficient water should be added to enable bricks to be made from the mixture, after the manner of dry-pressed bricks. The powders may also be most effectually blended by adding a large amount of water, so as to form a paste or slurry. This excess of water must afterwards be got rid of by drying. The bricks or dried slurry are then to be burnt to a clinker. This may be effected in various types of kilns. The kiln to be preferred is one that admits of economy of fuel, and offers facilities for inspecting the charge during its burning, and has provision for regulating the temperature. The magnitude of the operations will determine the class of kiln. Many of the improved brick-kilns which have been designed to give economy of fuel consumption would answer for cement burning.

In the absence of chalk the limestones and marbles must be the source from which to draw the necessary supplies of lime for the purpose of manufacturing cement in this colony. The nearest limestone beds to the metropolis are those before referred to at Piper's Flat and Marulan. Both are coralline limestones of a pure quality. A considerable portion of the deposit at each place is in the form of marble. The following are two analyses of limestone from Marulan, Piper's Flat, and Wallerawang—

	No. 1.	No. 2.
Carbonic Acid ...	42·33 ...	42·70
Lime ...	53·42 ...	54·09
Silica ...	2·9 ..	·72
Oxide of Iron ...	·75 }	1·10
Alumina ...	·11 } ..	
Magnesia ...	·56 ...	·567
Phosphoric Oxide ..	·11 ...	
Undetermined ...	...	·813

The limestones exist at each place in practically inexhaustible quantities. At Piper s Flat the limestone crops out near the margin of the coal measures, from the clay shales of which the silica and alumina ingredients may be obtained. The Marulan limestone is somewhat further from the boundary of the coal measures, but no doubt suitable silica and alumina-bearing rocks exist in the neighbourhood. In both cases the proximity of the coal beds affords a source of supply of cheap fuel.

The well-known Wianamatta beds, which extend over a arge area of the metropolitan county, consist mainly of clay shales, some ferruginous, some practically free from iron. These shales are suitable for mixing with lime for cement making. The author, about nine years ago, made numerous experiments on a small scale for the purpose of testing their value. Dry slaked Marulan lime was intimately mixed with pulverized shale, made into a paste by the addition of water, formed into small pats, dried, and afterwards calcined in a portable smith's forge. A forge is very convenient for the purpose, as the temperature can be easily regulated and the progress of the clinkering easily watched. The clinkers obtained were powdered with a pestle in an iron mortar. The cement powders obtained gave various results when tested.

The shales experimented with were obtained from excavations at Crown-street Reservoir, Sydney, Ashfield, Standard Brick-works, Petersham, Berry's Estate, North Shore, Bexley, Granville, Prospect, and other localities in the county of Cumberland. Shale obtained from the site of the embankment, Prospect Reservoir, gave the best result of all. From a mixture of two parts of lime and one of shale, each by weight, a good-looking clinker was obtained, which gave a powder of good cement colour. A test part set quickly and well. A minature briquette was made from a portion of the powder; it had an area of cross section at the neck of one-sixteenth square inch, set one day in air and six days in water. A gradually increasing load was applied by means of a small stream of water falling into a can. The fracture took place with 20 ℔s. 14 ozs., equal to 334 ℔s. on the square inch. The quantities experimented with were necessarily small, and the appliances and processes somewhat crude, but successful results produced a conviction that there are ample supplies of material from which first-class Portland cement may be made. Other experimentors have been at work, and the result of their labours is that this year has witnessed the manufacture of Portland cement pass from the experimental into the practical stage, and added one more to the list of native industries.

The advent of locally-made cement will necessitate the exercise of constant vigilance on the part of users of this material. Hitherto the cement used in the colony has been imported, and the distance of the point of consumption from the seat of manufacture has protected the consumer from dangerous cements. By dangerous cements is meant those in which caustic lime is present free, or not properly combined, and which expand slowly, although they may appear to set at first when made into mortar. The result is rupture of the work in which they may be used. In the case of imported cement the period which must necessarily elapse between the time of burning and grinding, and the time of using, gives the cement an opportunity to season, which is a decided advantage and safeguard to the builder. The writer has never yet heard of an instance where work in the city has been fractured or distorted by the blowing of the cement used in its construction. Weak cements have been imported, but weakness is a mild fault compared to the other. Theoretically, the raw materials for cement, when mixed in the proper proportions, ought, when calcined, to make a perfect combination, but practically this result is seldom obtained, hence, the users of cement in countries where it is made have to be constantly on their guard. No doubt the one factory that has been started in this colony will be followed by others, as the undertaking must—if properly conducted—prove profitable. There will be competition, and it is possible the experience of other cement producing countries may be repeated here. Through unskilfulness, ignorance, or the use of improper materials, worthless or dangerous cements may find their way on to the market. A manufacturer may at any time find himself with a kiln full of inferior clinker on his hands, and have to consider whether it shall be discarded at a loss or ground up, and run the risk of disposing of it somehow or other. The test for expansion must be constantly made by users, and the usual pat tests should be supplemented by placing some freshly mixed neat cement mortar in a thin glass bottle—a chimney glass closed at one end will answer very well—if the slightest expansion take place the glass will be cracked. A dangerous cement may generally be rendered harmless by spreading it out on a dry floor and leaving it to season for about a month. This will be a wise provision to make in specifications for works in which quantities of cement have to be used. There is no reason why first-class cements should not be made locally at a price which will enable them to compete successfully with the ordinary imported article; and the production of a cheap reliable cement will be a boon to the metropolis and the colony generally, the value of which cannot be over-estimated. Some analysis of limestones, &c. are given as an appendix for the information of any who take an interest in the subject.

APPENDIX.

RUTHERFORD'S DARK HYDRAULIC LIME.

This lime has been imported from New Zealand in considerable quantities, commencing about two years ago. Although called an hydraulic lime it is a natural cement. The stone is simply burnt and ground. A recent analysis by the Government Analyst gives the following result:—Lime 59 per cent., silica 28, Public and alumina 10 per cent. Tested at the Sewerage Branch, Works Department, on 13th February, 1890, gave the following result :—

The briquettes were kept in the air for 24 hours, and the rest of the time in water, thence taken and immediately tested. The average breaking weights of six briquettes taken for each test.

NEAT LIME	Tensile strength at	3	days	213 lbs.	per square inch.
	,, ,, ,,	7	,,	319 lbs.	,, ,, ,,
	,, ,, ,,	28	,,	418 lbs.	,, ,, ,,
MORTAR— 1 LIME & 3 SAND.	Tensile strength at	7	days	83 lbs.	per square inch.
	,, ,, ,,	28	,,	124 lbs.	,, ,, ,,
	Crushing strain ,,	28	,,	2,000 lbs.	,, ,, ,,

PERMEABILITY.—Neat Lime.—None.

TESTED FOR EXPANSION AND COLOUR. { Constant.—No variation in volume.
Colour.—Light Grey.

CULLEN BULLEN CEMENT.

This is a colonial cement now being manufactured near Wallerawang. The following analysis is from a report by Mr. W. A. Dixon, exhibited at the Company's office.

Soluble silica	23·01
Insoluble silica	0·41
Alumina	9·40
Oxide of iron	3·08
Lime	61·39
Magnesia	0·86
Carbonic acid	1·11
Water	0·70
Mace alkali and loss ...	0·04

HYDRAULIC LIMESTONE NEAR MUSWELLBROOK.

There is a large deposit of this limestone, and it could, by suitable treatment, be made into a Portland cement. The following analysis is extracted from the report of T. W. E. David, Geological Surveyor:—

Hygroscopic moisture	1·1
Combined moisture	1·29
Carbonate of lime	66·55
Carbonate of magnesia ...	1·66
Alumina and oxide of iron ...	7·65
Silica	21·75
Phosphoric acid	strong trace

WIANAMATTA SHALES.

Some of the shales form good fire-clays, which are frequently used as a substitute for English fire-clay. The following analysis is from the report of the Department of Mines for 1889.

Moisture at 100° C.	1·45
Combined moisture	3·44
Silica	80·79
Alumina	13·20
Oxide of iron	0·86
Lime	0·15
Alkalies, loss, &c.	0·11
	100.00

The Wianamatta beds contain patches of impure limestone. The following analysis was recently made of a sample obtained by the writer :—

Moisture	2·71
Organic matter	trace
Oxide of iron	4·47
Alumina	2·17
Lime	30·02
Magnesia	0·70

Strontia	trace
Insoluble in acids, silica chiefly, and a little clay ...	34·93
Carbonic acid	24·78
Sulphuric acid	nil
Phosphoric acid	trace

The insoluble matter consists almost entirely of coarse sand.

DISCUSSION.

Mr. W. Shellshear stated that the material referred to in the Paper possessed good qualities for manufacture of cement; but there were some difficulties to consider. One was that the briquettes commenced to crack and blow after standing a short time, showing that there was a large amount of free lime in their composition.

Mr. W. D. Cruckshank asked whether the cement, after having reached its maximum strength, would maintain that strength? He would also like to ask why hydraulic lime was so named? Could the cement be profitably manufactured here to compete with the imported article?

Mr. Haycroft pointed out that cement cost 2/- per barrel more in freetrade Sydney than in Melbourne. No comparison could be made between hydraulic and fat lime, as the latter was only used as a cushion to prevent inequalities in building.

Mr. Seaver considered the most important point touched on was the slaking of cement. At Home this was always done. He must disagree with Mr. Haycroft's statement concerning fat lime, as he (the speaker) believed that it made one of the strongest cements, which could be proved by work still in existence in old castles.

Mr. W. E. H. Nicolle, referring to the spreading of cement, stated that at the new dock at Cockatoo Island, the cement