BRITISH GEOLOGICAL SURVEY

MINERAL PROFILE

CEMENT RAW MATERIALS

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British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Office of the Deputy Prime Minister
Creating sustainable communities

MINERAL PROFILE: CEMENT RAW MATERIALS

Contents

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1: Definition, mineralogy and deposits

1.1 Definition and mineralogy

Cement is a manufactured product made by blending different raw materials and firing them at a high temperature in order to achieve precise chemical proportions of lime, silica, alumina and iron in the finished product, known as cement clinker. Cement is therefore essentially a mixture of calcium silicates and smaller amounts of calcium aluminates that react with water and cause the cement to set.

The requirement for calcium is met by using high calcium limestone (or its equivalent calcareous raw material) and clay, mudstone or shale as the source of most of the silica and alumina. Finished cement is produced by finely grinding together around 95% cement clinker with 5% gypsum (or anhydrite) which helps to retard the setting time of the cement.

The quality of cement clinker is directly related to the chemistry of the raw materials used. Around 80–90% of raw material for the kiln feed is limestone. Clayey raw material accounts for between 10–15%, although the precise amounts will vary. Magnesium carbonate, which may be present in limestone, is the main undesirable impurity. The level of magnesia (MgO) in the clinker should not exceed 5% and many producers favour a maximum of 3%; this rules out dolomite or dolomitic limestones for cement manufacture. Other deleterious materials include excessive alkalis (sodium oxide, Na_2O or soda and potassium oxide, K_2O) which would be unacceptable because of durability problems with the concrete (due to the reaction of alkalis with some siliceous aggregates to form a swelling gel[†]).

Portland cement is the most widely produced cement, both in the UK and worldwide. The term ‘Portland cement’ was created by its inventor in 1824 because of the presumed resemblance of the set material to Portland Stone, the well-known natural building stone. Other varieties include rapid hardening, low heat, sulfate resisting, and low-alkali cements. In addition, **blended cements** are produced by finely grinding Portland cement clinker with other constituents, such as blast furnace slag, natural pozzolanas[‡], silica fume, metakaolin[§], siliceous fly ash[**], calcareous fly ash, limestone fines and shale. In Europe, for example, these types of cement are standardised to BS EN 197-1. This covers five main types of cement used for concrete (Table 1.1.1) and indicates the relative proportions of Portland cement clinker, a second main constituent, the standard (28 day) strength class and the rate of early strength gain.

[†] A jelly-like substance that increases in volume with adverse effects on cement durability and strength.
[‡] Volcanic ash, named after the type locality Pozzuoli, in Italy, used in the manufacture of a kind of mortar which hardens under water.
[§] Metakaolin is an altered form of the clay mineral kaolinite.
[**] Small ash particles carried in suspension in combustion products, typically from coal.

Table 1.1.1 Types of cement for concrete (BS EN 197-1)

CEM I Portland cement	Comprising Portland cement and up to 5% of minor additional constituents
CEM II Portland-composite cement	Portland cement and up to 35% of other single constituents
CEM III Blastfurnace cement	Portland cement and higher percentages of blastfurnace slag
CEM IV Pozzolanic cement	Comprising Portland cement and higher percentages of pozzolana
CEM V Composite cement	Comprising Portland cement and higher percentages of blastfurnace slag and pozzolana or fly ash

1.2 Deposits

The availability of suitable raw materials is normally the determining factor in the location of cement works and these are normally located in close proximity to limestone deposits and ideally close by other major raw materials (clay and gypsum).

Limestones, clay, mudstone and shale deposits are common lithologies and are widely distributed in most parts of the world. Nevertheless, such sedimentary rocks may vary considerably in their chemistry and thickness and thus in their suitability for cement manufacture on a large scale. Generally, large quantities of a uniform source of calcium, silica, alumina and iron are required. If uniform raw materials are not readily available (and they rarely are) it is essential that chemical variation within the deposit is known so that development can be planned, and proper blending of stockpiles can consistently achieve the desired chemistry. The process of cement making is, however, remarkably flexible in terms of the raw materials that can be used to achieve required chemical compositions. Many limestone deposits, provided they are low in MgO, easily meet the requirements and a number of other CaO-containing raw materials are known to be used. Alternative materials include marble, chalk, marl, shell deposits, blastfurnace slag and alkali waste. The overburden to limestone deposits is also used frequently as a source of silica, alumina and iron. Other mineral components (such as iron oxide wastes, silica sand, etc) are sometimes used to blend into the raw material mix to optimise the chemistry. The variety of raw material used worldwide for cement manufacture is very great.

2: Extraction and processing

2.1 Extraction

The raw materials used in cement manufacture are extracted in large quarries, typically with outputs of up to, or over, 2.5 million tonnes per year. Typically about 1.65 tonnes of limestone (1.5 to 1.8 tonnes) and 0.4 tonnes of clay are quarried for each tonne of cement produced. Large reserves of feedstock, particularly of limestone, are required to provide security of supply and these are normally quarried in close proximity to the cement works. Clay or mudstone may be worked in the same, or an adjacent quarry, or transported from more distant sites.

The raw materials which supply cement works, and which may be required in quantities of over 4,000 tonnes per day, must be thoroughly proven if the plant is to run successfully. Consistent quality feed is required and an extraction plan must be made to ensure that a uniform flow of raw material will always be available to the kilns.

2.2 Cement making

Cement clinker is manufactured by heating the blended and ground raw material (typically limestone and clay or shale and other materials) to partial fusion. The clinker burning takes place at a temperature of 1450°C in kilns, which are normally inclined rotating cylinders lined with heat-resistant bricks. Clinker emerges from the kiln after several hours as granulated spherical pebbles. Afterwards, the clinker is finely ground by ball milling with a small amount (typically 5%) of gypsum/anhydrite to give Portland cement. Gypsum/anhydrite is introduced to control the initial rate of reaction with water and to allow concrete to be placed and compacted before hardening commences. Blended cements are produced by intergrinding cement clinker with materials like fly ash, granulated blastfurnace slag, limestone dust, natural (eg. volcanic ash) or artificial (eg. metakaolin) pozzolanas, in addition to gypsum/anhydrite. The finished cement is transported in bulk or in bags to the market. Cement clinker and finished cement are traded internationally.

Cement manufacture is a very energy intensive process and results in the production of large amounts of carbon dioxide (CO_2). The carbon dioxide is chiefly produced when the calcareous raw material is calcined to produce calcium oxide. Generally around 0.5 tonnes of carbon dioxide is released for each tonne of cement produced — a figure that does not include carbon dioxide released during energy generation to power cement manufacturing plants. Worldwide it is thought that cement making is responsible for around 7% of total man-made CO_2 emissions.

The UK cement industry has agreed to reduce its primary energy consumption by 25.6% per tonne of cement produced by 2010, from a 1990 baseline. In return, the industry receives an 80% rebate from the Climate Change Levy. The reductions are phased over a number of years (Table 2.2.1)

Table 2.2.1 Projected improvements in primary energy consumption of UK cement production up to 2010

	Primary energy per tonne of cement produced (kWh)	Improvement over 1990 baseline figure (%)
2002	1.463	13.2
2004	1.414	16.1
2006	1.303	22.6
2008	1.287	23.6
2010	1.253	25.6

Additionally, Lafarge has committed to reducing its worldwide CO_2 emissions by 20% per tonne during the period 1990 – 2010. Lafarge plans the reduction by intensifying a series of actions such as improving energy efficiency, using waste fuels and incorporating cementitious additions such as steel slags and fly ash from coal-fired power stations.

The processes of milling, blending, calcining and grinding the clinker are described as dry, semi-dry/semi-wet or wet depending on how the raw material is handled before being fed to the kiln. Moisture content of the raw materials (ranging from 3% for hard limestone to over 20% for soft limestones such as chalk) is the main criterion for governing the process used.

In the dry process the feed material is in a dry, powdered form. It is either preheated by the kiln's hot exit gases prior to entering the kiln (preheater kiln) or, if fuel is added in a special combustion chamber, the calcination process can almost be completed before the raw material enters the kiln (precalciner kiln).

In the wet process, the feed material is made by wet grinding and the resultant slurry, which contains typically 30 – 40% water, is fed directly into the kiln.

In the semi-dry or semi-wet process water is either added to the ground dry feed or removed from the slurry by filter pressing, resulting in a feed material containing about 15-20% moisture.

Over recent decades there has been a move away from the wet process to the more energy efficient dry process. In Europe, for example, about 78% of cement production is from dry process kilns, a further 16% of production is accounted for by semi-dry/semi-wet kilns, and only about 6% of European production now comes from wet process kilns.

3: Specification and uses

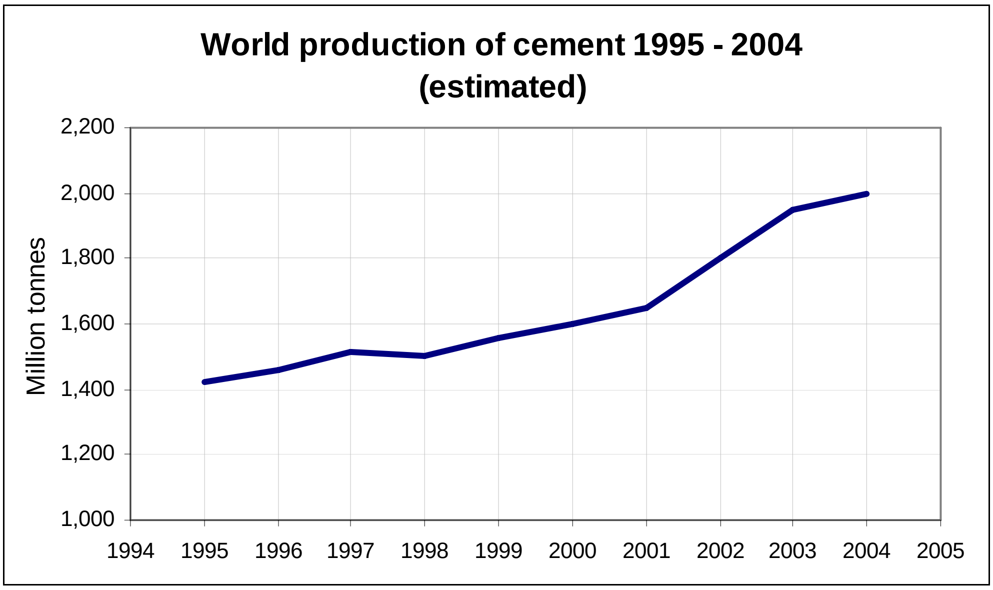
3.1 Specifications

Most national specifications (http://www.bca.org.uk/main.asp?page=197) for Portland cement require that the cement should not contain more than 5% MgO (less than 3% in the limestone raw material); therefore identification of dolomite is crucial in the evaluation of carbonate rocks for cement manufacture. Other chemical specifications may limit sulphur trioxide (SO_3) and phosphorus pentoxide (P_2O_5) to less than 1% and total alkalis to less than 0.6%. Additional specifications may apply to speciality cement types, such as sulphate-resisting cement, oil-well cement and white cement (for example, less than 0.01% Fe_2O_3).

3.2 Uses

Cement is an essential constituent of concrete, which is a mixture of cement and coarse and fine aggregate. When mixed with water, this material can be placed in situ or cast in moulds (such as concrete blocks). It is a highly versatile building material valued for its high compressive strength, fire resistance, mouldability, impermeability and durability. Mortar (a mix of cement, fine aggregate and water) is used for joining structural blocks, brickwork, and plastering. Both concrete and mortar are vital, and essentially irreplaceable, construction materials for the building and civil engineering industries. They are widely used in all construction sectors, including house building, road construction, bridges and dams, and in other infrastructure projects, such as railways, airport facilities, hospitals, schools, new offices and shops. Demand for cement is a function of economic activity and construction activity, both of which can be highly cyclical.

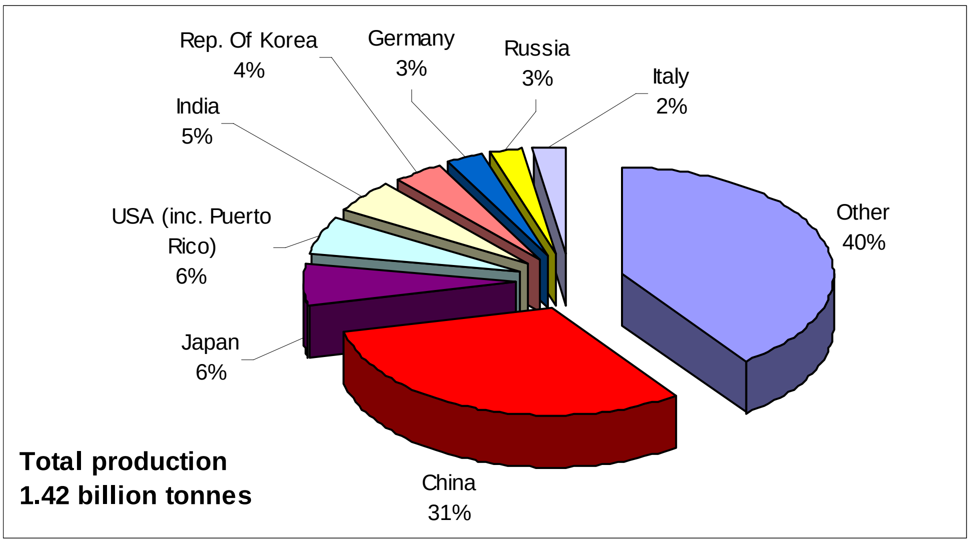
4: World production



Source: United States Geological Survey

Figure 4.1 World cement production 1995 to 2004

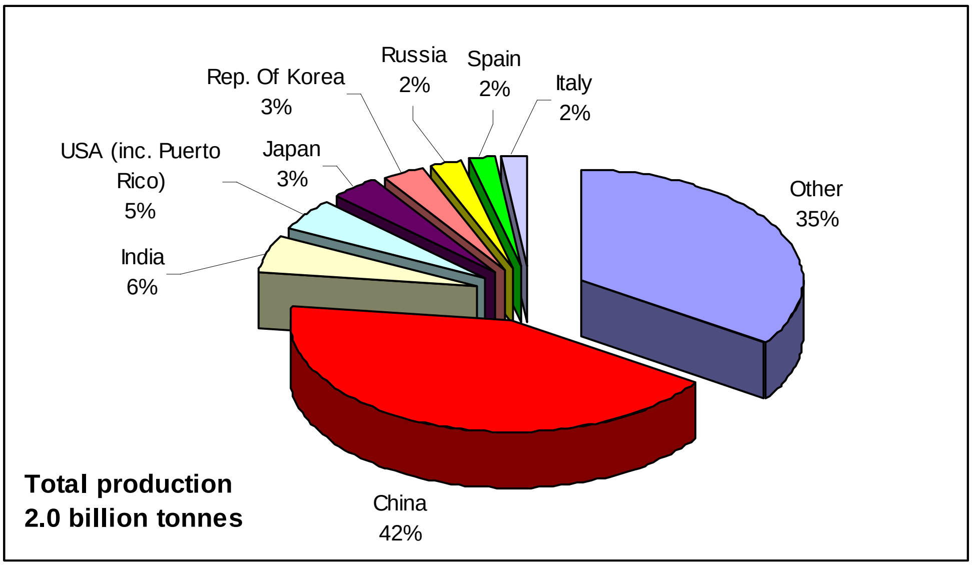
World production of cement rose steadily from 1995 to 2004 (Figure 4.1), increasing by almost 600 million tonnes during this period. It is estimated that cement production in 2004 was around 2,000 million tonnes. This is consistent with improving economic conditions and population growth in many parts of the world.



Source: United States Geological Survey

Figure 4.2 World cement production in 1995

4: World production



Source: United States Geological Survey

Figure 4.3 World cement production in 2004

Recent economic growth in China has stimulated growth in its construction industry, with the result that China's cement production now constitutes 42% of the world's total production. Actual Chinese cement production increased from 445 million tonnes to 850 million tonnes per year over the period 1995 – 2004 (Figures 4.2 and 4.3), an increase of over 90%. It is clear from Figure 4.3 that cement production is a function of population and economic growth, both on country and world scales. With the global population expected to rise to over 9 billion by 2050 (http://www.un.org/) further growth in world cement production can be expected.

5: Alternative materials

5.1 Alternative raw materials

The principal objective of using alternative materials is to optimise the mix to make best use of available raw materials. A range of calcareous raw materials can be used for cement manufacture, but limestone, chalk or marble predominate. In most cases other calcium-bearing sources do not occur in sufficiently large deposits or amounts to be used as alternatives. Clay/mudstone is the main source of silica, alumina and iron oxides because of its availability and low cost. However, mudstone often does not supply the correct chemical balance of constituents and bought in supplements are sometimes required. These may include silica sand, fly ash/pulverised fuel ash (PFA), iron oxides and bauxite. PFA has a higher alumina to silica ratio than most mudstones, and also lower alkalis. It is used in some cement plants to add alumina so that higher silica limestone can also be utilised. It also helps to reduce alkalis. Ash from the coal burn also contributes to the overall chemistry of the cement feed. However, alternative fuels are increasingly substituting for coal (see below).

The production of blended cements is increasing. These may contain for instance, singly or in combination, a proportion of PFA (a by-product of coal-fired power stations), blastfurnace slag (a by-product of ironmaking), tuff (a type of volcanic rock) and limestone dust. These act mainly as lower cost diluents, their main purpose being to reduce the amount of cement clinker used per unit of concrete produced. However, their use may also impart additional properties to the product. Both PFA and slag, for example, have cementitious properties.

5.2 Alternative fuels

Cement manufacture is energy intensive (Section 2.2) and coal has been the traditional fuel used. In many countries the cement industry is seeking to increase the proportion of alternative fuels that it uses as kiln fuel. These fuels include end-of-life tyres, secondary liquid fuels (such as waste solvents from printing and cleaning), paper and packaging wastes, sewage sludge, meat and bone meal. All these fuels will have to meet strict environmental specifications. The use of these fuels is not only less costly, but reduces carbon dioxide emissions and the amount of waste that otherwise would be landfilled.

6: Cement raw materials — focus on Britain

6.1 Resources

Limestones of varying geological ages are distributed widely in England and Wales. Scotland and Northern Ireland possess fewer limestone resources. They vary considerably in their chemistry and thickness and thus their suitability for cement manufacture on a large scale. Dolomites and dolomitic limestones are unsuitable for cement manufacture, because of their high magnesia (MgO) contents. This precludes the use of dolomites (with subordinate limestones) of Permian age occupying a narrow outcrop from Newcastle to Nottingham.

In Britain the cement industry uses limestones from the Cretaceous (Chalk), Carboniferous and Jurassic (Figure 6.1.1). Carboniferous limestones are the major source of limestone raw materials in Britain. Both Carboniferous and Jurassic limestones mostly have low porosities, and thus low moisture contents; thus the dry process is used in cement manufacture from these resources. Chalk is generally highly porous and has a high moisture content. Consequently wet or semi-wet manufacturing processes are used to make cement from chalk.

Carboniferous limestones are relatively extensive and occur as thick consistent deposits that are easy to work and which are generally of relatively high purity. The Peak District of Derbyshire has extensive resources and the limestones are characteristically thick bedded and flat-lying and are noted for their uniformity over wide areas. Large areas of both North and South Wales, the northern Pennines and the fringes of the Lake District are also underlain by Carboniferous limestones, some of which are relatively thick, pure and consistent in quality. Elsewhere, Carboniferous limestones occur mainly in the Mendips, although here they are more variable and do not exhibit the same degree of purity. Cement plants using Carboniferous limestones are located at Hope and Tunstead in Derbyshire, Cauldon in Staffordshire, Clitheroe in Lancashire, Dunbar in East Lothian, Mold in Flintshire and at Cookstown in Northern Ireland.

Limestones of Jurassic age outcrop widely from Dorset, through the Vale of Glamorgan and central England to the Yorkshire coast. The limestones of Middle Jurassic age are the most extensive, although individual beds are comparatively thin. Currently Jurassic limestones are worked at only two sites for cement manufacture: at Ketton in Rutland (which works the Lincolnshire Limestone) and at Aberthaw in South Wales (which works the Lower Lias, in addition to local outcrops of the Carboniferous limestone).

The Cretaceous Chalk is a soft, fine-grained, white limestone that occurs extensively and thickly in eastern and southern England. It is generally of high purity with a uniform composition. The main impurities are flint, occurring as nodules and tabular beds, and clay material represented by calcareous mudstone seams and partings. The lowest 25 –60 m of the Chalk has a higher clay content and it is this material that was formerly extensively worked as a natural cement mix. There are currently five quarries producing chalk as raw material for cement: at Northfleet in Kent, Westbury in Wiltshire, Kensworth in Bedfordshire, Barrington in Cambridgeshire and South Ferriby in North Lincolnshire.

6: Cement raw materials - focus on Britain

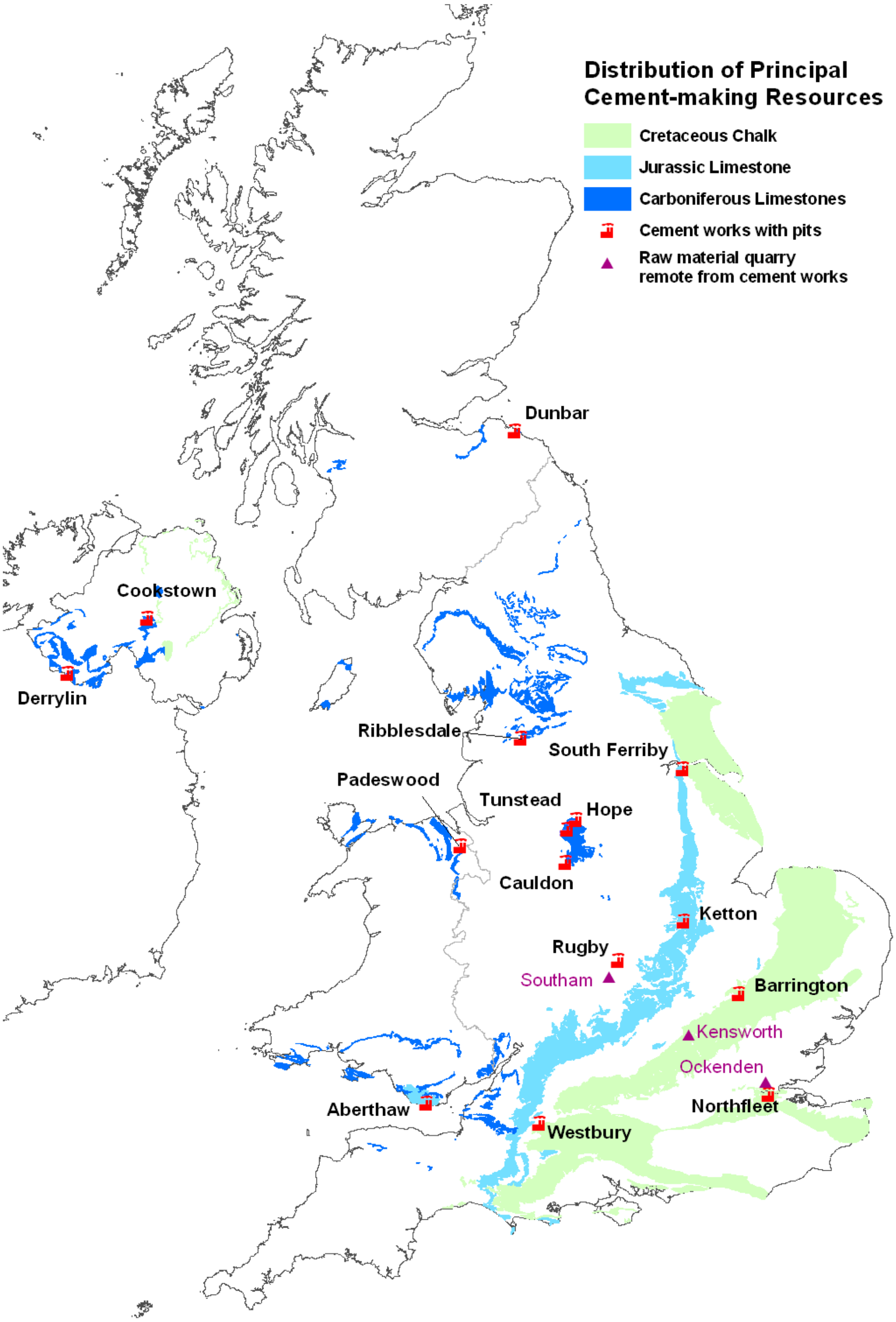


Figure 6.1.1 Location of cement works and major raw material sources in the UK

Resources of clay and mudstone suitable for cement manufacture are widespread and normally obtained from quarries adjacent to cement plants. One major exception is the use of the London Clay at Ockendon in Essex, which is slurried with water and piped beneath the Thames to supply the Northfleet cement works.

6.2 Reserves

Cement plants are highly capital intensive. The construction of new plant costs about £10 million for each 100 000 tonnes per year of cement capacity. Large modern plants can, therefore, cost over £100 million. Ongoing capital investment at individual plants can also typically amount to several million pounds a year.

Cement raw materials must be available in sufficiently large quantities to justify these large capital investments. Current policy in Mineral Planning Guidance 10 Provision of Raw Material for the Cement Industry is that the stock of permitted reserves should provide at least 25 years supply for a new plant or new kiln. Elsewhere the stock of permitted reserves should be at least 15 years.

Permitted reserves of limestone and chalk for cement manufacture at 2003 are shown in Table 6.2.1.

Table 6.2.1 Permitted reserves of limestone and chalk for cement manufacture in Britain in 2003

MPA	Plant	Clinker capacity (thousand tonnes/year)	Reserve (Mt)	Reserve Life (Years)
Staffordshire	Cauldon	920	117	49.2
Peak District National Park	Hope	1 400	45	28
Kent	Northfleet	1 250	9.4	5
Kent/Medway	Medway (planned)	1 200	71.3	32.5
Wiltshire	Westbury	720	9.4	9.1
Ketton	Rutland	1 300	na	23
Ribblesdale	Lancashire	1 300 (current) 800 (future)	na	24
North Lincolnshire	South Ferriby	750	na	50
Cambs	Barrington	250	na	38
Bedfordshire	Kensworth quarry	1 250	na	Many
Derbyshire	Tunstead	750	na	40
Flintshire	Padeswood	800	na	na
Vale of Glamorgan	Aberthaw	500	22.0	49.2
Tyrone	Cookstown	650	na	na
East Lothian	Dunbar	1 000	48.0	34.0
Warwicks/Beds	Rugby	1 250	na	na

6.3 Structure of the industry

There are four producers of cement in the UK. These are (with their approximate market share): Lafarge Cement UK (48%), Castle Cement (25%), Rugby Cement (20%) and Buxton Lime Industries (7%). The cement plants are listed in Table 6.3.1 and their locations shown on Figure 6.1.1.

6: Cement raw materials - focus on Britain

Table 6.3.1 Cement plants in Britain, clinker capacity and raw materials

Company	MPA	Plant	Clinker capacity (Thousand tonnes/ year)	Process	Raw materials	Transport
Lafarge Cement UK	Staffordshire	Cauldon	920	Dry	Carboniferous limestone and / mudstone	Road
	Peak District National Park	Hope	1 400	Dry	Carboniferous limestone and / mudstone	Road/Rail
	Kent	Northfleet	1 250	Semi-wet	Chalk and London Clay	Road
	Kent/Medway	Medway (planned)	1 200	Dry	Chalk and Gault clay	Road/Rail
	Wiltshire	Westbury	720	Wet	Chalk and Kimmeridge Clay	Road/Rail
	Vale of Glamorgan	Aberthaw	500	Dry	Jurassic limestone and mudstone and Carboniferous limestone	Road
	East Lothian	Dunbar	1000	Dry	Carboniferous limestone and mudstone	Road/Rail
	Tyrone	Cookstown	470	Dry	Carboniferous limestone and mudstone	Road
Castle Cement	Rutland	Ketton	1 300	Dry	Jurassic limestone and mudstone	Road/Rail
	Lancashire	Ribblesdale	1 300 (current) 750 (future)	Wet Dry (planned)	Carboniferous limestone and / mudstone	Road
	Flintshire	Padeswood	800	Dry and wet	Carboniferous limestone and shales	Road
Rugby Cement	North Lincolnshire	South Ferriby	750	Semi-dry	Chalk and Kimmeridge clay	Road
	Cambs	Barrington	250	Wet	Chalk and Gault clay	Road
	Warwicks/ Beds	Rugby	1 250	Wet	Chalk and Jurassic mudstone	Road
Buxton Lime Industries	Derbyshire	Tunstead	750	Dry	Carboniferous limestone and / mudstone	Road/Rail

There have been a number of cement plant closures in recent years due to rationalisation and concentration on larger plants. Recent closures by Lafarge Cement have included Masons in Suffolk, and Plymstock in Devon, both in 1999, and Weardale in Durham in 2001. Rugby Cement closed plants at Rochester, Kent and Southam in Warwickshire after the new Rugby works came into full production in 2000.

6: Cement raw materials - focus on Britain

Lafarge Cement UK is part of the Lafarge Group of France, which is the world's largest cement producer. Castle Cement is a subsidiary of the Heidelberg Cement Group of Germany and Buxton Lime Industries is part of Tarmac, a subsidiary of the Anglo-American Corporation. Rugby Cement is a subsidiary of the CEMEX Group of Mexico. With the exception of Castle Cement, all the cement manufacturers are also large producers of aggregates in the UK.

6.4 Production

The cement industry in Great Britain consumed some 14.6 million tonnes of limestone and chalk and about 2.2 million tonnes of mudstone in 2004, together with about 0.6 million tonnes of gypsum/anhydrite and much smaller quantities of ancillary materials, including silica sand, pulverised fuel ash (PFA) and iron oxides. Cement plants in the UK have clinker capacities of between 0.25 million tonnes per year to 1.4 million tonnes per year (Table 6.3.1). They are, therefore, major consumers of mineral raw materials.

The industry had its origins in South East England in the mid 19th Century, where it was based on chalk. This was because of the ease with which chalk and clay could be converted to a uniform slurry with the equipment then available. The industry became concentrated along the Thames east of London and in the Medway valley of Kent. The later introduction of more efficient grinding mills made the use of harder limestone and mudstone possible. In addition, rising energy prices favoured the use of the dry process based on limestone at the expense of chalk using the wet process. Consequently, whilst the consumption of limestone has remained fairly constant, there has been a declining use of chalk in an overall declining market (Figure 6.4.1). In 2004, limestone accounted for about 65% of the total requirement for calcareous material. Plant closures have been mainly those based on chalk. However, a proposed new works in the Medway valley of Kent will be based on chalk, although is intended to replace the existing Northfleet works in Kent, which is also based on chalk.

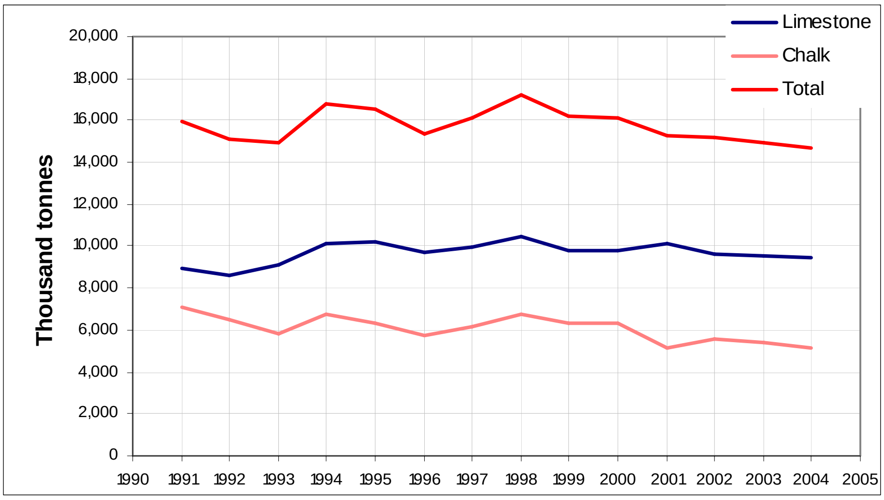


Figure 6.4.1 Great Britain: Production of limestone and chalk for cement manufacture, 1980 – 2004

Source: UK Minerals Yearbook 2004, BGS

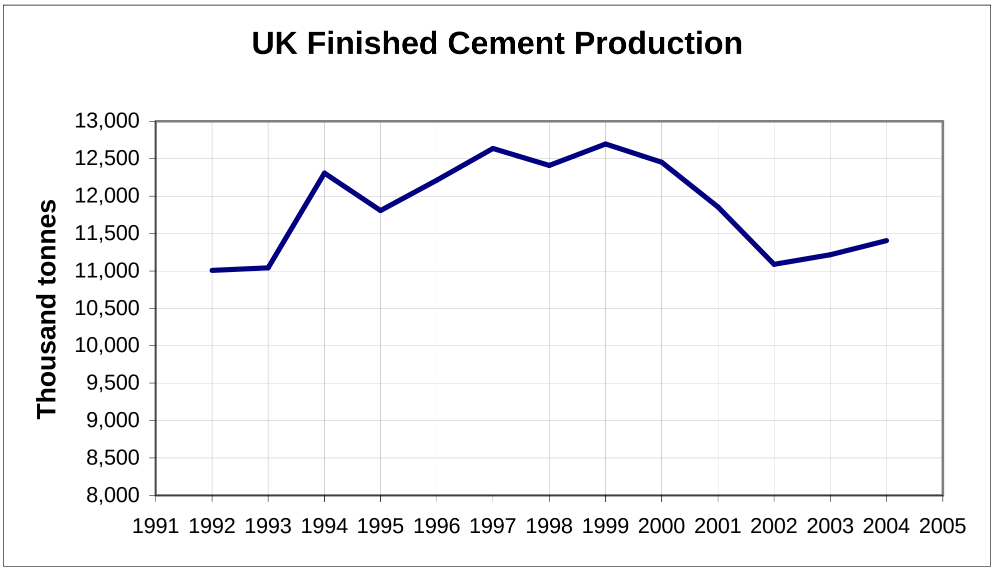
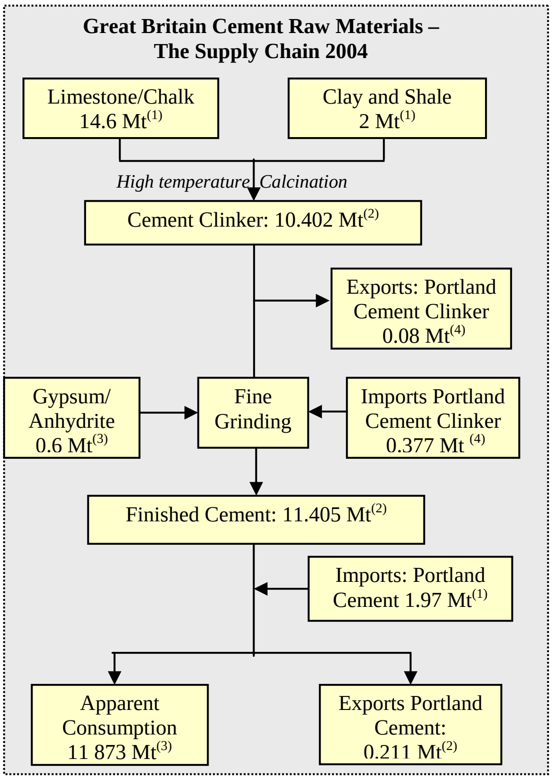


Figure 6.4.2. UK cement production in the UK, 1992 – 2004

Source: *UK Minerals Yearbook 2004, BGS*

Over the last 20 years UK cement clinker production has been in the range 15 million tonnes per year to 10 million tonnes per year, but with a generally declining trend. Clinker production was some 10.4 million tonnes in 2004 (GB). Production of finished cement is shown in Figure 6.4.2.

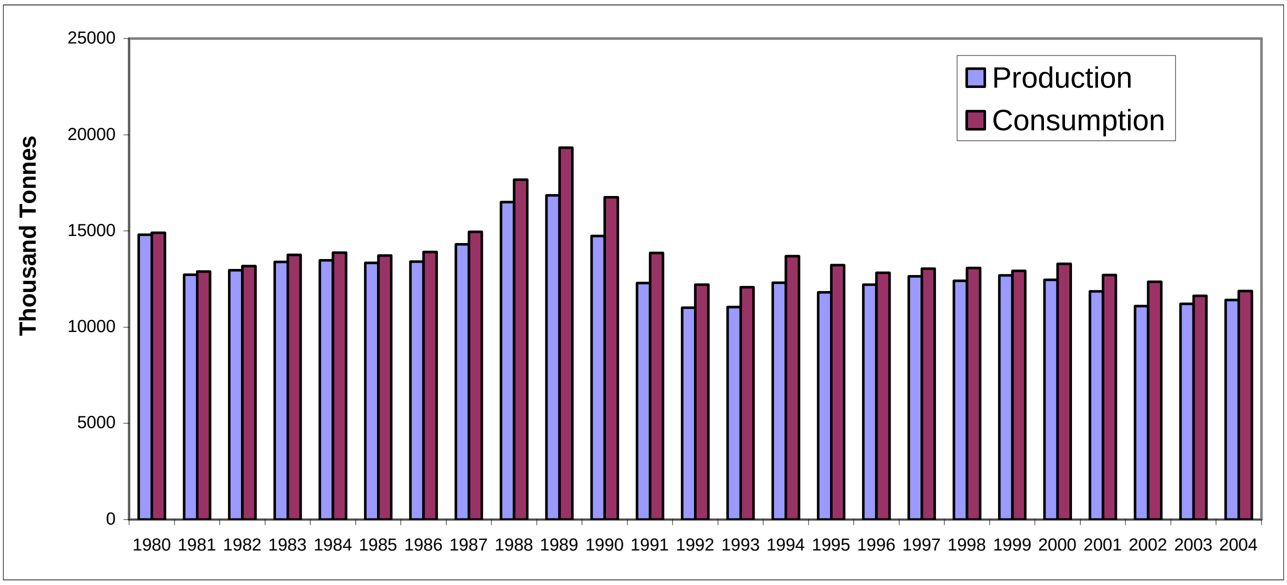


1. Office of National Statistics (includes White Portland and Grey Portland cements +blended cements).
2. Monthly Statistics, Building Materials and Components, DTI
3. BGS estimate
4. HM Revenue and Customs (UK)

Figure 6.4.3 Cement raw materials supply chain

6.5 Consumption

UK consumption of cement includes cement made from indigenously produced cement clinker, cement made from imported clinker and imports of finished cement (Figure 6.5.1). Total UK consumption of cement is 12–13 million tonnes a year, of which 90–92% is supplied by the UK industry and the remainder is imported. Forecasts of demand for cement raw materials published in Mineral Planning Guidance Note 10 published in 1991 have proved to be too high. This is due to a reduction in domestic capacity, increased imports and increased use of blended cements (in which some of the cement is replaced by PFA and granulated blast furnace slag). Total consumption of cementitious material (including blended cement) was about 12 million tonnes in 2004. Per capita consumption of Portland cement in the UK was about 220 kg in 2004.



Source: Monthly Statistics, Building Materials and Components, DTI, 2004 GB only

Figure 6.5.1 UK: Production and apparent consumption of cement, 1980 – 2004

6.6 Trade

In the late 1970s and early 1980s, the UK was a significant exporter (> 1 million tonnes per year) of cement. However, increasing competition in overseas markets has led to a decline in exports and from 1987 onwards, the UK became a net importer due to insufficient domestic production capacity (Table 6.6.1). The value of UK imports of clinker in 2004 are estimated at about £21.6 million, with exports valued at about £1.3 million. Portland cement imports are valued at about £62 million in 2004, and about £13.5 million for exports.

Table 6.6.1 UK: Imports and exports of Portland cement, 2001 – 2004

	Exports	Imports	Exports	Imports
Tonnes				
	White Portland		Grey Portland	
2001	10 812	92 552	13 488	39 961
2002	18 996	229 297	11 206	57 439
2003	16 232	250 974	12 774	51 677
2004	27 794	293 027	13 309	61 952

(Grey Portland cement includes blended cement)

Source:http://www.statistics.gov.uk/downloads/theme_commerce/PRA-20040/PRA26510_20040.pdf

6.7 Issues

6: Cement raw materials - focus on Britain

Cement raw materials are not sold on the open market, but are entirely consumed in the manufacture of cement. The value of UK sales of Portland cement, including blended cements, was £765 million in 2004. Some 3 000 people are employed in the industry. Cement is an essential material for the UK construction industry, which is a major sector of the economy. In 2004 the total gross value added at basic prices of the work done in the construction sector in Great Britain was £67.6 billion: of which about 60% is new work and 40% is for repair and maintenance.

The principal raw materials used in cement manufacture are almost always supplied from adjacent quarries in order to avoid the high costs of transporting large tonnages of low-cost raw materials. In England the only major exception is the Rugby works in Warwickshire, where both the calcareous and clayey raw materials are transported into the plant. The cement industry in Warwickshire was originally based on local impure Jurassic limestone, but these are unsuitable for modern cementmaking. Since 1965 a slurry pipeline from Kensworth Quarry in Bedfordshire has been the source of chalk into the county. Clay is also transported by road to Rugby from Southam. A pipeline is also used to transport clay from Essex beneath the Thames to the Northfleet cement works. It is unlikely that pipelines will be used in the future to transport raw materials, because of their high cost and the economic disadvantages of the wet or semi-wet process, which slurrying in water would entail. Six of the cement works in the UK are rail connected. A number of cement works remain entirely reliant on road transport.

Modern cement operations tend to be large-scale and long-lived. The economies of scale required in order to make individual operations profitable mean that production has tended to concentrate on units which require large inputs of limestone and clay. This means that there has been a trend toward more extensive quarries and larger processing plant, both of which are likely to be more visually intrusive.

Cement manufacture requires complex plant which is expensive to install and maintain. As a consequence operators require security of supply of both limestone and clay over relatively long periods of time (see section on Reserves above). As a consequence, individual extraction and processing sites can be long lived relative to other mineral operations. Despite the fact that individual planning authorities have been largely successful in following current guidance in bringing forward reserves to maintain security of supply, economic conditions have meant that the indigenous cement industry has contracted and there is an increased reliance on cement imported from elsewhere in Europe.

7: Further reading

Mineral Planning Guidance 10 Provision of Raw Material for the Cement Industry

The British Cement Association: (http://www.bca.org.uk/)

The Portland Cement Association: (http://www.cement.org/)

http://www.bgs.ac.uk/mineralsuk/statistics/uk/home.html

Lafarge Cement: http://www.cement.bluecircle.co.uk/index.htm

Castle Cement: http://www.castlecement.co.uk/

Cement, Concrete and Mortar FAQ: http://www.axp.mdx.ac.uk/~john49/cemfaq.htm