Office of the Deputy Prime Minister
Creating sustainable communities

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Mineral Planning Factsheet

Limestone

*This factsheet provides an overview of **industrial limestone** supply in the UK. It is one of a series on economically important minerals that are extracted in Britain and is primarily intended to inform the land-use planning process.*

January 2006

Three types of carbonate rock are produced in the UK for industrial (and agricultural purposes) – **limestone**, **chalk** and **dolomite**. Dolomite is considered separately (see factsheet on **Industrial Dolomite**). Limestones are sedimentary rocks consisting principally of calcium carbonate ($CaCO_3$). With an increase in magnesium carbonate ($MgCO_3$), limestone grades into dolomite or dolostone [$CaMg(CO_3)_2$]. Chalk is a type of very fine-grained limestone. Most limestones contain varying amounts of impurities in the form of sand, clay and iron-bearing materials. These impurities are usually present in very small proportions in industrial limestones, which are generally valued for their high chemical purity (generally >97% $CaCO_3$). However, for many applications it is the amount of specific impurities present (such as iron, sulphur, silica and lead) and overall consistency that is important, rather than absolute values for calcium carbonate content. Limestone used in glassmaking is required to contain <0.036% Fe_20_3.

Limestone is an important raw material and it is often said to be the world's most versatile mineral. It has a wide variety of applications, but its primary use is in the construction industry where it is the principal source of crushed rock aggregate in the UK (see factsheet on **Construction Aggregate**). It is also an essential raw material for cement manufacture (see factsheet on **Cement Raw Materials**), and a source of building stone (see fastcheet on **Building Stone**). Industrial limestone (Figure 1) is a commercial term for limestone used for non-constructional purposes, where its chemical properties or degree of whiteness are important. Limestone used for industrial purposes accounts for a relatively small but important proportion of total limestone output (about 9%).

Dowlow Quarry, Derbyshire.

Demand

Total demand for limestone and chalk for industrial and agricultural use was 6.9 million tonnes and 2.1 million tonnes respectively in 2004 (see Table 1). In addition, net imports of crushed and powdered marble, were about 113 000 tonnes in 2004.

Industrial limestone is an important raw material in iron and steel making, glass manufacture, sugar refining, and numerous chemical processes, notably the manufacture of soda ash (sodium carbonate). It is also used as a mineral filler in paper, paints, plastics, rubbers, pharmaceuticals and cosmetics, and in agricultural and environmental applications. In these industrial applications, limestone (or lime, derived from the calcination or 'burning' of limestone) may be used either as a chemically reactive raw material ('chemical stone'), or as an inert filler or pigment ('limestone powder'). For almost all of these applications, the limestone must have a high chemical purity. Most markets for industrial limestone are mature markets or are shrinking due to the decline in UK manufacturing. One growth area is limestone (or lime) for environmental applications and in water and effluent treatment and pollution control. A particularly important market for high purity limestone, which has emerged in the last 10 years, is flue-gas desulphurisation. This involves the removal of sulphur dioxide contained in the flue gases at coal fired power stations, in a water based slurry of finely ground limestone. Gypsum is produced as a by-product (see factsheet on **Gypsum**).

Chemical stone

Limestone is used in a number of industries where its chemical properties as a basic oxide,

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flux, neutralising agent or source of calcium are important. Glassmaking, sugar refining and flue gas desulphurisation use raw limestone, but most of the remaining processes use limestone that has been 'burnt' to produce quicklime (CaO) or hydrated lime [$Ca(OH)_2$]. Most lime sold in the British market is quicklime. UK lime production is around 2.5 million tonnes per year. About 1.7 tonnes of limestone are required to produce 1 tonne of quicklime. Tunstead Quarry in Derbyshire is the largest producer of lime and chemical stone in the UK. Other major lime producing units include Shapfell in Cumbria, Batts Combe in Somerset and Hindlow in Derbyshire. Lime production at Melton Ross in North Lincolnshire is based on chalk.

Limestone powders

Limestone and chalk are relatively soft and easily ground to a fine powder. This is non-toxic and usually white in colour. These properties ensure that limestone powders are extensively used as fillers in a diverse range of products where the primary purpose is to add low cost bulk. Some limestone powders also make use of the chemical properties of the stone. Examples include acting as a source of calcium in animal feeds, and as an acidity regulator in some agricultural and pharmaceutical products. Powder made from chalk is usually known as 'whiting'.

Many high-volume applications of limestone powders, (such as agricultural lime, carpet backing and asphalt manufacture) do not require pure limestone and are sourced from a variety of limestone quarries across Britain. In contrast, powders used in applications such as pharmaceuticals and food must be of very high purity. These are generally made by dissolving limestone or lime in acid and then precipitating pure calcium carbonate from solution. This precipitated calcium carbonate (PCC) has a very high brightness and other desirable properties related to particle size and morphology. There are three plants in England producing precipitated calcium carbonate. These mostly utilise high purity Carboniferous limestone from Derbyshire as feedstock.

Limestone powders used as fillers in paper, plastics and high quality paints typically require particle sizes within a closely defined range, along with high brightness (whiteness), good rheological (fluid) properties and low oil absorption. There are several producers of ground calcium carbonate powders in Britain, generally from Carboniferous limestone or chalk. Some marble and dolomite is imported and processed to meet demand for very high specification carbonate fillers.

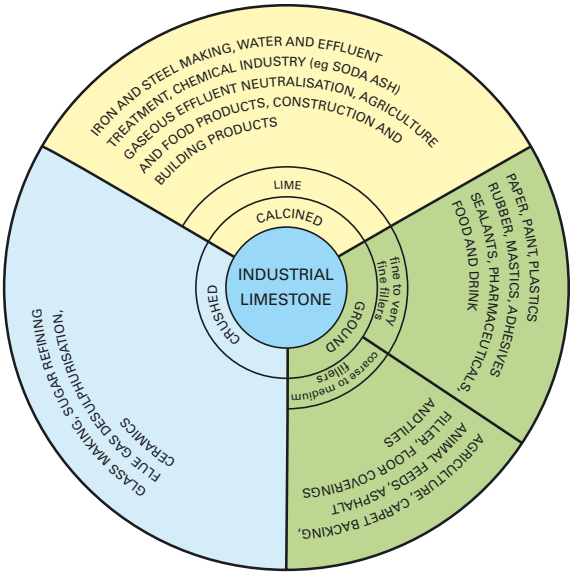

Figure 1 Industrial uses of limestone.

Supply

Detailed production data for limestone and chalk for industrial and agricultural purposes by individual use are not publicly available because of confidentiality considerations. However, in 2004 it is estimated that a total of 9 million tonnes were produced in Great Britain, of which 77% was limestone and 23% chalk (Table 1). All of the chalk and the bulk of the limestone was produced in England. For industrial use limestone accounted for 72% (6 Mt) of the total (Table 1). A large proportion of this output was from Derbyshire and the Peak District National Park. Some industrial limestone is produced in South Wales for use in the steel industry. The production of limestone and chalk for industrial and agricultural purposes between 1980 and 2004 is shown in Figure 2. There has been an overall decline in the use of

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limestone. Chalk production shows a modest increase over the same period. The proportion of limestone and chalk used for industrial and agricultural purposes as compared to overall consumption is shown in Table 1. Only 9.1% of total limestone production in 2004 was for industrial and agricultural use, compared with 26% for chalk.

Mineral	Limestone	Chalk
	Thousand tonnes	
Constructional uses (a)	59 615	705
Cement making	9 474	5 177
Agricultural uses	921	na
Industrial uses	6 000	2 114(b)
Total	**76 014**	**7 997**

Table 1 Great Britain: Production of limestone and chalk by broad end use category in 2004. *Source: Annual Minerals Raised Inquiry, ONS.*

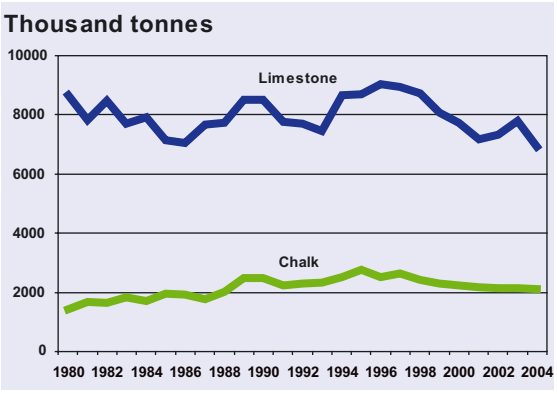

Figure 2 Great Britain: Sales of limestone and chalk for industrial and agricultural applications, 1980–2004. *Source: UK Minerals Yearbook.*

One of the largest uses of limestone and lime is in the iron and steel industry. Limestone is used as a flux in ironmaking and some 2 million tonnes was used for this purpose in 2004. Lime is used as flux in steelmaking and some 0.6 million tonnes was used in 2004. Consumption has been decreasing in line with a decline in steel production.

Trade

The UK is a modest net exporter of limestone, chalk and lime for industrial purposes, the latter contributing some £9 million to the balance of trade in 2002. The UK has no significant marble resources (a metamorphic rock produced by the alteration of limestone at high temperatures/pressures). Marble has superior optical brightness properties compared to chalk. Significant quantities of marble, valued at £4.9 million, are imported principally for use in the paper industry. Net trade in these minerals is shown in Table 2.

Year	Limestone (a)	Chalk (a)	Marble (b)	Lime (a)
	Tonnes			
1999	143 398	25 958	122 491	122 953
2000	228 445	19 700	144 631	121 913
2001	73 906	20 487	234 568	109 876
2002	71 824	21 039	254 433	75 041
2003	242 679	21 011	132 729	345 097
2004	224 946	34 793	110 151	97 412

(a) Aggregates and building stone
(b) Agricultural and industrial use
na not available

Table 2 UK: Net trade in limestone, chalk, marble and lime, 1999–2004. *Source: HM Revenue & Customs.*

Economic importance

The total value of sales of limestone and chalk for industrial and agricultural uses is of the order of £156 million. However, this figure greatly undervalues their true economic impor-

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tance because of the multiplicity of downstream industries that rely on these minerals as essential raw materials. They are, for example, essential for the production of quicklime and UK sales of lime produced from limestone and chalk are some £60 million. However a significant proportion of the lime produced in the UK is for captive use, for example in the manufacture of soda ash, for sugar beet refining and for use as flux in steelmaking. The production of soda ash by Brunner Mond is reliant on two principal feedstocks, brine and limestone. The company's turnover from UK operations based on these feedstocks is some £104 million. The iron and steel, and glass industries are other sectors that are highly reliant on limestone as an essential raw material. Other important downstream users are the paper, paint, rubber and plastics industries.

Structure of the industry

There are about ten principal industrial limestone and chalk producers in the UK. The largest is the Tarmac Group, which is part of the Anglo American Corporation, with the main output coming from the Tunstead-Old Moor Quarry complex, near Buxton that straddles the Derbyshire-Peak District National Park boundary. The company is the largest lime producer in the UK and currently is the only supplier of high purity limestone for flue gas desulphurisation. The company also supplies all the chemical stone for Brunner Mond's soda ash factories in Cheshire. This company is the UK's sole producer of soda ash (sodium carbonate) and limestone is one of the principal raw materials used in the process (see also factsheet on **Salt**). Tarmac also produces industrial limestone powders at Ballidon Quarry also located in the Peak District National Park and industrial limestone at Stainton Quarry in south Cumbria mostly for export to Norway. The company also produces limestone for use as a flux in ironmaking at Wensley Quarry, near Leyburn in North Yorkshire.

Hanson Aggregates produces lime for use in steelmaking in South Wales at its Batts Coombe Quarry in Somerset and also supplies limestone from Shap Beck Quarry to Corus for lime production at their Shapfell Quarry. Corus Steel operates the Shapfell (Hardendale) Quarry in Cumbria primarily for the production of lime for steelmaking.

Longcliffe Quarries Ltd and Ben Bennett Jnr Ltd, produce high purity limestone for a range of applications at, respectively, their Brassington Moor and Grangemill quarries in Derbyshire.

Lhoist UK operates the Hindlow Quarry in Derbyshire for the production of lime.

OMYA UK produces chalk for filler applications at Melton Quarry in the East Riding of Yorkshire and at Steeple Morden Quarry in Cambridgeshire. The company also produce industrial limestone powders in Derbyshire at Ashwood Dale Quarry and at Dowlow Quarry. At Dowlow, the company's grinding plant is supplied by Lafarge Aggregates, who operate the quarry.

Singleton Birch Ltd is an important producer of chalk for lime production at Melton Ross Quarry in North Lincolnshire, and also supplies chalk for use as a flux in ironmaking at Scunthorpe.

IMERYS Minerals Ltd produces chalk for filler applications at Queensgate Quarry in the East Riding of Yorkshire and at Quidhampton Quarry in Wiltshire. Minelco Specialities Ltd also produce chalk for filler applications at the Lund Quarry in the East Riding of Yorkshire.

In addition, a number of other companies produce some limestone and chalk for use as agricultural lime.

The British Calcium Carbonates Federation and the British Lime Association (part of the Quarry Products Association) are the relevant trade associations.

Resources

Although limestones are widely distributed in the UK, many are unsuitable for industrial use because of their chemical and/or physical properties. The only important resources of industrial limestone in the UK are the Carboniferous lime-

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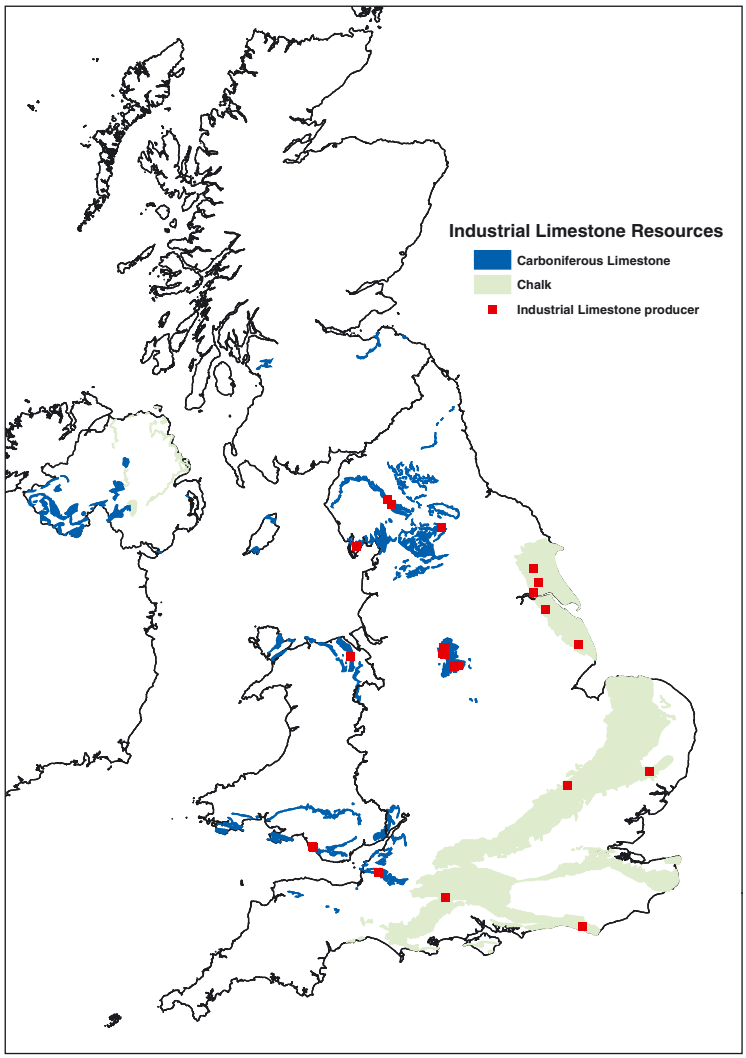

Figure 3 Distribution of principal Industrial Limestone Resources in the UK.

stone and Cretaceous-age Chalk (Figure 3).

Carboniferous limestones are the major source of both construction (aggregate) and industrial limestone raw materials in in the UK (Table 3). This is due to the quality, consistency and thickness of these limestones, as well as their extent and location relative to their markets. These factors make Carboniferous limestones relatively easy and cheap to work. As such, they are the preferred raw material for construction and industrial use, and cement manufacture. Unfortunately, the Carboniferous limestone is also associated with high quality landscapes.

Geological Age and lithology	%
Cretaceous Chalk	9.1
Jurassic and Cretaceous limestones	6.0
Permian limestone and dolomites	14.7
Carboniferous limestones	66.7
Devonian limestones	2.7
Silurian limestones	0.8

Table 3 Great Britain: Production of limestone for all applications by geological age.

Carboniferous limestones are extensively quarried in the Mendips, the Peak District, parts of the northern Pennines and around the fringes of the Lake District, as well as in adjacent areas of both North and South Wales.

A high proportion of the limestones worked in the Derbyshire Peak District are used for industrial purposes. They are characteristically flat lying and are noted for their uniformity over wide areas. The Bee Low Limestone is the most extensively quarried unit and is consistently of very high purity and of consistent chemistry throughout the region. In contrast, Carboniferous limestones in the Mendip Hills are typically steeply dipping and highly faulted. This feature constrains their non-constructional usage, since the resultant clay-filled fault zones, joints and fissures tend to contaminate the resource.

Large areas of the northern Pennines and the fringes of the Lake District are underlain by Carboniferous limestones, some of which are relatively thick, pure and consistent in quality. Notable units of high purity limestone include the Cove Limestone, which crops out widely in the southern part of the Yorkshire Dales; the Park Limestone in south Cumbria and north Lancashire and the Knipe Scar Limestone at Shap on the eastern side of the Lake District. Relatively small amounts of industrial limestone are extracted, but lime for the steel industry is produced on a large scale at Shap.

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The thick and extensive deposits of the Chalk of eastern and southern England constitute an important source of limestone raw materials which are used in the manufacture of cement, lime, in agriculture and for the production of chalk 'whiting'. Approximately 8 million tonnes of chalk are quarried annually, including around 2 million tonnes produced for industrial purposes (chiefly 'whiting', although lime produced from chalk is used by the steel industry at Scunthorpe in Lincolnshire).

Extensive outcrops of Carboniferous limestone occur in North and South Wales and Northern Ireland, some of which are of high purity. In South Wales, limestones crop out around the flanks of the South Wales Coalfield and are worked for industrial uses, including for use in the iron and steel industry. Limestones in Gower and South Pembrokeshire have also been exploited on a minor scale. In North Wales, Carboniferous limestones occur in three main areas: on the western flank of the North Wales Coalfield, the west side of the Vale of Clwyd, on Anglesey and the Menai Straits. This limestone is locally worked for industrial fillers. Carboniferous rocks in Northern Ireland include two thick limestone formations. These have been exploited for construction aggregates at a number of quarries, with some minor agricultural lime production.

In contrast to the rest of the UK, Scotland possesses few limestone resources. Dalradian rocks in the Central Highlands of Scotland and Shetland contain beds of limestone, which are worked for agricultural lime.

Cretaceous Chalk occurs in Northern Ireland, where it is locally known as White Limestone. It is some 50 m thick and is extensively overlain by Tertiary lavas. The White Limestone is worked at four sites for agricultural purposes and industrial fillers.

Reserves

Figures for total permitted reserves of industrial limestone and chalk are not available. Permitted reserves at most of the major sites are believed to be extensive, although there are limited reserves at Shapfell Quarry near Shap. There are also reserves of limestone that would be suitable for industrial use at quarries that currently do not produce limestone for non-aggregate purpose.

Relationship to environmental designations

The Carboniferous limestone and Cretaceous Chalk are the two principal resources on which industrial limestone production is based in the UK. These two resources give rise to some of Britain's most attractive scenery and consequently extensive areas are covered by national landscape designations (Figure 4). In addition, these calcareous rocks give rise to areas of conservation interest, both geological and biological. Consequently, extensive areas are also covered by national and international nature-conservation designations. The approximate proportion of the outcrop covered by some of these designations in England is shown in Table 4. Nature-conservation designations and landscape designations are not mutually exclusive.

Extraction and processing

Because of economic and safety considerations, almost all industrial limestone extracted in the UK now comes from surface quarries. The Middleton Mine in Derbyshire, which operates pillar and stall methods, has produced high quality industrial limestone for fillers and glass manufacture for many years. However, the mine closed in August

	% National Park	% AONB	% SSSI	% Outside national designation
Chalk	5	25	5	66
Carboniferous Limestone	42	17	16	39

Table 4 Proportion of limestone and chalk resources covered by landscape and nature-conservation designations in England. (SSSIs occur in both National Parks and AONBs).

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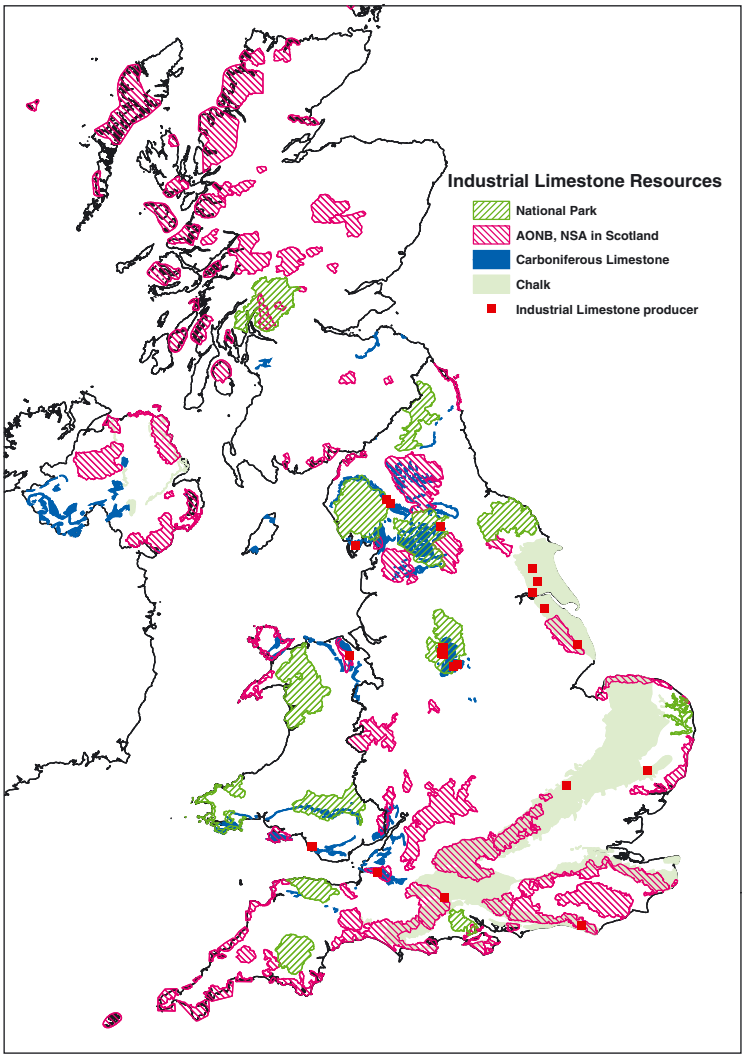

Figure 4 High-purity limestone and environmental designations.

2005 and is currently on a care and maintenance basis.

Processing of limestone can be simply divided into crushing/grinding, sizing and storage prior to loading and transportation. Chemical stone is sold as lime or lumpstone of a specified particle size. Lime is produced by burning the stone in specially designed rotary or shaft kilns. During this process, the calcium carbonate is calcined. At about 900°C, the carbon dioxide component is driven off as a gas, leaving behind calcium oxide or 'quicklime'. This is then sold as lump lime, pulverised lime, or is hydrated and sold as hydrated lime to meet specific customer requirements. *Limestone powders* for use as fillers are produced by dry grinding the limestone to a fine powder. They might be then further refined by air classification. Particle sizes range from relatively coarse grades, with 90% less than 50 microns, to fine grades with material mostly less than 5 microns (Table 5).

The price of a limestone product is largely governed by the cost of extraction, processing and transportation. The high capital costs of quarrying, due to the high investment in machinery to work and process the stone, has led to the development of large quarries that can produce high tonnages over long periods of time. Because transport costs may exceed production costs, it is important for the quarry to have good road, rail and/or water transport links and for the

Coarse fillers (generally low value); 75 micron to several millimetres	- agricultural lime - animal feedstuffs - asphalt - fertilisers.
Medium fillers (generally medium value); less than 50 microns	- carpet backing - floor tiles - sealants - adhesives and putties.
Fine fillers (generally medium value); maximum particle size 50 microns; 50% less than 2 microns	- paper fillers - rubbers and plastics - cheaper paints.
Very fine fillers and pigments (generally high value); maximum particle size 10 microns; 90% less than 2 microns	- paper coatings - paints - rubbers and plastics.

Table 5 Limestone powders for filler applications.

most appropriate form of transportation to be used.

By-products

Most producers of industrial limestone from Carboniferous limestones also produce aggregates in order to obtain sales for most of the grades of limestone produced. The largest producing complex comprising the Tunstead and Old Moor quarries (5.5 Mt/y), near Buxton, produces about 45% aggregates. In most cases, aggregates production accounts for between one-third and one-half of quarry output. Wastage can markedly affect the economics of a quarrying operation. It can be as low as 2% in an integrated operation such as Tunstead where quarry waste is utilised on-site in cement manufacture, to a typical value of around 10-20% and to over 20% in quarries such as Hardendale near Shap, which principally supplies lime kilns.

The Cretaceous Chalk is generally too soft to produce aggregates. Some limestone and chalk quarries produce building stone.

Alternatives/recycling

Because of its intrinsic properties as a neutralising agent and/or as a source of alkali, there are few opportunities for substitution or recycling of limestone used in the manufacture of chemicals. However, calcium carbonate is recovered from the sugar refining process and sold for agricultural purposes.

Limestone and chalk powders used as fillers compete with other minerals such as kaolin or talc. Because limestone and chalk powders tend to be of lower cost relative to these other minerals, limestone has tended to increase it's market share relative to many other minerals in the filler market. Recycling of paper and some plastics allows the mineral component to be recovered. Recycling glass also recycles the lime (CaO) and soda (Na_2O) used in its manufacture.

Effect of economic instruments

Limestone and chalk used in prescribed industrial and agricultural processes are not subject to the Aggregates Levy. Limestone that is unsuitable for these applications is produced as an ancillary product at all industrial limestone sites and is generally sold for construction use. This material is subject to the Aggregates Levy. The Levy was introduced at the rate of £1.60/t in April 2002. Some operators also claim that the Levy has made it more difficult to sell waste 'scalpings' for construction use and, as a result these are building up at quarries and may be sterilising reserves.

Transport

Four industrial limestone operations are rail linked (three in Derbyshire/ Peak District National Park) and one in Cumbria. All other industrial limestone and chalk operations rely on road transport.

A number of limestone quarries that are capable of producing high-purity limestone are also rail linked.

Melton chalk quarry in the East Riding of Yorkshire has recently been rail linked.

Planning issues

The outcrop areas of the Carboniferous limestone and Chalk in the UK are extensive. Many of these resources have a high calcium carbonate content and are potentially suitable as raw materials for industrial purposes. However, local variations in small (but significant) impurities such as iron may preclude the use of these resources in some applications. Nevertheless, the UK has large resources of high-purity limestone.

Both Carboniferous limestone and Chalk give rise to landscapes and habitats which are designated for their quality. The majority of working sites, as well as sites which could potentially produce industrial limestone and chalk, are located within or immediately adjacent to National Parks (Peak District, Lake District, Yorkshire Dales) or AONBs (South Downs, Mendip Hills). These designations create inevitable conflicts of interests and this is a key planning issue for industrial limestone. Mineral Planning Authorities are likely to prefer devel-

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opment outside rather than within protected areas wherever practicable.

Carboniferous limestone and, to a lesser extent, chalk are versatile minerals which are also valued as aggregates and cement-making raw materials. All industrial limestone quarries also produce aggregate as a by-product. However, Mineral Planning Authorities try to ensure that the limestone is used, as far as possible, for high-quality end uses. A limited number of aggregate quarries working Carboniferous limestones have the potential to produce industrial limestone.

Further information

Appraisal of high-purity limestones in England and Wales. Part 1 Resources. D J Harrison, J H Hudson and B Cannell. *British Geological Survey Technical Report WF/90/16*. A report for the Department of the Environment.

Authorship and acknowledgements

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