



Dolomite

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

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(Table 1 updated August 2006)

Dolomite is used as a soil conditioner in agriculture.

Dolomite, also known as dolostone, is a sedimentary carbonate rock, consisting mainly of the mineral dolomite $[\text{CaMg}(\text{CO}_3)_2]$. Rocks containing only 10–50% of the mineral dolomite are called dolomitic. Most, if not all, dolomite is a replacement of pre-existing limestone and this replacement process is known as **dolomitisation**. The process is often incomplete and rocks termed 'dolomite' are usually a combination of dolomite, dolomitic limestone and limestone. Dolomite deposits are, therefore, usually associated with limestones. This fact, together with the presence of variable amounts of impurities, such as silica, sulphur, iron oxides and alumina, has an important bearing on the suitability of dolomite for specific applications.

Dolomite has a number of uses, the most important of which, by volume, is in construction, where it may substitute for limestone. However, for some uses dolomite is specifically valued for its magnesia (MgO) content, and chemical composition is all-important.

Industrial dolomite is a commercial term for dolomite used for non-construction purposes

where its chemical properties (or degree of whiteness) are important. The MgO content of dolomite is commonly expressed after calcination (heat treatment involving the removal of carbon dioxide). Pure dolomite has an MgO content of about 40%. However, glass manufacturers normally use pre-calcined MgO content for control purposes and there is a theoretical maximum of about 21.8% MgO. Dolomite for industrial purposes accounts for a relatively small and decreasing proportion of total dolomite output. Like limestone, dolomite used in construction is a low-value commodity, which does not normally lend itself to long transport distances, although this may not be true for high-quality industrial dolomite.

Demand

The principal uses of industrial dolomite, firstly as a refractory and later as a flux, have been linked with iron and steelmaking since the latter part of the 19th century. For this reason industrial dolomite has been regarded as of vital importance to the iron and steel industry. The other major markets for dolomite are in glassmaking and for agricultural use (Figure 1).

Raw dolomite and calcined dolomite have a number of different uses in the iron and steel industry. However, changes in iron and steel-making technology during the 20th century have had a marked effect on the demand for dolomite for specific uses and the market continues to evolve.

The principal uses of dolomite are those that utilise the mineral in the calcined form (dolomitic lime). The most important of these is as a steelmaking slag flux, where the dolomitic lime replaces some of the quicklime (CaO) used in slag production. In addition to increasing slag fluidity, the presence of magnesia also helps to protect, and thus improve the life of, the steel vessel's refractory linings, which are made of magnesia. The total quantity used has been declining in line with a fall in iron and steel production. Some 260 000 tonnes of calcined dolomite were used for this purpose in 2004.

Hard burnt dolomite, which is subsequently formed into pellets and fired again to achieve a



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higher bulk density, is used in the manufacture of dolomite refractory bricks. Dolomite refractory bricks are no longer produced in the UK but calcined dolomite is exported to Germany and Turkey for this purpose. Low levels of silica and iron oxides are required for this use. Another form of calcined dolomite with added iron oxide is used to repair furnace linings.

Dolomitic lime was formerly used on a substantial scale for the manufacture of seawater magnesia principally for refractory use at a plant in Hartlepool. However, the production of refractory magnesia ceased in 2002. Production of chemical grade magnesium oxide powders and magnesium hydroxide suspensions continued until June 2005, when the seawater plant completely closed.

The use of raw dolomite as part of the flux burden in ironmaking has been replaced by an igneous rock containing a high proportion of the mineral olivine [(Mg, Fe)₂SiO₄], which in addition to supplying magnesia, also contributes silica. However, raw dolomite may be introduced as a flux directly into the Basic Oxygen Steelmaking vessel where it also replaces steel scrap as a coolant.

For many of the applications in the iron and steel industry there are strict limits on the chemistry of the dolomite used, which mainly needs to be low in silica (often <0.55% SiO₂) or <0.3% for some applications, with low iron (<0.55% Fe₂O₃), sulphur (<0.1%) and phosphorus (<0.02%).

Another important market for industrial dolomite is in glassmaking. Most commercial glasses consist essentially of silica together with soda (Na₂O) and lime (CaO), the lime being partly replaced by magnesia (MgO) for some purposes. Lime is introduced into the glass melt as limestone (CaCO₃) and magnesia by adding dolomite [CaMg(CO₃)₂]. However, in the flat glass industry most lime is introduced with the dolomite and only a little limestone is used to balance the CaO/MgO ratio. Lime and magnesia improve the durability of the glass but magnesia also inhibits the devitrification process, which is particularly important in the manufacture of flat glass. Dolomite is also used

in container glass. A critical factor in the supply of any glassmaking raw material, including dolomite, is iron content as this is a serious impurity in the manufacture of colourless glasses. In contrast to silica sand, mineral processing cannot effectively lower the iron content of dolomite (or limestone). Although the UK has high quality limestone resources with very low iron contents (see factsheet on **Industrial Limestone**), there is a deficiency of low iron dolomite resources, which only rarely have iron contents as low as 0.2–0.25% Fe₂O₃. Imported dolomite, with iron contents of less than 0.03% Fe₂O₃, is required for the manufacture of colourless glass containers and, sometimes, low iron float glasses.

Dolomite is relatively soft and easily crushed to a fine powder, which is used as agricultural lime ('aglime') by farmers to reduce soil acidity and also to adjust magnesium deficiencies. Dolomite is equally good as limestone in neutralising soil acidity, but the element magnesium is itself also an important plant nutrient. Two types of aglime are produced (unburnt and calcined).

Dolomite is also used for a range of filler applications in plastics, paints, rubbers, adhesives

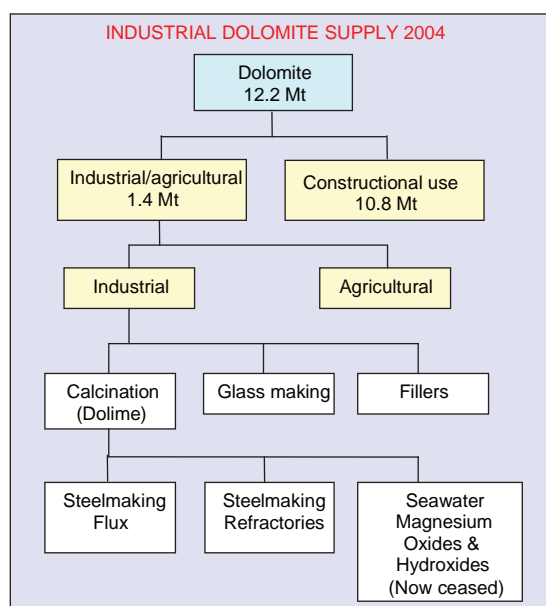


Figure 1 Principal uses of dolomite and dolomitic lime.

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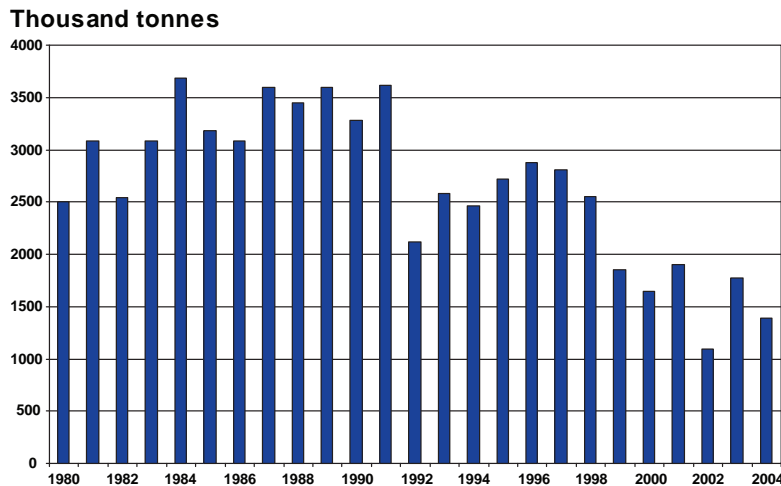


Figure 2 Great Britain: Dolomite production for industrial and agricultural purposes, 1980-2004. Source: Annual Minerals Raised Inquiry, Office for National Statistics.

and sealants. Dolomite is finely ground to precise size specifications. Pure white (high brightness) filler grades are preferred but these are rare in the UK.

Most markets for industrial dolomite are mature markets, or are in decline, due to the decline in UK manufacturing. A notable exception is the manufacture of flat glass. Export markets for dolomite are, therefore, of considerable importance.

Supply

Production data for dolomite for industrial and agricultural use have not been disclosed separately for a number of years, because of commercial confidentiality considerations. However, a combined figure is available and about 1.4 million tonnes of dolomite were reportedly produced for industrial and agricultural use in 2004. Total production of dolomite in the UK in 2004 was 12.2 million tonnes, most of which was used in construction. Almost all of the dolomite produced in the UK is sourced from quarries working Permian dolomites in Durham, South Yorkshire and Derbyshire. Minor quantities are produced from dolomites of Carboniferous age in Shropshire, Derbyshire, Gloucestershire and South Wales, although not for industrial use. Dolomite is an important soil conditioner but

	Exports		Imports	
	Tonnes	£thousand	Tonnes	£thousand
1999	91 489	4 358	228 874	4 198
2000	112 875	4 947	174 353	3 798
2001	131 073	4 653	188 312	3 671
2002	104 126	4 393	184 948	3 694
2003	35 804*	1 677	179 003	4 129
2004	24 736*	1 271	170 888	3 631
2005	126 022	4 411	215 990	4 019

*These figure are incomplete because some data are confidential.

Table 1 UK: Imports and exports of dolomite, 1999-2005. Source: HM Revenue & Customs.

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the largest industrial uses are in the production of calcined dolomite (dolomitic lime) and for glassmaking.

Production of dolomite for industrial use has decreased significantly in recent years (Figure 2) due to an overall decline in iron and steel production following the closure of the Ravenscraig and Llanwern iron and steelworks, the cessation of dolomite refractory brick production and the closure of the Hartlepool seawater magnesia plant. In addition, the use of dolomite for sinter feed for ironmaking has been replaced by imported olivine.

Trade

The UK is a net importer of dolomite (Table 1). Exports, consisting of both calcined dolomite for use in steel making and refractories, and agricultural dolomite, are to a number of countries, but mainly the Republic of Ireland, Ivory Coast, Netherlands and Germany (official figures from HM Revenue & Customs). Imports are of high purity, low-iron dolomite mainly from Spain and Norway for use in glass manufacture. Imports of calcined dolomite are minimal.

Consumption

Most (89%) of the dolomite used in the UK is for construction use where chemistry and magnesium content is not important. Magnesium oxide content and the levels of impurities present are important for industrial and agricultural uses. Total consumption for these applications has declined significantly in recent years and is about 1.4 million tonnes, although this figure is believed to be somewhat underestimated. No major increases in demand are anticipated.

Economic importance

The long association of dolomite with the iron and steel industry has meant that the mineral has been regarded as of considerable economic importance. Despite a decline in usage, steelmaking remains the major market for dolomite both for use as a flux and refractory raw material. Because of the restricted distribution of suitable quality dolomite for these applications, certain sites will remain of considerable eco-

nomic importance. In addition, dolomite is an important raw material in the glass industry where it is used notably as an essential constituent of flat glass.

Structure of the industry

There are a limited number of industrial dolomite producers in the UK (Figure 3). Lafarge Aggregates Ltd owns and supplies most of the rock for industrial dolomite production from three quarries; Whitwell Quarry in Derbyshire, Thrislington Quarry in County Durham and Cadeby Quarry near Doncaster. The actual production of industrial dolomite is by Steetley Dolomite Ltd, which now owns and operates the kilns at Whitwell and Thrislington quarries and is the only UK producer of dolomitic lime for the steel industry. Steetley Dolomite Ltd was formed in 2004 following a management buyout of the manufacturing operations, including kilns, that formed Lafarge Lime, i.e. Whitwell in Derbyshire and Thrislington in Durham. The Whitwell plant produces only hard burnt refractory dolomite whilst the Thrislington plant produces only dolomitic lime, principally for use as flux in the steel industry. Lafarge has retained the quarries at Whitwell and Thrislington, which also supply large quantities of aggregate. Lafarge Aggregates also supplies dolomite to OMYA UK, which operates a grinding plant at Cadeby Quarry to supply dolomite for glassmaking and filler and agricultural uses. Warmsworth (The Dolomite) Quarry, also near Doncaster, is operated by WBB MINERALS Ltd and supplies dolomite to the glass industry, principally for flat glass manufacture. All of these sites also produce dolomite for agricultural use, some for export, and crushed rock aggregate. Dolomite fines produced at several other crushed rock aggregate quarries are also sold for agricultural use.

Britain's sole seawater magnesia plant at Hartlepool closed in June 2005.

Resources

Permian dolomites are the main source of dolomite in the UK and are a resource of national and regional importance. Dolomite

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also occurs in some parts of the Carboniferous limestone sequence but in most areas the dolomitisation is not sufficiently extensive, or of consistently high grade, to form a resource of industrial dolomite. In sharp contrast to the large resources of high-purity limestone that occur in the UK, dolomite resources are of lower chemical purity notably with respect to iron content which is only very rarely in the range of 0.2–0.25% Fe₂O₃. However, a low iron content is not critical for all applications.

Dolomites and dolomitic limestones of late Permian age crop out as a narrow, easterly dipping, north-south belt running for some 230 km from Newcastle to Nottingham (Figure 3). It comprises a series of dolomites, dolomitic limestones and limestones up to 300 m thick. The sequence is highly variable, both regionally and locally, in its geology, and chemical and physical properties and thus in its suitability for particular applications. Impurities such as silica, iron oxides and alumina are a prime consideration in the selection of dolomite for industrial applications, and some industrial uses also require a relatively hard stone. Dolomites with sufficiently low levels of impurities to be used as a flux in steelmaking, for refractory use and glassmaking are comparatively scarce in the UK.

In north-east England (County Durham), the Raisby Formation and Ford Formation are important carbonate resources. The Raisby Formation at Thrislington Quarry is a major source of high-grade dolomite for steelmaking. Other quarries in these formations provide local sources of aggregates, with quarry fines being used as aglime. In South Yorkshire, Derbyshire and Nottinghamshire, the Permian sequence is made up of two carbonate units (the Cadeby and Brotherton formations) separated by calcareous mudstone. The total thickness (mostly <125 m) is much less than in County Durham. The Cadeby Formation is between 30–70 m in thickness and consists of a varied sequence of dolomites and limestones. Most quarries in the formation produce aggregate, but locally near Doncaster it is of higher purity, with a low iron content, and is extracted for glassmaking at Warmsworth and Cadeby quarries. It is also of relatively consistently high

quality near Worksop where it is quarried at Whitwell for use in manufacturing refractory products. The quality of the stone is variable and selective quarrying of specific horizons is required to ensure that the stone meets the differing raw material requirements.

The Carboniferous limestone has been dolomitised, or partially dolomitised, in many parts of its outcrop and in some areas the dolomitisation is sufficiently extensive to form a dolomite resource. In the Peak District of Derbyshire a large area of Carboniferous limestone between Matlock, Monyash and Brassington has been dolomitised, although it is of variable thickness and quality. There is currently no production of industrial dolomite from these rocks, although they are locally of relatively high purity and may be of sufficient quality locally to be suitable for glassmaking. Dolomitic limestone of Carboniferous age is also extracted near Oswestry in Shropshire mainly for construction use, although some is sold as aglime. Some Carboniferous dolomite is also produced in Gloucestershire for agricultural use.

Carboniferous limestones containing dolomite resources of commercial significance are found in South Wales, cropping out around the flanks of the South Wales Coalfield. To the south of the coalfield, along its eastern fringes in the Taffs Well-Risca-Pontypool area, the whole limestone sequence is dolomitised and has been worked at a number of quarries. The dolomites here are generally much finer and denser than dolomitised Carboniferous limestones elsewhere and hence produce strong and durable aggregate. However, they have limited use as a source of industrial dolomite. Dolomite occurs infrequently in North Wales, but has been worked on a small scale near Llandudno for agricultural purposes.

In contrast to the rest of the UK, Scotland possesses few limestone resources. The Durness Limestone in north-west Scotland is mainly of Cambrian age and is worked at Ullapool for dolomite which is sold mainly for aggregate and agricultural purposes. In Skye metamorphosed Durness Limestone known as Skye Marble is worked at Torrinn for dolomite, which is largely used for agricultural applications.

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Dolomite is unusual in the Dalradian limestones of Scotland, with the exception of the Appin Limestone, which is reported to be dolomitic in most outcrops.

Dolomite is not produced in Northern Ireland, but resources occur within the main Carboniferous limestone units in Fermanagh and Tyrone.

Reserves

Permitted reserves of industrial dolomite need to be considered on a site-by-site basis, and also by their suitability for specific applications. Permitted reserves at current sites range from less than 10 years to some 15 years supply. Plants producing industrial dolomite, and particularly those with kilns for calcining dolomite, require a large capital investment of the order of tens of millions of pounds. Ongoing capital investment is over one million pounds a year. Permitted reserves should reflect this large investment.

Relationship to environmental designations

The Permian dolomites are not covered by any national landscape designations but resources are constrained in part by nature conservation designations. However, at Thrislington Quarry an SSSI (limestone grassland) was successfully translocated to another piece of land within the company ownership. Cadeby Quarry is a geological SSSI and the type locality for the Cadeby Formation. The adjacent Sprotborough Gorge is an also SSSI. The Creswell Crags SSSI bounds Whitwell Quarry to the south.

Extraction and processing

Dolomite is extracted by surface quarrying using drill and blast techniques although breaking by impact hammer is used at one operation. The dolomite is selectively quarried at several distinct levels, known as 'benches', to manage the stone quality, which may vary considerably in chemistry and hardness. Lower quality dolomite is sold for construction use, although the dolomite forming the top bench at Thrislington Quarry is soft and mainly waste

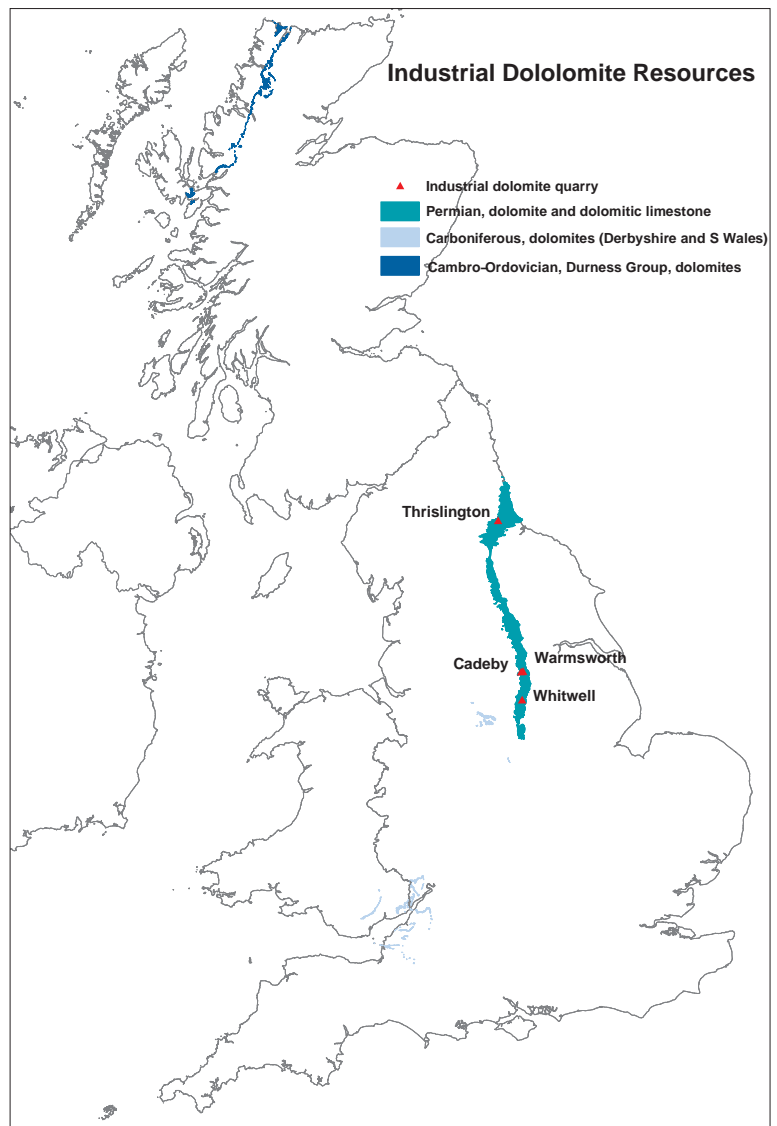


Figure 3 Distribution of principal industrial dolomite resources.

rock. Processing can be simply divided into crushing, screening, grading and storage prior to loading and transportation. However, various grades of dolomitic lime are produced at Thrislington and Whitwell quarries by burning the stone in rotary kilns at very high temperatures in the range 1450°C–2000°C. Residence times in the kiln are between 3.5 and 6 hours. At such high temperatures the dolomite is transformed from the double carbonate



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(CaCO₃.MgCO₃) to the oxide form (CaO.MgO), with carbon dioxide being driven off as a gas. Depending on the product being produced, additives, mainly iron, are also injected into the kiln. For refractory brick manufacture the dolomite goes through a second sintering (firing) stage after being pelletised to achieve the high bulk densities necessary for refractory use. Lower temperature calcination produces a more reactive, dolomitic lime suitable for use as flux. Distinct size fractions (typically 38 mm–19 mm and 19 mm–8 mm) are required for burning. This is a factor of some practical importance in that the yield from crushing to achieve suitably sized stone for burning can be as low as 45% because of losses into the fines. These fines, including fines generated in the kiln, are sold for agricultural use.

A critical factor in dolomite used for glassmaking is consistency in quality and notably in iron content. A major feature of processing is, therefore, achieving a consistent product by carefully controlled blending.

By-products

All industrial dolomite quarries also produce significant quantities of crushed rock aggregates. The largest quarries producing industrial dolomite are Thrislington and Whitwell and each quarry produces over 1.2 million tonnes annually. The proportion of dolomite going for industrial use is generally less than 50% of the total. The fines from quarrying dolomite both for industrial and construction use are typically sold as aglime.

In Durham the Permian Yellow Sands crop out intermittently at the base of the Permian escarpment and dip to the east beneath the dolomite. They consist of fine to medium-grade sand and comprise a resource of fine aggregate mainly used as building sand. The sand is mainly worked in association with the overlying dolomite, for example where they are exposed in the base of Thrislington Quarry. Permian limestones overlie concealed coal-bearing strata and some coal extraction has taken place in the floors of large dolomite quarries in Durham.

Alternatives/recycling

Dolomite is valued for its magnesia (MgO) content and it is this, which distinguishes it from limestone. It can be partly substituted for by limestone for certain applications, although in practice it is dolomite that tends to replace limestone. Dolomite and limestone both neutralise soil acidity but only dolomite can correct magnesium deficiencies in the soil.

Magnesium, like calcium, is a plant nutrient. As a flux in steelmaking, dolomitic lime also contributes magnesia and this imparts additional benefits, notably protection of the steel vessel linings from chemical wear. In ironmaking, however, olivine has largely replaced dolomite as a lime-free source of magnesia for use as a flux and slag conditioner.

In glassmaking both lime and magnesia improve durability, but magnesia is essential in improving the devitrification properties of some glasses (e.g. float glass). Dolomite is an essential raw material for float glass manufacture and there is normally no economic alternative.

One of the main advantages of dolomite as a raw material is that it is relatively inexpensive. Dolomite, because of its low price, remains the popular choice when available locally. However, the use of dolomite over its limited mineral alternatives is dependent on the mineral's purity and its proximity to the market.

Effects of economic instruments

Dolomite that is used for prescribed industrial and agricultural processes is not subject to the Aggregates Levy.

Transport issues

Most dolomite is transported by road, using backhaul opportunities where feasible. Both Thrislington and Whitwell quarries have rail links, but only the rail link at Thrislington Quarry is in use. Substantial quantities of steel flux are transported by rail to Port Talbot steel works in South Wales. Some dolomite is trans-

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ported by rail to Scotland for soil conditioning. Elsewhere dolomite is transported by road, either loose or in bulk tankers, or packed in individual bulk bags. Some bulk shipments are made overseas but mostly it is exported in sealed containers.

Planning issues

Resources of higher purity dolomite and dolomitic limestone are more scarcely distributed than high purity limestone. However, the demand for dolomite is significantly lower. Industrial dolomite is currently produced at only four sites in the UK but constraints on quality mean that indigenous dolomite is not of sufficient purity for all applications and imports are required. The close association of the uses of dolomite with iron and steelmaking, both as a flux and refractory, has meant that the mineral is considered to be of considerable national importance. Both Derbyshire and Durham have made provision to protect resources at the two main sites (Whitwell and Thrislington). Consequently, in allocating reserves, Mineral Planning Authorities, have wished to see these maximised for industrial end uses. However, all sites also produce substantial amounts of aggregate from inferior quality dolomite unsuitable for industrial use. In addition, because of particle size requirements for kiln feed material, the yield of calcined product can be as low as 50%.

Processing dolomite, and particularly high temperature calcination, requires substantial capi-

tal investment in plant. Longer-term security of supply issues are, therefore, of concern to the industry.

Authorship and acknowledgements

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