Courtesy of Sepiol SA

by Penny Crossley, *Senior Assistant Editor*

Absorbent minerals have a valuable role in improving the environments in which we live, work, and play. Their natural ability to retain fluids of all types while remaining inert, and to do so at a low cost, makes them the favourite product over other synthetic, organic or inorganic products in many industrial and environmental applications. Spillage control is a traditional but solid market for mineral absorbents; soil amendment is a market expected to have a promising future; and the applications for minerals in landfill sealing are diversifying, as increased recycling slows growth in this sector.

Absorbent minerals have been cleaning up our environment for over half a century. Numerous applications have emerged from their early use as floor absorbents *(see box, p.35)*, which continues to be a big volume market, albeit one now growing at a gentle pace.

Minerals that can act as absorbents have a high surface area and pore space, which enables fluid to replace air held in the voids. Diatomite, sepiolite and attapulgite are used as traditional industrial spillage absorbents, and in evolving agricultural applications such as soil amendments. These highly absorbent minerals can retain up to 60-70% of their weight in liquid.

Zeolites are less absorbent – taking on around 15% of their weight in liquid – but are highly *ad*sorbent, an absorbency on an ionic scale. This allows them to preferentially hold and release specific ions. Zeolites can be used in many similar applications to diatomite, sepiolite and attapulgite, and have an interesting future in other environmental markets.

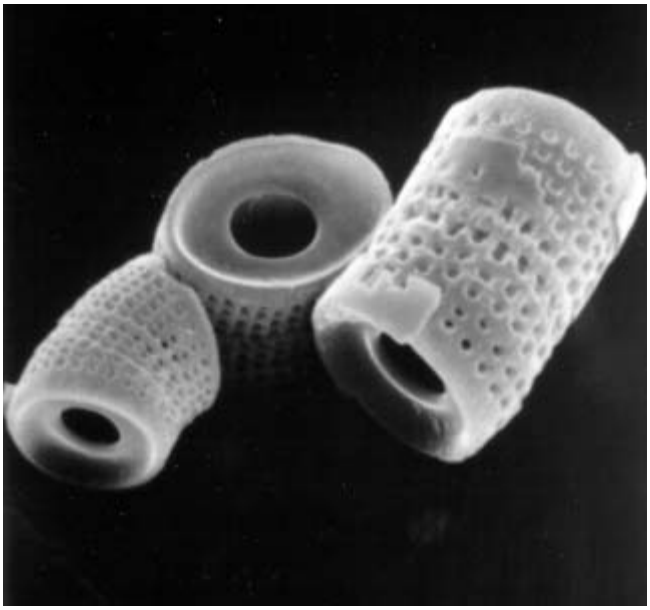
Environmental applications for bentonite stand alone from those of other absorbent minerals, and depend upon bentonite's ability to absorb water, swell, and form a watertight seal, invaluable in landfills and in the containment of fluids, and toxic and hazardous waste.

All these minerals are linked by the factors that drive their markets –an increased awareness of environmental, health and safety issues. Minerals used to absorb industrial spillages are affected by occupational safety guidelines; those used in landfill by recycling targets and controls such as the EU Landfill Directive. Minerals used in soil amendments and other horticultural applications are driven by a desire to improve the appearance of the surroundings in which we live.

This feature examines the trends within some of the industrial and environmental applications for absorbent minerals, and reviews the activities of selected companies in the sectors.

Spillage absorbents

Spills in the workplace, on roads, at home, or in the great outdoors can endanger health, safety, and the environment.



Courtesy of Eagle Picher Minerals Inc.

Magnification of diatoms, the fossilised algae that are the building blocks for diatomite, clearly shows the intricate pore structure that makes the mineral an excellent absorbent

Spills can be toxic, odorous, slippery and unsightly, and need to be disposed of quickly, safely, and without leaving a residue. While at home we might make do with a mop or a brush, industrial spills are often much larger, and can be any number of harmful substances – aqueous, oily, or chemical – which need an efficient absorbent that makes the area safe for employees as quickly and efficiently as possible.

Absorbent minerals have been used since the middle of the last century to clean up industrial spillages. Diatomite generally has the highest absorbency for industrial spills. Calcining attapulgite, however, can give a similar absorbency, and sepiolite can also be used.

Although bentonite is used extensively as an absorbent in cat litter, harder porous minerals like diatomite, sepiolite and attapulgite are more commonly used for industrial spillages because they are less likely to leave a slippery residue. Montmorillonite is available as an industrial absorbent – its absorbency is lower than the others, but it is more robust and less likely to generate dust. Generally, the softer the mineral, the more absorbent it is, but also the more likely to produce dust when swept up.

Because diatomite competes with so many other types of mineral, such as attapulgite, sepiolite, calcined bentonite, gypsum, as well as concrete-based absorbents, paper and organic products, it is difficult to confirm whether worldwide it is the most widely used absorbent for industrial spills. In Europe however, where the total market for industrial spillage absorbents is around 120-150,000 tpa, diatomite is the biggest volume absorbent, followed by sepiolite.

If the mineral has been used to absorb non-hazardous waste, then the common disposal method is in a landfill. The absorbency of the mineral prevents leaching once in the landfill. If hazardous waste has been absorbed, then both mineral and spill must be appropriately containerised.

The market for industrial mineral absorbents is perceived as stable, or with low levels of growth, partially because of competition from inorganic or synthetic absorbents. The onus is on the workplace to take more care in reducing spills before they occur, and to recycle any spillages. Recycling the spilled fluid after it has been absorbed by a mineral such as diatomite *can* be done in theory, but is rare in practice.

Regional differences in waste disposal also have an effect on consumption: in southern Europe, for instance, the market is growing faster than in northern Europe, where incineration of waste is becoming more common.

Although synthetic absorbents are not a new invention, they are only now beginning to experience significant growth. They are available as mats or pads that sit on the factory floor, waiting for a spill to occur, and are in that respect a precautionary measure. Minerals are used in a reactionary manner, as and when spills occur, and have a cost advantage over synthetic absorbents. They can, however, leave a slight residue, and require more 'elbow-grease' for proper application.

Environmental, health and safety concerns put pressure on industry to clean up responsibly, and to avoid spills before they occur. In industry, cleanliness is much more of an issue than it was even five years ago. ISO 14001 accreditation calls for more rigorous disposal of spills, and to recycle the spill if at all possible. There is no legislation at an EU level; cleanliness issues are handled by guidelines in each country, and vary depending on the substance of the spill. In the future, some absorbent producers think these guidelines could turn into legislation, with more strict policing.

There are still applications where absorbent minerals are not widely used, but would be a far more effective alternative. Sand

Other applications for absorbent minerals

- **Pet litter** – one of the biggest volume applications for absorbent minerals bentonite, montmorillonite, attapulgite, sepiolite and diatomite. Cats are the main consumers, but some products can be used to deodorise the stalls of larger animals such as horses. Litter trays for small dogs are expected to catch on *(a full review given in IM December '00)*.
- **Oil and beverage clarifying** – bleaching clays such as activated bentonite are used to remove impurities from edible oils and beverages such as wine, beer and fruit juice *(see IM March '01)*.
- **Nuclear waste treatment** – bentonite can act as a sealant in containing nuclear waste *(see IM April '02 for more on the progress being made in this application in the Czech Republic)*; after the Chernobyl nuclear plant disaster, zeolite was added to food to help remove radiation from people living in the fallout zone.
- **Gas separation** – absorbent minerals with a cation exchange capacity, such as zeolite, can be used to separate oxygen and nitrogen present in air.
- **Water treatment** – organoclays (bentonites coated with amines) will remove certain compounds like grease, fat, and hydrocarbons from groundwater, landfill leachate, and industrial effluent. The process also involves adsorption, since cation exchange takes place and increases the bentonite's ability to swell in oily substances.
- **Domestic uses** – for the absorption of grease in barbecue and grill drip trays, and to absorb odours in fridges, ash trays and rubbish bins.
- **Cosmetics** – minerals used in cosmetic powders to absorb oils include talc and special clays such as attapulgite, sepiolite and white bentonite.
- **Pharmaceuticals** – absorbent minerals with adsorbent properties, such as activated bentonite, can be used to regulate the release of cationic drugs.

Courtesy of Sepiol SA

Sepiol's absorbent minerals can be used for cleaning up oily automotive spills

is certainly cheaper, and is commonly used to 'absorb' oily spills. Really, the sand does little more than mask the spill, and much larger volumes are required than would be if minerals were used instead.

Absorbent minerals are not suitable for use on oil spills that take place on water, because they would sink, disperse, and not be recoverable. Materials such as fibres, bark, and polyurethane chips which are less dense than water are used on spills such as crude oil at sea. Large booms are manoeuvred on the surface of the water to thicken the spill, which is pumped up or skimmed off.

Producers are diversifying their markets – in the past, one producer might have sold exclusively to industrial, or environmental uses; now there is a trend for producers to become 'one-stop shops' and sell a wider range of products for all types of spill. The following are among the mineral producers with sales geared towards industrial spillage applications.

Damolin

Danish diatomite producer *Dansk Moler Industri A/S (Damolin)* is the European market leader for industrial spillage minerals. Most of the products use Damolin's moler (a material containing diatomite and around 20% plastic clay) from its mines on the islands of Fur and Mors. Damolin also sells, but does not mine, vermiculite absorption products. Damolin's diatomite products are also used for cat litter, carriers, animal feed, and as soil amendment. The diatomite product is calcined so that it stays hard regardless of what it absorbs, making it safe for use on roads, garages and factories.

Steetley Bentonite

UK-based *Steetley Bentonite and Absorbents Ltd* produces industrial absorbents based on attapulgite, sepiolite and diatomaceous earths, as well as soil amendment products. Steetley does not mix the minerals across its various products, as it feels the performance and cost characteristics are better suited to one product. All the products are suitable for all spills, and all applications, from the shop floor to the open road. Steetley markets products for Europe's biggest producer of industrial absorbents, Danish diatomite producer Damolin A/S.

Steetley also sells a range of cellulose absorbent products. The industrial minerals absorbents market is showing gentle growth, partially because of the competition with synthetic or organic absorbents. Steetley began to offer cellulose absorbents when it recognised a hole in its portfolio, and made alliances with manufacturers.

Eagle Picher

Reno, Nevada-based *Eagle Picher Minerals Inc.* produces diatomaceous earth-based industrial absorbents and soil amendments from its Clark Station plant, near Reno. After extraction, the diatomite is screened and calcined to increase its hardness, and make it less likely to break down upon absorbing a fluid.

Eagle Picher started producing oil and grease absorbents over 50 years ago. The coarser 6-20 mesh product is the standard grade, a primary absorbent generally used for absorbing spills around machinery. A finer 20-60 mesh product is used when the spill needs to be swept up quickly. Diatomite can be used to absorb almost all types of spill – water, oil, chemicals – with the exception of hydrofluoric acid, which reacts with silica. Oils are more viscous, and hence harder to absorb.

Patrick T. Flynn Jr., Eagle Picher's director of research, explained that 50 years ago, diatomite absorbents were mainly used in industrial areas, worker safety being the main concern. At that time, there was much less concern for the environment. Now, both workplace health and safety, and environmental considerations are more important, and applications for mineral absorbents have developed accordingly.

Since its early days in the absorbents business, Eagle Picher has diversified its product offering to include soil amendment products, which have found use in golf courses, sports fields, and various landscape projects. Flynn sees this as a more relevant application, which is showing the most growth, and also has the most potential for further growth. Eagle Picher's products are available worldwide but the USA is the main market for industrial absorbents. South East Asia and Europe are the regions where soil amendment product sales are growing fastest.

Oil-Dri

Georgia, USA-based *Oil-Dri Corp. of America* was founded in 1941 for the production of mineral floor absorbents. It has since diversified to become the world's largest producer of cat litter. Oil-Dri is a leading manufacturer of products for industrial spillage, and like Steetley, offers both mineral-based (diatomite, attapulgite and montmorillonite) and synthetic products.

Oil-Dri mines diatomite in Christmas Valley, Oregon, and within the next year and a half will start to produce from a new mine near Reno, Nevada. Oil-Dri quotes 20-30 markets for its products, including floors, roads, oil refineries, and environmental clean-up agencies. The mineral-based products can only be used on solid surfaces, but the synthetic products can be used on water too.

The synthetic absorbents are made from melt blown polypropylene, in the form of mats or pads. Unlike mineral-based products, which will absorb virtually everything, synthetic absorbents absorb oils but are naturally hydrophobic. If required to absorb water they are first treated with a surfactant.

Oil-Dri's synthetic absorbent products can be used separately from, or in conjunction with mineral absorbents. The customer's decision whether to use synthetic or mineral products depends on if they prefer a more preventative or reactionary approach. The synthetic pads are left in place on the workplace floor all the time, whereas the minerals are put down and swept up when a spill occurs. In general these can be less effort to use, and leave less residue than mineral absorbents.

Supersorb

Supersorb Environmental NL is Australia's leading supplier of absorbent minerals, formed in 2001 from the merger of

Courtesy of Bermuda Tourism

Golf courses are one of the biggest potential growth markets for mineral soil amendments

Talon Resources NL and *Supersorb Minerals NL*. The Australian market for mineral absorbents is around 50,000 tpa: roughly 80% for cat litter and 20% for industrial and horticultural applications. Supersorb supplies around 50% of total demand.

Supersorb mines zeolite in Springvale, Queensland; diatomite in Barraba, New South Wales; and spongolite in Mt Barker, Western Australia for industrial absorbent applications. The biggest sales are of spongolite – a porous silicic mineral formed from fossilised sponges – and diatomite, while zeolite is showing the most interesting growth *(see agriculture/horticulture section).* The majority of sales are for general workshop spills.

The Australian market is reasonably steady, but not entirely static, as consumers are being more responsible about cleaning up. More people are using mineral-based absorbents rather than cheaper alternatives like sawdust, because of their superior performance.

Supersorb believes it is the only company with commercial production of spongolite. This mineral has a similar absorbency to diatomite, but is harder and breaks down less easily.

Supersorb recently formed an export and marketing partnership with UK-based *Euremica Environmental Ltd*, which supplies instrumentation for environmental applications *(see IM April '02, p.12).*

Spain – Sepiolsa and Tolsa

Sepiol SA, based in Guadalajara, Spain, produces some 11,000 tpa of sepiolite for industrial spillage applications, 10,000 tpa of which is exported. While sepiolite has a lower absorption capacity than alternative minerals, Sepiol says that its products offer advantages in terms of price and disposal cost.

Fellow Spanish producer *Tolsa SA* produces bentonite, attapulgite and sepiolite for a range of industrial absorbent applications, including soil amendment, treatment of effluent from paper production, inertisation of liquid waste, and sealing of waste.

Agriculture and horticulture

If the industrial spillage market is fairly stable and mature, it is the agricultural and horticultural markets that are receiving attention as arenas for growth.

Porous minerals such as perlite are already widely used in growing mixes, and as hydroponic substrates. Diatomite and zeolite are now finding increased acceptance as soil amendments. Fertiliser additives, animal feed and sewage treatment present interesting future demand, especially for zeolites, with companies such as Australia's Supersorb Environmental investing heavily in technical trials and marketing.

Roots revival – soil amendments

A verdant, flat, thick and healthy lawn is a gardener's dream, but can be more of a nightmare to attain. Compaction, poor drainage, root damage, and lack of nutrients prevent many lawns from looking their best. When that turf is a money-spinner, for instance in sports fields, golf courses, landscaped gardens and recreation areas, it becomes even more vital to keep the lawn in its prime. Most landscape gardeners, green-keepers and architects will use soil amendments to improve porosity and drainage of the soil, and promote the lawn's health from its roots.

Apart from being unattractive, unhealthy turf can rupture, and cause people to trip, particularly dangerous to the sportsman. Large sports grounds currently account for the bulk of consumption, followed by golf courses, with parks and recreation spaces still a fairly small market.

Porous, hard, absorbent minerals such as diatomite and zeolite have excellent potential as soil amendments, but face stiff competition from sand. While sand is cheap, and does aid drainage, it does not provide slow release of water or nutrients, and since it migrates through the soil, should be regularly replaced. Mineral products are more expensive, but are a much longer-term investment, and are starting to steal market share from the more basic alternatives.

Diatomite consists of the fossilised remains of aquatic plants,

Courtesy of Eagle Picher Minerals Inc.

Soil amendments such as Eagle Picher Minerals' AXIS diatomite-based products can improve the health of the root zone in golf courses and sports grounds

and can be reintroduced to the soil to help promote the healthy growth of living plants. The intricate pore structure of diatoms keeps the pores in the soil open, and controls the water supply to roots, holding and releasing moisture when required. The diatomite oxygenates the soil and helps to break up clay. Around 10-20% of diatomite would be included per volume of soil. A lower concentration is required for turf, a higher percentage for potting mix. (In potting mixes, diatomite competes with perlite and calcined clay).

Zeolite works in a similar way, but it is imperative to use the most appropriate form of the mineral. Clinoptilolite is often the form of the mineral that works best, and has the highest rates of absorbency and adsorbency.

Zeolite's potential as an 'environmental mineral' has been recognised for some time, but it has been relatively slow to gain acceptance. Many of zeolites' past failures have resulted from incomplete understanding of the minerals' vast variety, which has meant the wrong product being matched to the wrong application. In the past, there have been some fairly questionable products, largely when producers have not differentiated their products, and the roles they can perform, from others. Precise marketing is essential to push the right product toward the right market.

And those markets are certainly growing. People are spending more on fitness, and the quality of sports facilities is increasingly important. Sports clubs are looking to improve the appearance and performance of their golf courses and playing fields.

In the USA, India and China, there is still a construction boom for new golf courses, but in Europe this has largely subsided. Instead, most golf development is in the renovation of existing courses.

David Hemstock of *David Hemstock Associates* golf architects, and regional construction consultant with the UK's *Sports Turf Research Institute (STRI)*, says the golf industry views new soil additives with a degree of scepticism. Products offered in the past, based on materials as diverse as sintered clay and seaweed, have lacked proper testing, and the performance has not been up to the job. Bodies such as STRI can carry out new product trials, and would be a good port of call for mineral producers eager to enter the market.

Some diatomite and zeolite producers have already established themselves in the market, and many others venturing into the sector with small volume sales.

Steetley Bentonite sells soil amendment products based on diatomite for the green care of golf courses. Steetley plans to expand into other market areas, such as fertiliser carriers, which it would aim to sell to some of its existing customers. The company is also making some other innovative developments, such as a product for plants and trees at the side of roads, where the soil can be salty after gritting. Diatomite acts as a buffer to preferentially absorb the salt.

Damolin agrees that diatomite is now accepted as a soil amendment, but that the market is in an introductory phase, and that price is a serious barrier to growth. Together, Steetley Bentonite and Damolin have invested heavily to promote real growth of the application. Most diatomite producers have started to sell a little material into this market.

Eagle Picher produces the AXIS range of diatomite-based soil amendments, which were chosen after 18 months of on-site field testing to be used in the 11 football fields of the J-Village World Cup training facility in Japan. The result is one of the world's largest single applications of inorganic soil amendments. Sports fields are more of a vibrant growing industry than golf courses, largely because of the investment they receive in the form of grants.

Oil-Dri's agricultural division sells minerals for soil amendment and waste solidification purposes; and reports both applications to be seeing growing demand.

Supersorb Environmental markets spongolite, diatomite and zeolite for soil amendment applications. The minerals hold onto water, and also release nutrients in the water to the plants. They can be used to increase the fertility of land that has been farmed extensively. Euremica, marketing Supersorb's products in the EU, has received interest in the material from the French wine industry, and from Saudi Arabia, where the land has been heavily deforested and lost a lot of its nutrients. Soil amendment minerals are particularly useful in hot countries where the soil is parched, as they lock in the water and reduce the demands for irrigation.

Fertilisers to the fore

As well as the physical absorbency zeolites have for retaining fluids, their adsorbency means they can selectively retain pollutants such as heavy metals, or nutrients such as nitrogen. This ability to retain and then slowly release nutrients makes zeolite an efficient carrier for fertiliser.

Up to 70% of fertiliser applied to crops can be wasted, and causes serious pollution problems when it washes into water systems. Excess fertiliser also produces the greenhouse gas nitrous oxide N_2O. A mineral carrier such as zeolite reduces the wastage, and hence the amount of fertiliser required.

According to Supersorb, quite a number of farmers have begun to use its zeolites to carry fertiliser, but the market is still in its infancy. Supersorb continues to trial its products in these applications, and is expecting to pick up sales. Supersorb has a proprietary activation process for its zeolite, which enhances adsorbency. Since the process does not involve chemicals, the zeolite is suitable for organic farming.

Supersorb says bentonite and gypsum can be used in similar ways to zeolite, but as their cation exchange capacity is short-term, they require repeated applications. The company has had 'great results' from technical trials, and is embarking on sustained and focused marketing to propel the products forward in their chosen applications. Outside Australia, the UK is Supersorb's main target market.

Beefing up animal feed

Zeolite's absorbency and adsorbency are also being exploited in livestock farming. Supersorb Environmental has developed an animal feed additive zeolite, which – when used in rations of around 5% – can increase the beef yield of cows by over 30% during the 80-day fattening cycle.

Zeolite gives more efficient protein conversion, helps the digestive process, and reduces mortality. The product is now commercially available and suitable for cows, pigs, and

chickens. The zeolite also helps to dry out and deodorise the animal's manure, making it easier to spread and simultaneously creating a slow release fertiliser.

Waste not want not

Sewage disposal is extremely costly, with the main emphasis on purifying the effluent so it can be discharged into the environment without causing pollution. Since large amounts of nutrients go to waste, the conundrum is how to turn this waste into a product with value.

Traditional sewage treatment methods include passing the sludge through a gravel or charcoal filtration bed. The gravel or charcoal becomes virtually useless, and creates a second disposal problem.

Zeolite is being developed as a sewage filter aid. The basic premise would see the zeolite used to absorb the waste material, and then used as a slow release fertiliser. Cost concerns are the main barrier to the development of this market. Charcoal and aggregates are far less expensive than zeolite, but do not add value to the waste as zeolites have the potential to do.

Supersorb Environmental, one company trying to develop this market, is taking its technology to water authorities, encouraging them to evaluate the economics of switching to zeolite sewage treatment.

Other absorbent minerals, such as diatomite, would also have the capability to absorb sewage, but there has been little progress developing this market because of the large amounts of minerals required for this application, and the inherently large cost.

The final frontier

And finally, NASA is studying the potential for using zeolites to grow plants in space. Hydroponic growth (no soil involved) has been deemed too complicated, but zeolites can be used to manufacture a synthetic soil that absorbs and slowly releases nutrients over time.

Landfills – a seal of approval

Bentonite's absorbent and rheological properties make it an excellent sealant in the construction of landfills. Traditionally the bentonite is mixed with soil, and enters the pore voids. When water is added, bentonite swells to fill the pore space remaining, and creates a waterproof seal. Bentonite is also used, in much smaller volumes, as the filling in the sandwich of a geosynthetic clay liner (GCL).

Bentonite's advantage over other types of clay is that it is not affected by freeze-thaw action, or burrowing creatures, which would disrupt a clay barrier. Bentonite is self sealing, and remains a permanent barrier against landfill leachate. The bentonite-soil layer is usually 300-500mm thick. Sandier soils with more pore space require a thicker layer of bentonite.

An alternative to bentonite enhanced soils came onto the market around 12 years ago. Geosynthetic clay linings (GCLs) are two layers of geosynthetic textile surrounding a thin bentonite layer. Their full width is usually 0.5-1.5cm. The thinness of these linings has cast doubt over their performance, but GCLs have been proved to have equal or superior performance to a much thicker layer of bentonite soil sealant.

Standards have been set for the minimum required thickness of landfill linings. In the USA, for instance, the standard is for 600mm of clay. Since GCLs are much thinner, government agencies are reluctant to recommend lone use of GCLs, and encourage a combination of a GCL with a layer of bentonite-soil mix.

GCLs have certain obvious advantages, such as ease of installation, and the fact that they free up larger volumes of the landfill than if a half metre thick bentonite-soil layer is used.

Courtesy of Eagle Picher Minerals Inc.

Applying Eagle Picher's AXIS diatomite-based soil amandments

GCL use in the USA is estimated to grow 15-20% per year. Five years ago, this growth was more like 10-20%. While they have made great in-roads into the market, they are still only used by around 25-30% of landfills. The majority employ a layer of bentonite enhanced soil, and will continue to do so, but with more GCLs being used in tandem.

Driven by environmental guidelines such as the 1999 EU Landfill Directive *(see box p.41)*, landfill construction is under scrutiny. Recycling targets have been elevated, so less waste will be landfilled, and other uses such as waste water ponds, sewage containment facilities, and canals will rise in importance.

In the EU, the Benelux countries are leading the movement towards total recycling. Countries such as the Netherlands have also begun to remove material from landfills and incinerate it as fuel, but this has led to worries about dioxin release, and as yet, there is some uncertainty as to the best solution for landfill sites. It is estimated that regeneration of landfills will start in the UK within three years, and there may be demand for absorbent minerals with a high cation exchange capacity such as zeolite to be used to produce slow release fertiliser.

Cebo Holland BV, and its UK-based subsidiary *Cebo Envirotek BV*, supply bentonite enhanced soils (BES) for landfill capping and lining. Cebo purchases activated sodium bentonite from India, Greece and the USA, with high absorbency, which is mixed to precise proportions with soil.

According to Cebo, at one point it looked as if GCLs were going to become more popular than BES. Two years ago, Cebo's market started to decline, but in the last 8-9 months this has turned around, with growth again looking strong. Cebo blamed the previous decline on the initial effects of the EU Landfill Directive, which is calling for a phase out of material sent to landfills.

However, the landfill industry has a recognised cyclicity. Charles McAughan, Industrial Products Sales Manager for *Bentonite Performance Minerals*, explained the pattern: getting permission for landfills can be a lengthy process, taking years to complete. Every two to three years, we see a spate of landfill construction, followed by a period of no building when the landfill is being filled.

BES looks set to remain the product of choice for landfill sealing, and Cebo expects the market to continue to improve over the next few years. The Landfill Directive will lead to decreased demand for landfills, and increased levels of recycling, and so other, smaller volume applications for mineral sealants may come to the fore.

Amcol – GCLs in-house

Illinois-based *Amcol International Corp.*, the world's largest producer of bentonite, has its own subsidiary, *Colloid Environment Technologies Co. (CETCO)*, which produces GCLs and granular bentonite soil sealants to be mixed directly with soils. The products are used in landfills, lagoons, ponds, reservoirs, and tank farms.

CETCO Lining Technologies' technical service manager Jim Olsta told ***IM*** that the customer's decision whether to use a GCL or soil sealant bentonite tends to be governed by their proximity to one of Amcol's bentonite mines. Since GCLs contain much lower volumes of bentonite, they are the more economical choice for those further from Amcol's bentonite production in western USA.

As volumes of recycled waste continue to increase, the world will need fewer landfills, and so the most growth for minerals in lining and sealing will come from other applications such as waste water and agricultural waste lagoons. CETCO identifies canals and mines as areas where growth will be greatest, two areas where GCLs and soil sealants have not been widely used to date.

EU Landfill Directive targets

- Not later than 16 July 2006, biodegradable municipal waste (BMW) going to landfill must be reduced to 75% of the total amount by weight of BMW produced in 1995*.
- Not later than 16 July 2009, BMW going to landfill must be reduced to 50% of the total amount by weight of BMW produced in 1995*.
- Not later than 16 July 2016, BMW going to landfill must be reduced to 35% of the total amount by weight of BMW produced in 1995*.

*or the latest year before 1995 for which standardised Eurostat data is available.
Source: Council Directive 1999/31/EC on the landfill of waste

Bentonite Performance Minerals

Amcol is unique among bentonite producers in having its own manufacture of GCLs. Others, such as Denver-based *Bentonite Performance Minerals (BPM)*, supply a portion of their output to independent GCL manufacturers. The majority of bentonite for GCLs in the USA comes from Wyoming, and, like its principal competitors, BPM has mining and processing operations in the state.

BPM's plants are in Colony, north-east Wyoming, and Lovell, west Wyoming; mining areas are around 45km away from each site. BPM blends bentonite from different beds to the parameters defined by its two GCL customers. The bentonites are dried to remove the 30-34% water present, first naturally, and then in kiln dryers. The dried bentonite is screened to give granules which are sold for use in GCLs.

BPM also sells bentonite for use in 'in-situ mixing', where it is mixed directly with the soil on the landfill site. Since US environmental agencies recommend the combined use of GCLs and bentonite enhanced soils, it makes sense to be involved in both applications. The granular bentonite is ground in Raymond mills to 200 mesh for this application. It is either spread on the surface of the ground and mixed with a tiller, or both soil and bentonite are fed into a pug mill, and the mixture dumped back onto the ground.

BPM is being more aggressive in smaller-volume markets for bentonite sealants, such as waste water and agricultural containment ponds. For waste water ponds, BPM sells bentonite to the waste management companies, which add polymers to clean the water. IM