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Industrial minerals: south-west England's connections to the world

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We all know where south-west England is but when I came to preparing this talk I had some difficulty. Cornwall, the UK's major centre for kaolin production, and Devon, the internationally recognised home of traditional ball clays, are the obvious counties to be included. Looking at a map indicated Somerset, an important aggregates producer, to be included as well, but Avon? I took my cue from De la Beche who included West Somerset in his report on the geology of the region which was the first memoir published by the Geological Survey in 1839. This seemed to exclude Avon which represents the northern part of the old county of Somerset, and with it one of only four major celestite operations in the world.

Again, turning to a map, a case could be made for including Dorset in south-west England as the county essentially lies west of the mid-point of England's south coast but in terms of minerals its inclusion does not materially alter the discussion. However, on this basis, one would also include Wiltshire which is host to one of the UK's two major producers, five in all, of chalk whiting. But, in the context of this presentation all forms of calcium carbonate will become relevant as the corporate connections of south-west England's major producers to the world arena are made. So, south-west England remains classically the province of Cornwall, Devon and Somerset for this review.

Industrial minerals

Before proceeding with the discussion further let's take a moment to consider exactly what is meant by the term, industrial minerals. In the broadest sense it conveys inclusion of all the naturally occurring minerals that are exploited for some purpose and would include materials used for erecting shelter, keeping warm, providing food, enabling transportation, easing communication, enhancing leisure, widening choice, etc. But, acceptance of the classification of a sector of minerals into fuels and another into metals left a huge and diverse sector which has become recognised as that of the industrial minerals. Many people have tried to describe the industrial minerals in a readily understood and all encompassing definition with varying degrees of success. This is my definition:

> Industrial minerals are those minerals, and their synthetic analogues, which are exploited for their physical and/or chemical values but which are not used for the extraction of a metallic or fuel value.

It takes its cue from the marketplace. Although strictly speaking synthetic versions of any mineral are products of the chemist's laboratory there are many instances where the market is able to choose between the synthetic and natural form, e.g. soda ash and calcium carbonate. Many minerals straddle the industrial mineral/metal mineral boundary in that, without qualification, the mineral could be exploited for its metal content or some other property - lithium minerals for lithium or ceramics, glass, and chemicals; bauxite for aluminium or refractories, abrasives, cement, and chemicals; titanium ores for titanium or white pigment and welding rods; magnesite for magnesium or refractories, chemicals, animal feed; chromite for chromium or chemicals, refractories, and foundries; iron ore for iron or pigments and dense media; stibnite for antimony or chemicals; and so on for zircon, rare earths, dolomite, manganese ore, and more.

Now we are focussed on what we're talking about let's look at south-west England's industrial minerals connections. A superficial view would indicate the discussion to be limited to the region's big three minerals -- kaolin, ball clay, and aggregates - as well as cement and slate. But, it is surprising to discover that south-west England's industrial minerals connections to the world, through corporate links, involve more than 25 industrial mineral categories exploited from as far flung as California in the west to Japan in the east, and from Ontario in Canada to Victoria in Australia. They include:

> attapulgite, bauxite, bentonite, borates, chalk, cement,
> diamonds, dolomite, fireclay, fuller's earth, ilmenite,
> leucoxene, limestone, lithium minerals and brines,
> magnesite, mica, monazite, potash, rutile, salt, silica sand,
> talc, vermiculite, xenotime, zeolites, and zircon.

Therefore we'll take a look at south-west England from two main perspectives:

> the minerals that are produced and their international significance,
> the companies involved and their other mineral connections.

Finally, we'll take a look at some of the region's minerals that are not exploited for one reason or another.

The minerals

Kaolin, ball clays, and aggregates have already been identified as the region's major industrial minerals whilst cement and slate are also produced albeit on a much less significant scale so far as south-west England and their operating companies are concerned.

Kaolin (china clay)

UK kaolin output, all from Cornwall and Devon, of more than 3m. tonnes in 1986 makes the region the world's second largest producer after the USA with around 7m. tonnes primarily from the southeastern states. However, in terms of exports the UK leads the world with over 2.5m. tpa of this versatile industrial mineral -- an almost countless number of grades of varying degrees of brightness and whiteness, finenesses down to submicron particle sizes, and specially treated forms through coating or heat treatment serving markets in paper (coating and filling), ceramics, refractories, paint, rubber, plastics, chemicals, pharmaceuticals, etc.

UK kaolin production comes from just four companies - ECC International (2.7m. tpa expanding by 20% over two years) with its centre of operations and headquarters in St. Austell, Watts Blake Bearne (130,000 tpa) with headquarters in Newton Abbot, The Goonvean and Rostowrack China Clay Company (110,000 tpa) also in St. Austell, and Steetley Minerals (80,000 tpa) whose operational location is St. Austell although the location of its headquarters is in Worksop, Nottinghamshire. Of these companies only ECC has kaolin operations outside the region. WBB and Steetley each have more important industrial minerals interests whilst Goonvean and Rostowrack is a smaller independent producer with 10,000 tpa china stone production and quartz and feldspar by-products.

So, ECC accounts for 90% of national kaolin production. Set against the world stage the company's UK output accounts for about 13.5% of world production which lies around the 20m. tpa level and makes it the world's largest single kaolin producer. Its nearest rivals, in terms of volume, are three companies, amongst 20 kaolin operators, in the USA -- Engelhard, Georgia Kaolin, and J.M. Huber -- each with over lm. tpa capability although ECC's wholly-owned subsidiary, ECC America also has a US operation in Georgia able to produce over 0.7m. tpa. Elsewhere ECC has subsidiary kaolin producing companies in Britanny, France (50,000 tpa); Guadalajara, Spain (75,000 tpa); Viano do Costelo, Portugal (40,000 tpa); Sao Paulo, Brazil (70,000 tpa); and Victoria, Australia (60,000 tpa) which takes the company's international kaolin capacity towards 3.7m. tpa. With expansions under way in various parts of the world, including the UK, ECC will command a production capacity of about 4.25m. tpa by the turn of the decade -- more than a fifth of 1985 world production when some 32 countries each contributed in excess of 50,000 tpa.

Such an international spread of activity for kaolin might give the impression that wherever the mineral is exploited it is able to serve all applications and markets. This would be a totally wrong and simplistic view. The very nature of formation of kaolin, along with the economics governing its processing, ensures that each operation has its own characteristics. The net result is that whilst there are many deposits of kaolin around the world, with numerous examples too remote to exploit, comparatively few are able to serve the full spectrum of kaolin markets. The present buoyant demand by the paper industry has led to capacity working by paper filler kaolin producers in the face of shortage during 1987 and the requirement for higher value paper coating clays has also been good. This shortfall has been particularly felt by European papermakers and especially those in the Nordic countries. Increased demand of calcined kaolin, particularly in the USA, is the result of the continuing tight supply of increasingly expensive titanium dioxide pigment which this form of kaolin is able, to some extent, to substitute in paper, paint, and plastics. Therein lies an example of market forces leading to a classic example of one mineral replacing another, mineralogically totally unrelated, in order to fulfil the same purpose but within tolerable economic constraints.

Ball clays

At least 90% of ball clay output is used in its two main related industries -- ceramics and refractories -- of which ceramics is the traditional market. In ceramics ball clays are used to provide high plasticity and high dry strength, with the higher qualities needed to supply a white colour on firing and special casting properties. They are used in the manufacture of wall tiles, fine earthenware, vitreous china, sanitaryware, electrical porcelain insulators, and stoneware. Unlike kaolin, which readily defines itself mineralogically, the ball clays are somewhat more elusive so far as their identity is concerned. Essentially they are mixtures of disordered kaolinite (70%), illite, montmorillonite, chlorite, quartz, and small amounts of carbonaceous material. As such there is a great variety of ball clay products which are also alternatively referred to as plastic clays.

The typical fine grained and highly plastic sedimentary ball clays are, however, surprisingly rare with just four major commercial provinces in the world -- in Kentucky and Tennessee in the USA where the majority of 800,000 tpa is produced, in Devon and Dorset of south-west England where a similar volume is produced, the Cheb basin of Czechoslovakia, and the Chasovyar district of the Don basin in the USSR.

But, because of the relative rarity of these ball clays other types of plastic clays, generally with lower white firing characteristics, are used and are perfectly adequate for much of ceramics production. Renowned production centres for these clays are the Westerwald district of West Germany (between Cologne and Koblenz to the east of the Rhine), the Provins area to the east of Paris and the region around Angouleme in France, and regions in other countries such as East Germany, Spain, and Japan. Such plastic clays are also used in heavy clayware production such as pipes, bricks, and tiles.

Set against this international background is Watts Blake Bearne which is not only the UK's leading producer of ball clays with over 400,000 tpa production it is also the world's leading exporter from its operations in the Bovey Basin in South Devon and the Petrockstow Basin in North Devon. The company's position as the world's leading producer of plastic clays is probably confirmed with its wholly-owned West German subsidiary, Fuchs'sche Tongruben GmbH & Co KG, which produces around 500,000 tpa at Ransbach-Baumbach in the Westerwald. The major competitor in West Germany is Stephen Schmidt KG with 600,000 tpa capacity although more than 40 companies are involved in the region. English China Clays has a 21% shareholding in WBB although taking no part in its management.

It will come as little surprise to discover ECC being directly involved in ball clays in both North and South Devon although its principal area of production is near Wareham in Dorset. Combined annual production capacity of around 300,000 tpa makes ECC Ball Clays the UK's second major producer although, again, a foreign ECC International subsidiary enhances the company's status in this mineral. In the USA Southern Clay Products produces around 160,000 tpa from crude clay mined in Cherokee County; processed in Palestine; and part manufactured into prepared ceramic bodies in Gonzales; all in Texas. Other major US producers include Kentucky-Tennessee Clay Co, H.C. Spinks Clay Co, Cyprus Industrial Minerals, and Old Hickory Clay Co.

In general, most countries with domestic ceramics and refractories industries base production on indigenous clay deposits, as indeed did the UK more than 300 years ago, and it is only for the higher quality end of the market that better quality clays are imported. For this reason ceramic bodies in most countries consist of various blends of clays, some of which may be imported. The fact that WBB is the world's leading exporter of ball clays to worldwide destinations is testiment to the quality of south-west England's deposits.

Aggregates

Oftentimes regarded as mundane the facts are that, in terms of volume, aggregates represent the major UK extractive industry. Diminishing aggregate resources place ever greater demands on less easily accessible sources. Exploitation of sand and gravel and hard rock sources of aggregates provide very difficult environmental situations yet they are a necessary requirement for the fabric of a sophisticated society that requires concrete and roadstone as well as specialist uses in sewerage filtration, sports grounds, rail track maintenance, etc. Aggregates also provide substantial income for the producers as well as major employment throughout the country.

South-west England is host to two major aggregate producing companies -- ARC Ltd (once Amey Roadstone Corporation), whose aggregate operations are spread nationwide and offshore, and ECC Quarries Ltd, with operations spread mainly across

southern Britain. Both companies have been in the news in recent months.

ARC's traditional major location in south-west England is the Batts Combe Quarry, near Cheddar on the West Mendips in Somerset but last October saw the official opening of the redeveloped Whatley Quarry to the west of Frome, Somerset. This added a further 10m. tpa limestone aggregate capacity (initially 6m.) with 70m. tonnes of planned reserves and now constitutes ARC's largest quarrying operation.

Nevertheless, ARC's Somerset quarrying operations are just a part of the much larger ARC Group organisation which constitutes the UK's largest producer of aggregates, both land won and marine dredged, which in 1987 generated over £398m. in turnover and provided an operating income of almost £5lm., up 20% compared with the previous year. Coated roadstone and premix concrete are important added value products for ARC's aggregate operations which are supported by downstream activities in civil engineering and building, building products (concrete pipes, tiles, blocks, and bricks), and property development.

These activities are mirrored by overseas operations in the Republic of Ireland (Spollen Concrete Group) and the USA where ARC America contributed £218m. in turnover and over £25m. in operating income to the Group's total 1987 turnover of almost £820m. which provided an operating income of almost £86m. ARC America's position in the USA was further reinforced last March when American Aggregates, the country's fifth largest aggregates producer, was acquired.

The significance of ARC's aggregate-based business is highlighted further when compared alongside its parent company's, Consolidated Gold Fields', profit on other activities. For the year to 30 June 1987 CGF achieved a total operating profit of £288m. of which 29% was derived from ARC. In the previous year ARC contributed almost 43% of CGF's total profit. The reduction for 1987 was largely due to markedly increased performances from Gold Fields Mining Corp (up £20m. from £6m.) and Newmont Mining Corp (up £68m. from £16m.) which outweighed ARC's better performance (up £14m. from £70m.) although the aggregate business still represents CGF's largest and best performing sector, especially when extraordinary charges amounting to nearly £29m. are offset against Newmont's contribution.

South-west England is the main area of activity for ECC Quarries where operations are centred around Plymouth and Exeter, based on granite, and the Mendips, based on limestone. Until now the company's aggregate business has been strictly a UK affair but last month ECC announced that it planned to make an acquisition, at a cost of £42m., in the USA. The target company is Minnesota-based J.L. Shiely Co. which has operations in Minneapolis/St Paul, Denver, and Colorado Springs. Naturally, ECC plans to use the acquisition as a first stage in developing its aggregates business in the USA.

Slate

The Wadebridge/Camelford area of North Cornwall has a long tradition of mining the Devonian slates. Since 1984 the operating company, Delabole Slate Ltd, has been a wholly-owned subsidiary of tin producer, Carrion Consolidated Ltd, which provides a toehold interest in the region's industrial minerals activity for its parent, The Rio Tinto-Zinc Corporation, itself a major international force in industrial minerals.

Delabole produces a range of slate products including roofing slates, slabs, cladding, pavings, building stones, and powders and granules for filler applications. The company's business predominantly supplies UK markets and is part of an internationally renowned UK slate business that is dominated by Penrhyn Quarries Ltd, a part of Alfred McAlpine plc, with operations in North Wales, Cumberland, and the USA.

Cement

To complete the picture of industrial minerals extraction in south-west England limestone and clays are extracted for cement manufacture by Blue Circle Industries plc at Plymstock to the east of Plymouth. The plant operates the dry manufacturing process and has a capacity of around 275,000 tpa. As such it is one of the smaller of the company's 15 or so UK production units which produced a total of 7.7m. tonnes in 1986. Plymstock is even further dwarfed in comparison with BCI's international cement interests in Chile, New Zealand, USA, and Zimbabwe (subsidiaries) and in Australia, Indonesia, Kenya, Malaysia, Mexico, Nigeria, and Singapore (related companies). As such BCI is one of the world's top three cement producing groups which includes Switzerland's Holderbank and France's Lafarge Coppee. Production cuts and rationalisation in the UK, involving the loss of 2,000 jobs and a reduction in capacity from 8.5m. tpa to under 8m. tpa, are presently being implemented by BCI.

Whilst BCI is clearly the leader in UK cement two other major companies have similar sized operations. RTZ Cement which entered the business by acquisition in 1982 and now operates five plants with a combined capacity of just over 3m. tpa. Rugby Portland Cement operates six UK plants with a combined capacity of 2.5m. tpa. Following sale of its US interest RPC is now solely a UK domestic cement producer. Two much smaller companies, Lafarge Aluminous Cement and ICI, also operate in the UK.

A buoyant market has persisted for the past two and a half years in the UK leading to imports of low priced competitive material from East Germany (100,000 tonnes in 1987), Poland (100,000 tonnes), and Greece (80,000 tonnes). Imports from the latter country have led to complaints by UK producers to the EEC Commission that unfair advantage is being taken of EEC endorsed subsidies in order to penetrate the UK market. The threat of losing business to imports, along with competition from alternative materials in concrete such as fly ash and blast furnace slag (a fact referred to in ARC's annual report), was partly responsible for the UK producers dissolving the cement price cartel in February in order to return to free market economics.

The companies

We've covered the major industrial minerals of south-west England and placed these in an international corporate context. Whilst Watts Blake Bearne is exclusively a ceramic clays producer and The Goonvean & Rostowrack China Clay Co. a kaolin producer, the other major south-west England industrial minerals producers have far wider industrial minerals interests. English China Clays, Consolidated Gold Fields, The Rio TintoZinc Corporation, Blue Circle Industries, and Steetley are all publicly owned company's with much wider industrial minerals interests borne from natural business evolution and through acquisition in response to market lead and technological change. It should be instructive to briefly review these other activities in order to better appreciate the context of south-west England's role in this diverse sector of the world's extractive industry.

English China Clays (kaolin, ball clay, aggregates)

In addition to the minerals discussed ECC is a major producer of calcium carbonate in three continents; a significant producer of bentonite and talc in Texas, USA: mica in France; silica sand, barytes, and synthetic zeolite in the UK.

From this cocktail of industrial minerals activity calcium carbonate is probably the most significant although the overlapping nature of most of these minerals in market application should be appreciated. With respect to calcium carbonate, the fine ground high whiteness versions of chalk, limestone, dolomite, or marble, the major applications are for the filling and coating of P&W paper in the newer alkaline sizing process, as a cost effective filler/pigment in paint and plastic systems, and a variety of miscellaneous uses stretching from pharmaceuticals to adhesives.

In Europe ECC Calcium Carbonates produces chalk whiting in the UK near Salisbury, Wiltshire and at Beverly in North Humberside. In Italy ECC International SpA extracts marble at Carrara and elsewhere in northwest Italy through the recent acquisition of Italy's Microcal SpA. In France Cie FrancoAnglaise de Mineraux SA, 80% owned by ECC and 20% by France's Blancs Mineraux de Paris, produces chalk whiting at Precy-sur-Oise near Paris. Elsewhere in Europe, ECC has subsidiary operations processing imported material at Lixhe in Belgium and at Koping in Sweden.

In the USA, ECC now has two calcium carbonate operations. A joint venture company with Redland, Atlantic Carbonates Corp, was the result of a 1986 acquisition of Genstar Stone Products, the original co-owner, by Redland. Atlantic Carbonates has a mine and plant at Texas in Maryland. In the same year ECC America acquired the Sylacauga Calcium Products Division of Moretti-Harra Marble Co which operates at Sylacauga in Alabama.

In Japan, ECC has recently purchased the other 50% share in Fuji Kaolin which operates two calcium carbonate plants on the country's main island of Honshu. The company has now been renamed ECC Japan Ltd. As part of ECC's development in the Far East Pacific region the company has now formed a subsidiary company, ECC Pacific Ltd covering the operations in Australia and Japan with offices in Singapore.

The highly competitive nature of the calcium carbonate business worldwide has created a comparatively secretive flavour where information is not easy to discover. This is probably largely due to the apparent ready availability of less specialist grades of calcium carbonate at low prices as a result of a large number of suppliers in the market. The scene is changing through adding value to products, mergers, and acquisitions. On the world scale ECC's major competitor with an equally potent international presence is Switzerland's Pluess-Stauffer group.

Consolidated Gold Fields (aggregates)

In addition to ARC's involvement in aggregates, and that company's interest in silica sand through the Buckland Sand & Silica Co. in Surrey and Bedfordshire, Consolidated Gold Fields has interests in heavy mineral sands through an associated company. In Australia, 49% owned Renison Goldfields Consolidated is the world's leading producer of heavy mineral sands - accounting for approximately 25% of the world's natural rutile production, 40% of the world's synthetic rutile, 40% of the world's zircon, and 40% of the world's monazite from operations at Eneabba and Capel in Western Australia and at Green Cove Springs in Florida, USA.

Markets for all mineral sands products have been particularly good for the past couple of years and since late 1983 for rutile. Although rutile has since softened a little demand remains strong but attention is now focussed on zircon which looks very likely to be in severe shortage for 1988.

Also, through its 26% interest in Newmont Mining Corporation, CGF has, until completion of a deal announced on 16 December for the Sale of Foote Mineral Co. to Cyprus Minerals Co., an interest in spodumene production at Kings Mountain in North Carolina, USA and in lithium-bearing brines at Silver Peak in Nevada, USA and Antofagasta in Chile. Although this connection seems about to be severed from CGF this is the second deal to be announced. Earlier in 1987 an announcement was made that US Borax was to purchase Foote Mineral but this fell through at the eleventh hour. Today's lithium minerals business is characterised by over-capacity well in excess of demand with an installed world production capacity of 116m. lbs of lithium carbonate equivalents supplying an estimated 81 m. lbs LCE market (61.1m. lbs LCE for western world consumption in 1986). This is supported by drilled and inferred reserve estimates of a huge 36m. tonnes of contained lithium - enough for a thousand years at present consumption rates.

The Rio Tinto-Zinc Corporation (slate)

RTZ's tiny presence in south-west England belies its substantial involvement through subsidiary and associated companies world-wide. These include boron minerals (US Borax & Chemical Corp), silica sand and attapulgite [US Silica and Rio Tinto Zimbabwe (56% RTZ)], cement (RTZ Cement), vermiculite and baddeleyite [Palabora Mining Co (39% RTZ)], diamonds [Argyle Diamond Mines (57% CRA Ltd which is 49% RTZ)], abrasive grade bauxite and kaolin [Comalco (33% RTZ and 67% CRA)], salt [Dampier Salt Ltd (100% CRA Ltd)], potash (Potash Company of America (88% Rio Algom which is 53% RTZ), and heavy mineral sands exploration (CRA Ltd).

A detailed discussion of all these minerals is beyond the scope of this presentation. Suffice it to point out that the company's industrial interests which include most of the above activities as well as fabricated and engineering products earned 60% of RTZ's net attributable profits in 1986. The actual industrial contribution would be further enhanced if the figures for vermiculite and baddeleyite from Palabora and abrasive grade bauxite from Comalco were included, rather than absorbed within the metals sector. The following shows the net attributable profits for RTZ's three business sectors in 1986:

Industrial Interests (60%)	
Speciality minerals and chemicals (Boron minerals, silica sand, attapulgite, and chemicals);	£99.3m.
Fabricated and engineered products (RTZ Pillar):	£64.3m.
Construction materials and services (cement):	£20.4m.
Other products and services (Diamonds, salt, potash, and kaolin):	£18.6m.
Total 1986	£202.6m.
(Total 1985)	(£144.0m.)
Metals Interests (25%)	
Aluminium:	£16.2m.
Copper, gold and by-products:	£19.9m.
Iron ore:	£44.1m.
Lead, zinc, and silver:	£(3.4)m.
Speciality steel:	£4.4m.
Tin:	£1.6m.
Total 1986	£82.8m.
(Total 1985)	(£82.0m.)
Energy Interests (15%)	
Coal, oil, gas and uranium:	£51m. (£93m.)

Steetley

In similar fashion to ECC and RTZ, Steetley has a far wider interest in industrial minerals than its single presence in southwest England would seem to indicate. In recent years the company has fought off an unwelcome takeover attempt by one of its major competitors in the refractories business (Hepworth Ceramic), sold off the whole of its Australian business to Anglo American Corporation, reorganised itself, sold marginal businesses, and acquired businesses more closely associated with its core activities in construction both at home and overseas in order to return to health following an exceptionally difficult period.

In summary, Steetley is involved in the production of aggregates, calcium carbonate fillers, industrial limestone, and chalk whiting; fuller's earth and bentonite; dolomite and seawater magnesia; fireclays and a range of refractory products; and talc through its Canadian subsidiary. Other overseas operations are in Spain, West Germany, and France. Additionally the company is a leading producer of special quality facing and engineering bricks and plain clay roofing tiles using clays from its own pits.

Whilst Steetley has responded to changes in one of its major traditional core businesses, refractories, owing to the decline in steel output and that industry's more efficient use of improved quality refractory materials, the company remains the world's largest producer of seawater magnesia in Hartlepool which has over 200,000 tpa capacity for dead burned and caustic calcined grades.

Steetley earned a worldwide reputation for its developmental role in the technology for seawater magnesia production in Europe where natural magnesites were insufficient to meet demand. Today, the story is very different with excess production capacity having pushed Steetley to concentrate on high quality speciality grades - a market adaptation in which Steetley has been particularly successful.

Competition is set to become even more acute in magnesia with a large scale new magnesite project timed to come on stream in the next couple of years in Kunwrara, central Queensland. Here, over 500m. tons of refinable raw magnesite extends over 31 sq kms with material averaging 93% MgO content on an LOI-free basis - and some yielding 99% MgO LOI-free. Between these Australian deposits and the huge reserves in China and Korea it would seem to indicate even more difficult times ahead for synthetic magnesia production from seawater or brines.

This brief review of the companies represented in south-west England demonstrates their diversity of industrial minerals interest which, in some instances, indicates a degree of competitive overlap. Also it highlights the international nature of the industrial minerals industries and the depth of technical and commercial expertise required to serve a full spectrum of industries.

Other south-west England minerals

Several other minerals for which south-west England is well known but which, for one reason or another, are not exploited are worth mentioning.

Fluorspar

In the last century several thousands of tonnes of fluorspar were produced as by-products of copper mining in the Camborne district and lead mining near Callington. Fluorspar occurs as veins, veinlets, and disseminated within granite in numerous locations in the region but nowhere has it been found in favourable circumstances for exploitation in its own right--apart from some of the dumps from old workings which have been removed and transported to the north of England for processing.

Today's fluorspar business is the subject of depressed international dollar prices, substantial spare and dormant capacity in South Africa, Spain, Thailand, Mexico, and the UK, very tight chemical specifications, global environmental concern in an important market sector, and a continuing buyer's market. Despite this depressing scenario opportunities are perceived by some with new projects coming on stream in Canada, Brazil, Namibia, and the USA. So far as the UK is concerned the two domestic producers currently face difficulty in the free market, both at home and abroad, owing to the drastically weakened US dollar.

Barytes

This mineral is not very common in the region although workable quantities have been described in the Teign Valley and parts of Somerset. Today's major market for barytes, oilwell drilling, is better than it was a year ago but still provides for a much reduced level of international activity compared with the heady days of the late 1970s when exploration worldwide was at a peak. Cheap imports from China, Thailand, and North Africa provided major headaches for the big barytes producers, especially in Nevada, USA, which were eventually beaten out of the US Gulf drilling market by Far East sources owing to the high cost of overland rail freight. Today, imports of Irish and Moroccan barytes for the North Sea market provide severe competition for British producers, mainly in Scotland.

But, oilwell drilling is not the total market for barytes. Applications as a white dense filler in paints, paper, plastics, rubber; as an inert filler in friction materials; as a source of barium chemicals for use in glass, ceramics, etc; and as an effective shield against radiation all provide higher value outlets for barytes although not the tonnage of the oil business. The nonoilwell drilling markets for barytes tend to be small and specialist demanding a traditional industrial minerals marketing approach.

Mica

Accompanying the kaolin are substantial amounts of mica which have to be removed in the early stages of kaolin separation. Although ECC has, from time to time, looked at the recovery of mica for possible use in a variety of applications which stretch from functional filters, through oilwell drilling, to fire resistant board, the mineral is not recovered at the present time largely because the economics are out of line with the prevailing market. Indeed it would probably require the installation of too large an operating unit for the available market which is presently supplied from overseas sources in Europe, Brazil, China, and elsewhere. Mica is, however, recovered by three of the Britanny producers including ECC's own subsidiary, Kaolins du Finistere, which is imported to the UK through another ECC subsidiary, Fordamin, for refining in the UK.

Lithium minerals

Certain of the micas associated with the kaolinised granites contain appreciable amounts of lithium in certain areas. Lithium-bearing micas, lepidolite-zinnwaldite, occur in pockets where grades of around 4% contained lithium metal have been identified. The market for lithium has been referred to already in the context of reserves being vastly in excess of demand as well as the existence of over-capacity which points to an increasingly overcrowded market through the turn of the decade.

However, because of lithium metal's strategic nature (lightweight high strength alloys, batteries, and nuclear fusion reactors) some are of the opinion that the south-west England material should be separated for possible future processing during the recovery of kaolin and reserves systematically identified. So far as I am aware such recovery is not made at the present time.

Other minerals

Certain parts of the region have provided a source for various natural iron oxide pigments in the past - ochre, the earthy hydrated iron oxide, umber, the dark brown mixture of hydrated oxides of iron and manganese, and specular hematite from Dartmoor. Much of today's ochre is derived from other sources, as well as synthetic versions, from as far afield as Cyprus.

South-west England is often referred to geochemically as a boron province because of the widespread presence of tourmaline. Because of this it is worth noting that tourmaline has no commercial significance as a source of boron or its derivative compounds. For this we have to turn primarily to Turkey and the USA where RTZ has rooted its leading income earning business

which supports a number of boron chemicals businesses in many locations. These operations are based on evaporite sequences where exogenetic earth processes have concentrated boron to a higher degree than exists in the granites and into minerals that are much easier to process.

Conclusion

In this discussion of south-west England's industrial minerals and their connections to the world I hope to have highlighted many of the factors governing the successful operation of an industrial minerals business. Of fundamental importance in the achievement, maintenance, and enhancement of any industrial minerals activity are three factors:

The nature of the raw material and product

Geographical location of the operation

The benefit to the consumer of using the product
Before any industrial minerals project can hope to succeed the market needs to be prospected to discover what minerals are required, what distances need to be covered, what prices prevail
for similar grades in the market, and what advantage any proposed new product might have to offer an existing market.

As the end product of an industrial minerals company is usually still mineral and its successful application is dependent upon its innate, or tailored/enhanced through processing, mineral properties it is hardly surprising that geologically-trained personnel with appropriate additional training oftentimes are involved at both ends of the business - at the geological end involved with maintenance of reserves, mine planning, and quality control and at the marketing end where an appreciation of manufacturing technology enables the mineralogist to refine and improve the product range and add value to the company's business.

For any given industry a company needs:

A base geological knowledge of available rocks and minerals in a region.

Expertise in transforming rocks and minerals into marketable materials through separation, treatment, and/or fabrication.

A wide appreciation of the demands and trends in the spectrum of mineral-using industries.

The role of the geologist is easy to identify in all three sectors which are fundamental to maintenance of sales and successful marketing - the ability to have a desirable mineral in an advantageous location so that it can be transported to a demanding customer when needed and at the best price achievable.

So, the industry is primarily concerned with its customers requirement for materials and the geologist is often much more concerned with sustaining an overall business plan as part of an interdisciplinary team turning a mineral deposit into saleable products.