

NGU



Norges geologiske undersøkelse
Geological Survey of Norway

GEOLOGY FOR SOCIETY

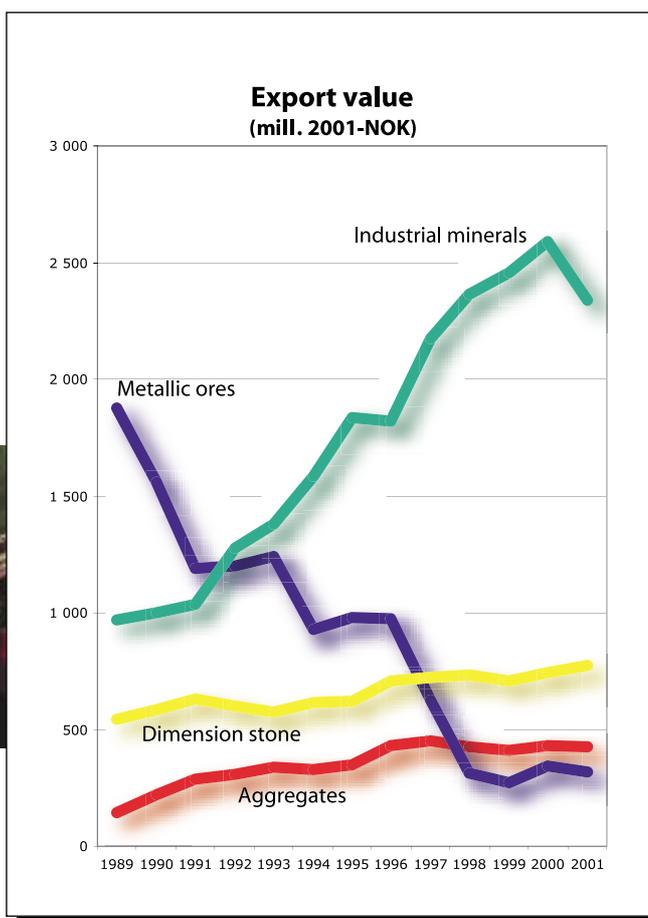
The Norwegian industrial minerals, mining and quarrying industry in 2001





The Norwegian mining and quarrying industry in 2001

The Norwegian mining and quarrying industry had a turnover of approximately NOK 7 billion in 2001, 0.904 billion EUR and employed some 5200 workers. It is a major industry in some regions, and the most important counties are Nordland, Møre & Romsdal, Rogaland and Vestfold.



Export value

The export value of minerals in 2001 was NOK 3.8 billion, 498 million EUR.

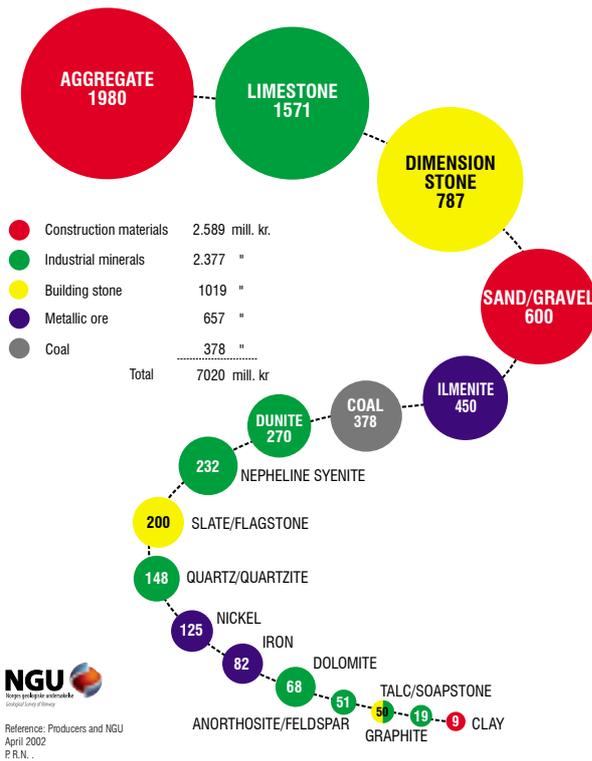
Contents

Side

1. Introduction	6
1.1. Why publish an annual survey of the mining and quarrying industry?	7
1.2. Trends in the mining and quarrying industry	8
1.3. High values require good management	9
2. Status in 2001	10
2.1. Industrial minerals	10
2.2. Dimension stone	12
2.3. Raw materials for construction	13
2.4. Metallic ores	14
2.5. Energy minerals (coal)	15
3. Good prospects for the future	16

PRODUCTION OF NORWAY'S MOST IMPORTANT MINERAL PRODUCTS

(2001, FOB, MILL. NOK)



1.2 Trends in the mining and quarrying industry

The industry has gone through an immense structural change over the last 10 years. The production of industrial minerals has risen greatly and that of dimension stone, crushed rock, sand and gravel moderately, whereas there has been a substantial reduction in metal mining. From 2000 to 2001, the turnover for industrial minerals was NOK 2.8 to 2.4 billion, dimension stone from NOK 0.9 to 1.0 billion. Metallic ores rose somewhat, from NOK 0.5 to 0.6 billion.

Gravel and crushed rock, however, dropped from NOK 3.1 to 2.6 billion, because of less building activity, particularly in the road sector.

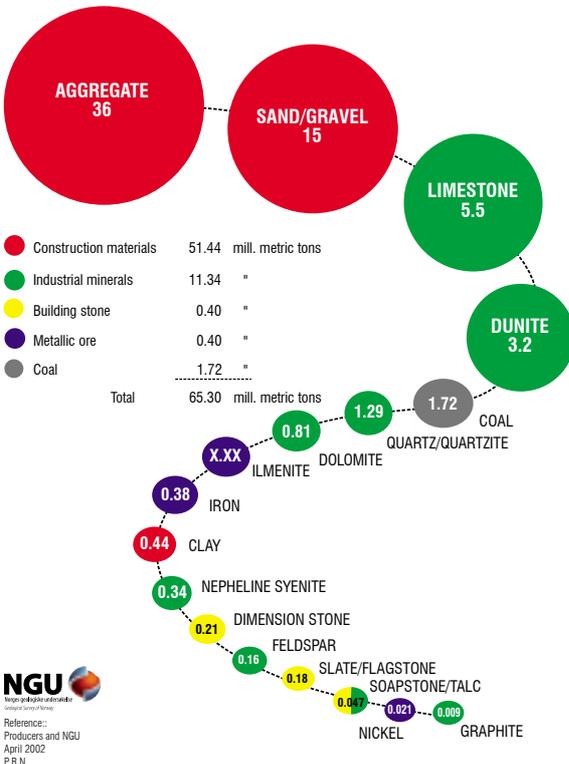
Production in the mining and quarrying industry requires large investments, significantly more real capital per employee than the industrial average. More than half of the mineral production is exported. Profitability varies from one part of the sector to another and between individual companies within each sector.

Approximately 65 million tonnes of mineral resources were extracted in Norway in 2001. The value of the output has risen from NOK 3.7 billion in 1982 to NOK 7 billion in 2001 (Table 2). For comparison, the primary value of timber from Norwegian forests is approximately NOK 3 billion.

The mineral industry is a typical regional industry, and coastal districts have a particularly large number of companies. Some 5200 people were employed in April 2002, divided among 900 companies (Table 1). Nordland, Møre & Romsdal, Rogaland and Vestfold are the major mining and quarrying counties as measured by the number of employees.

PRODUCTION OF NORWAY'S MOST IMPORTANT MINERAL PRODUCTS

(2001 MILL. METRIC TONS)



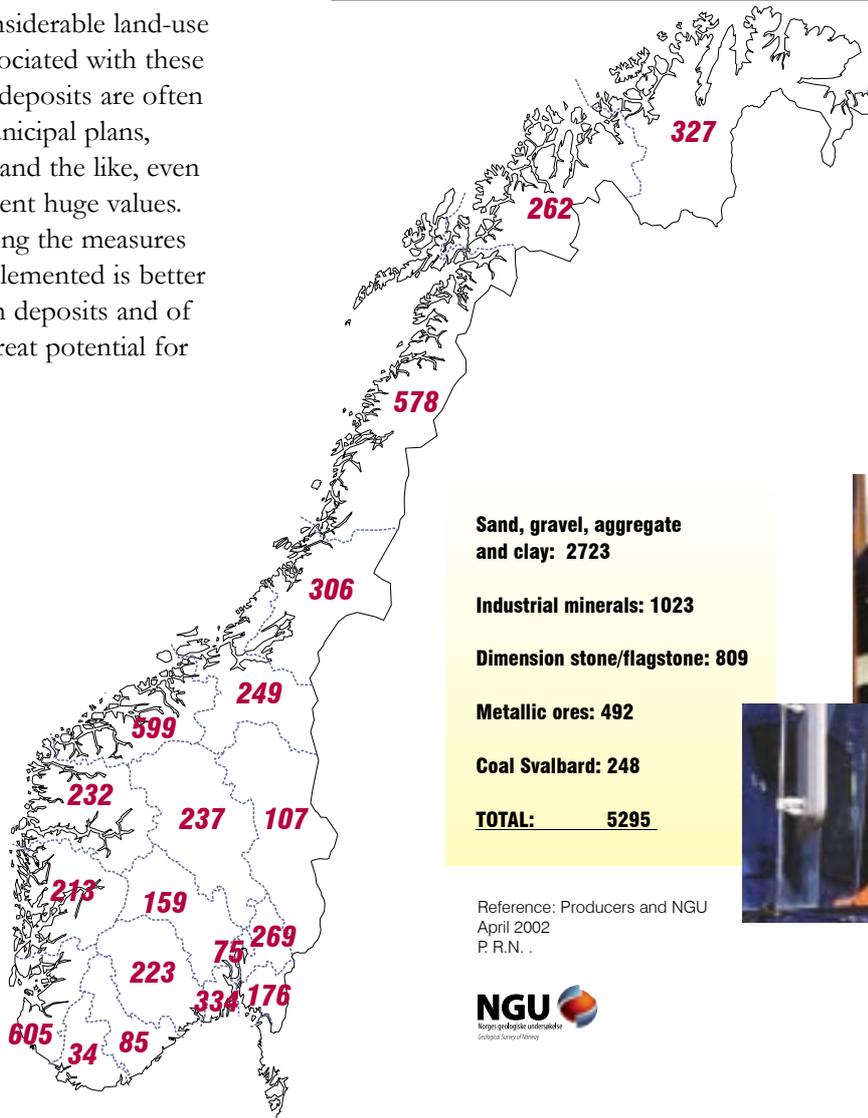
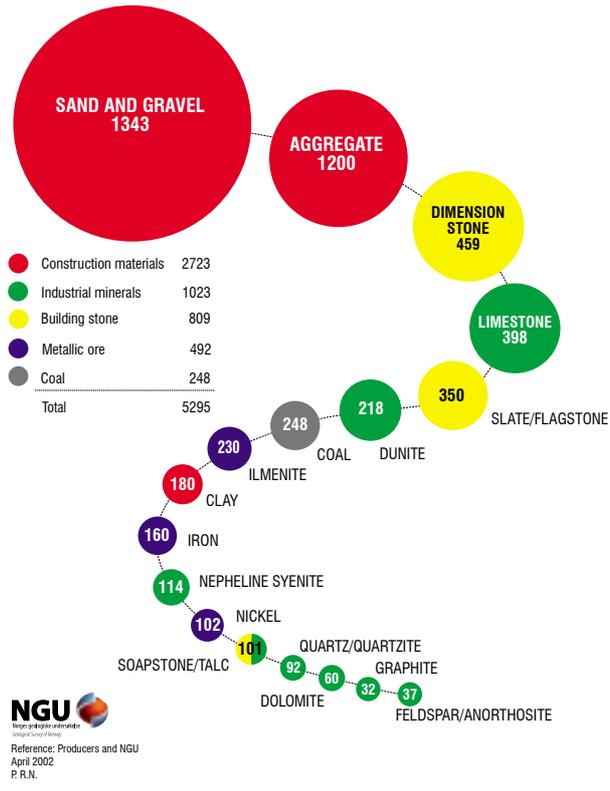
1.3 High values require good management

In the petroleum industry for instance, it is usual to calculate in situ values of deposits. These are gross values calculated on the basis of a given price for oil and the number of barrels of oil in the reservoir. If a corresponding calculation is made for the mineral industry, we find that deposits of minerals and rocks represent appreciable values. Some deposits of industrial minerals have in situ values of more than NOK 100 billion.

Society has for a long time underestimated the management tasks attached to these resources. This becomes obvious if we compare the public management taking place with regard to other kinds of natural resources, like forestry, agriculture and areas that have conservation value. Whereas considerable land-use management is associated with these resources, mineral deposits are often not included in municipal plans, coastal zone plans and the like, even though they represent huge values. Consequently, among the measures that should be implemented is better mapping of known deposits and of areas that have a great potential for new deposits.

EMPLOYED IN THE MINERAL INDUSTRY

April 2002



Sand, gravel, aggregate and clay: 2723

Industrial minerals: 1023

Dimension stone/flagstone: 809

Metallic ores: 492

Coal Svalbard: 248

TOTAL: 5295



Reference: Producers and NGU
April 2002
P. R.N. .



2. Status in 2001

2.1 Industrial minerals

Industrial minerals are minerals and rocks which form a basis for industrial utilisation because of their physical and chemical, non-metallic properties.

Norway produces olivine, nepheline syenite, limestone, quartz, feldspar, ilmenite, talc and graphite. These can be put to many uses. Many of the products we are surrounded with every day contain industrial minerals, for instance paint, paper, plastics, ceramics, glass and cement.

amounted to NOK 2.4 billion, 12 million tonnes being extracted. 1023 persons are employed in this sector. Most of the Norwegian production is exported, lime slurry, olivine and nepheline syenite being the most important export products. According to figures from the Central Bureau of Statistics, the value of this export in 2001 was NOK 2.3 billion.

Norway is one of the world's leading producers of *olivine and nepheline syenite*. A total of 3.2 million tonnes of olivine are produced in Norway by two companies, together employing about 218 people. The largest is A/S Olivin at Åheim and Raubergvika in Møre & Romsdal. Olivine improves the smelting properties of iron ore and gives a higher production capacity when raw iron is being manufactured. Olivine is also used as an alternative to dolomite in the manufacturing of steel, resulting in a significant reduction in the output of CO₂ from the steelworks, in addition to its ability to help to form slag.

Nepheline syenite is produced by North Cape Minerals on the island of Stjernøy, near Alta, and is chiefly used in the glass and ceramics industries. North Cape Minerals also produce quartz and feldspar at Glamsland near Lillesand, and olivine at Bryggja in Nordfjord. The principal owner of the company is UNIMIN/Sibelco, which controls much of the world



A/S Olivin in Åheim in Møre & Romsdal producing dunite. Dunite improves the smelting properties of iron ore and gives a higher production capacity when raw iron is being manufactured.

Industrial minerals has been the strongest growing branch of the industry over the last 8 to 10 years, particularly as regards the production of lime slurry. In 2001, the value of industrial minerals produced here

market for quartz, feldspar and nepheline syenite.

Limestone and dolomite are produced by 20 companies, with a total workforce of about 460. Norway has become a significant producer of limestone for use as filler, and the Hustad Group is the largest producer. The opening of its new mine in Velfjord, Nordland, marked an important milestone in the Norwegian mining and quarrying industry. The limestone produced by the Hustad Group goes to Hustadmarmor AS at Fræna in Møre & Romsdal, where lime slurry or limestone filler is made. Hustadmarmor AS is now the world's largest supplier of limestone filler to the paper industry. The survey of mineral production here takes account of the value and tonnage of lime slurry supplied from the producers.

There is also an appreciable production of lime for other purposes, including the making of cement, quicklime and lime for agriculture. The value of this production in 2001 was NOK 164 million and the tonnage 4.3 million tonnes. In the case of cement and quicklime production, only the value of the limestone prior to processing is given.

Quartz and quartzite are produced by seven firms employing 92 people. Production has risen in recent years to 1.3 million tonnes, representing a value of NOK 148 million. Quartz is used as a raw material in the manufacturing of glass, ceramics and porcelain, and the metallurgical industry has various uses for silicon. It is also used as a filler in plastics, rubber and paint. Other uses are in semiconductor technology, quartz glass and fibre optics.

Talc and graphite are produced in limited quantities by Norwegian Talk Altemark A/S near Mo i Rana in Nordland, Kvam Talk A/S in

Gudbrandsdalen and Skaland Grafittverk A/S on the island of Senja in Troms.

Owing to the advantages with which it has been endowed by nature, with unusually large deposits of olivine, nepheline syenite and pure limestone, it may be said that Norway is in a fortunate position. However, the foundation for large-scale exploitation of such deposits exists in the many years of research and development from



From limestone to paper.

the initial mapping of the deposit, via ideas for possible economic products, to extraction and continual development of the product and its marketing. Without all this development, the deposits would have been worth no more than ordinary rock.

There are good possibilities for finding new, economic deposits of minerals such as limestone, dolomite, talc, quartz, feldspar and mica, as well as for developing deposits that are already known. Much will nevertheless depend upon the climate for investments in mineral production in the future and long-term thinking from the viewpoint of the resources, the technology and the marketing.

2.2 Dimension stone

Dimension stone is the term given to all stone that can be sawn, split or hewn for use in outdoor spaces, in and on buildings and for monuments. Two varieties are recognised, blocks and flagstone. *Larvikite* from the Larvik area in southern Norway dominates the production of blocks in Norway and this is a natural resource of unique quality that fetches a high price on the world market. Most of it is exported as raw blocks, chiefly to Italy, France and Spain. New technology making production more efficient, and the favourable location close to the coast, have contributed to raising the profitability. In addition, blocks of syenite are produced at Lødingen in Nordland and anorthosite at Hå in Rogaland. Nine companies are producing blocks to a total value of NOK 722 million.

Granite, syenite, gneiss, and marble to a value of NOK 59 million are produced by 18 companies. Marble from the Fauske area in Nordland



A popular, new type of block is labradorite antique, an anorthosite from Ognå, Hå, Rogaland, produced by Granitt 1893 A/S and NSSI A/S.

has experienced a drop in production in recent years, but 2001 saw its value rise slightly to approximately NOK 10 million. Norway also has deposits of some other rocks that are worked on a smaller scale, or have recently been put into production with a view to being developed for the export market. Examples are

white trondhemite in Sør-Trøndelag and Hedmark, syenite at Lødingen, anorthosite at Hå in Rogaland, granite in Østfold, Buskerud, Oslo and Sogn & Fjordane, and soapstone at Otta in central-southern Norway and Bardu in Troms.

Flagstone and building stone are produced at a number of places throughout the country. In 2001, production was recorded in 28 companies employing a workforce of 350 and producing rock to a value of NOK 198 million. Quartzitic flagstone from Alta in Finnmark and Oppdal in central Norway, and phyllitic slate from Otta are of greatest industrial importance. Nearby factories process all the flagstone and slate. Around 60 per cent of production is exported and the hard-wearing Norwegian quartzitic flagstone is particular well suited to spaces exposed to a great deal of traffic.

Continued worldwide growth in the use of dimension stone is expected, and the home market for both building stone and stone for outdoor spaces has grown. On the whole, the dimension stone sector has a higher return on invested capital than the rest of the mining and quarrying industry. The last ten years has seen a trend towards fewer and larger companies in the Norwegian stone industry. This has been most obvious with regard to flagstone and larvikite production. In 2001, blocks to a value of NOK 787 million were produced, based on the extraction of about 210,000 tonnes of rock, and the figures for flagstone and building stone were NOK 200 million based on 180,000 tonnes of rock. Around 809 persons are employed in this kind of activity. Blocks and flagstone to a value of NOK 772 million were exported in 2001.

2.3 Raw materials for construction

Crushed rock, sand and gravel are raw materials used for building and construction purposes. They are extracted from bedrock by blasting, or from natural sand and gravel deposits. The material is crushed and sorted to the most appropriate size and shape for the purpose in mind.

It can no longer be claimed that Norway has unlimited quantities of sand, gravel and crushed rock. Consequently, there has been a growing need for information from NGU's Gravel and Crushed Rock Database and the resource statements held by the county authorities, both of which give overall surveys as well as detailed information about these resources.

Crushed rock can be used for the same purposes as natural sand and gravel, but is more expensive to produce because bedrock has to be blasted out and crushed. Crushed rock nevertheless has an increasing share of the consumption of raw materials for construction. This is a consequence of the scarcity of sand and gravel, and because higher demands are being placed on the quality of raw materials for construction which natural gravel cannot always satisfy.

Because of high transport costs, much of the production of gravel, sand and crushed rock takes place in the vicinity of where the material is to be used. About half the production is used for road construction, 20 per cent for making concrete and approximately a third for other purposes like rock fills, levelling of construction sites and covering pipelines on the Norwegian shelf.

NGU has mapped approximately 9000 sand and gravel deposits and about 1000 deposits for crushed

rock. A total of 4700 quarries and gravel pits are in continuous or sporadic operation. (Link to NGU's Gravel and Crushed Rock Database: <http://www.ngu.no>) The utility value of the Gravel and Crushed Rock Database is first and foremost to ensure that areas where sand, gravel and crushed rock are being extracted now, or may be in the future, are included in the municipal land-use and area development plans.



The value of the output of crushed rock, sand and gravel in 2001 was NOK 2.6 billion, based on the extraction of 51 million tonnes of raw materials. Approximately 2300 persons are employed in this sector. 27 per cent of the Norwegian production of crushed rock is exported. Export to the European continent has risen by 150 per cent since 1990. In 2001, 9.8 million tonnes of crushed rock and 0.3 million tonnes of sand and gravel were exported, amounting to a value of NOK 425 million. Most of this export went to Germany, Denmark, England and the Netherlands. An additional 1,9 million tonnes of crushed rock were produced for offshore purposes on the Norwegian, British and Dutch shelves. There are about 100 impor-

Per capita in Norway uses one lorry loaded with 4 tonnes of gravel and one with 5 tonnes of crushed rock a year.

tant producers of sand, gravel and crushed rock in this country. The largest ones in terms of turnover and production are located in south Norway. They include Feiring Bruk A/S, Franzefoss Pukk A/S, NorStone AS, Norsk Stein A/S, NCC Råstoffer Norge AS, Kolo-Veidekke A/S, Halsvik Aggregates AS and Oster grus og sand A/S.

Clay is used to manufacture building blocks, and Optiroc as/Leca extracts the raw material at Leca Rælingen in Akershus and Leca Borge in Østfold, both in south-east Norway.

2.4 Metallic ores

Metallic ores are rocks that contain metal-bearing minerals in such quantity that the metals can be worked economically.

Ore mines are extremely export-intensive. The market prices for metals

fluctuate greatly and this also affects the prices of the mineral concentrates. The production and export figures for the ore sector in 2001 were NOK 657 and NOK 317 million, respectively. Approximately 1 million tonnes of concentrated ore were extracted, and the workforce amounted to 492. Production in Norway has declined greatly in recent years and only three mines are now working. Titania AS produces ilmenite concentrate which, after further refining, is used as white pigment in paint, plastics and paper. The possibilities for working new deposits containing titanium minerals seem good, and the rutile deposits near Førde are specially interesting. NGU believes the chances of making new economically viable finds of titanium minerals are good and, in cooperation with the industry, it is planning to continue regional investigations in the coming years.

The opencast mine worked by Titania AS at Tellnes in Sokndal, Rogaland.



- Extraction of various mineral resources:
Ca. 65 million tonnes

- Production value:
NOK 7 billion, 0.906 billion EUR

- Proportion exported:
54 per cent

- Number of companies
96 not aggregates

- Number of gravel and crushed rock companies:
805

- Number of employees:
5300

Mineral types	No. of companies	Employees
Sand and gravel	537	1343
Crushed rock	268	1200
Clay	3	180
Limestone and dolomite	20	458
Olivine, talc and graphite	7	322
Quartz and quartzite	7	92
Nepheline syenite, feldspar and anorthosite	4	151
Ilmenite, iron and nickel concentrate	3	492
Coal	1	248
Flagstone/building stone	24	350
Blocks - granite/gneiss	18	65
Larvikite/anorthosite/syenite	9	383
Sum	904	5295

Table 1 Figures and facts.

In 1982, iron ore was the most important mineral raw material produced on land in Norway. Iron ore production has subsequently declined. The sole remaining iron ore mine in Norway, Rana Gruber AS, has reduced its production and concentrates on special, more highly processed products. AS Sydvaranger has been wound up, but an Australian company, Arctic Bulk Minerals, is considering new activity at the former Sydvaranger mine in the far north-east of Norway. The plan is that 350 employees will work the deposit for 15 years, extracting 5 million tonnes of ore and producing 2 million tonnes of pellets each year.

The only sulphide ore mine currently working is Nikkel og Olivin AS at Ballangen in northern Nordland. It produces a nickel, copper and cobalt concentrate, but will close down in the course of 1 to 2 years. Some exploration for nickel-copper

and copper-zinc ores is taking place, partly in the Rørøs area.

Gold was produced profitably at Biddjovage near Kautokeino in Finnmark from 1985 to 1992.

Some exploration for gold has subsequently been taking place, among elsewhere at Pasvik in Finnmark, Kvænangen in Troms and in Nordland.

2.5 Energy minerals (coal)

Energy minerals are compounds that emit energy when burned. Oil, gas, peat, coal and oil shale are energy minerals.

Interest arose towards the end of the 19th century for mining coal on Svalbard. Apart from a pause during the Second World War, coal has been worked there continuously since then and it has been exported as well as being used on the Norwegian mainland. Store Norske Spitsbergen Kulkompani A/S is now mining coal at Longyearbyen and Svea. A new field at Svea Nord is ready to go into production and will be able to ensure Norwegian coal mining in Svalbard for another 30-40 years. Most of the Svalbard coal is used in the metallurgical industry, but some is employed for generating power and manufacturing cement. Production has risen in recent years and the value of the output is NOK 122 million. The company has 223 employees.

The demand for coal on the world market is rising. The total world production is 3.4 billion tonnes, the Store Norske Spitsbergen Kulkompani A/S share of this being only 0.1 part per thousand. Recipient countries are Germany, Denmark, Finland, Great Britain, France, Sweden and Iceland.



The Norwegian Edelsplitt KS plant at Hellevik in Eigersund, Rogaland, where white anorthosite is produced for use in asphalt and ceramics.

Table 2 Mineral raw materials - values in mill. NOK supplied from the producer in 1982 - 2000.

	1982	1986	1991	1994	1997	2000	2001
Olivine	100	180	270	335	262	297	270
Nepheline syenite	100	150	200	231	171	220	232
Quartzite	30	100	100	83	81	145	148
Talc/soapstone			9	25	50	76	50
Feldspar/anorthosite			30	35	53	46	51
Graphite	20			13	19	23	19
Limestone	160	300	570	850	1 439	1 927	1 571
Dolomite	90	70	48	120	70	93	68
Sum industrial minerals	500	700	1 227	1 692	2 145	2 827	2 432
Illmenite	110	340	244	249	243	345	450
Coal			45	88	113	109	125
Nickel concentrate	680	650	523	501	127	94	82
Iron	200	250	298	84	74		
Iron sulphide	120		139	55	40		
Gold			47				
Lead			14	12	8		
Sum metallic ores	1 310	1 450	1 433	1 069	670	548	657
Blocks	90	210	430	510	853	699	787
Flagstone/slate/building stone		110	114	120	139	209	200
Clay			4			6	
Sum flagstone/blocks	90	320	544	630	992	914	1011
Crushed rock	800	1 000	1 350	1 430	1 859	1 825	1 980
Sand/gravel	1 000	920	900	1 000	900	760	600
Sum sand/gravel/cru.	1 800	1 920	2 250	2 430	2 759	2 585	2 534
Kull	160	210	100	80	64	122	378
Aggregate sum	3 700	4 300	5 454	5 821	6 565	6 996	7020
Consumer price index	50,8	66,3	86,6	91,9	97,8	105,5	

3. Good prospects for the future

Norway has a great variety of rocks. Many of these - like nepheline syenite, eclogite, extremely pure carbonate rocks, larvikite, special kinds of sandstone, anorthosite showing iridescence and white anorthosite - are not readily available elsewhere in Europe. Norway also has a long coast with good harbours for shipping its products, a high technological level and good Research and Development centres, all of which are advantages when competing for markets, and provide possibilities for the continued growth of mineral production in Norway.

Industrial minerals are economically valuable minerals and rocks which are extracted because of their physical and chemical, non-metallic properties, but fossil fuels, water and precious stones are not classed as industrial minerals. Industrial minerals are used in many different types of products, including fillers in paint, paper and plastics, and as the main constituents in ceramics, glass and cement.

Dimension stone is the term for all stone that can be sawn, split or hewn into slabs and other shapes for use in outdoor spaces, buildings and monuments. A distinction is made between flagstone or slate and blocks.

Flagstone and slate are rocks that can be split along natural planes. Common varieties are slate, phyllitic schist, mica schist and quartzitic schist. Blocks are quarried as large blocks, which are then sawn or hewn into slabs or other shapes. Important varieties are syenite, marble, granite, limestone and sandstone.

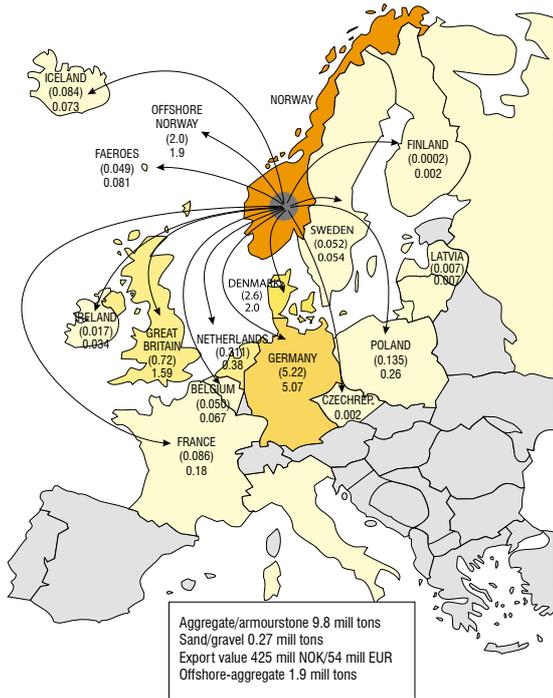
Sand and gravel are used interchangeably as the collective term for superficial deposits used for building and construction purposes. Geological terminology defines the material in specific grain fractions: sand 0.06-2 mm, gravel 2-64 mm and cobbles 64-256 mm. **Crushed rock** is quarried rock broken down by mechanical crushers. The most common rock types used for this purpose are gneiss, granite, quartzite, gabbro and syenite.

Metallic ore is a term for rocks that contain minerals carrying metals with a specific weight in excess of 5.0 in sufficient quantity that they can be economically extracted. Traditions for ore extraction in Norway go back to the 1600s, the Røros Copper Mines and the Kongsberg Silver Mines being among the oldest.

Norwegian aggregate for export in 2001

Total production 11.7 mill. tons and export 9.8 mill. tons aggregate, sand and gravel and in addition 1.9 mill. tons for offshore use.

Production values in parentheses are from 2000.



Aggregate/armourstone 9.8 mill tons
 Sand/gravel 0.27 mill tons
 Export value 425 mill NOK/54 mill EUR
 Offshore-aggregate 1.9 mill tons

Bedrock map of Norway with important aggregate deposits

- Legend**
- PERMIAN ROCKS (OSLO REGION)**
(250 to 290 million years)
 - Nordmarkite, larvikite, granite
 - Basalt, rhombporphyry
 - DEVONIAN ROCKS**
(350 to 400 million years)
 - Sandstone, conglomerate
 - CALEDONIAN ROCKS**
(400 to 650 million years)
 - Granite, trondhjemite
 - Gabbro, anorthosite, amphibolite
 - Schist, micaceous slates
 - Greenstone
 - Sandstone, schist
 - Marble
 - PRECAMBRIAN ROCKS (BASEMENT)**
(600 to 2900 million years)
 - Granite
 - Gabbro, anorthosite, amphibolite
 - Basalt, rhyolite
 - Sandstone, micaceous schist
 - Gneiss, migmatite

IMPORTANT NORWEGIAN AGGREGATE DEPOSITS IN PRODUCTION

- Aggregate production
- Aggregate for export 2001
- Sand/gravel for export 2001





NGU
N-7491 Trondheim- Norway

Visit address:
Leiv Eirikssons vei 39

Phone: +47 73 90 40 00
Telefax: +47 73 92 16 20

E-post: ngu@ngu.no
<http://www.ngu.no>