

**NGU**

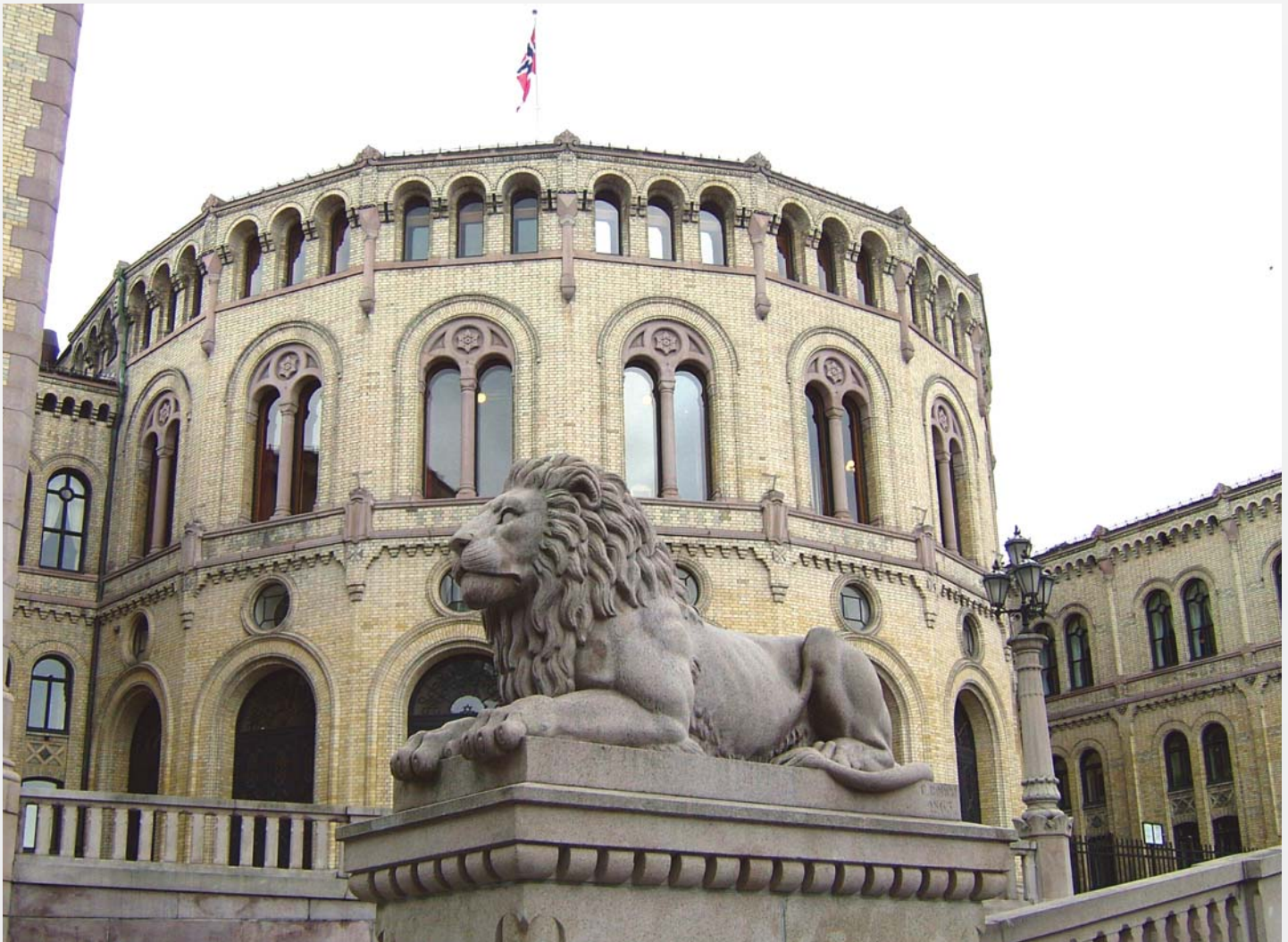
Norges geologiske undersøkelse  
Geological Survey of Norway



**GEOLOGY FOR SOCIETY**

## **Mineral resources in Norway**

### **The Norwegian mining and quarrying industry in 2003**



The Norwegian mining and quarrying industry had a turnover of approximately NOK 7.6 billion in 2003 (0.913 billion EUR) and employed some 5100 workers.

It is a major industry in some regions of the country. The most important counties are Nordland, Møre & Romsdal, Rogaland and Vestfold.

The export value of minerals extracted in Norway during 2003 (including the Norwegian coal mines on Svalbard) was NOK 4.9 billion (545 million EUR).



From a serpentinite breccia to a bowl, Sparbu Nord-Trøndelag. Photo: P. R. Neeb



From flagstone to roofing asphalt. Icopal AS, Østre Slidre, Oppland. Photo: Icopal AS



A stone block of Rhomb-Porphry found in a gravel deposit in Østfold. The artist: Jon Gundersen, Oslo. Photo: P. R. Neeb

The lion in front of the Parliament building was carved out of a pale red Permian gresfen syenite by inmates from Akershus prison in 1865. Photo: P. R. Neeb

# INTRODUCTION

The mining and quarrying industry comprises companies engaged in extracting and processing minerals and rocks from bedrock or superficial deposits. Five categories of raw materials are distinguished:

- industrial minerals (e.g. limestone, olivine, nepheline syenite, quartz and dolomite)
- dimension stone (e.g. larvikite, granite, marble and flagstone)
- raw materials for construction (sand, gravel, crushed rock and clay)
- metallic ores (iron, nickel and titanium oxide)
- fuel minerals (coal).

These are essential raw materials that enter our everyday lives. In modern society, we are unable to do without, for example, iron and steel, limestone for cement, paper and agriculture, crushed rock for roads, gravel for concrete and coal for many industrial processes.

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*The objectives of this survey are:*

- to demonstrate the importance of the minerals industry to the Ministry of Trade and Industry and other ministries and public authorities.
- to assist counties, local authorities and industry in optimised land-use planning for both current mineral reserves and future mineral resources.
- to be up-to-date and accurate. The survey must be published quickly and should therefore be available by the end of May the following year.

NGU has compiled a survey of mineral production in Norway based on enquiries made to the producers. The figures for gravel and crushed rock are to a large measure based on information in the Gravel and Crushed Rock Database and figures from Bergvesenet. Where fewer than three companies are involved, NGU has come to an arrangement with the producers regarding how the figures can be presented in figures and tables. First and foremost, we concentrate on the value of raw materials supplied by the producer and the tonnages of mineral products produced. In addition, it is important to show the size of the workforce at each production site. The added value at the production site has been stated by agreement with the individual companies concerned.

*Peer-Richard Neeb  
Programme Leader,  
Mineral resources*

*Trondheim, 15.05.04*





# NGU'S MINERAL RESOURCE DATABASES

NGU is continually building and updating a series of national databases, which comprise current information on, among other things, Norway's mineral resources. An overview of the nation's mineral deposits of sand, gravel, metallic ores, industrial minerals and dimension stone can be found under 'databases' on NGU's webpage ([ngu.no](http://ngu.no)) in the section 'Geological Services'.

It is NGU's intention to communicate information and knowledge to industry and administrative authorities in the most effective way. NGU and Bergvesenet plan therefore to develop a separate internet entry point with the title 'Mineral resources' that will provide geological data, information on mining rights, exploration claims and protected areas, as well as other useful and relevant data. The presentation of geological maps and information about mineral deposits will be a valuable aid designed to increasing awareness and interest for prospecting, both within the domestic industry and international companies.

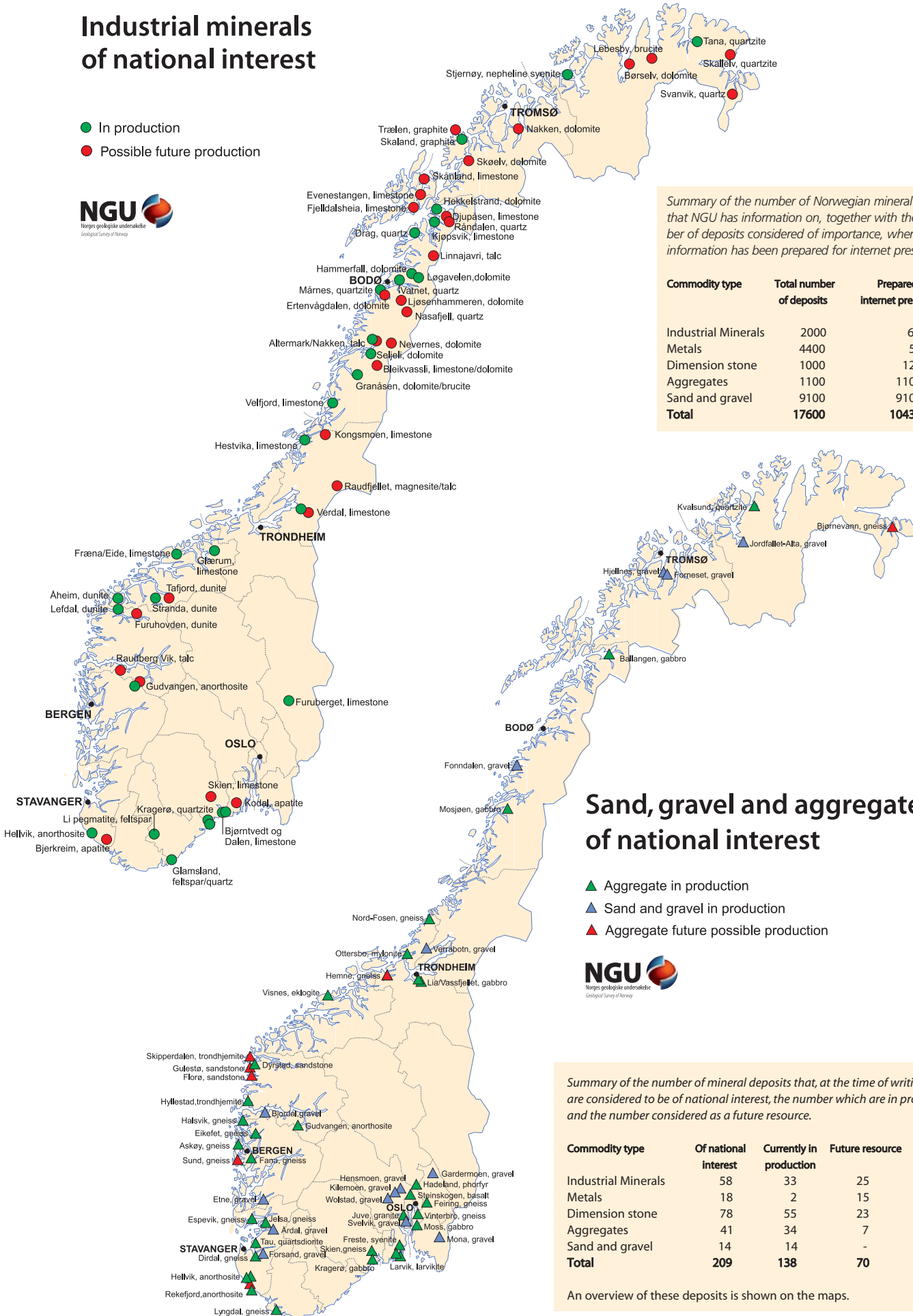
NGU has prepared a preliminary overview of mineral deposits of national interest. These are deposits considered to be strategic long-term value, and which deserve to be taken into consideration in future land-use management. The criteria used to select 'deposits of national interest' are:

- Deposits with potential for significant export, or which could deliver raw materials to export-oriented processing/refining companies in Norway.
- Deposits that are potentially significant suppliers to the domestic market.
- Deposits for which the anticipated start-up of exploitation is likely to be in the next 50 years.

It is important to ensure that deposits deemed to be of national interest, as well as current deposits of local or regional significance, are satisfactorily dealt with in plans for land management. How, and in which way the potential future resources can be secured will naturally vary from deposit to deposit. NGU's overview is intended to contribute to a sustainable, long-term administration of mineral resources on the national, county and community scales.

# Industrial minerals of national interest

- In production
- Possible future production



Summary of the number of Norwegian mineral deposits that NGU has information on, together with the number of deposits considered of importance, where the information has been prepared for internet presentation.

Commodity type	Total number of deposits	Prepared for internet presentation
Industrial Minerals	2000	60
Metals	4400	55
Dimension stone	1000	121
Aggregates	1100	1100
Sand and gravel	9100	9100
<b>Total</b>	<b>17600</b>	<b>10436</b>

## Sand, gravel and aggregate of national interest

- ▲ Aggregate in production
- ▲ Sand and gravel in production
- ▲ Aggregate future possible production



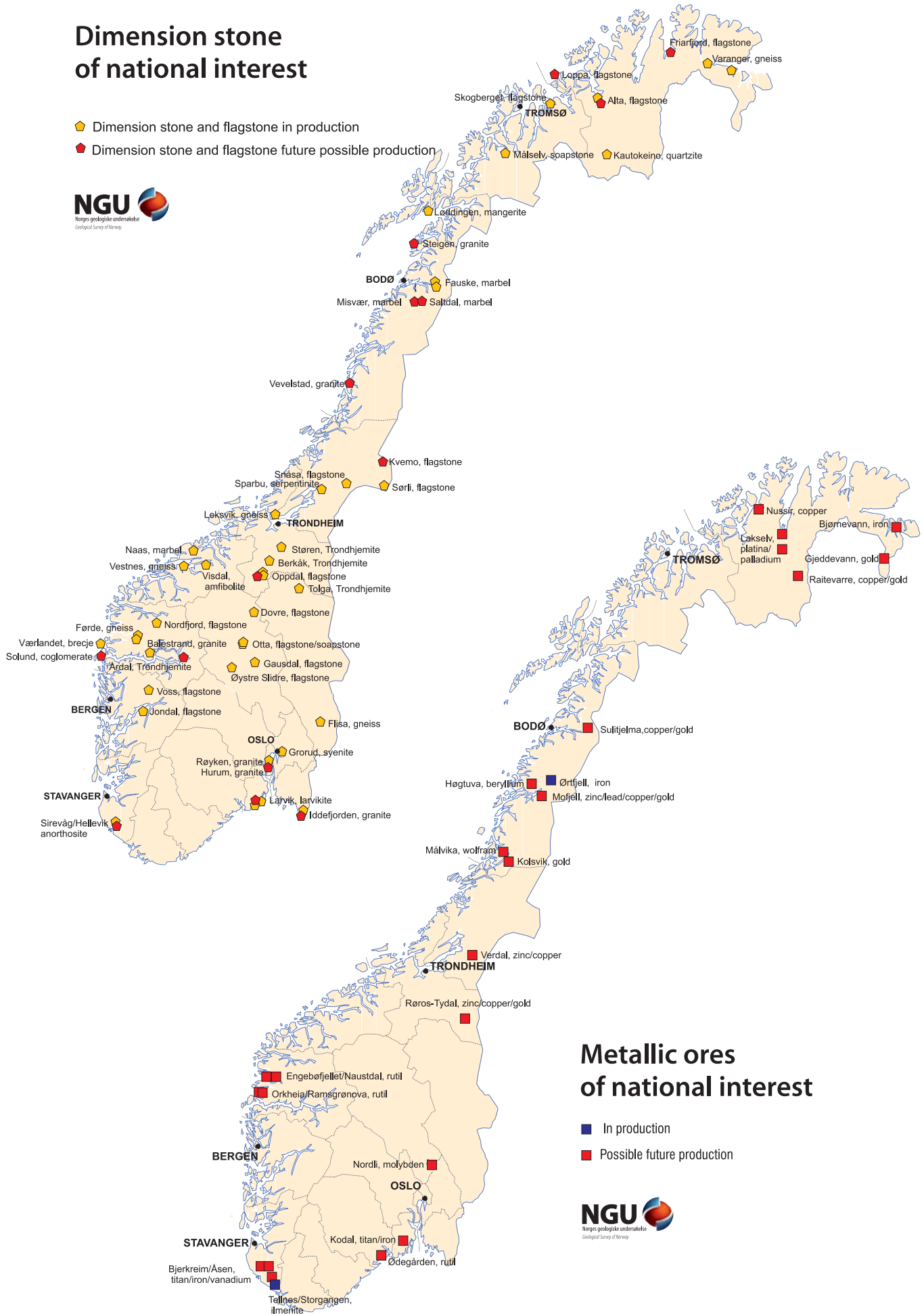
Summary of the number of mineral deposits that, at the time of writing, are considered to be of national interest, the number which are in production and the number considered as a future resource.

Commodity type	Of national interest	Currently in production	Future resource
Industrial Minerals	58	33	25
Metals	18	2	15
Dimension stone	78	55	23
Aggregates	41	34	7
Sand and gravel	14	14	-
<b>Total</b>	<b>209</b>	<b>138</b>	<b>70</b>

An overview of these deposits is shown on the maps.

# Dimension stone of national interest

- ◆ Dimension stone and flagstone in production
- ◆ Dimension stone and flagstone future possible production

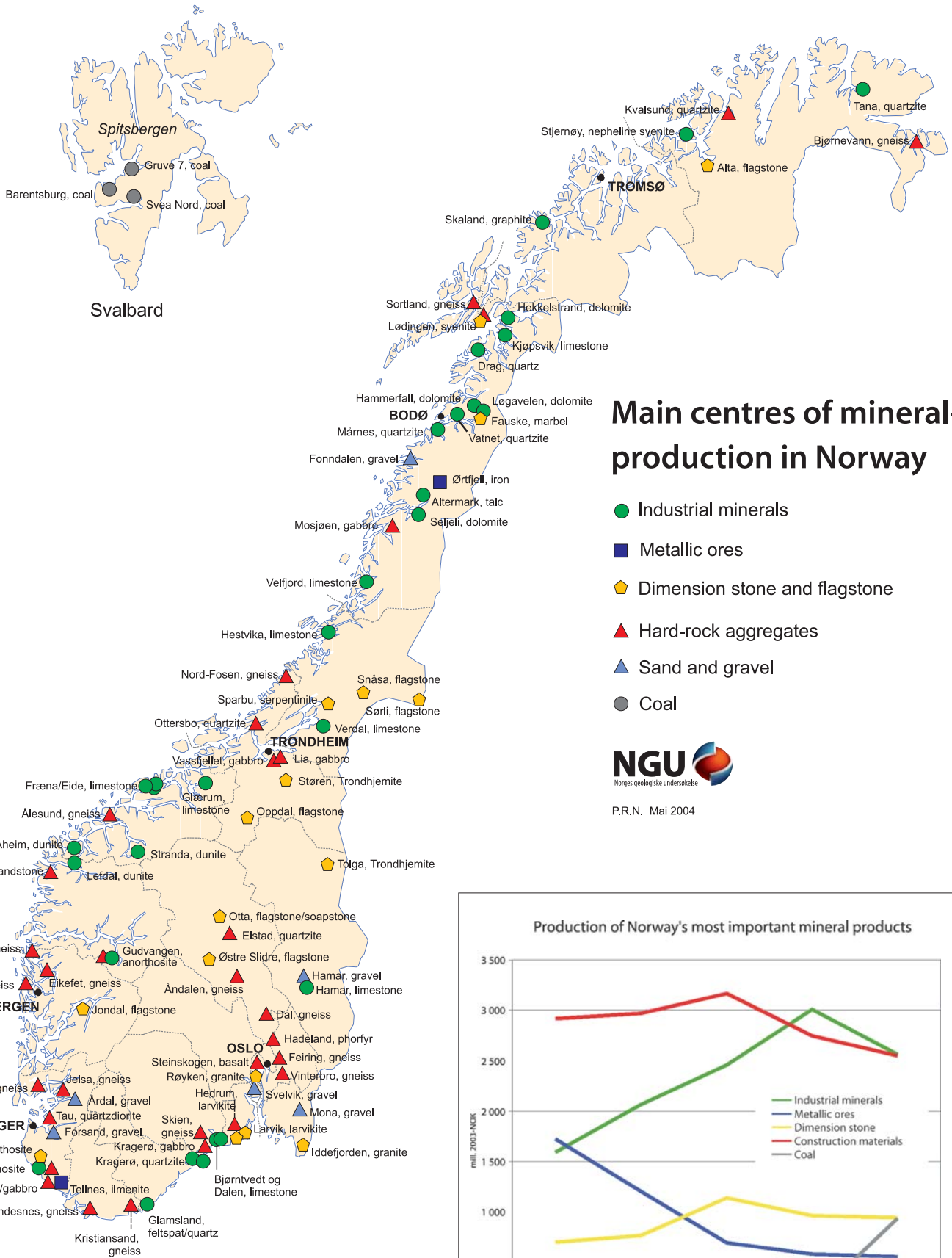


# Metallic ores of national interest

- In production
- Possible future production

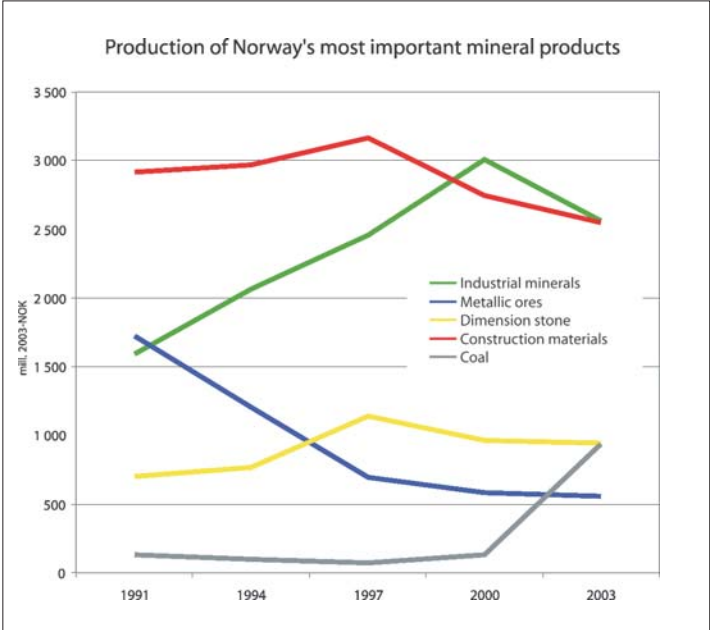






## Main centres of mineral-production in Norway

- Industrial minerals
- Metallic ores
- ◆ Dimension stone and flagstone
- ▲ Hard-rock aggregates
- ▲ Sand and gravel
- Coal





# DEVELOPMENTS IN THE MINING AND QUARRYING INDUSTRY IN THE PAST DECADE

The industry has gone through an immense structural change over the last 10 years. The production of industrial minerals has risen greatly, dimension stone has increased moderately, and crushed rock, sand and gravel have been stable. These changes have, however, been accompanied by a substantial reduction in metal mining.

Twenty years ago, the state was a major player in the industry, particularly through its ownership of Norsk Jernverk, Rana Gruber and AS Sydvaranger, and their subsidiaries. Today, when the privatisation of AS Olivin is completed, the state will be without any commercial interest in the mining and quarrying industry on mainland Norway. Foreign or multinational companies today own, to a greater or lesser degree, many of the larger, export-oriented companies in the sector.

The total value of mineral production has changed in a similar way as that of the agricultural industry during the period 1991-2001. Subsidies to the industry were a little under NOK 200 million in 2001. This represents a considerable reduction during the past decade.

The mining and quarrying industry requires large investments, significantly more real capital per employee than the industrial average. Although more than half of the mineral production is exported, domestic demand has enabled a significant processing and refining industry. Profitability varies from one part of the sector to another and between individual companies within each sector. Several companies are considered to have excellent profitability.

## Mineral raw materials - values in mill. NOK supplied from the producer in 1982 - 2003

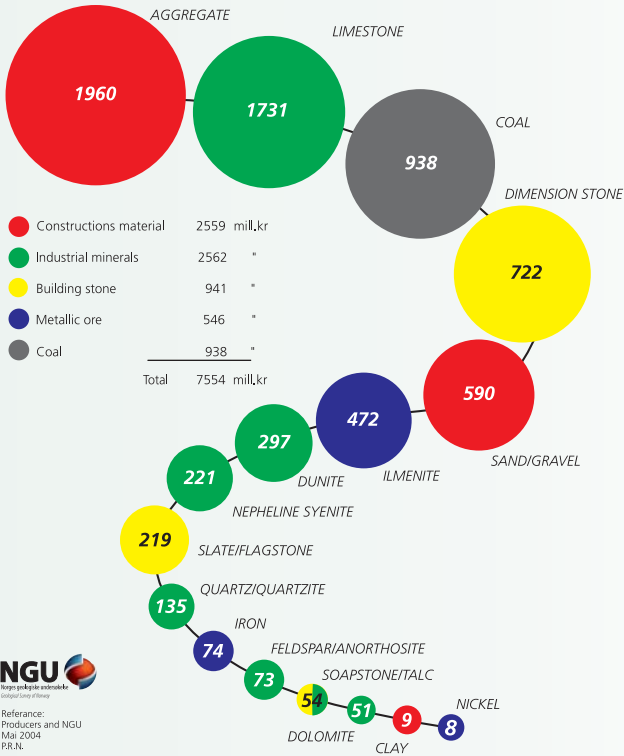
	1982	1986	1991	1994	1997	2000	2002	2003
Olivine	100	180	270	335	262	297	278	297
Nepheline syenite	100	150	200	231	171	220	219	221
Quartzite	30	100	100	83	81	145	140	135
Talc/soapstone	--	--	9	25	50	76	48	54
Feldspar/anorthosite	--	--	30	35	53	46	52	73
Graphite	20	--	--	13	19	23	19	—
Limestone	160	300	570	850	1 439	1 927	1 488	1 731
Dolomite	90	70	48	120	70	93	57	51
<b>Total ind.min.</b>	<b>500</b>	<b>700</b>	<b>1 227</b>	<b>1 692</b>	<b>2 145</b>	<b>2 827</b>	<b>2 301</b>	<b>2 562</b>
Illmenite	110	340	244	249	243	345	470	472
Nickel concentrate	--	--	45	88	113	109	93	8
Iron	680	650	523	501	127	94	91	74
Copper	200	250	298	84	74	—	—	—
Iron sulphide	40	--	23	—	—	—	—	—
Zinc	120	--	139	55	40	—	—	—
Gold	—	20	47	—	—	—	—	—
Lead	--	--	14	12	8	—	—	—
<b>Total met.ores</b>	<b>1 150</b>	<b>1 260</b>	<b>1 333</b>	<b>989</b>	<b>605</b>	<b>548</b>	<b>654</b>	<b>554</b>
Blocks	90	210	430	510	853	699	836	722
Flagstone/building stone	--	110	110	120	139	209	234	219
<b>Total flagstone/blocks</b>	<b>90</b>	<b>320</b>	<b>540</b>	<b>630</b>	<b>992</b>	<b>908</b>	<b>1070</b>	<b>941</b>
Crushed rock	800	1 000	1 350	1 430	1 859	1 825	1 950	1 960
Sand/gravel	1 000	920	900	1 000	900	760	590	590
<b>Total aggregates</b>	<b>1 800</b>	<b>1 920</b>	<b>2 250</b>	<b>2 430</b>	<b>2 759</b>	<b>2 585</b>	<b>2540</b>	<b>2 550</b>
Clay	--	--	4	--	--	6	10	9
Coal	160	210	100	80	64	122	684	938
<b>Total</b>	<b>3 700</b>	<b>4 410</b>	<b>5 450</b>	<b>5 821</b>	<b>6 565</b>	<b>6 996</b>	<b>7259</b>	<b>7554</b>

-- No information

— Zero

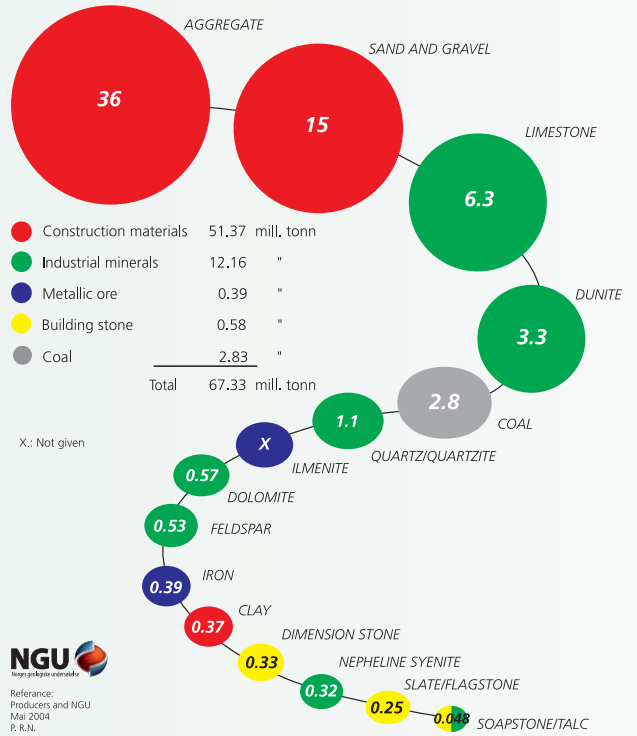
## PRODUCTION OF NORWAY'S MOST IMPORTANT MINERAL PRODUCTS

(2003, FOB, MILL. NOK)



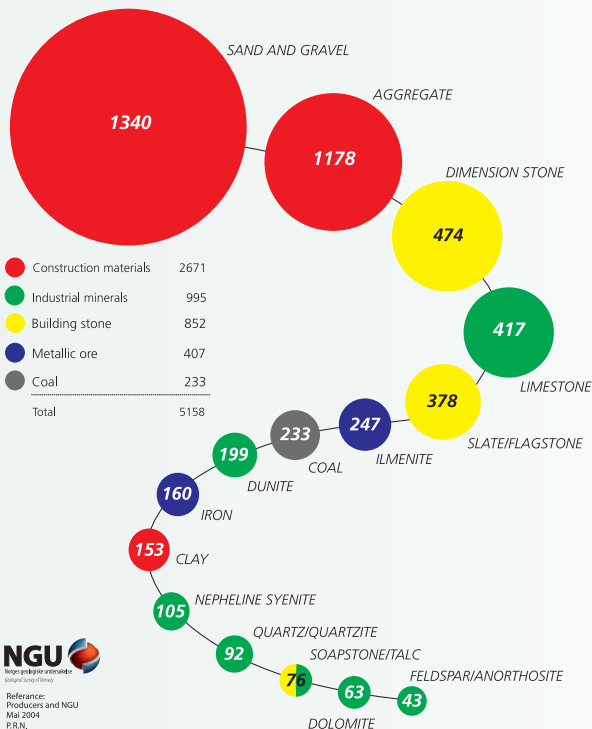
## PRODUCTION NORWAY'S MOST IMPORTANT MINERAL PRODUCTS

(2003 MILL. METRIC TONNS)

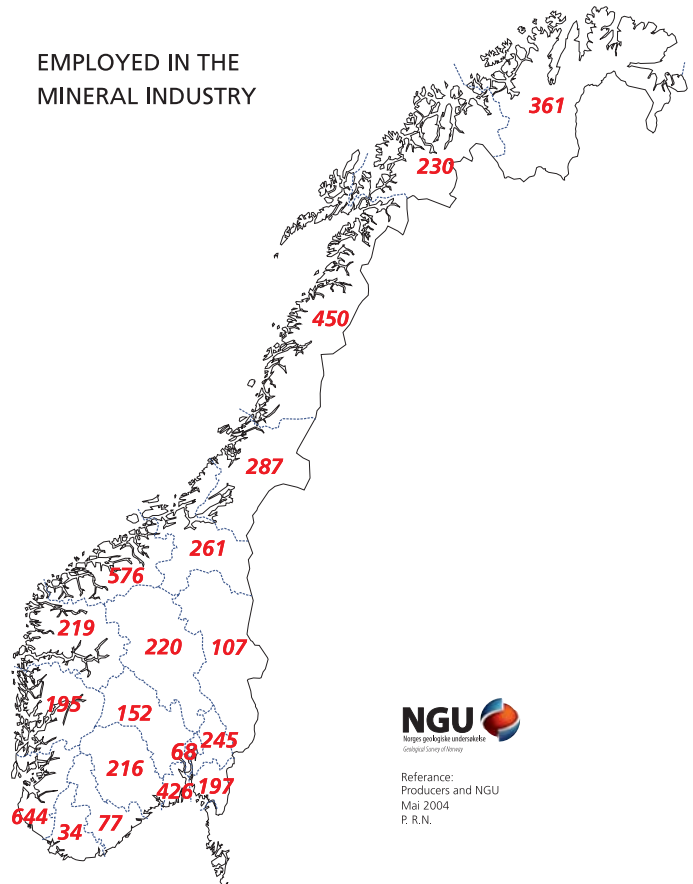


## EMPLOYED IN THE MINERAL INDUSTRI

April 2004



## EMPLOYED IN THE MINERAL INDUSTRY



# THE INDUSTRY IN 2003

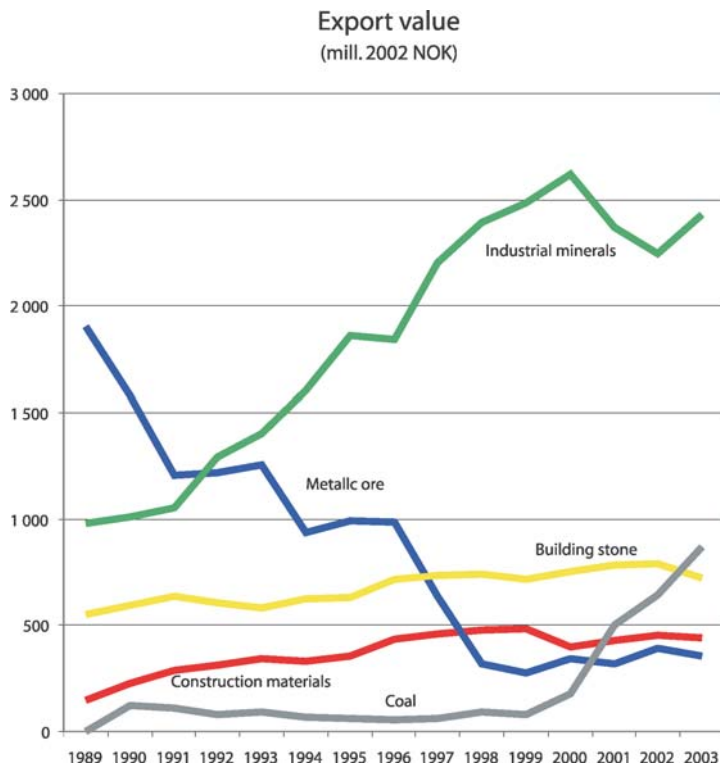
- Extraction of various mineral resources:  
**C. 68 million tonnes**
- Production value:  
**7,6 billion kroner**  
**0.91 billion EUR**
- Export:  
**65 percent of production**
- Number of gravel and crushed rock companies:  
**790**
- Number of companies:  
**90, not including aggregate production**
- Number of employees:  
**5100**

## Overview

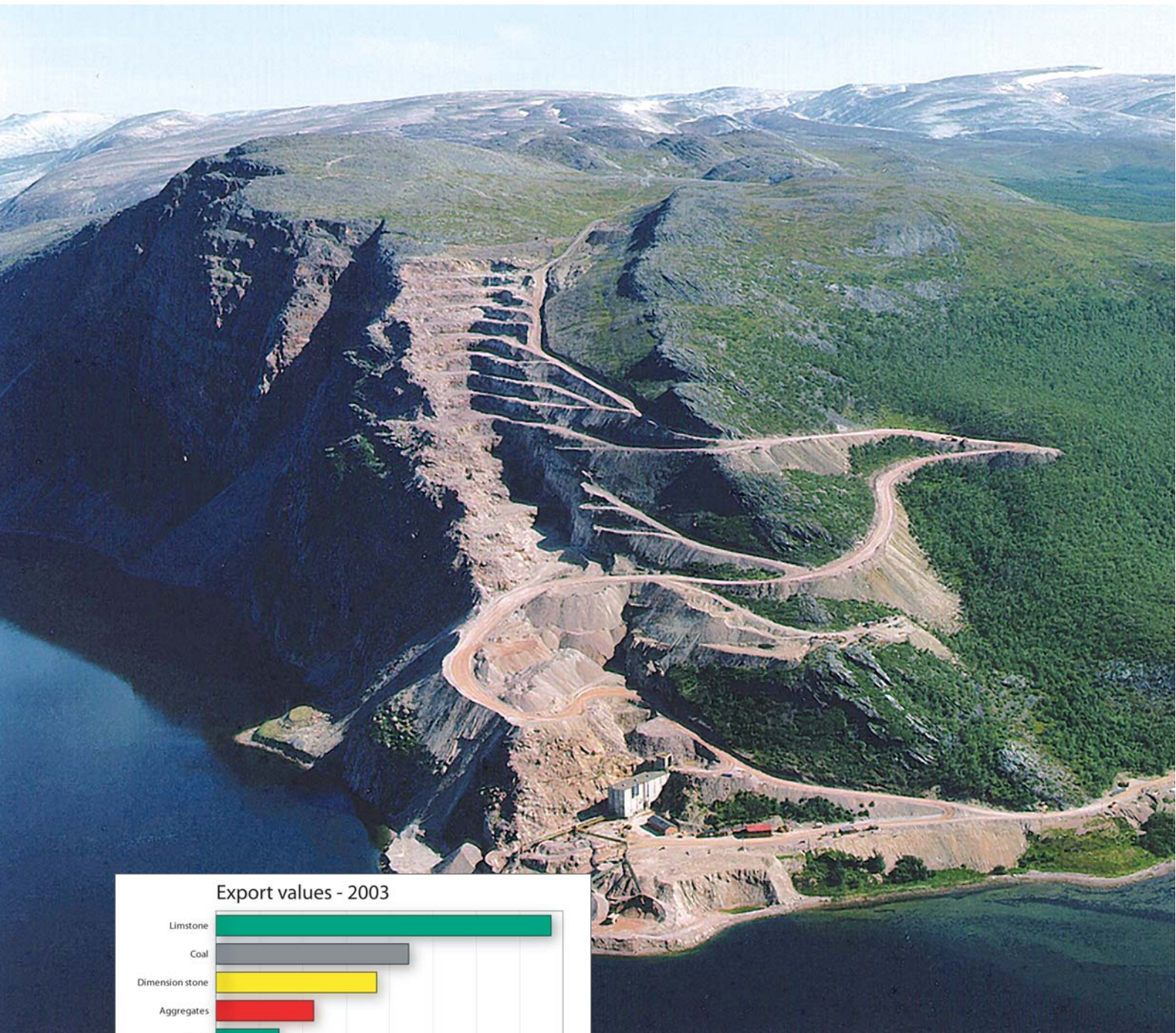
Approximately 68 million tonnes of mineral resources were extracted in Norway during 2003 with a total value of NOK 7.6 billion. For comparison, the primary value of timber from Norwegian forests is under NOK 3.4 billion. From 2002 to 2003, the production value for industrial minerals increased from NOK 2.3 to 2.6 billion, dimension stone decreased from NOK 1.0 to 0.9 billion, and metallic ores decreased from NOK 0.7 to 0.6 billion. Production of crushed rock, sand and gravel had a total value of NOK 2.5 billion in 2003, approximately the same as in 2002.

The industry exported goods worth NOK 4.9 billion in 2003, about 65% of the total production value. Industrial minerals accounted for NOK 2.5 billion; lime slurry, olivine and nepheline syenite being the important products. Dimension stone worth NOK 743 million was exported. The corresponding figures for building materials was NOK 450 million, while exports from the metallic ores branch was NOK 305 million, distributed between ilmenite, iron and nickel. Coal worth NOK 890 million was exported.

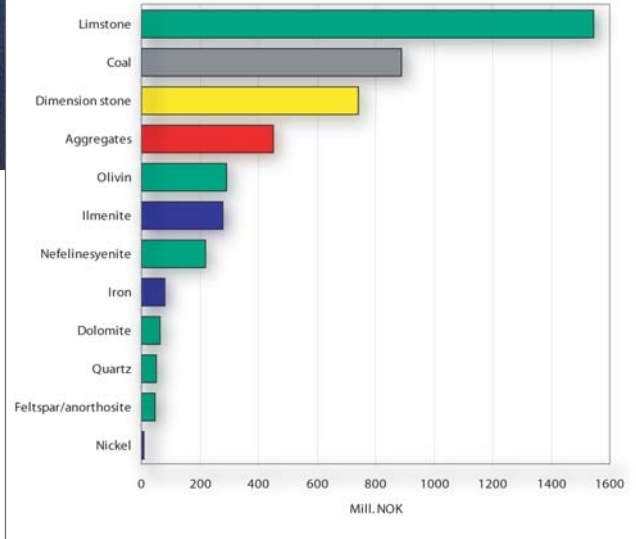
The mineral industry is a typical regional industry, and coastal districts in particular have a large number of companies. Some 5100 people were employed in April 2004, divided among 900 companies. Møre & Romsdal, Rogaland, Nordland, Vestfold and Finnmark are the major mining and quarrying counties as measured by the number of employees.







Export values - 2003



Quarziteproduction, Elkem Tana AS, Finnmark.

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

Industrial minerals has been the branch of the mining and quarrying industry that has grown most strongly over the past decade, particularly as regards the production of lime slurry. In 2003, the value of industrial minerals produced here amounted to NOK 2.6 billion, 12.2 million tonnes of raw materials being extracted. 995 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 2003 was NOK 2.5 billion.

Norway is one of the world's leading producers of olivine and nepheline syenite. A total of 3.3 million tonnes of olivine are produced in Norway by two companies, which together have 200 employees. The largest company 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 manufacture of steel and can result in a significant reduction in the output of CO<sub>2</sub> 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 in Finnmark, 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 market for quartz, feldspar and nepheline syenite.

Twenty companies with a total of about 480 employees produce limestone and dolomite. 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. Limestone produced by the Hustad Group goes to Hustadmarmor AS at Fræna in Møre & Romsdal, where lime slurry or limestone filler is made. A significant part of the source limestone comes from the company's four quarries in Møre & Romsdal. 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 appreciable production of lime for other purposes, including the making of cement, quicklime and lime for agriculture. The value of this production in 2003 was NOK 204 million and the tonnage 4.6 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 operations employing 92 people. Production has decreased in last year to 1.1 million tonnes, representing a value of NOK 135 million. Quartz is used as a raw material in the manufacturing of glass, ceramics and porcelain, and the metallurgical industry has various uses for silica. It is also used as filler in plastics, rubber and paint. Other uses are in semiconductor technology, quartz glass and fibre optics.

Talc is produced in limited quantities by Norwegian Talk Altemark AS near Mo i Rana in Nordland and by Kvam Talk AS in Gudbrandsdalen. Skaland Grafittverk AS, on the island of Senja in Troms, produced graphite until 2003, but production was ceased following the company's bankruptcy in 2003.





Extraction of Larvikite, Larvik,  
Vestfold. Photo: P. R. Neeb



# 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, blockstone and flagstone.

In 2003, the branch produced blockstone to a value of NOK 722 million, with an extraction of 330,000 tonnes of rock. Flagstone production was valued at NOK 219 million with extraction of 250,000 tonnes. 852 persons are employed in the industry. Exported blockstone and flagstone was valued at NOK 743 million in 2003.

Larvikite from the Larvik area in southern Norway dominates blockstone production in Norway and this is a natural resource of unique quality that fetches a high price on the world market. In 2003, production was recorded in 6 companies employing a workforce of 365 and producing larvikite to a value of NOK 647 million. Most of the production is exported as raw blocks, chiefly to Italy, France and Spain. Implementation of new technology has made production more efficient, and together with the favourable location close to the coast, has contributed to an increase in profitability. Lundhs Labrador AS is the largest producer.

In addition, syenite blockstone is produced at Lødingen in Nordland, anorthosite from Hå in Rogaland, and marble from the Fauske area in Nordland. In all, six companies with 30 employees produce syenite, anorthosite or marble with a total value of NOK 41 million.

Granite, gneiss and soapstone with a value of NOK 32 million are produced from 14 companies. Among these are producers of white trondhemite in Sør-Trøndelag and Hedmark, granite from Østfold, Buskerud, Oslo and Sogn & Fjordane, as well as soapstone from Otta and Bardu.

Flagstone and walling stone are produced at a number of places throughout the country. In 2003, production was recorded in 18 companies employing a workforce of 378 and producing rock to a value of NOK 219 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 % of production is exported. The durable Norwegian quartzite 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. The last decade 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







# BUILDING MATERIALS

## Sand, gravel, crushed bedrock and clay

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 in some areas, but also because of the higher demands 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 % 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 9100 sand and gravel deposits and about 1100 deposits for crushed rock. A total of 4500 quarries and gravel pits are in continuous or sporadic operation. (NGU's gravel and crushed rock database: [www.ngu.no](http://www.ngu.no)) The utility value of the 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 2003 was NOK 2.6 billion, based on the extraction of 50 million tonnes of raw materials. Approximately 2500 persons are employed in this sector, distributed among approximately 800 small or large companies. By volume, 28 percent of the Norwegian production of crushed rock is exported. Export to the European continent has risen by 150 per cent since 1990. In 2003, 11.2 million tonnes of crushed rock and 0.2 million tonnes of sand and gravel were exported, amounting to a value of NOK 450 million. Most of this export went to Germany, Denmark, England, Netherlands and Poland. An additional 2.0 million tonnes of crushed rock were produced for offshore purposes on the Norwegian, British and Dutch continental shelves, fig. s. 22.

There are about 100 important 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 AS, Franzefoss Pukk AS, NorStone AS, Norsk Stein AS, NCC Roads Norge AS, Kolo-Veidekke AS, Halsvik Aggregates AS and Oster Grus og Sand AS.

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. In Telemark, clay is exploited for the production of tiles at Bratsberg in Bø Kommune, and in Sandnes, clay is exploited for ceramics. In total, 370,000 tonnes of clay are exploited with a total value of NOK 9 million before processing. Including processing, the companies in this branch had 153 employees.



# METALLIC ORES

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

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 2003 were NOK 546 and NOK 365 million, respectively. Approximately 0.4 million tonnes of concentrated ore were extracted, and the workforce amounted to 407 in April 2004. Production in Norway has declined greatly in recent years and only two mines are now in operation. Titania AS, located at Sokndal in Rogaland, 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 excellent in the long term, and the rutile deposits near Førde are particularly interesting.

In the early 1980's, 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.

The sulphide ore mine operated by Nikkel og Olivin AS at Ballangen in Nordland ceased operation in 2003 because of exhaustion of reserves. The company had produced nickel, copper and cobalt concentrate.

Gold production took place profitably at Biddjovagge near Kautokeino in Finnmark from 1985 to 1992. There has recently been a resurgence of interest in gold exploration in Norway, among elsewhere at Pasvik in Finnmark, Kvænangen in Troms, Mo i Rana in Nordland, Setesdal and in Bindal. On Svalbard, Store Norske Spitsbergen Grubekompani AS have established a gold exploration division, Store Norske Gull AS.

A further encouragement to interest in metal ores in Norway have been the reports of significant finds of platinum-group-elements at several sites in the Karasjok greenstone belt, Finnmark by the company Tertiary Minerals PLC.

One of the special products which Rana Mines produces is Sirfloc, water purifying mineral concentrate. It is a product which is used to extract pollutants from water. Photo: Rana Gruber AS



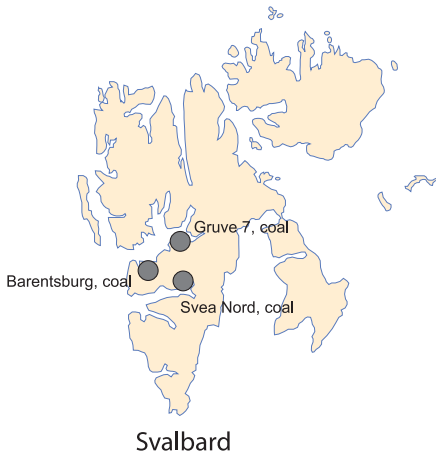
Three different red pigments made from hematite.



Rana Mines makes several types of iron oxide pigment, here is a pallet of red pigment. The pigments are used in concrete, paint, varnish, cosmetics etc. Photo: Rana Gruber AS



# FUEL MINERALS (COAL)



Energy minerals are compounds that emit energy when burned. Oil, gas, peat, coal and oil shale are fuel 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 is exported as well as being used on the Norwegian mainland. Store Norske Spitsbergen Grubekompani AS (SNSG) is now mining coal at Longyearbyen, Mine 7 and Svea Nord. The Svea Nord field entered production in 2001 and will ensure the continuation of Norwegian coal mining for another 15-20 years. Most of the Svalbard coal is used in the metallurgical industry, but some is employed for generating power and manufacturing cement. Exported coal from SNSG goes to Germany, Denmark, Finland, Great Britain, France, Sweden and Iceland.

Production has risen steadily in recent years and in 2003, 2.8 million tonnes of coal were produced with a total value of NOK 938 million. The company has 233 employees directly in the coal mining operations. Some 377,500 tonnes of coal are produced and exported from Barentsburg, also on Svalbard. Demand for coal on the world market continues to rise. Total world production of coal is 3.4 billion tonnes.



Coal sample from The Svea Nord Mine. Photo: P.R. Need



The Svea Nord Mine on Van Mijenfjorden. Photo: H. Carstens





## FACTS

Mineral types	No. of companies	Employees
Sand/gravel	529	1340
Crushed rock	266	1178
Clay	4	153
Limestone	17	417
Dolomite	3	63
Olivine	3	199
Quartz	7	92
Feldspar	3	43
Nepheline syenite	1	105
Talc and soapstone	5	76
Graphites	1	0
Ilmenite	1	247
Iron	1	160
Nickel	1	- *
Coal	1	233
Slate	12	327
Building stone	7	51
Blocks - granite/gneiss	15	79
Marble	3	12
Larvikite	9	383
<b>Total</b>	<b>889</b>	<b>5158</b>

\* Incl. ilmenite

The lion in front of the Parliament building was carved out of a pale red Permian greisen syenite by inmates from Akershus prison in 1865.

Photo: P. R. Neeb.

# FUTURE PERSPECTIVES

Norway has an enormous variety of different rock types. Many of these, such as nepheline syenite, eclogite, extremely pure carbonate rocks, larvikite, certain types 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 centres for research and development. Each of these is an advantage when competing for markets, and provides, collectively, the basis for the continued growth of mineral production in Norway.

*Nevertheless, considerable challenges face the mining and quarrying industry with respect to:*  
Exploration for, and development of future mineral resources.  
The need for increased research.  
Securing a place for potential future mineral resources within land management.

## **Exploration and development of future resources**

There was relatively broad exploration activity throughout Norway during the 1960's and 1970's. In the past 20 years this has become significantly reduced. Today, companies use only NOK 5-10 million each year in the search for new deposits. This represents something like 0.1% of total company turnover and approximately 1% of the total profits for the industry. In Sweden, company-sponsored exploration activity alone has been ca. SEK 200 million each year over the past five years. It continues to be a challenge to increase exploration activity in Norway to levels approaching these.

## **Increased research**

Demands for quality and specialisation of mineral products are increasing steadily. A company can either raise the quality of its products by improving the processing, or it may find new deposits with higher purity of raw materials. For these reasons, even deposits with large proven resources can be faced with closure. Such developments require increased knowledge and skills in the companies themselves and in the relevant research institutions.

The Norwegian Research council has begun a project "From quartz sand to solar cells" that can be considered an example of what is required to initiate an increase in wealth creation in the future. Considerable research and development input is required in other sectors of the minerals industry to attain a corresponding comparable increase in understanding for other rocks and mineral commodities.

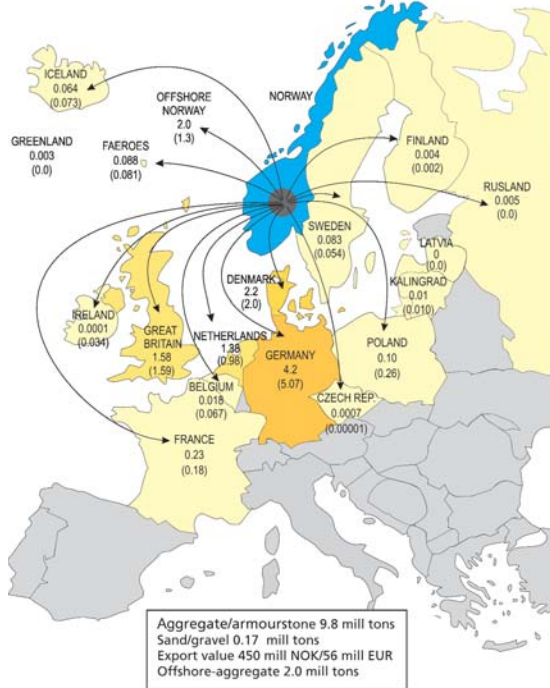
## **Securing future mineral resources within land-use administration**

In the oil industry, deposits are attributed an in situ value. This value is a gross value calculated from the volume of exploitable oil and/or gas in the reservoir, and the price that the company is likely to earn from the sale of those commodities. If we do the same for mineral deposits, we could readily calculate that many mineral deposits have extremely high values. Indeed, individual deposits in Norway would have values that exceed NOK 100 billion.

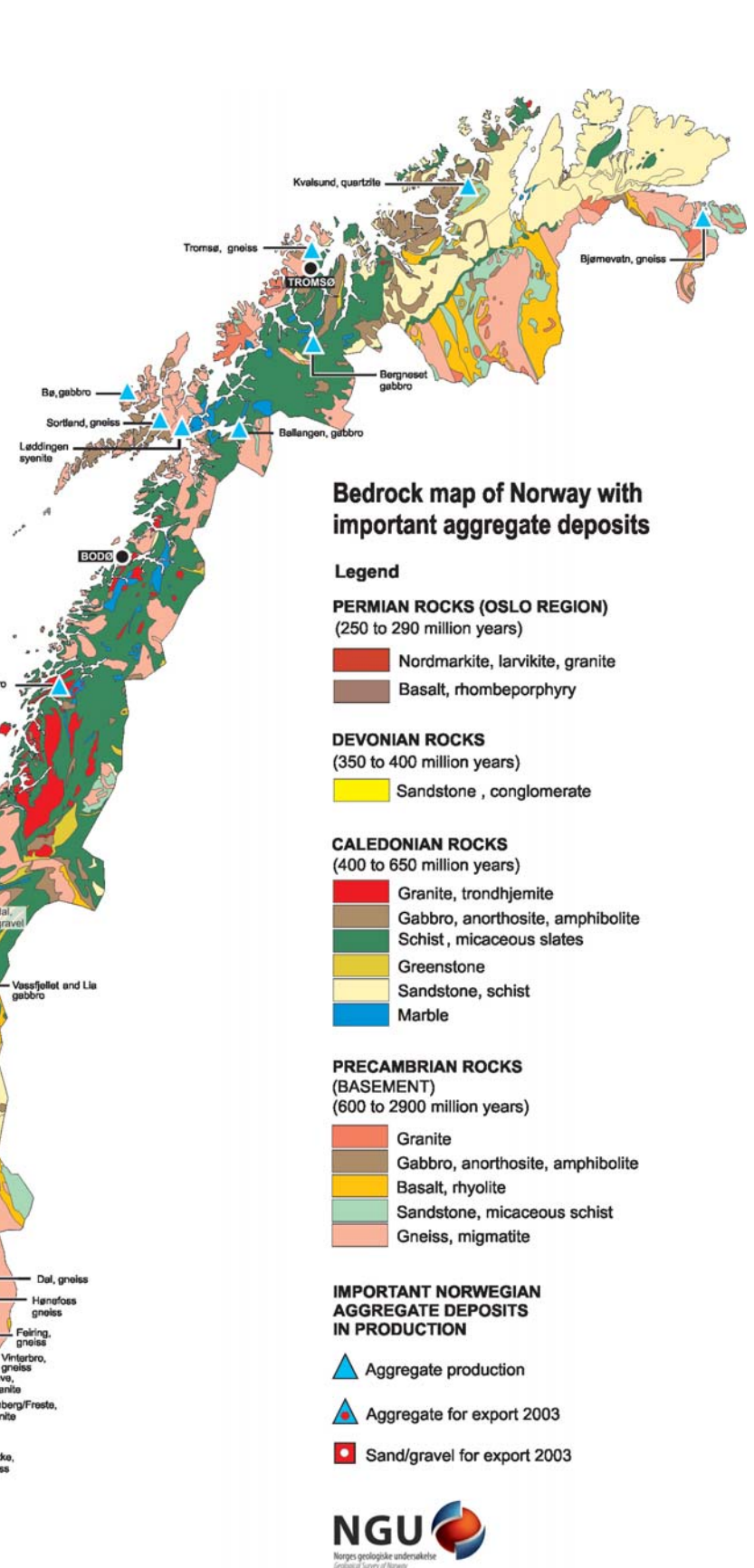


## NORWEGIAN AGGREGATE FOR EXPORT IN 2003

Total production 12 mill. tons and export 9.7 mill. tons aggregate, armourstone, sand and gravel and in addition 1.3 mill. tons aggregate for offshore use.  
Production values in parentheses are from 2002



Aggregate/armourstone 9.8 mill tons  
Sand/gravel 0.17 mill tons  
Export value 450 mill NOK/56 mill EUR  
Offshore-aggregate 2.0 mill tons



Compared to other industries, the mineral industry requires only limited surface areas. Figures from Sweden indicate that the minerals industry uses only 0.05% of the total land area - and most of this is tied to the extraction of sand and gravel. Companies must operate where the resources are - they cannot be moved to other locations.

Society at large has long undervalued the obligations related to the effective management of mineral resources. This discrepancy is apparent if we compare the way in which other types of natural resources, such as forestry and agriculture are managed, not to mention protected areas. While we have efficient and comprehensive land-use management schemes for these resources, important mineral deposits are often not given the same importance when considering long-term land-use strategy, if they are considered at all. This is despite the considerable economic value that the mineral resources represent. It is necessary to undertake a better mapping and characterisation of known deposits and of areas that have large potential for the discovery of new deposits.

**Industrial minerals** are economically valuable minerals and rocks that are extracted because of their physical and chemical, non-metallic properties. 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 blockstone. Flagstone and slate are rocks that can be split along natural planes. Common varieties are slate, phyllitic schist, mica schist and quartzite schist. Blockstone is 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.



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