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# Construction Raw Materials Policy and Supply Practices in Northwestern Europe.

Facts and figures - Norway.

NGU
Norges geologiske undersøkelse
Geological Survey of Norway

# REPORT

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Abstract:

This report contains information on the Norwegian production of raw materials for building and construction, including 1) sand, gravel and crushed rock, 2) limestone including marble and dolomite, 3) silica sand, 4) clay, 5) filling materials, 6) recycled and secondary materials, and 7) renewable materials, ie. timber.

Data are collated from the webpages of the Geological Survey of Norway (www.ngu.no) and Statistics Norway (www.ssb.no), diverse reports, research articles, and other resources. Much of the facts on policy, trends and production targets is 'read between the lines' and was distilled from a great number of different documents.

Producers are very reluctant with providing exact production data, anxiously protecting their competitive market position. More general data could be obtained through Statistics Norway.

Maps, charts and diagrams have all been prepared in-house.




| Keywords: Mineralressurser | sand | grus |
|---|---|---|
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# Preface

Norway has vast (virtually endless) resources for the production of raw materials for building and construction purposes. The great variety of rock types allows the production of materials with diverse qualities, to fulfil customers specifications and even specialty requirements.

The most popular materials include: 1) sand, gravel and crushed rock, 2) limestone including marble and dolomite, 3) silica sand, 4) clay, 5) filling materials, 6) recycled and secondary materials, and 7) renewable materials, ie. timber. This report provides available data for these materials.

The Norwegian mining and quarrying industry produces a large amount of such materials. Production for covering local demand is governed by consumption. Deep-water fjords with steep walls provide easy access to potential production localities. There is an enormous potential for the further and future development of extraction sites for raw materials.

Trondheim, December 1, 2002

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# A. General Information

## 1 Authors

This report has been prepared by Peer-Richard Neeb (civil engineer) and Maarten Broekmans (PhD). Neeb is employed as manager in charge of the NGU program ‘Economic Growth in the Mineral Industry’. In previous years, Neeb has collated and statistically analyzed annual production numbers from the mineral industry, which have been published in a number of open-graded NGU-reports.

Maarten Broekmans graduated for his MSc Geology at Utrecht University in 1992. Until early in 1997, he has been employed as the technical manager of an engineering consultancy where he developed procedures for the geochemical and petrographic analysis of deteriorated concrete. He received his PhD in February 2002 on mineralogical and geochemical aspects of some Dutch concretes and Norwegian mylonites as related to the so-called alkali-silica reaction ASR. He also is employed by NGU, currently involved projects on the detailed characterization of quartz and other building materials, including natural stone.

## 2 Report date

June 2002. The data given are from 2001, unless specifically stated otherwise.

## 3 Country

Data are provided for the mainland of Norway only; Svalbard (Spitsbergen) is not included.

## 4 Geography, demographics, general politics

The country of Norway stretches across more than 13 degrees of latitude. The mainland of Norway forms the outer rim of the Scandinavian peninsula, from the North Sea in the south to the Barents Sea in the far North. The southern tip lays at Lindesnes at around 58° N, Knivskjellodden protrudes just a few hundred metres (or arcseconds) further North than the Nordkapp at more than 71° N right next to it, the westernmost point lies at Stad near 4° E, and the easternmost point lies at Jakobselv bordering to Russia near 24° E. If it were possible to rotate Norway around its southernmost point, it would reach all the way down to the Mediterranean. From deep South to far North is an approximately 2650 km drive by road; the total length of the coast line is well over 21000 kilometres, a great multiple of that distance.

The Atlantic coast in the West is characterized by deep fjords up to 242 km long (Sognefjord), whereas the Skagerrak coast in the SE of the mainland is rather characterized by skerries and islet archipelagos. The more than 160 000 lakes and as many islands testify to the ancient glaciers that once scoured its landscape and coastlines with the movement of tremendous masses of ice, earth, rock and aggregates.

The total land area is 323 895 square kilometres, which is as much a Great Britain and Italy put together. The population is small at around 4.83 million inhabitants, ie. overall less than 15 inhabitants per square kilometre. To put this number into perspective: the Netherlands has above 400 inhabitants per square kilometre. However, due to the very same spectacular nature as described above, only a relatively small part of the entire main land area is inhabitable, and only 3% of the land area is suitable for agriculture.

Arranged to size, main settlements include Oslo (~0.5 million inhabitants), Bergen (0.23 million), Trondheim (0.15 million), and Stavanger (0.11 million) in the South. In the northern part of Norway, the population is concentrated around the (near) coastal towns of Tromsø, Mo i Rana, Narvik, Alta, Hammerfest and Kirkenes, and Kautokeino and Karasjok inland. Industrial and agricultural activities are concentrated in the same areas.

The Kingdom of Norway is a constitutional (hereditary) monarchy, with an open and accessible governmental structure. The constitution was drafted in 1814 at Eidsvoll. Baedeker's travel guide to Scandinavia [Hogarth 1993] informs that legislative power rests with the Storting (ie., Parliament), subject to the King's right of veto. The King holds executive power, exercised by his 165 ministers, who are not member of the Storting but have the right to speak in it.

Storting members are voted by elections in the nineteen counties ('fylke'), which have a limited degree of autonomy; Norway is *not* a federal state. However, the counties responsibilities *do* extend to infrastructure and thus affect mineral planning [Hogarth 1993].

# 5 Geology

## 5.1 Brief outline

The rocks of Norway consist of a variety of sedimentary, metamorphic and igneous rocks. The oldest bedrocks are found in the northernmost parts towards the old Finnish-Scandinavian continental core and contain ortho- and paragneisses of so-called Archaean age, ie. up to 3800 million years old. The age of the bedrock decreases down the hanging lobe of the Scandinavian peninsula, with Meso- and Neoproterozoic (ie. 1700-900 million years) rocks in the southernmost parts. The bedrock has locally been deformed during the Caledonian orogeny at around 400 million years ago, and is transected by several Paleoproterozoic greenstone belts of much older age.

The ~400 million year old Caledonian orogenic belt (eg. the French-Spanish Pyrenees are of similar age) consists of metavolcanics, metasediments and ophiolite sequences, locally intruded by mafic and/or felsic rocks of younger age, and is positioned on top of the much older Proterozoic bedrock. Locally, later thrusting and deformation has resulted in stacked allochthon nappes with minor Precambrian intercalations, meaning that on their interface, the two rock sequences may have become intermixed. Low-grade metamorphic Devonian sediments (~300 million years) are found in western Norway, and even younger Permian (~200 million year) igneous rocks can be found in the Oslo graben. Locally, Quaternary glacial deposits top the rock pile. Also check the map on the next page.

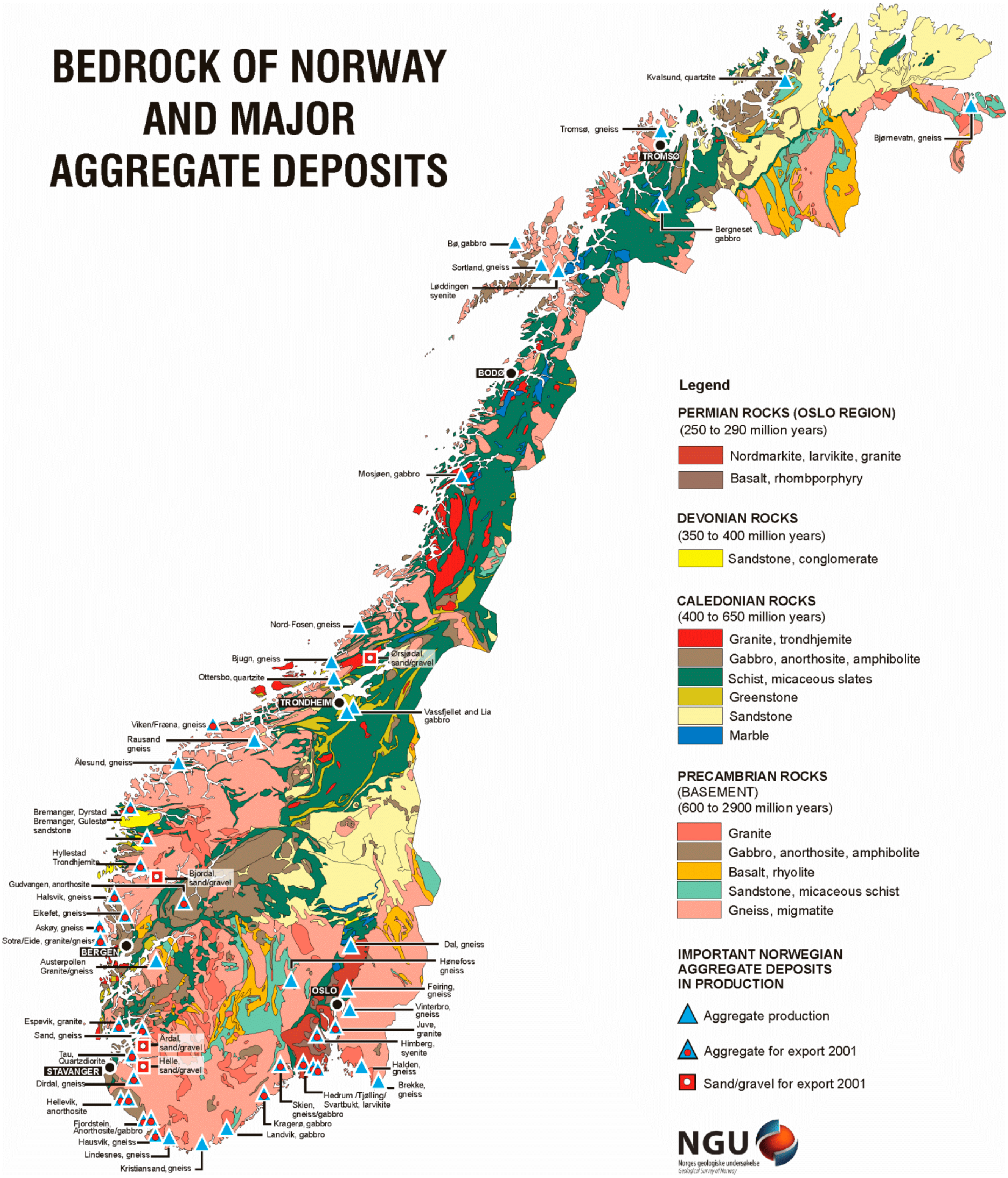
## 5.2 Mineral reserves

Potential mineral extraction sites are in principle only limited by the rock quality. The rock quality (depending of intended application) is the main criterion for Norwegian aggregate producers, rather than rock type which in itself provides no guarantee for quality. Though many sites have been charted and mapped, the potential for new sites is at least one order of magnitude larger.

The most important sand and gravel deposits are located on the bottom of valleys and deep inside fjords. The most interesting sites for hard rock aggregate are located just above that level and are typically hardly weathered. Moreover, deep-water anchoring, low tidal range and a well-developed infrastructure allow for the construction of new harbouring facilities for large bulk carriers. Apart from the geological and logistic aspects, Norway does have an attractive investment and taxation climate, and overseas investments are particularly encouraged. National and local authorities are indeed aware of the potential for the development of large coastal (super-) quarries designed for the production and export of rock aggregates.

### *5.2.1 Coarse sand, gravel and crushed rock*

Rather than going for a particular rock type to stamp potential extraction sites, Norwegian practical experience has learned that assessing (mechanical and chemical) rock properties with appropriate methods prior to extraction provides the best guarantee for 'quality', the definition of which latter




depends on the intended use. Thus, the non-reserved parts of coastal Norway in potential represent one major extraction site, unrestricted to rock type. Moreover, the varied lithology provides plenty opportunities for ‘specialty aggregate materials’ with specific mineral properties, like eg. high specific weight, great hardness, extreme wear resistance, etc. [Neeb 2001, Neeb 2002a].

### *5.2.2 Limestone for industrial use*

Limestone deposits suitable for aggregate and/or cement production are less common in southern Norway than in the North (particularly Nordland and Vest-Møre counties), with the exception of the

Oslo region. There are considerable developments of limestone in northern Norway though their suitability for application as aggregate materials has not been assessed, with few exceptions.

Norway has become an important producer of limestone, mostly for use as a filler but not excluding natural stone (marble), slurry, and other applications. Limestone resources are large but restricted to certain areas. The prospects for finding new economically profitable occurrences are certainly more than good, while deposits that are worked currently may and will be developed further.

### *5.2.3 Silica sand*

Silica sand *sensu stricto* is a scarce material in Norway. Norwegian sands contain considerably less than 95% silica, whether that be measured as volume or mass of free silica (ie., 'quartz'), or geochemically as $SiO_2$ in bulk material. Typically, silica contents are around 50-70wt%, but may be as low as 0wt% depending on the type of bedrock. Concentration techniques like eg. flotation to upgrade the quartz content are not used. Given the vast resources of pure and ultrapure quartzite, the demand for 'silica sand' for construction purposes can easily be met with crushed material.

### *5.2.4 Clay*

The clay present at the few production sites located in southern Norway is entirely used to produce bricks and tiles for the local market. Export is negligible, bricks and tiles are rather imported, for example from Denmark. Other clay deposits are available but less suitable for production due to inappropriate composition and/or contamination with silt or sand.

### *5.2.5 Filling materials*

The Norwegian construction practice makes use of locally available materials. For egalisation purposes in road works, remaining riprap from blasting activities is commonly used as a filling material, which is usually rammed for compaction. Finer material for upper egalisation layers may be extracted locally from nearby producers or from a temporary production site, including eg. tunnelling activities further up.

# 6 Definitions of raw materials

Nota bene that the NGU statistics are compiled from Statistisk SentralByrå figures; therefore, material definitions are equal and identical. Nota bene that the term 'quality' as used in this report is rather synonymous with 'feature' and *not* with 'degree of excellence'.

### *6.1.1 Coarse sand and gravel*

In Norway, (coarse) sand is *geologically* defined as having a grain size from 0.06 -2mm, gravel has a grain size of 2-64mm. However, in the available statistical data as used in this report there is no distinction between coarse sand and gravel, the annual production is listed as one single number including both materials, the terms even being used interchangeably [Neeb 2001, Neeb 2002a; ipse dixit]. According to Norwegian tradition, the term 'coarse sand and gravel' implicitly refers to the glacio-fluvial origin of the material. The term also includes crushed material produced from larger boulders in waste overburden, removed prior to actual mining. Both these materials are lumped together in the statistics.

### *6.1.2 Limestone for industrial use*

Talking *sensu stricto*, 'pure limestone' solely consists of calcium carbonate $Ca(CO_3)$, known in natural form as the mineral calcite. However, many limestones contain some magnesium, most commonly contained in the mineral dolomite, $CaMg(CO_3)_2$, not rarely in considerable amounts. Moreover, since the calcareous rocks recrystallized under ‘elevated conditions’, their proper nomenclature is marble, not limestone, eventually with a prefix ‘dolomitic’.

The definition for the limestone included in the fact sheet in section C of this report lacks any further specification of, or reference to maximum allowable contents of contaminants and/or impurities. However, limestone for paper filler purposes is of course of high purity. Therefore, numbers are provided on an ‘as is’ basis, without further specification. Thus, taking all the above into account, the figures presented in the fact sheet in section C of this report refer to ‘high purity marble’.

### *6.1.3 Silica sand*

The data provided in this report refer to crushed quartzite used as an alternative for ‘silica sand’, including material for production of ferrosilicium, silicium metal, and foundry sand. The terms ‘quartz arenite’ and ‘quartzite’ as on the fact sheet in section C of this report refers to *consolidated* rock that needs to be crushed to sand fraction grain size [Gjelle & Sigmond 1995].

Loose, unconsolidated (silica) sand with a sufficiently high quartz content (ie. ≥90vol%) is exceptionally rare in Norway. Quartz arenite (ie. ‘sandstone’ in colloquial terms) and/or quartzite are crushed prior to further use. The silica sand thus produced is almost entirely used to meet the own Norwegian demand for the production of ferrosilicium and silicium metal, of diverse qualities. Vanishingly small amounts of crushed silica sand are used for production of glass (<5000 tonnes annually, ie. <0.4wt%), and too fine grained crusher dust (ie., waste) is used by the Norwegian cement industry. Given the vast Norwegian olivine resources, virtually no silica is used for foundry sand [Hugaas/ELKEM, pers.comm. 2002 with Wanvik/NGU].

### *6.1.4 Clay*

Clay is defined as fine grained material with a grain size of 2μm or less, but may to a limited extent be contaminated with minor amounts of coarser material.

### *6.1.5 Crushed rock*

According to Norwegian terminology, crushed rock refers to the bedrock origin of the material rather than to the aspect of being crushed material itself. Notably, eg. crushed boulders from waste overburden are labelled ‘coarse sand and gravel’ instead of ‘crushed rock’.

The fact sheet in section C of this report does not specify to grain size nor rock type, as those criteria are considered subordinate to ‘rock quality’ irrespective of its precise definition.

### *6.1.6 Filling materials*

The Norwegian construction practice makes use of locally available materials. For egalisation purposes in road works, remaining riprap from blasting activities is commonly used as a filling material, which is usually rammed for compaction. Finer material for upper egalisation layers may be extracted locally from nearby producers or from a temporary production site, including eg. tunnelling activities further up.

### *6.1.7 Secondary and recycled raw materials*

The definition applied here for secondary and recycled materials is according to that used by the CEN Technical Committee TC154. Specifications for individual materials are according to preliminary EN standards [prEN13242draft 1998, prEN12620draft 1998, prEN13043draft 1998].

# B. Policy

# 1 Actors in mineral planning and their role

## 1.1 Government at national, regional, local level

National and local authorities are aware of the potential for the development of large coastal quarries (super-quarries) designed for the production and export of rock aggregates. The Geological Survey of Norway (NGU) is undertaking a number of investigations of potential coastal sites for such quarries, so that local government planners, can classify such sites for future development. NGU's goals are to ensure that areas with potential for extraction of construction materials are included in areal and regulatory planning. NGU has a motto: Geology for Society or Community.

Norwegian authorities are both especially decentralized and autonomic. That results in national policy basically providing a wide-spaced framework of regulations and guidelines, the details of which are filled in by local authorities to optimally suit local needs.

### *1.1.1 Counties and NGU's geological investigations*

Norway is divided into 19 administrative counties. The county councils act as regional government authorities in addition to national and local authorities. Among the duties of the county councils is county planning, which involves development of objectives for future socio-economic development of the county, including management of natural resources and recommendations for land use. The outlines are drawn up in accordance with the major aims of employment, population, environment and structure of trade and industry. County activities aim to co-ordinate planning made by the different tiers of local government within the county [Dagestad 1999].

In the rural counties of Norway, one of the major challenges faced by the county administrations is to reduce the levels of migration to urban and more centrally situated areas. An important strategy in this is the development of interesting and safe jobs based on exploitation of natural resources. As a result, geological issues and support for the minerals industry are of critical importance for many local communities [Dahl et al 1999].

Since 1981, the Geological Survey of Norway (NGU) has been involved in 4 designated 'county programmes', each with a duration of 6-10 years and carried out in co-operation with county councils. These programmes have consisted of multi-disciplinary geological investigations, and have contributed to the development of current and potential mineral-based industries. They have also provided geological information essential for land use and planning. The fourth and last of current county programmes finishes in 2002, but NGU intends to continue to build-up levels of co-operation with the local governments in the remaining 15 counties.

National and local authorities are aware of the potential for the development of large coastal quarries (super-quarries) designed for the production and export of rock aggregates. The Geological Survey of Norway (NGU) is undertaking a number of investigations of potential coastal sites for such quarries, so that local government planners, can classify such sites for future development.

In Norway, the government is very decentralized with 435 municipalities in the country having a large degree of autonomy, which eventually may override state regulations. Final permission for mineral planning activities is issued by the relevant municipalities. Only when all municipal permits and state licences needed are obtained, the operation may start. Though this may all sound very strict, it is relatively speaking quite easy to obtain all necessary legal documents in Norway as compared to surrounding countries.

### *1.1.2 The Directorate of Mining in Norway*

The Directorate of Mining is a technical service unit subordinated to the Ministry of Trade and Industry. It is the main service unit concerned with the acquisition and production of mineral resources.

The Directorate is under the leadership of a Commissioner of Mines and handles the Mining Act of June 30th 1972 no. 30. Important activities in this connection are dealing with preclaim and claim applications and control of investigations within preclaim and claim areas. The Directorate issues updated lists of pre-claims and claims in the beginning of April each year. These lists can be obtained directly from their office.

The Directorate of Mining is responsible for handling applications for concessions according to the limestone and quartz acts and is entitled to comment upon applications for concessions according to the concession act of 1974 and the industrial concession act of 1917 [see section B.3]. Concessions given according to the above acts determine the conditions which give the Directorate the right to approve plans and to control the start and termination of production. In addition, the Directorate of Mining is the technical service unit for matters which shall be dealt with according to the regulations to the planning and building act concerning EIA. It is also the court of the first instance for dealing with submission plans [Dagestad 1999]. Finally, the Directorate has a number of duties related to the exploitation of mineral deposits. Companies interested in mineral deposits in Norway are advised to contact the Directorate of Mining before starting prospecting operations.

## 1.2 Environmental organisations

Increasing environmental consciousness limits the amount of inconvenience which is regarded as acceptable in the vicinity of important housing, recreational and national park areas etc. The quarrying for aggregates leads to scars on the countryside and to increased levels of noise, dust and heavy vehicle traffic. Norway has a series of requirements concerning environmental impact that have to be fulfilled, similar to most other (EU) countries. Full details of these requirements and of the necessary procedures are also available from the Directorate of Mining.

National responsibility is deposited at the Ministry of the Environment, assisted by the national watchdog-organisations like eg. Bellona, the Norwegian Association for Environmental Protection (alias Miljøvernforbundet), and the Norwegian Society for Conservation of Nature (alias Norges Naturvernforbund). Addresses are in the Sources section G.

## 1.3 Industry associations

Below is a list of main players in the Norwegian building materials resources industry.

| Bergindustriens Landssammenslutning (BIL), contact: Kari-Merethe Kjellsen |
|---|
| The BIL is the organization for producers of rock materials, including industrial minerals and building and construction materials. |

| Prosessindustriens Landsforening (PIL), contact: Per Helge Fredheim |
|---|
| The PIL is the organization for employers/employees in the mineral extraction industry (and other branches). |

| Pukk- og Grusleverandørenes Landsforening (PGL), contact: Elisabeth Gammelsæter |
|---|
| The PGL is the organization for aggregate producers, including secondary and recycled raw materials. |

| Statens Vegvesen |
|---|
| The Norwegian public roads administration is rather a governmental/consumer than an aggregate materials producer, but still a very important player. |

| SND |
|---|
| The SND is the national board of Norway for development of local/regional districts, by encouraging new businesses to invest in the (geographic, business) area of interest. |

# 2 Main social issues related to mineral planning

## 2.1 Issues determining current policy

The current policy is generally targeted at preservation of the environment, with respect to nature and society. Details are laid out in a couple of brochures, issued by the Norwegian Ministry of the Environment [EIA-brochure: Anonymous 1998]. Basically, the environmental impact of a new extraction site or otherwise has to be assessed in a EIA-study prior to any other action.

One major, essential issue in obtaining permission for extraction of materials is estimating the potential impact of the operation upon the environment. Preservation of nature and of cultural and/or historical sites is paramount in entire Norway and at all levels of government, and needs to be assessed thoroughly in an Environmental Impact Assessment study prior to any further development.

### *2.1.1 Mineral planning and the industry in Norway, aspects for society and nature*

Over the last decades society has increasingly become aware of nature as a finite resource. Man has become aware of the need for unspoiled land as a source of: amenity for rural areas, a source for habitats for the species living there and a source for recreation and outdoor life for the people. As a result of this awareness it is not as easy as it used to be to get the permissions needed in order to mine or quarry a known deposit. The best land use is no longer always the way the market allocates use of the areas. The aim of the planning and permitting process is to weigh the market decision (which almost always will be in favour of the quarry) against other more public values without the same market value. This public goods does not represent a cost that must be taken in to consideration in the project as expenditure.

Some qualities are quite unique to the mineral industry and need to be addressed in the planning process. Firstly a mineral deposit can only be worked were it occurs. The quarrying of the deposit creates adverse environmental impacts. The environmental impact is higher per spending in the mineral industry than in almost any other industry. Yet, it is perfectly possible to restore the land back to a degree where it can be useful for several purposes.

When a developer applies for a planning permission to build a factory or a rural area it makes sense to start a location process. This is not the case with the mineral industry and it is one of several reasons why the mineral industry faces problems because of the modern regime of land use planning and pollution control. No developed country allows any mining or quarrying operation to take place without several permissions such as mining or quarrying concession, pollution concession, land use and planning permission and environmental impact assessment.

## 2.2 Recent developments

NGU is working actively with local authorities in designating potential sites for large coastal aggregate quarries. This allows planners within these authorities to schedule such sites for future industrial development. In a preliminary project description to the national and regional authorities, NGU has started a project for mapping the best-suited areas along the coastline from the county of Vest Agder in the south to that of Troms in the north (see map “Bedrock of Norway and major aggregate deposits” on page 9). Central and North Norway have been included in this preliminary description to cover the eventuality of future aggregate export to parts of the east coast of America.

NGU has already received enquiries from interested leading producers in the USA. The main objective of the mapping and sampling project is to find the most suitable areas for establishing large coastal aggregate quarries, in relation to areal planning continuously undertaken by Local and County planning agencies. This has particular relevance to ongoing coastal zone planning.

Over the last few years, the Norwegian mineral industry has undergone a major restructuring to meet shifting demands and interests from mineral users. The production of industrial minerals has really jumped up while the production increase of natural stone, sand and crushed rock remained more moderate. In contrast, the production of gravel has gone down a little, and the production of metals has seriously decreased. The net sum effect of all the above is that, since 1982, annual production has nearly doubled from 3.7 billion Kroner to over 7 billion Kroner. With the current (ie., report date) exchange rate of 1€=7.37NOK, this amounts to over €500 million and €950 million, respectively.

#### *2.2.1 The challenges of a new land-use regime*

To get all of the permissions necessary is a time consuming process. In Norway, an environmental impact assessment (EIA) may take as long as two years to complete, the planning permission and the pollution permission may very well add another year to the process. If the project is controversial governmental environmental agencies and non-governmental organisations may stall the process for several more years.

# 3 List of relevant actual policy documents and laws

List below are relevant legal Acts for the exploitation of mineral resources. The applicability of each of these Acts may be very different, as some or all of these Acts may apply, depending on the case in particular. Details about which acts and under what conditions they may apply can be obtained from the Directorate of Mining, and is considered to be beyond the scope of this report.

- Act of July 3, 1914 no.5 on acquisition of limestone deposits
- Act of December 14, 1917 no.16 on acquisition of waterfall, mines and other real property, the so-called Industrial concession Act.
- Act of March 15, 1940 no.3 on water systems
- Act of June 17, 1949 no.3 on acquisition of quartz deposits
- Act of March 21, 1952 no.1 on expropriation of land etc for mining of non-licensable mineral deposits
- Act of March 18, 1955 no.2 on development of agriculture
- Act of June 21, 1963 no.12 on underwater deposits other than petroleum
- Act of May 21, 1965 on forestry and forest protection
- Act of June 19, 1970 no.63 on nature conservation
- Act of June 30, 1972 no.30 on mining
- Act of June 10, 1972 no.82 on motorized traffic in uncultivated areas
- Act of May 31, 1974 no.19 on concessions and the option for the state to acquire property
- Act of June 9, 1978 no.50 on cultural monuments
- Act of June 9, 1978 no.50 on reindeer pasturing
- Act of March 13, 1981 no.6 on protection against pollution and refuse
- Act of June 14, 1985 no.77 on planning and building

# 4 General policy lines on raw materials

## 4.1 Goals (qualitative)

The goals are obvious: Norway wants to develop its (potential) mineral deposits and make their vast resources available for production, provided environmental aspects and preservation of nature are taken into account.

The great variety of available rock types allows production of aggregate materials with virtually any thinkable combination of qualities and properties. Aggregate resources are to be regarded as virtually unlimited, and access is easy because of the favourable coastal geomorphology with deep fjords having steep walls featuring convenient deep anchoring waters for large bulk carriers. Over the last decade, the export value of industrial minerals has grown by a factor of three!

## 4.2 Targets (quantitative)

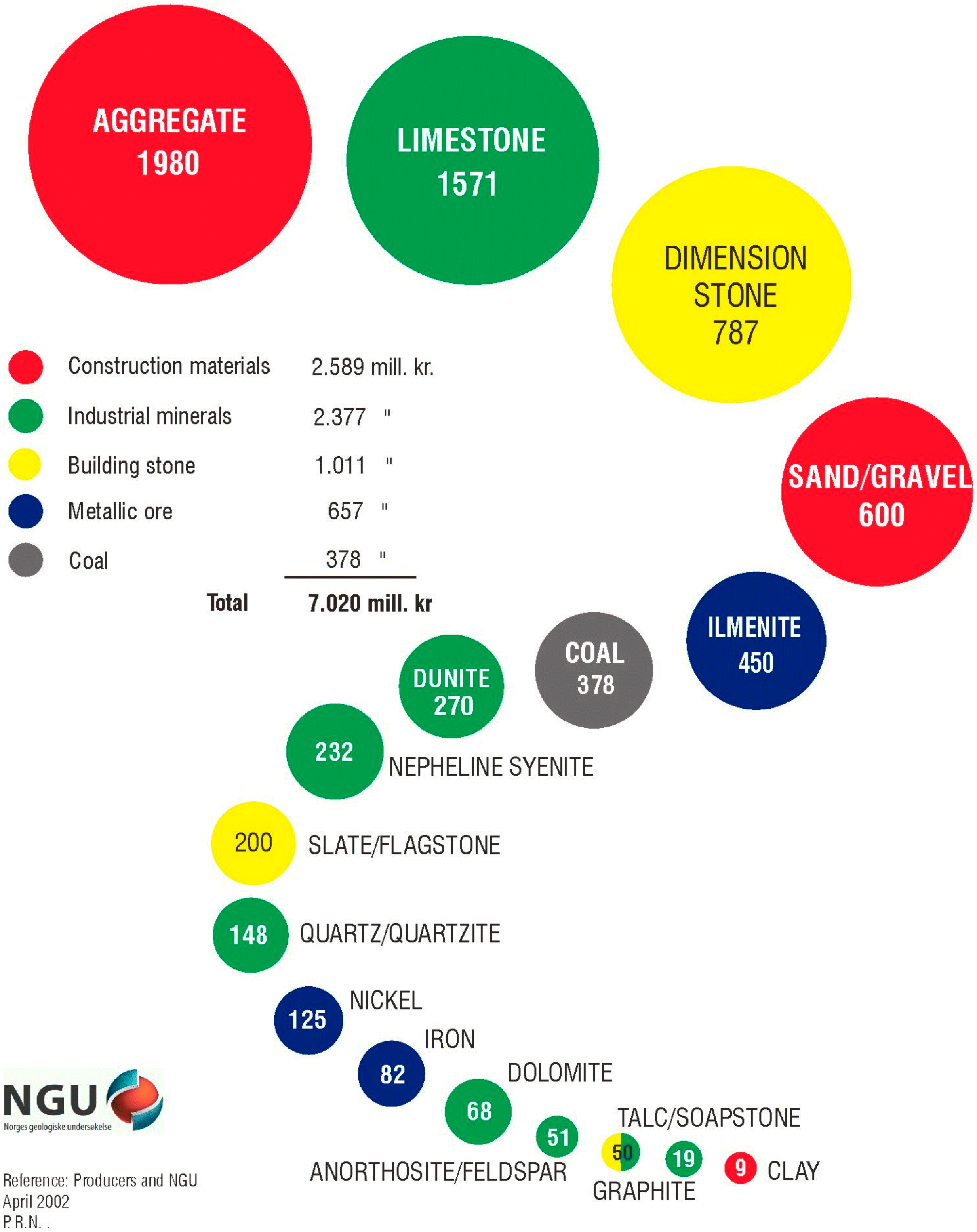
Annual aggregate production is currently of the size order of 36 million tonnes, sand and gravel near 15 million tonnes per annum, their total sum amount currently stabilizing. There is an increasing tendency towards crushed material to replace sand as sand deposits are diminishing. Limestone production is around 8 million tonnes per annum including dolomite (some 10wt%), quartz plus quartzite are well over 1 million ton, clay production is over 0.4 million tonnes, and dimension stone for building purposes lays at 0.25 million tonnes per annum. General production data on mineral materials and commodities are presented in the snake figure on the next page. Nota bene: monetary amounts have to be divided by 7.37 to convert from NOK to EUR (€).

Production is adjusted to demand and resources are virtually unlimited, hence it is difficult to provide a target in definite numbers. However, like any other business, aggregate industry aims at a few percent of growth per annum. Moreover, the aggregate industry is willing and able to meet large demands, and the opportunities to open new quarries to meet really large demands or specific requirements are there.

The snake graph on the next page portrays annual production data in million Norwegian kroner, for the most important mineral products. Figures are collated from production data as stated by their respective producers (mostly several per product). The size of each dot refers to production volume, its color to the type of material. Obviously, quartz/quartzite are reckoned as industrial minerals, not as construction materials.

# PRODUCTION OF NORWAY'S MOST IMPORTANT MINERAL PRODUCTS

(2001, FOB, MILL. NOK )




All numbers are in million Norwegian kroner. Note that quartz/quartzite is reckoned as an industrial mineral, and not as a construction material in the first place!

# 5 Meeting demand for primary raw materials

## 5.1 Current policy and strategy

Production is adjusted to demand and resources are virtually unlimited, hence it is difficult to provide a target in definite numbers. However, like any other business, aggregate industry aims at a few percent of growth per annum. Moreover, the aggregate industry is willing and able to meet large demands, and the opportunities to open new quarries to meet really large demands or specific requirements are there. Up-to-date information can be obtained at *www.ngu.no/grusogpukk*.

## 5.2 Policy under development

Presently, no policies addressing the issue of demand-production are under development. Authorities and instances like the Directorate of Mining and the Norwegian Industrial and Regional Development Fund (SND) are most helpful to help develop starting enterprises and/or operations through their wide knowledge and acquaintance networks. The latter instances are at the forefront of policy developments and will be able to inform those interested, as well to provide contacts.

# 6 Substitution of raw materials

## 6.1 By secondary and recycled raw materials, current policy

Current policy is first and foremost aimed at increasing the use of recycled materials in both bound and unbound applications. National guidelines for bound application of recycled material have been published a few years ago and are permanently critically re-examined [Mehus et al 2000, and references therein]. New rules for new (bound) applications will be developed in concert with developing demands.

In contrast, guidelines for unbound application of recycled materials are lacking, even though this is generally prospected to be (or become) the most important application by volume. Preliminary results from research projects are promising, and some local authorities (ie., municipality of Oslo) allow use of recycled aggregate material on a general basis, if and only if written proof of its suitability for the use as intended can be provided [Mehus et al 2000].

For example, concrete may under certain conditions contain up to 30wt% of recycled material, depending on desired strength and quality of the concrete and the quality of the (recycled) aggregate. This requires however that the recycled-material-to-be is tested prior to demolition of the old structure.

Higher replacement grades than 30wt% with recycled coarse material are only allowed with the application of specialized mix design rules, and with restrictions to final design strength of the new concrete. Finally, when recycled old concrete is used for aggregate in new concrete, the material is regarded as susceptible for a deleterious alkali-silica reaction (ASR) if not documented otherwise.

## 6.2 By secondary and recycled raw materials, policy under development

In daily building and construction practice, only a few percent of secondary and/or waste materials are actually recycled. The post-WWII building and construction boom of the last century will sooner or later translate in an increasing amount of building and construction waste material potentially usable for aggregate replacement. Modern and durable structural design more and more aims for an extended service-life to 30-100 years, and for large coastal works, hydropower plants, major road and transport structures up to 200 or even 300 years, depending on the type of application.

Currently, there are no official agreements between parties to restrict waste material in building and construction, including demolition. Several branch organisations gathered in the Resiba project [Mehus et al 2000] have initiated a program to develop procedures to secure proper handling of (hazardous) waste, to reduce its amount, and for enhanced separation at the source. The program contains clear targets for recycling of different waste types and fractions.

## 6.3 By renewable raw materials, current policy

The market for renewable materials is large: Norwegian housing construction is traditionally in (juvenile) wood, though apartment buildings and condominiums in urbanized areas are typically constructed in concrete. Nevertheless, also the building process itself uses quite an amount of wood that is as a rule usually separated from other waste materials at the construction site.

Waste wood could easily be chipped, but unfortunately for the recycling industry, the production and availability of 'juvenile wood chips' from the well-established wood industry is so high that there is as good as no market for 'recycled wood chips', which are therefore incinerated for power production. Some waste wood is not suitable for recycling as it contains heavy metals (typically As, Cr, and/or Cu) intended for preservation (by eg. the Wolman process).

## 6.4 By renewable raw materials, policy under development

It is prospected that the total amount of waste wood will greatly increase in the years to come, and that the proportion of heavy metal-containing wood will increase disproportionately. Current and coming legislation would have to provide rules to deal with an evolving situation. Presently, no such policies are under development.

# 7 Other relevant policy

Many data on other relevant policy issues can be found in literature, but much of it is 'reading between the lines', as stated by their authors [Mehus et al 2000, Torsen et al 2002]. Additionally, the guidelines thus provided are very general as details are filled in by local authorities to best suit local demands. In a country as large as Norway, government is necessarily very decentralized, and local authorities are autonomous. At the same time, this is a serious disadvantage in introducing one uniform detailed national policy.

### *7.1.1 The environmental impact assessment (EIA)*

In order to obtain the development plan and the planning permission the applicant must first go through the environmental impact assessment (EIA) process. In Norway, the EIA-process is not a permission as such and does not give any legally binding conditions towards the developer. The EIA process is meant to safeguard that the necessary information is available for the planning authorities when they are giving the necessary permits. The EIA process in Norway ends up with an environmental impact statement as well as a final statement from the authority conducting the process. In Norway the Directorate of mining conduct the process. The statement is not only supposed to show the impact from the proposed project but it shall also point out important mitigating measures.

The EIA process is in two stages. First the applicant must submit a preliminary report. This report is sent on a hearing, and based on the answers from the different authorities and Statens Kartverk (the national map agency), a program for the final environmental report is set. The final EIA-report is then sent on a new hearing and even now the Directorate of mining may ask for more information. Based on the outcome of the report together with the answers gathered during the hearings, the Directorate gives its final statement in the matter.

When the Directorate gives its final statement the project may commence into the next phase, which are the development plan and the planning permission. The EIA is a time consuming process. Theoretically the EIA may be done in 12 months time, however, practice has learned that one should not bet on less than 18 months and it may very well take as much time as two years before an assessment study is finalized and completed.

### *7.1.2 The pollution control act*

The emission of noise and dust from the quarry are considered environmental pollution. Therefore, the quarry must obtain a concession to pollute. Again this process may to some extent go on parallel to the process of EIA and to the process of getting the planning permission. In some rare cases, the lack of getting a concession to pollute has put a stopper on projects. In such cases the resistance against the project from neighbours and non governmental organisations usually will be quite high. The turning down of a pollution concession will rarely come as a big surprise on the applicant. The pollution concession may take 6 months and up.

### *7.1.3 Other permissions sine qua non*

According to the Cultural heritage act § 3 it is forbidden to damage, destroy, move or cover so-called "automatically protected sites". These are sites from before the reformation of the Norwegian church in 1537 AD. If there are automatically protected sites in the area where the quarrying is to take place, it is possible to obtain permission to go ahead from the appropriate authority dealing with the site, as a rule the regional archaeological museum. A permission to go ahead in spite of an automatically protected site normally requires an excavation financed by the mining entrepreneur to survey the contents of the site, to secure no important founds are lost.

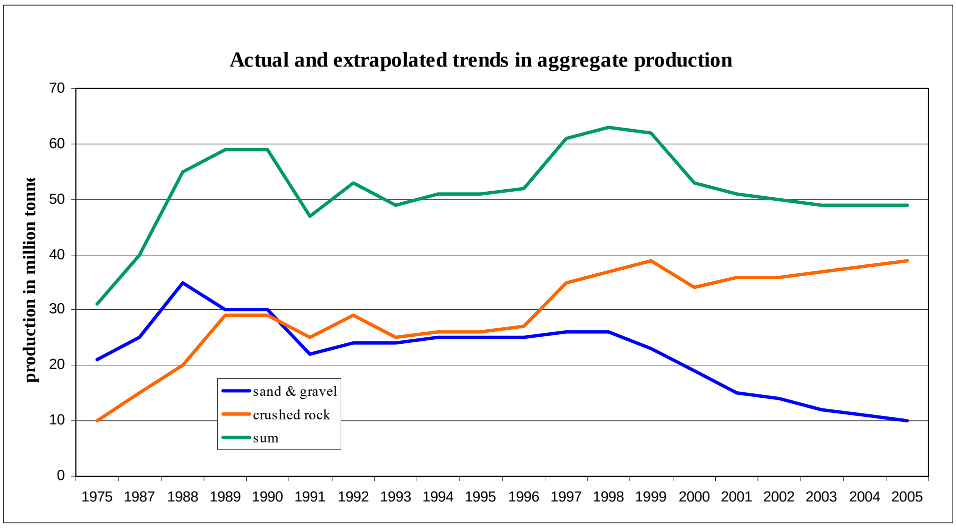
Even if there is no known automatically protected site, the mining entrepreneur is legally obliged to find out whether the proposed work may affect any unknown sites, prior to any further activities.
If there is/are important automatically protected site (-s) in the area of interest, this may even put a full stop on the project. If protected sites are around or near, the process of clearing the area according to the cultural heritage act may take up to one year, if not, this time may be reduced to 3-4 months.

# 8 Mineral planning system

## 8.1 Projection methods to determine future demand

For Norway as a whole, future demand is determined through extrapolation from production graphs over the last two decades, which provide excellent general trend lines. However, short-term variations (like eg. the so-called '911 effect') can of course not be predicted. Individual aggregate producers use a similar procedure, based on individual production numbers. Generally, annual production is still governed by demand.

The extrapolated trend in the graph on the preceding page is put together after extensive phone interviews and analysis of questionnaires with the 13 most populated provinces in Norway. Then, per capita production numbers were calculated from annual production numbers and recalculated to project trends for the whole of Norway. The final outcome was then translated in the graph presented.



## 8.2 Geological survey system

The Geological Survey of Norway is nationally responsible for all geological mapping, including mapping of potential extraction sites for industrial minerals and building and construction materials. Detailed analysis of a potential site may be done by NGU as well, however, this is often done by a specialized department of the company interested. Additionally, NGU is responsible for hosting and maintenance of the national databases on mineral resources which are freely accessible through the internet for all those interested (*www.ngu.no/grusogpukk*).

NGU actively cooperates with local authorities to select and assess potential sites for future coastal (super) quarries. NGU has started mapping the best suited areas along the Atlantic coast line from Vest Agder in the South to Troms up north. The main objective is to identify the economically and environmentally most interesting areas, in an on-going collaboration with local planning agencies. Selection criteria include:

- local area plans allow for mineral extraction,
- located directly at, or in the direct vicinity of the coast,
- available infrastructure and distance to potential markets,
- natural harbor with negligible tidal movement,
- satisfactory rock quality and sufficient resources,
- maximum feasible production tonnage.

Central and northern Norway have been included to also cover the eventuality of aggregate export to the American east coast along a great circle route. Indeed, some leading aggregate producers in the USA have inquired already.

Results from surveys are laid down in assessment reports, and from some promising localities, extensive modeling studies have been made, providing insight to local authorities what their quarry site may look like after extraction is finished.

## 8.3 Spatial planning system

Documents specifying spatial planning details are available at the offices of the relevant municipalities. Thus, information is very decentralized on the one hand, but on the other hand, once they have been located one can deal directly with the people who determined the spatial planning (policy and strategy) for the area of interest.

Spatial planning may start with acquisition of land, by staking of claims. By law, any minerals with a specific gravity of $5 kg \cdot l^{-1}$ or higher are owned by the state of Norway; these are called ‘claimable’. All other minerals are hence ‘non-claimable’, with the exceptions of titania (rutile, anatase, brookite, all other $TiO_2$-modifications), arsenic, and quartz ($\alpha$-$SiO_2$). Special rules also apply to limestone (ie., limestone *sensu stricto*, marble, dolomitic limestone and dolomite), and quartz (ie., quartz crystal, crystalline quartz, and quartzite). The reader is also referred to paragraph B3 above which contains a listing of applicable law acts.

Any Norwegian legal entity (ie., a live person or a company) or EU-citizen has the right to stake a claim. All others may register a Norway-based company and stake claims on its behalf. However, prior permission for prospecting must first be obtained from the owner of the area.

A staked-out claim (initially called a ‘preclaim’) gives the claimholder the right to examine the claims’ potential for extraction for seven years. During that period there is no obligation to financial expenditures on the preclaim. For ultimate convenience, claims can even be staked out on a map and be filed by mail to the Directorate of Mining in Trondheim. They can also provide further information on subsequent procedures to follow.

The industry must therefore take into consideration the time consuming process ahead when planning for new resources. The legal gestation of a project is often a very costly process with a considerable risk of loss. The time spending alone represents a significant cost. The making of an environmental impact assessment, the application for the necessary permissions is often very costly. It is often necessary with a considerable amount of geological knowledge at this stage. If the planning authorities are to weigh quarrying/mining against other land use it is necessary to show the size and value of the deposit in order to obtain the permission. Core drilling and geological exploration work costs money and the industry may be forced to spend this money without any security of the outcome of the permission process. This is sometime seen to create a catch 22 situation. On the one hand, the industry is reluctant to spend any money on exploration/preparation of necessary information without any security for their expenditures. On the other hand the authorities need for the necessary information on the land use value of the deposit as a project in order to give the permission.

### *8.3.1 The planning process*

If handled correctly the planning process is going on parallel with the EIA process. The hearing and handling of the Environmental Impact Report may go parallel with the compulsory hearings in the planning process. If this is done it should be possible to get the planning permission within 6 month *after* the EIA has been completed, and the final verdict of the Directorate of Mining has come in. Because of the nature of mineral excavations this is however rarely the case. The planning permission in Norway consists of the planning stage where the area is designated to the proposed utilisation, and the building permission stage where the final permission to actually go ahead is given.

Norway has four planning levels. Three of the planning levels are legally binding. The levels that are important for the mineral industry include the land use part of the municipal master plan where the different areas are designated, and the local development plan where the different land uses are zoned. In addition, Norway has a building development plan, though this is hardly ever of application for mineral development. The planning process with its EIA is the most crucial stage in the legal gestation process of a mineral excavation in Norway.

In the end, it is the municipality that gives permission for mineral extraction. The planning permissions are given at a policy level. It is not necessary for the municipality to go through all of the planning levels in order to give the final plan; instead, the municipality may refer directly to the local development plan.

If the county municipality, neighbouring municipality or national sector authorities which area is affected by the plan submits a formal objection against the plan, the municipality may not issue the local development plan themselves. The plan is then submitted to the Ministry for the Environment who officially issues the plan as originally proposed by the municipality, or with the adaptations the Ministry deems necessary. Alternatively, the Ministry may also choose to reject the plan. If there is any objection to the initial plan and the plan has to be submitted to the ministry, then the process is easily delayed with at least one year.

When the local development plan is issued, the question of whether to quarry or not is almost resolved. Though under certain conditions it may be necessary to obtain permission according to the building planning act as mentioned earlier, this should not pose a problem once the local development plan has been rewarded.

### *8.3.2 The length of the legal gestation period*

The total period of time from the start of the EIA process until final permissions needed in order to commence with the quarrying have been issued will differ for each case. Typically, a period of 18-24 months is needed in order to get a complete EIA-study through the system, and another 6-12 months to acquire the rest of the essential permissions. The total time span needed would in most cases be between 2-3 years. However, if the project receives much dispute it may take several years longer to parry all opponents objections and find efficacious remedies.

In some unfortunate cases where the project is heavily disputed, authorities seem to get paralysed by their fear of making a wrong decision, resulting in a wait-and-see strategy. In several cases, this has led to loss of interest of the investor/entrepreneur, effectively killing the project before it had come to life. In some cases, a slow strategy may be followed with just this intent.

### *8.3.3 Conclusion for mineral planning*

The permissions that are needed according to the planning and building act of 14 of June 1985 are the most important permissions [see section B.3]. According to that act, it is necessary to acquire a development plan as well as a planning permission. The Mining Directorate will be happy to provide any details on the content and relevance of each act; it is considered beyond the scope of this report to give an exhaustive review of these acts. The permitting process of a quarry, sometimes a lengthy process with low transparency, is not special for Norway.

From a general point of view, Norway is not at all a particularly difficult country to operate in. In fact, it is quite possible to develop quarries in Norway, even is it encouraged by governmental development offices like SND (also see section B.1.3). And for topographic and geomorphological reasons, Norway is among the very few western European countries were it is possible to develop large coastal superquarries.

The process of obtaining the essential permits takes some time and there are some important ramps that should be taken in to consideration. If the overall view in a given municipality is negative towards developing a quarry in the area, one should probably not try to develop the project. It is also smart to run a local social research project, in order to try and find out weather or not the area is more controversial for development of a quarry than usual. This should provide the developer with a pretty good picture on whether it will be feasible to obtain the necessary permissions.

The examinations conducted on a preclaim must be collated into a report for a formal claim application, provided the existence of claimable minerals that could get mined within a reasonable time span has been confirmed. The Directorate of Mining will then issue a non-discretionary claim. The claim owner then has ten subsequent years to obtain a mining concession, for which he has to provide a statement on the economic feasibility of the claim deposit as well as his own qualifications to actually mine it.

Once the mining concession has been issued, the claim holder is responsible to have the environmental impact officially assessed in a EIA-study, which has to be submitted to the Directorate of Mining for review. Typically, this entire procedure takes 2-3 years. Finally, planning permission may be issued by the municipality.

In conclusion, if the developer decides to go ahead with the project he should at least have a 4 year perspective on the development. To the entrepreneur with a currently operative quarry running towards the end of its extraction period to start the project of expanding the boundaries of the quarry at least 3-4 years prior to exhaustion [Dahl et al 1999].

# 9 Taxes, legal dues, fees, premiums

No taxes apply to the produced material itself. During the development phase of a potential extraction site, certain investment and taxation incentives may apply. Details can be obtained at the Norwegian Trade Council SND, as taxes, exemptions and/or premiums may differ per region and/or municipality.

# 10 Enforcement

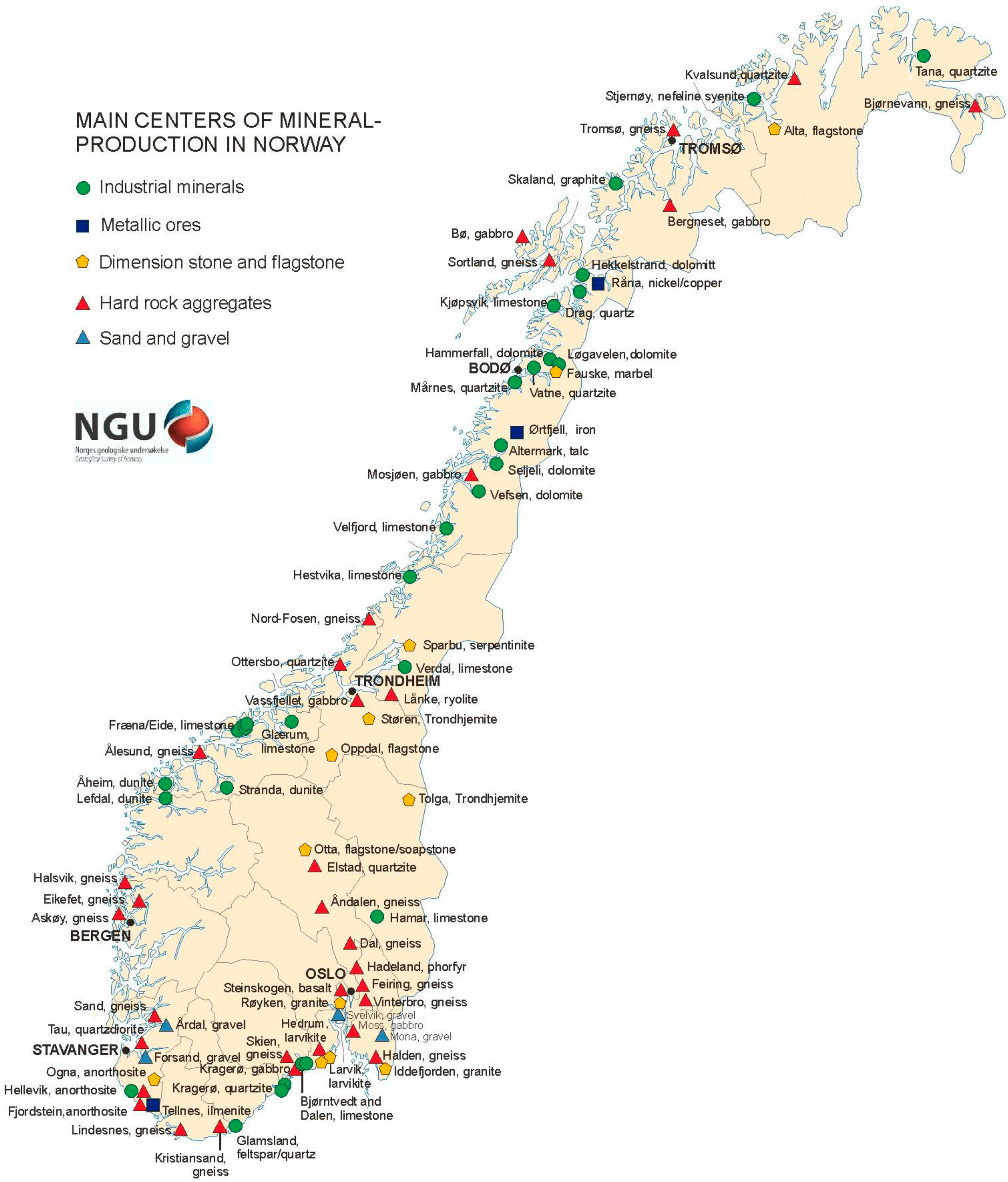
The third power in the state of Norway is the judiciary. Political and civil rights are guaranteed by the constitution. The judiciary power is headed by the Supreme Court, consisting of five judges. Additionally, there are communal and municipal courts [liberal after Hogarth 1993]. Law enforcement is taken care of by police and/or several other instances, depending on the issue as seen from a judiciary viewpoint. Thus, eg. financial issues are taken care of by a different body than eg. environmental issues.

# 11 Restoration practices, use of former extraction sites

Building and construction waste may alternatively (ie., to recycled use) be stored at landfill sites. Details on restoration of former extraction sites can be obtained from local authorities, due to differences in local policies. Remember that Norwegian local authorities are largely autonomous. In some cases, former extraction sites have been put into use for residential building, eg. Bergheim Amfi in Trondheim [*www.bergheimamfi.no*].

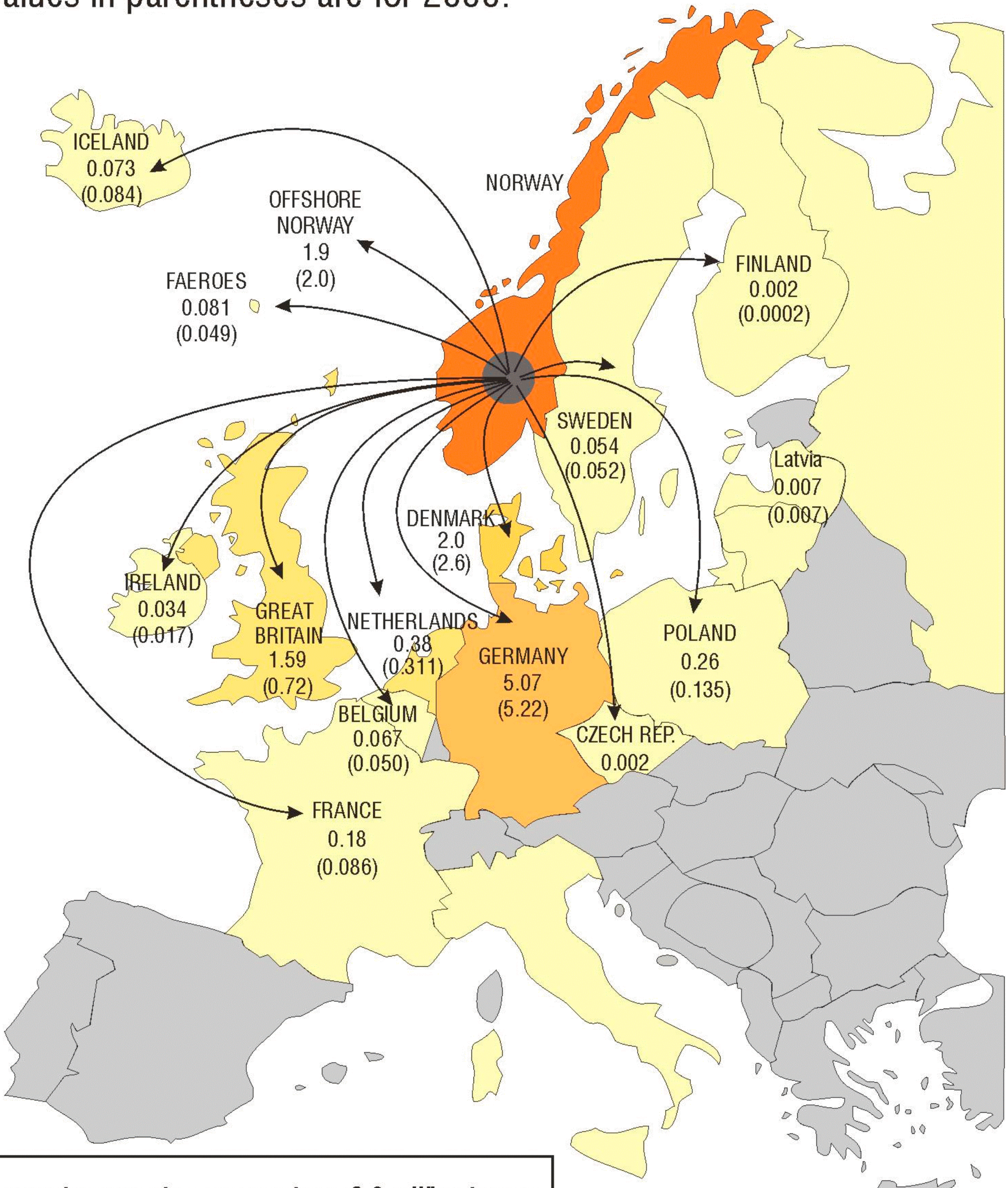
# C. Market for primary raw materials

Below is a map showing the main centers of mineral production in Norway. Large extraction sites are concentrated along the coast (fjords) or near other main waters (lakes, rivers) for easy access and transport of material produced.



# NORWEGIAN AGGREGATE EXPORT IN 2001

Total production 11.7 million tonnes, total export 9.8 million tonnes, including sand and gravel, crushed rock and armourstone.
In addition 1.9 million tonnes aggregate for offshore applications.
Values in parentheses are for 2000.




**export aggregate+armourstone: 9.8 million tonnes**
**(of which sand+gravel: 0.27 million tonnes)**
**export value: 425 million NOK/54 million EUR**
**off-shore ballasting aggregate: 1.9 million tonnes**

NGU
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## *NOTA BENE!*

All data in the tables presented on the following pages have been collated from Statistisk Sentralbyrå (*www.ssb.no*) and the mineral resources databases from the Norges Geologiske Undersøkelse. The part containing data on aggregate and building and construction materials is already accessible for all at *www.ngu.no/grusogpukk*; other NGU-databases are currently being adapted for web access and will be published within short.

| C.1 | **Coarse sand, gravel and crushed rock** | **in $10^6$ tonnes, for 2001** |
|---|---|---|
| *1* | *Annual demand in Norway* | *40* |
| | for unbound use (included) | 14.7 |
| | for concrete aggregate (included) | 24.5 |
| | for offshore ballasting etc. (not included) | 1.9 |
| *2* | *Export* | *9.8* |
| | Belgium | 0.067 |
| | Denmark | 2.0 |
| | Czech Republic | 0.002 |
| | Fær Øer | 0.081 |
| | Finland | 0.002 |
| | France | 0.18 |
| | Germany | 5.07 |
| | Iceland | 0.073 |
| | Ireland | 0.034 |
| | Latvia | 0.007 |
| | The Netherlands | 0.38 |
| | Poland | 0.26 |
| | Sweden | 0.054 |
| | United Kingdom | 1.59 |
| *3* | *Import* | *0* |
| *4* | *Total annual production* | *51.7* |
| *5* | *Small-scale extraction for regional use* | |
| | Currently, there are 802 small companies owning 4700 quarries altogether | |
| *6* | *Large-scale extraction* | |
| | There are some 40 companies each producing over 0.25 million tonnes annually | |
| *7* | *Marine dredged material* | *0* |
| *8* | *Trends* | |

Over the last two decades, the production of coarse sand, gravel and crushed rock has gradually diminished, with an upward bump centered around 1997. This decrease can be attributed to the fact that no large drilling/production rigs (like the famous Troll) have been constructed since 1998, and that those that have been constructed are built of steel.

The amount of concrete (and thus of aggregate material) involved in construction of oil rigs is illustrated by the fact that when oil rigs were still built of concrete, Norwegian concrete production *per capita* exceeded that of the Netherlands by a factor of around three.

Nowadays, concrete production is in essence limited to road and housing construction and maintenance as no truly sizeable construction projects are currently running or scheduled. Though the main trend is still a decreasing one, it seems that the decrease stabilizes.

| 9 | *Market structure* | |
|---|---|---|
| The market for primary raw aggregate materials in Norway consists of some twenty larger aggregate producers mainly concentrated in or near urbanized areas and operating large quarries, and a huge number of smaller and tiny producers operating smaller and tiny quarries to cater local demands, even down to individual household scale.<br><br>The gravel and crushed rock-database ([http://www.ngu.no/grusogpukk](http://www.ngu.no/grusogpukk)) provides production and quality data (including Los Angeles value, polished stone value, and density) for almost 9000 quarries, of which the larger are also reported in the annually upgraded NGU-report [eg. Neeb 2002b]. Some of the larger aggregate quarries are owned by building and construction companies, that may very well own several quarries. Depending on the desired quality of the extracted material, export may be planned from one quarry or another. All of the companies listed below follow that policy. | | |
| 10 | *Exporting quarries* | *tonnage exported* |
| | Norsk Stein A/S | 2.8 |
| | Amrock JV A/S | varying; each from 0.25-1.0 |
| | Bremanger Quarry A/S | |
| | Franzefoss Pukk A/S (export until 2002) | |
| | Gudvangen Stein A/S | |
| | Halsvik Aggregates A/S | |
| | Hyllestad Pukk A/S | |
| | Juve Pukkverk A/S | |
| | Kolo-Veidekke A/S | |
| | KS Norwegian Edelsplit | |
| | NCC Råstoffer | |
| | NorStone | |
| | Oster Grus og Pukk | |
| | Stema Shipping Norway | |
| | Viken Pukkverk A/S | |
| 11 | *Remarks* | |
| Reference [Neeb 2002b] contains a valuable and regularly updated listing of exporting quarries. | | |

| C.2 | **Limestone and dolomite (including marble)** | **in $10^6$ tonnes, for 2001** |
|---|---|---|
| *1* | *Annual demand in Norway* | *4.3* |
| | for cement | 2.51 |
| | for environmental applications | 1.8 |
| | (for building and construction: see table C.1) | (0.10) |
| *2* | *Export* | *2.01* |
| | slurry and filler applications, export to virtually every country in the world | |
| *3* | *Import* | *0* |
| *4* | *Total annual production* | *6.31* |
| *5* | *Small-scale extraction for regional use* | *(0.10)* |
| | for use within the quarry | 0.01 |
| *6* | *Large-scale extraction* | *6.20* |
| | around 20 major companies, only a few exporting | |
| *7* | *Marine dredged material* | *0* |
| *8* | *Trends* | |
| Norway has become an important player in the production of limestone and dolomite, especially for filler purposes. The Hustad Group listed below has recently opened a new quarry in Velfjord in Nordland County. The entire Hustad Group production goes to Hustad Marmor A/S in Fræna in Møre og Romsdal County, making it the worlds largest producer of limestone filler for the paper industry. However, only a very small portion of the produced volume is used for aggregate material, basically for local (ie., in-quarry) use only. Irrespective of this, by far the most limestone is produced for cement making. Therefore, the general trend over the last two decades is definitely affected by the decreasing trend for aggregate materials due to the ceasing construction of large oil rigs and platforms. However, this decreasing effect is at least flattered by the increasing production of limestone filler. | | |
| *9* | *Market structure* | |
| Nearly 40wt% of the total limestone production is used to make clinker and cement within the country, a little over 30wt% is exported for limestone slurry and paper filler applications, and slightly under 30wt% is used to produce quicklime and lime for agricultural applications. The very small remainder (a few percent only) represents the material for own use in the quarry.<br><br>Though limestone/marble has been used in building and construction in the early post-WWII years, its use for concrete aggregate has always been and still is a rare exception. Use of limestone for concrete aggregate was more or less common around Oslo as well. Specifically to avoid deleterious ASR, limestone was used in a ship loading and mooring quay in Ålesund. | | |
| *10* | *Exporting quarries* | *tonnage exported* |
| | Hustad Group (limestone slurry) | together >5.0 |
| | Franzefoss Kalk A/S | |
| | Norwegian Rose A/S (dimension stone) | |
| | Verdalskalk A/S | |
| | Visnes Kalk A/S | |
| *11* | *Remarks* | |
| None. | | |

| C.3 | **Silica sand (ie., quartz arenite & quartzite)** | **in $10^6$ tonnes, for 2001** |
|---|---|---|
| *1* | *Annual demand in Norway [Hugaas/ELKEM pers.comm. 2002 with Wanvik]* | *ie., ~0.0001* |
| | (for building and construction: included in Table C.1) | |
| *2* | *Export* | *1.29* |
| | for production of ferrosilicium or Si-metal | 1.24 |
| *3* | *Import* | *0* |
| *4* | *Total annual production* | *1.29* |
| *5* | *Small-scale extraction for regional use* | *0.05* |
| | for use within the quarry | |
| *6* | *Large-scale extraction* | *1.29* |
| *7* | *Marine dredged material* | *0* |
| *8* | *Trends* | |

The production of silica sand as in the Dutch sense for building and construction purposes is included in the data for 'sand, gravel and crushed rock' in Table C.1. In Norway, these materials are not further specified.

The production data presented above are for silica sand from finely crushed quartz and/or quartzite. This high-purity material is not intended for building or construction purposes but for the refinement of $SiO_2$ to ultrapure native Si (commonly -but in fact erroneously- dubbed 'Si-metal') for the semi-conductor and chips industry. Less pure grades are intended for the manufacture of crystalline Si for solar cells.

The major boom in silica production for ultrapure semi-conductor Si started with the introduction of the personal computer by IBM in the early 1980's. The popularity of the pc in the subsequent years sent the demand for ultrapure silica soaring skywards. Today, almost 80% of all semi-conductor Si is produced from Norwegian silica, meaning that roughly four-fifth of the chips of an average pc contain a piece of processed Norwegian rock. Most of the rest is of Brazilian origin.

The market for personal computers is still growing as new applications are being developed, but it is no longer booming. It is characterized by replacement/sustenance of the existing computer base rather than completely new installs. Growth is to be attributed to the ongoing penetration of chips in device control units in daily life, ie. the increasing computerization of common household appliances like the obvious microwave ovens, tv sets and cordless phones, but also including toasters, light dimmers and timer switches, and 'thinking fridges'.

Specialty applications for high-speed or other chips increasingly rely on other semi-conductor materials than ultrapure Si, like eg. GaAs, GaInP, and some others. In addition to these inorganic materials, more and more chip manufacturers find ways to produce circuits and chips from organic materials.

It is hard to predict whether any of these alternative semi-conductor materials will overwhelm the use of Si, but nobody had foreseen the popularity of the electronic computer in the early 1950's either. It was then estimated that maybe five (and perhaps even six!) major leading institutions in the world would eventually own computers, ie. *one each*. However, practice has proven different, with a pc on virtually every single desktop. Further down the time-line and soon to leave the experimental stadium are optical computers, which may need ultrapure silica (together with other optical materials) for their internal communication pathways.

| | | |
|---|---|---|
| *9* | *Market structure* | |
| For this type of silica sand there is not really a local market here in Norway; rather, it is a global market. Owning a 15% share of that market, main producer of ultrapure Si is Elkem, who also produces ferrosilicium and other Si-containing alloys, microsilica for application in concrete, silicone, all fitting to the more general denominator 'silica for chemical, electronic and aluminium industries'. | | |
| *10* | *Exporting quarries* | *tonnage exported* |
| | Elkem Tana quarry | not specified |
| *11* | *Remarks* | |
| Once more, this type of silica sand is not intended for use as a building and construction material. Sand for that purpose is already included in Table C.1.<br><br>Silica produced for the glass industry is only a minor quantity (say, on the order of ~100 tonnes); for foundry sand olivine is used rather than silica [Hugaas/ELKEM pers.comm. 2002 with Wanvik; also see snake Figure on annual mineral production on page 18]. | | |

| **C.4** | **Clay** | **in $10^6$ tonnes, for 2001** |
|---|---|---|
| *1* | *Annual demand in Norway* | *0.044* |
| *2* | *Export* | *0* |
| *3* | *Import* | *0* |
| *4* | *Total annual production* | *0.044* |
| *5* | *Small-scale extraction for local use* | *0.044* |
| | for production of bricks and tiles, some of which for ornamental purposes | |
| *6* | *Large-scale extraction* | *0* |
| *7* | *Marine dredged material* | *0* |
| *8* | *Trends* | |
| Norway has always been self-supportive with its demand for clay. The entire production is used to make (refractory) bricks, and tiles for local use. Traditionally, Norwegian building and construction in urban areas is done with concrete and a lot of timber, in less urbanized and/or rural areas mostly with timber and some concrete. Bricks are comparatively rare in Norwegian building, though some ready-made bricks are imported, mainly from Denmark.<br><br>National clay resources are in principle large as much clay was deposited during and after the last Ice-age. The subsequent uplift due to the crustal rebound after removal of the icecap exposes these clay deposits, typically at the far end of fjords. However, this clay is of marine origin and contains a substantial amount of salt, negatively affecting its properties for brick production. It also restricts its use for building and construction substratum as the salt-rich clay may act as quick-clay: solid if untouched, liquid when stirred. | | |
| *9* | *Market structure* | |
| Oslo-based producer Optiroc claims to have a 90% market share. The same (international) company also imports some bricks. Currently, there is no clay being exported from Norway, nor is such scheduled for the near future. | | |
| *10* | *Exporting quarries* | |
| None. | | |
| *11* | *Remarks* | |
| Some of the clay is used for artistic purposes due to its particular color play when baked, for the trace metals present. | | |

| C.5 | **Filling materials** | **in $10^6$ tonnes, for 2001** |
|---|---|---|
| *1* | *Annual demand in Norway* | *not specified* |
| *2* | *Export* | *not specified* |
| *3* | *Import* | *not specified* |
| *4* | *Total annual production* | *not specified* |
| *5* | *Small-scale extraction for regional use* | *not specified* |
| *6* | *Large-scale extraction* | *not specified* |
| *7* | *Marine dredged material* | *not specified* |
| *8* | *Trends* | |
| The reader is referred to Table C.1 for sand, gravel and crushed rock. | | |
| *9* | *Market structure* | |
| The reader is referred to Table C.1 for sand, gravel and crushed rock. | | |
| *10* | *Exporting quarries* | |
| The reader is referred to Table C.1 for sand, gravel and crushed rock. | | |
| *11* | *Remarks* | |
| The reader is referred to Table C.1 for sand, gravel and crushed rock. | | |

# D. Market for secondary and recycled materials

| D.1 | **Construction and demolition waste** | **in $10^6$ tonnes, for 1998** |
|---|---|---|
| 1 | *Annual demand in Norway* | *1.54* |
| 2 | *Export* | *0* |
| 3 | *Import* | *0* |
| 4 | *Total annual production* | *1.54* |
| 5 | *Small-scale extraction for regional use* | *1.54* |
| | Østfold | 0.864 |
| | Akershus | 0.1124 |
| | Oslo | 0.2338 |
| | Hedmark | 0.0941 |
| | Oppland | 0.1111 |
| | Buskerud | 0.0744 |
| | Vestfold | 0.0938 |
| | Telemark | 0.0562 |
| | Aust-Agder | 0.0339 |
| | Vest-Agder | 0.0372 |
| | Rogaland | 0.1409 |
| | Hordaland | 0.1271 |
| | Sogn og Fjordane | 0.0214 |
| | Møre og Romsdal | 0.0815 |
| | Sør-Trøndelag | 0.0509 |
| | Nord-Trøndelag | 0.0599 |
| | Nordland | 0.0554 |
| | Troms | 0.0580 |
| | Finnmark | 0.0154 |
| 6 | *Large-scale extraction* | *0* |
| 7 | *Marine dredged material* | *0* |
| 8 | *Trends* | |

For brevity, construction and demolition waste is dubbed C&D waste. More recent data are currently not available.

The production of secondary and recycled materials in Norway appears low as compared to other countries, including eg. the Netherlands and adjacent Belgium, bordering in the south. Comparing this with population numbers, this implies that Norwegian recycling per capita is significantly lower indeed, and that the recovery rate of C&D waste (calculated as the ratio of produced over recycled waste ×100%) is low too, around 11% overall.

Of the entire amount of C&D waste produced, 62% stems from demolition, 24% from renovation and rehabilitation, and 14% from new building and construction activities.

The average composition of the final product ‘recycled C&D waste’ from one major producer is stated to contain 46% concrete, 37% ‘stone’ lacking further specification, 8% bricks and tiles, 8% asphalt, 0.5% organic material (eg. plastic, paper, timber), and 0.5% other materials including glass and metal [Mehus et al 2000]. It remains unclear whether these percentages represent data by weight or volume. The same producer has experimented with blending in more asphalt, up to 10%, but this was received negatively by the market [Mehus et al 2000]. Main conclusion is that recycling apparently does not include separation of different materials,

| | |
|---|---|
| a prerequisite elsewhere.<br><br>It is expected that recycling and re-application of C&D waste will gradually increase. Most probably due to the lack of separation of the diverse constituents, the final product is generally regarded as an inferior material only suitable for low-grade applications. Separation into individual constituents would be a major enhancement towards acceptation of recycled waste as a sensible, suitable and economical building and construction material.<br><br>New national guidelines to aid in market acceptation of the material are currently under review. Anyway, re-application of crushed concrete as aggregate material in new concrete is limited. Current British standards classify the material as among those with the highest ASR-hazard potential. | |
| *9* | *Market structure* |
| The largest producers/recycling facilities are located in 'Great Oslo' and include the counties of Akershus, Oppland, Vestfold, Østfold, and Hedmark. This vast area is the most urbanized in the whole country, explaining its relatively high waste production.<br><br>After the opening of the capitols' new main airport Gardermoen in early 2000, the old airport Fornebu located within the city limits is being demolished and transformed into a high-tech IT area. This process produces a substantial amount of recycled C&D waste, which is however not reflected in the provided production numbers as they are from before that date. The building and construction of Gardermoen airport of course had a major effect on the production of sand, gravel and crushed rock, but took place before 2001 and is hence no longer reflected in Table C.1.<br><br>Also the counties Rogaland and Hordaland along the Atlantic coast recycle considerable C&D waste. This can be attributed to the demolition of returned concrete oil rigs and platforms. | |
| *10* | *Exporting quarries* |
| None of application. | |
| *11* | *Remarks* |
| None. | |

| D.2 | Secondary and recycled materials | in $10^6$ tonnes for 1998 |
|---|---|---|
| *1* | *C&D waste* | *1.54* |
| *2* | *Asphalt waste (estimated)* | *no data* |
| *3* | *Dredged material* | *no data* |
| *4* | *Cleaned soil* | *no data* |
| *5* | *MSWI bottom ash (dry matter)* | *no data* |
| *6* | *MSWI fly ash* | *no data* |
| *7* | *Coal bottom ash* | *no data* |
| *8* | *Coal fly ash* | *no data* |
| *9* | *Blast furnace slag* | *no data* |
| *10* | *Steel slag* | *no data* |
| *11* | *Colliery spoil* | *no data* |
| *12* | *Other materials* | *no data* |
| *13* | *Trends* | |

Due to the combination of a vast available land area, large building and construction materials resources and the low population density, waste recycling is hardly an issue in Norway. This is reflected in the web-pages of Statistics Norway, where data on the above materials are virtually lacking, or at the very least impossible to extract or derive from other provided data.

Also, the referred-to project report "Use of recycled aggregate in building and construction - status 2000" (title translated) [Mehus et al 2000] hardly contains hard data on production volumes, though it is valuable for its other content.

It should be noted that the amount of colliery spoil is not merely 'large' but rather 'huge'. Collated annual production of new colliery spoil may be in the millions of tons, for some single projects even on the size order of 3-4 million tonnes (annually!). Depending on the nature of the mining activity, the spoil produced may be very different in quality, eg. grain size and shape, specific weight, mineralogical composition, abrasivity, etc.

One major example are the tailings heaps at Bjørnevatn, next to Kirkenes in the far north. They contain crushed leptitic gneiss which was won until a decade ago for iron ore. The material has been tested extensively to fulfill all requirements for use as concrete aggregate and/or road surface applications. The total resources at Bjørnevatn are on the size order of millions of tons, and are in principle ready for immediate transportation.

Another example is a quarry that has to be started up yet at Engebøfjellet east of Bergen, in an rutile-containing eclogite. To liberate the rutile ($TiO_2$, used eg. as paint pigment, or Ti-metal ore), the eclogite is crushed and ground, and the rutile is separated out by flotation or some other technique. The tailings (largely consisting of garnet and clinopyroxene) are in principle colliery spoil, but do have interesting and even useful mineralogical properties.

# E. Market for renewable raw materials

| **E.1** | **Renewable materials: wood and timber** | **in $10^3$ $m^3$, for 2001** |
|---|---|---|
| *1* | *Annual demand in Norway* | *4515* |
| | for wood pulp, cellulose (not included) | (2787) |
| | for other purposes (not included) | (194) |
| *2* | *Export (~5% of total annual production)* | *387* |
| | export to mostly NW European countries | |
| *3* | *Import* | *194* |
| *4* | *Total annual production* | *4708* |
| *5* | *Small-scale extraction for regional use* | *not specified* |
| *6* | *Large-scale extraction* | *4708* |
| *7* | *Marine dredged material* | *0* |
| *8* | *Trends* | |

Since the late 1970's, overall production numbers for timber including wood for cellulose pulp, fire wood and other purposes have been fluctuating a little. Around 1980 and 1990, peak production was over 10000, and in between were production lows just under 7500 $10^3$ $m^3$. For the last decade, the overall production volume seems to have stabilized and was well over 7688 $10^3$ $m^3$ for the year 2000, of which roughly 40% was *not* intended for building and construction purposes.

Only ~5% of the total annual production (including production numbers for wood pulp, cellulose and other purposes) is exported, being some ~8.5% of the volume for building and construction. The intended use of the exported volume remains unspecified.

Currently, there is a downward trend in building and construction for residential family housing and, whereas condominiums and apartment buildings show an increase. The downward trend for construction of facilitary buildings (eg. schools, parking house) is counterbalanced by a slight upward trend by building for industry and storage. Generally, this implies that residential building and construction in concrete increases, whereas in timber it is going down. To some extent, this can be attributed to an ongoing urbanization process: timber residential houses are more popular in rural areas, concrete multi-family residences are more practical in urbanized realms.

| | |
|---|---|
| *9* | *Market structure* |

The demand-trend for building and construction timber largely reflects that of the housing building market. Thus, the market is dominated by local building and construction companies. Also, many companies offer complete housing construction kits that are also exported at some significant amount. Whether and where these export companies and their produced and/or exported timber volume are included in the statistics, is not specified.

| | |
|---|---|
| *10* | *Exporting producers* |

Not specified or no data available.

| | |
|---|---|
| *11* | *Remarks* |

None.

| E.2 | Timber for building and construction | 2000 | | 2001 | |
|---|---|---|---|---|---|
| | | # | $10^3$ $m^2$ | # | $10^3$ $m^2$ |
| *1* | *Total number of new residential houses* | *23446* | *3311* | *25331* | *3418* |
| | of which timber framed | *16615* | *2600* | *15744* | *2439* |
| | percentage of total | *70.9* | *78.5* | *62.2* | *71.4* |
| *2* | *Volume of timber per timber framed house* | *no data* | | *no data* | |
| *3* | *Volume of timber per house, other* | *no data* | | *no data* | |
| *4* | *Volume of other significant timber structures* | *no data* | | *no data* | |
| *5* | *Trends for timber versus other raw materials* | | | | |

Generally, increased environmental awareness has resulted in increased application of both renewable and recycled materials.

According to Norwegian building tradition, residential houses are constructed in timber, particularly in rural areas. Timber resources are vast on the entire Scandinavian peninsula and Finland and have always been available, which is why the timber framed construction tradition developed as it is. However, timber construction using traditional techniques (ie., not multi-layer, high-pressure welded beams, but single logs) puts certain constraints to the maximum height of a timber framed structure and the number of storeys that can be built.

Height constraints for construction are quite impractical in urbanized areas where space is key and extra space can be gained by simply adding more storeys. Thus, residential building and construction in concrete is more popular in these areas. Nevertheless, the overall percentage of timber framed residential houses is high: more than two-thirds. Included are: one-family houses, two-family houses, and houses in a row (2 or 3 storeys high). Condominiums and apartment buildings are included as constructed of concrete together with facilitary and storage buildings. Residential housing for more than two families are included in the statistics as 50/50 timber/concrete.

| | |
|---|---|
| *6* | *Other renewable materials used as raw building material* |

None.

# F. Know-how and research

## 1 Key players in research

Many of the current research on aggregate materials is coordinated by PGL, the national organization for aggregate producers, including those producing secondary and/or recycled material. PGL serves as a platform for exchange of knowledge and as the official (yet informal) meeting point between scientists and engineers from different branches and interests.

The Geological Survey of Norway is located in Trondheim, and has qualified personnel to identify, locate, and map new and potential occurrences of raw materials for building and construction and other purposes. Furthermore, the Survey owns facilities to characterize geomaterials, determine mechanical properties, geochemical compositions and mineralogy using a broad spectrum of different and complementary techniques. Reader is requested to contact the authors for further details.

The national institution Sintef is also located in Trondheim. Sintef conducts research on the application of building materials, like eg. ASR-expansion potential according to RILEM guidelines, etc. Sintef owns extensive testing facilities, some of which in conjunction with the Norwegian University of Science and Technology (abbreviated as NTNU), again located in Trondheim. Sintef and NTNU are economically independent entities.

Though initially established to promote research on the alkali-silica reaction in Norway, FARIN (currently hosted at NGU premises) conducts research of building materials from daily practice. The acronym FARIN stands for Forum for Alkali-Reactions In Norway [Broekmans & Wigum 1999, Broekmans & Wigum 2001].

In 2000, FARIN initiated a research program currently under progress on practical aspects of (ASR-) damage, assessing concrete structures from real life. Current FARIN activities also include communication to the international 'ASR-community', education and training of microscopists [also see Broekmans & Wigum 1999, Broekmans & Wigum 2001], and hosting of the webportal *www.this.is/ergo/farin*.

For research on renewable materials including wood and timber, the reader is referred to the Norwegian institution for forestry research (Skogforsk), and the institution for wood construction (TreTeknisk). Both are mentioned in section B.1.3 on industry associations and G.1.4 on research.

## 2 Major research programs and projects

As the PGL is the coverall aggregate organization in Norway, it is involved in most research programs, including the pan-European COST-program. A project for use of unbound materials in roads, airport runways and rail roads was completed in 2000, but the final report is 'in progress'.

Another main project running in a conjunction between PGL and FARIN is dubbed 'Optimal use of aggregate resources in Norway', subtitled 'Alkali-silica reactions in concrete - advanced field research'. FARIN is conducting and coordinating research on Norwegian aggregate materials. Up-to-date information can be found at the webportal *www.this.is/ergo/farin*.

One major PGL-coordinated achievement which is now in the editing phase is the new manual for road construction, called 'Håndbok 018 Vegbygging' (ie. Handbook 018 Road Construction), which has been adapted to suit current CEN standards. After completion of the editing process, this work is expected published mid 2003.

Much of the current research is very applied, like eg. a collaboration project between NGU and PGL into rock quality and development of road gullies, to establish a proper working method for rock quality assessment with an adapted Los Angeles testing device.

Finally, PGL has projects running, or is planning to do so, on making the aggregate branch better known among the people in the street and make the aware of the need for aggregate material, increase the membership of the PGL and make consumers aware of the quality stamp that a PGL-member bears, and to increase efforts to provide the branch with standards that make sense. Most of the above information is reproduced from the PGL website.

# 3 Quality control measures for recycled and secondary materials

The Resiba report [Mehus et al 2000] mentioned above reports that many foreign countries (ie., foreign to Norway) appear to have official rules and guidelines on how to deal with recycled and secondary materials, how to classify them and how to apply them. In Norway however, such rules are currently under development [Mehus 2002a], and much of the material is still unsorted. More details are to be found in the Resiba report as referred to elsewhere in this report [Mehus et al 2000], and a preliminary guideline can be downloaded from *www.byggforsk.no/prosjekter/resiba* [Mehus 2002b].

Furthermore, PGL is involved in putting up a national plan for the handling of building and construction waste as a partner in the so-called Økobyggavfall board. Its future is somewhat uncertain due to budget cuts. PGL is also participating in a forum for recycling of ‘heavy building materials’, without further specification. Participants are divided in to sub-committees, one dealing with proper terminology and nomenclature, the other with guidelines for use of the material. Main goals of this forum are to avoid double work redone, and coordination and communication between interestees in a rapidly developing discipline.

# 4 Research for renewable materials

The same Resiba report [Mehus et al 2000] reports that hardly any research is being done on renewable materials. This may as well be attributed to the fact that (residential) building and construction to a large degree is done in renewable material, already traditionally. In Norway, two institutions coordinate research on renewable materials, knowingly the institute for forestry research Skogforsk, and the institute for wood and timber for building and construction applications TreTeknisk. Both are listed in sections B.1.3 and G.1.4.

# G. Sources

## 1 List of key players

### 1.1 Governmental organizations

| | |
|---|---|
| national geological survey | |
| Norges geologiske undersøkelse NGU | info@ngu.no |
| <no mailbox!!!> | |
| N-7491 TRONDHEIM | peer.neeb@ngu.no |
| Norway | www.ngu.no |
| phone: +47 7390 4000 | www.ngu.no/grusogpukk |
| national board for development of regional/international businesses | |
| Statens Nærings og Distriktsutviklingsfund SND | firmapost@snd.no |
| Postboks 448 Sentrum | |
| N-0104 OSLO | |
| Norway | |
| phone: +47 2200 2500 | www.snd.no |
| organization for aggregate producers, including secondary and recycled raw materials | |
| Pukk- og Grusleverandørenes Landsforening (PGL), contact: Elisabeth Gammelsæter | eg.pgl@pil.no |
| Postboks 5487 Majorstua | |
| N-0305 OSLO | |
| Norway | |
| phone: +47 2308 7785 | www.pgl.no |
| Norwegian public roads administration | |
| Statens Vegvesen | firmapost@vegvesen.no |
| Postboks 8142 Dep | |
| N-0333 OSLO | |
| Norway | |
| phone: +47 2207 3500 | www.vegvesen.no |

## 1.2 Environmental organizations

| | |
|---|---|
| the main governmental environmental organization | |
| Ministry of the Environment | postmottak@md.dep.no |
| Postboks 8013 Dep | |
| N-0030 OSLO | |
| Norway | |
| phone: +47 2224 9090 | http://odin.dep.no/md/ |
| general organization for environmental protection | |
| Bellona Foundation | info@bellona.no |
| Postboks 2141 Grunerlokka | |
| N-0505 OSLO | |
| Norway | |
| phone: +47 2323 4600 | www.bellona.no |
| Norwegian Association for Environmental Protection | |
| Norges Miljøvernforbundet | nmfnorge@online.no |
| Postboks 593 Marken 9 | |
| N-5806 BERGEN | |
| Norway | |
| phone: +47 5531 7100 | www.miljovernforbundet.no |
| Norwegian Society for the Conservation of Nature / Friends of the Earth Norway (FoEN) | |
| Norges Naturvernforbund | naturvern@naturvern.no |
| Postboks 342 Sentrum | |
| N-0101 OSLO | |
| Norway | |
| phone: +47 2240 2400 | www.naturvern.no |

## 1.3 Industrial organizations

The reader is referred to the report by Neeb [Neeb 2002b], essentially an index over aggregate producers, addresses, contact persons, quarry locations, and an indication of which mechanical testing data are available. The report is updated annually, and the 2002 version is appended to this report. Also, the addresses listed in section B.1.3 of this report may be of use.

| | | |
|---|---|---|
| national board for development of regional/international businesses | | |
| SND | | firmapost@snd.no |
| Postboks 448, Centrum | | |
| N-0104 OSLO | | |
| Norway | | |
| phone: | +47 2200 2500 | www.snd.no |
| organization for producers of rock materials | | |
| Bergindustriens Landssammenslutning (BIL), contact: Kari-Merethe Kjellsen | | klk@pil.no |
| Postboks 5487 Majorstua | | |
| N-0305 OSLO | | |
| Norway | | |
| phone: | +47 2308 7871 | www.pil.no |
| organization for employers/employees | | |
| Prosessindustriens Landsforening (PIL), contact: Per Helge Fredheim | | phf@pil.no |
| Postboks 5487 Majorstua | | |
| N-0305 OSLO | | |
| Norway | | |
| phone: | +47 2308 7831 | www.pil.no |
| organization for aggregate producers, including secondary and recycled raw materials | | |
| Pukk- og Grusleverandørenes Landsforening (PGL), contact: Elisabeth Gammelsæter | | eg.pgl@pil.no |
| Postboks 5487 Majorstua | | |
| N-0305 OSLO | | |
| Norway | | |
| phone: | +47 2308 7785 | www.pgl.no |
| Norwegian public roads administration | | |
| Statens Vegvesen | | firmapost@vegvesen.no |
| Postboks 8142 Dep | | |
| N-0333 OSLO | | |
| Norway | | |
| phone: | +47 2207 3500 | www.vegvesen.no |

## 1.4 Research institutions

| | |
|---|---|
| **national geological survey** | |
| Norges geologiske undersøkelse NGU | info@ngu.no |
| <no mailbox!!!> | peer.neeb@ngu.no |
| N-7491 TRONDHEIM | |
| Norway | www.ngu.no |
| phone: +47 7390 4000 | www.ngu.no/grusogpukk |
| **Norwegian institute for applied technological research** | |
| SINTEF Civil and Environmental Engineering | info@civil.sintef.no |
| <no mailbox!!!> | marit.haugen@civil.sintef.no |
| N-7034 TRONDHEIM | |
| Norway | |
| phone: +47 7359 0200 | http://www.sintef.no/units/civil |
| **Norwegian building research institution** | |
| Byggforsk | firmapost@byggforsk.no |
| Postboks 123 Blindern | |
| N-0314 OSLO | |
| Norway | |
| phone: +47 2296 5555 | www.byggforsk.no |
| **national research forum for the deleterious alkali-silica reaction (ASR) in concrete** | |
| Forum for Alkali-Reactions In Norway FARIN | wigum@itn.is |
| Geological Survey of Norway | maarten.broekmans@ngu.no |
| N-7491 TRONDHEIM | |
| Norway | |
| phone: +47 7390 4152 | http://this.is/ergo/farin |
| **general organization for forestry research** | |
| Norsk Institutt for Skogforskning | post@skogforsk.no |
| Høgskoleveien 12 | |
| N-1432 ÅS | |
| Norway | |
| phone: +47 6494 9000 | www.skogforsk.no |
| **general organization for research on wood and timber in building and construction industry** | |
| Norsk Treteknisk Institutt | firmapost@treteknisk.no |
| Postboks 113 Blindern | |
| N-0314 OSLO | |
| Norway | |
| phone: +47 2296 5500 | www.treteknisk.no |

# 2 References


Anonymous (1998?): Act 4 August 1995 on amendments of Act 14 June 1985 Chapter VII-a Environmental Impact Assessment. Regulations 13 December 1996 relating to Environmental Impact Assessment. Ministry of Environment Brochure (T-1174): pp 40.

Anonymous (1998?): Environmental Impact Assessment pursuant to the Planning and Building Act. Ministry of Environment Brochure (T-1176): pp 28.

Broekmans, MATM, and Wigum, BJ (1999): Alkali-aggregate reaction research in Norway: current status and future quo. In: Pietersen, HS, Larbi, JA, and Janssen, HHA (editors): Proceedings of the 7th Euroseminar on Microscopy Applied on Building Materials, Delft: 241-244.

Broekmans, MATM, and Wigum, BJ (2001): FARIN research in Norway: current quo vadis and future status. In: Stamatakis, M, Georgali, B, Fragoulis, D, and Toumbakari, EE (editors): Proceedings of the 8th Euroseminar on Microscopy Applied to Building Materials, Athens, Greece: 101-103.

Dagestad, B (1999): Mineral planning and the industry. In: Fuchs, PEK, Smith, MR, and Arthur, MJ: Mineral planning in Europe. Proceedings of the 2nd ECMP, October 4-7, 1999, Harrogate/UK: 19-26.

Dahl, R, Sandstad, JS, Øvereng, O, Neeb, PR, and Cook, N (1999): County programmes - a concept for collaboration between local government, the national geological survey and the minerals industry: Examples from Norway. In: Fuchs, PEK, Smith, MR, and Arthur, MJ: Mineral planning in Europe. Proceedings of the 2nd ECMP, October 4-7, 1999, Harrogate/UK: 97-107.

Hogarth, J (1993): Baedeker's travel guide to Scandinavia. 1st English edition. Prentice-Hall for the Publishing Division of the Automobile Association, Basingstoke/Hampshire: pp 591.

Gjelle, S, and Sigmond, EMO (1995): Bergartsklassifikasjon og kartfremstilling. Norges geologiske undersøkelse, Skrifter (113): pp 77.

Hugaas, KS (2002): Personal communication Elkem, October 2002.

Mehus, J, Lahus, O, Jacobsen, S, and Myhre, Ø (2000): Bruk av resirkulert tilslag i bygg og anlegg - status 2000. Resiba Prosjektrapport (01/2000): pp 64. (*in Norwegian*)

Mehus, J (2002a): Byggforsk informerer om bruk av resirkulert tilslag. Byggeindustrien (14): 56.

Mehus, J (2002b): Sørumsand videregående skole: Fra avfall til ressurs - et skoleeksempel. Byggeindustrien (14): 118-119.

Neeb, PR (2001): The Norwegian mining and quarrying industry in 2000. NGU-report (2001.066): pp 17. (*www.ngu.no/FileArchive/91/bergindustrien2000.pdf*)

Neeb, PR (2002a): The Norwegian mining and quarrying industry in 2001. NGU-report (2002.035): pp 17. (*www.ngu.no/FileArchive/91/Bergindustrien_2001_Eng.pdf*)

Neeb, PR (2002b): Norway's coastal aggregates. Current production in 2001 and potential. NGU-report (2002.037): pp 30. (*www.ngu.no/FileArchive/101/2002.037eksport27.05.02.pdf*)

prEN 13043 (1998): Aggregates for bituminous mixtures and surface dressings for roads, airfields and other trafficked areas. Version 98.11.25 (TG2-357/TG3-118): pp 12.

prEN 13242 (1998): Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction. Draft version: pp ??.

prEN 12620 (1998): Aggregates for concrete. Version 98.11.25 (TG2-357/TG3-118): pp 12.

Torsen, TB, Karlsen, C, Grjotheim, K, Brastad, O, and Sandengen, MK (2002): Avfall - avskaffelsen av kastesystemet. Bellona Rapport (5): pp 112. (*in Norwegian*)

*www.bergheimamfi.no/*