# 2011

# GEOLOGICAL SURVEY OF NORWAY

# ANNUAL REPORT


NGU
Norges geologiske undersøkelse
*Geological Survey of Norway*

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# CONTENT

# FROM THE FIELD TO THE PEOPLE

In 2011, we collected and processed more geological data and information than ever before. Record amounts of information and map data were, in addition, downloaded from our web pages and databases. NGU's maps and our information on bedrock, surficial deposits, mineral resources and groundwater are systematised and made freely available through Norway Digital and on NGU's web pages. In the last two years, the use of the web site, ngu.no, has increased by more than 50 per cent. The demand for data sets which the user can download has shown a particularly large increase.

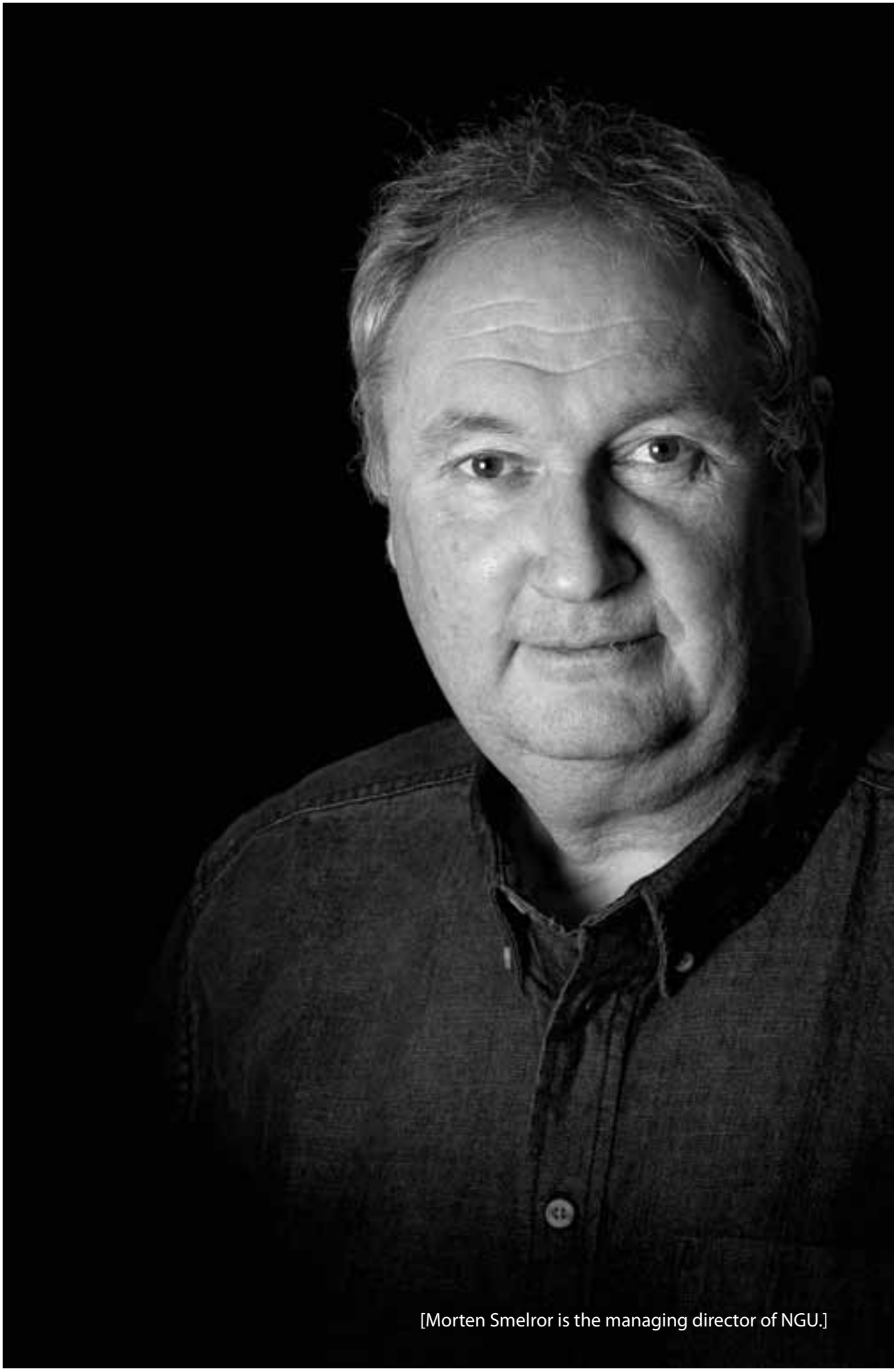
A five-year programme has begun to acquire basic geological, geophysical and geochemical data in northern Norway to provide a basis to prospect for commercial mineral deposits in this part of the country. High-quality geophysical data sets have been obtained by planes and helicopters in the Rombak-Skjomen area in Nordland, at Mauken and Vanna in Troms, and in inner Finnmark. With funding from three cooperating counties, Buskerud, Telemark and Vestfold, follow-up geophysical measurements were carried out in the Kongsberg district. In cooperation with the Norwegian Petroleum Directorate and the petroleum industry, aeromagnetic data have been acquired from the area around Jan Mayen, in Lofoten and Vestfjord, and along the coast of north-western Norway. In liaison with the Norwegian Radiation Protection Authority and the Reindeer Husbandry Management Authority, airborne radiometric measurements were performed over an area in the Jotunheimen that still has high concentrations of Cs-137 after the Chernobyl disaster 25 years ago.

New technology to acquire and process geophysical data has led to enhanced quality, more efficient and cheaper acquisition and quicker access to important data and information for the users in industry and management. People mapping in the field have also begun to use new technology. Electronically based background data and field PCs make fieldwork more effective and reduce the time needed to make the data ready for the users. Our aim is to get an efficient flow of information and knowledge from the field to the people. In 2011, the biggest effort in bedrock mapping has taken place in northern Norway, while mapping of surficial deposits has been concentrated in Vest-Agder. Another important NGU task has been to map hazardous areas with respect to landslides, earth slides and clay slides. Such mapping is performed on behalf of the Norwegian Water Resources and Energy Directorate in accordance with a national plan.

In cooperation the Norwegian Institute for Marine Research and the Marine Division of the Norwegian Mapping Authority, NGU is continuing to map maritime areas off Nordland and parts of the Barents Sea, a total area of some 16 000 square kilometres. Since its start in 2005, this Mareano Programme has completed the mapping of 83 700 square kilometres. Large volumes of data, along with numerous maps displaying detailed bathymetry, seabed geology, habitats, benthic fauna and the state of the environment, have been acquired and made available through mareano.no. This integrated geological and biological mapping is unique and wins international acclaim.

In 2011, NGU continued to prepare maps of the seabed in southern Troms and completed the preliminary mapping of 3600 square kilometres. The objective of this cooperative project in the Astafjord district is to make this one of the best documented coastal areas in the country, thus laying the foundations for sustainable and environmentally friendly industrial development and resource utilisation in the coastal zone.

NGU's task is to deliver "Geology for Society". We achieve this by acquiring, processing and disseminating geological knowledge that can be transformed into wise and coordinated decisions which are optimal for everyone. We continually strive to make data acquisition more efficient, thereby making maps, data and knowledge available to users as readily as possible. NGU places particular emphasis on preparing knowledge for industrial development and resource management. Through good cooperation with industry and business, governmental bodies and regional authorities, we will increase the scope and utility value of our knowledge.



[Morten Smelror is the managing director of NGU.]

# FIELDWORK

"The geologist is really on foot. What he can hastily observe when he leaves a carriage or dismounts from a horse for a moment, or sees from a sailing boat, will always be a minor matter", the first director of NGU, Theodor Kierulf, said.

Today, NGU's mappers do more than walk. Before Christmas 2010, the Norwegian Government promised 100 million NOK over a four-year period to map the potential for gold and other minerals in northern Norway. Classical geological mapping is a case of following a profile in the terrain and constructing maps on the basis of observations on the ground. In the Mineral Resources in North Norway (MINN) programme, the geologists are "on foot" supported by planes, boats and helicopters.

The first part of this NGU effort involved geophysical surveys from planes and helicopters of 15 000 square kilometres in Nordland, Troms and Finnmark. The geological follow-up in 2011 amounted to 55 weeks in the field between Repparfjord and Kautokeino in western Finnmark, on the island of Senja, at Mauken and Altevatnet in southern Troms, and in Vesterålen. Geochemists were in the field for 17 weeks to collect soil samples from the Nordkinn peninsula in Finnmark. In addition, geochemical analyses have been performed on 2000 previously collected samples from moraines.

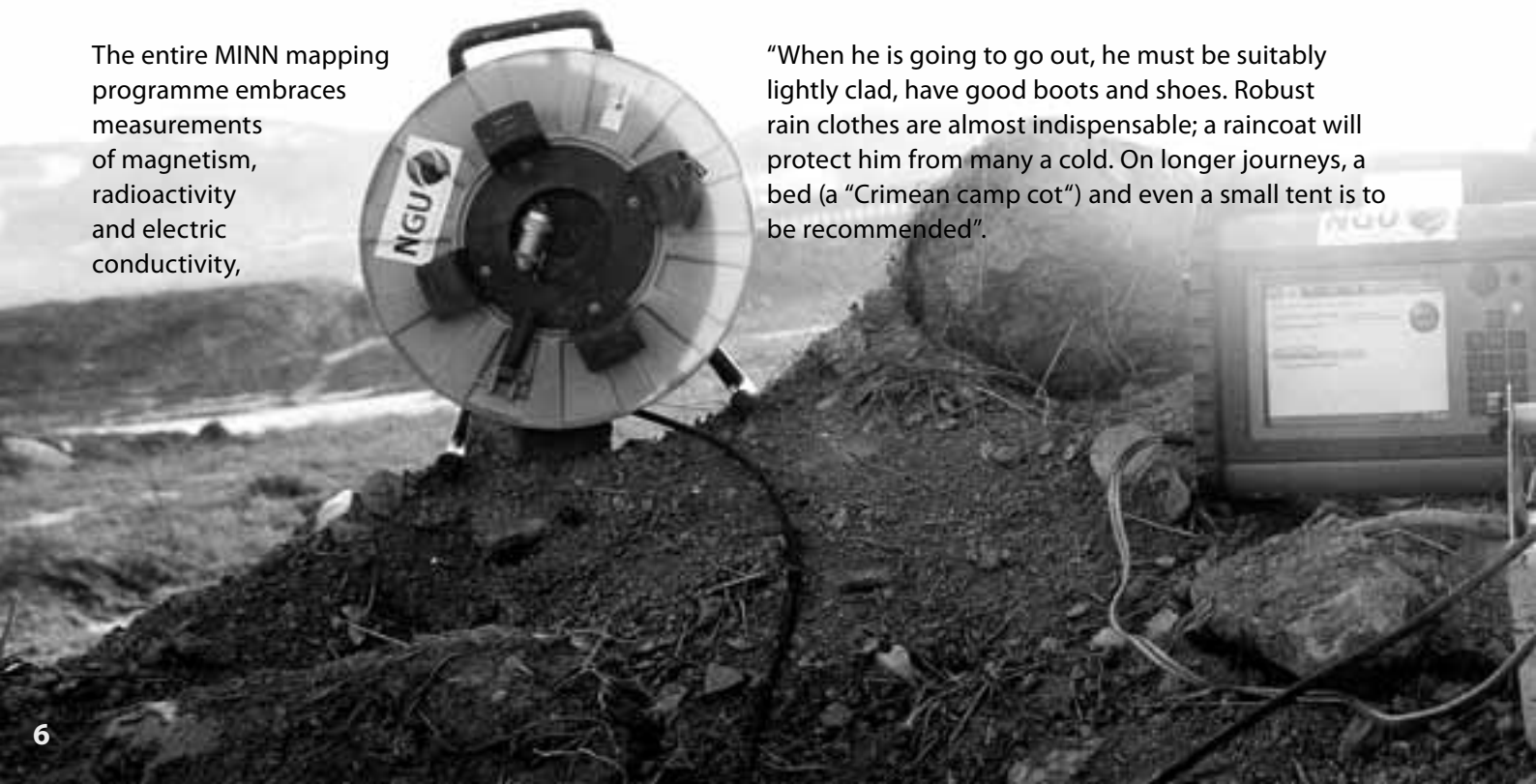
The entire MINN mapping programme embraces measurements of magnetism, radioactivity and electric conductivity, which are compiled with geochemical and geological data. Their interpretation helps researchers to obtain a reliable impression of the bedrock conditions. Many of the areas have a great potential for mineral and metal deposits, primarily copper, nickel, iron and gold.

An example of the effort is that geophysical measurements at Mauken were carried out in June 2011. The data were processed in July and geologists took them into the field in August. Following effective fieldwork, a preliminary bedrock map was completed already in September.

Everything suggests that the minerals industry will gradually become a more important occupation in Norway in the years to come. The value of known Norwegian mineral resources is reckoned at roughly 1500 billion NOK. The new effort can lead to more prospecting, new discoveries and a gradual development of business and commerce in this part of the country. Europe has a great need for mineral resources. European industry uses 20 per cent of the world production of metals, but only three per cent comes from mines in EU countries.

To be successful, modern technology, state-of-the-art equipment and skilled workers are needed. Nevertheless, Theodor Kierulf's exhortations about the geologist in the field holds true:

"When he is going to go out, he must be suitably lightly clad, have good boots and shoes. Robust rain clothes are almost indispensable; a raincoat will protect him from many a cold. On longer journeys, a bed (a "Crimean camp cot") and even a small tent is to be recommended".



[In 2011, Einar Dalsegg, an engineer, had to be secured with climbing gear to carry out measurements at Mannen in Romsdal. See and hear more about this in the film; scan the code or go to the mail address.]

http://bit.ly/wXpyOZ

[Lars-Petter Nilsson has performed research on everything from gold to graphite in the past year. See and hear more in the film; scan the code or go to the web address.]

http://bit.ly/AsQ863

# RESEARCH

Research is an active, thorough and systematic investigation to acquire new insight and enhance the knowledge of the community.

NGU's research on bedrock, surficial deposits, mineral resources and groundwater is successful. An evaluation of the geosciences at Norwegian universities and research institutes made by the Research Council of Norway in 2011 concludes that NGU is doing a good job. Seven of our research fields were measured against international standards. "The research groups included in the evaluation stand out as productive and very motivated, and operate in accordance with high scientific standards", the evaluation concludes. The grades achieved were 3-4, good to very good. One field attained the top grade of 5, excellent.

Science generally concerns presenting a hypothesis or theory, an untested explanation of a phenomenon, an opinion about experience or an idea about a relationship. By acquiring and analysing data, the researcher draws a conclusion that can give a picture that is more in keeping with experience.

In 2011, NGU researchers had more than 120 articles approved for publishing in international scientific journals. It is there poles of insight are hammered into the ground and fences of new knowledge are built before the construction can be attacked by other researchers who examine whether the knowledge stands the test or the construction has to be demolished.

Leaving the universities aside, NGU is one of the Norwegian research institutions publishing most scientific articles. We are at the forefront among the European geological surveys. NGU's motto, Geology for Society, points to more fundamental activities than research. NGU supplies high-quality geological knowledge for the business community and public management sector because our geologists have the opportunity to develop new methods and carry on research.

NGU's researchers deliver fundamental knowledge about the evolution of the Earth. Drill cores from the basement in north-western Russia, for instance, can tell us when the Earth was sufficiently rich in oxygen that life got a foothold. This was a small piece in a huge jigsaw puzzle concerning the primeval Earth; the never-ending, natural cycle involving water, air and soil. Researchers from 15 nations have already performed a variety of detailed studies on the material, which is stored in the NGU core store.

Another question: Why do we have mountains in Norway? Knowledge and data gathered over many years, cooperation over national boundaries, new theories and thoughts in smart heads. The research supplies a new piece for the huge jigsaw puzzle: Norwegian mountains are a result of the extreme thinning of the Earth's crust, which culminated with the opening of the Atlantic Ocean 54 million years ago. The rift structures in the Norwegian Sea control the topography on land in Scandinavia. The oil wealth and the Norwegian landscape are two sides of the same story.

# MANAGEMENT

While researchers acquire and develop knowledge about geology, management looks after the knowledge and processes it so that society can use it.

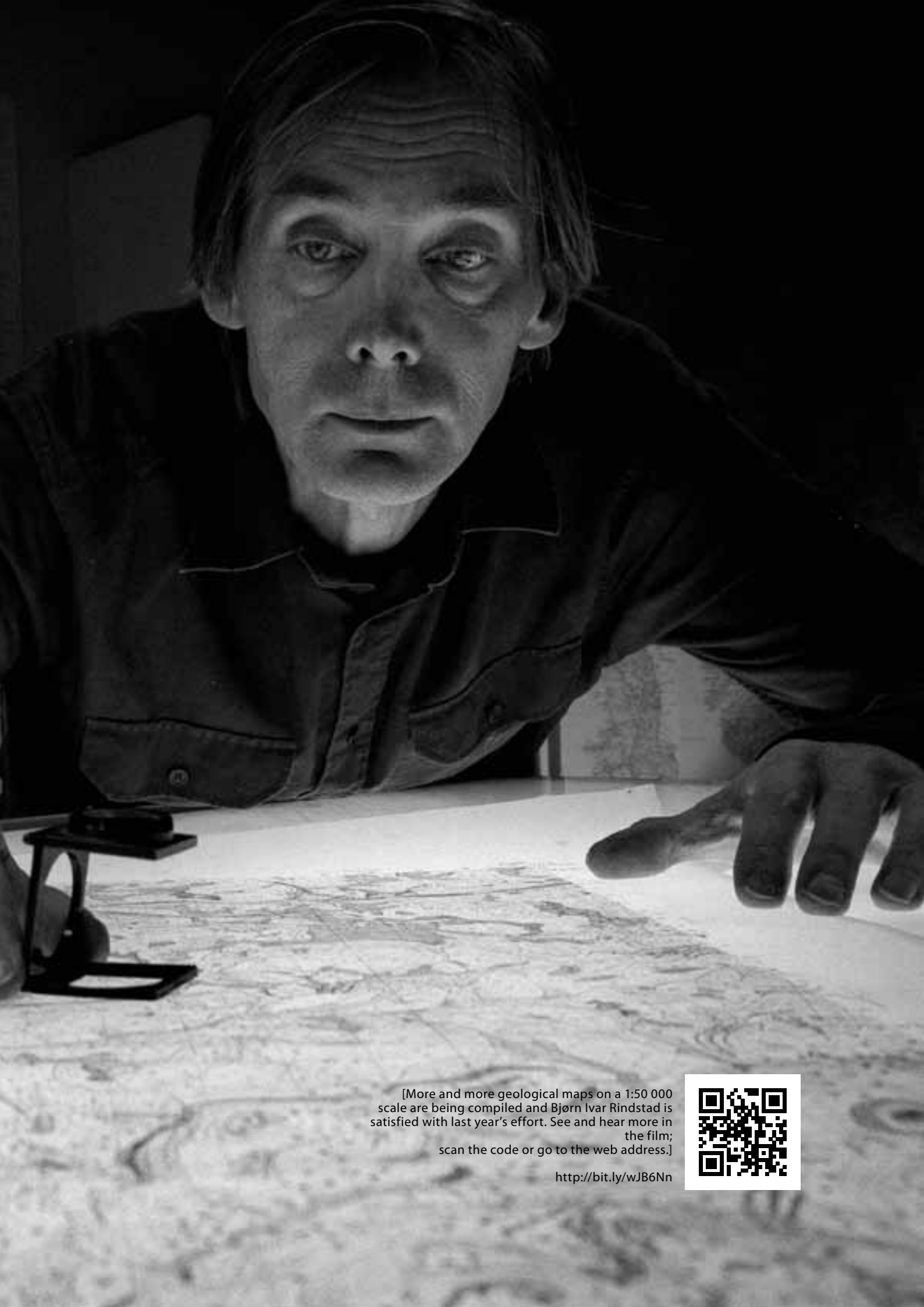
NGU's management of geological data has been an example of the sharing of geographical information. Through various cooperative bodies, NGU is still influencing how data should be managed in the best possible way so that the knowledge will benefit society.

So, the big question: What in fact is management of geological data? Basically, it concerns constructing systems to look after the data in the right way, processing them and ultimately making them available for the users in the shape of map services, fact sheets, means for downloading, searching services, maps on the Internet or traditional paper maps. To support this work, rules and standards have been established for how data are to be stored and supplied.

Data are acquired during fieldwork. A great deal is still done in the old way. However, since geologists are increasingly using a robust PC in the field as a digital map basis and notebook, it is becoming simpler to adjust new data to what is already in the database. This makes the management work more efficient.

The ultimate management, nevertheless, begins when the data have come into the building and after the geologists have performed their interpretations. NGU has to comply with more than ten ISO standards and OGC specifications when databases are being built up and data made ready to be passed on to society. This means that geological data can be utilised by users all over the world through GIS tools or in the form of WMS services. The user is his own boss and can combine data from a variety of sources just as he pleases, depending entirely on how he intends to use them.

NGU has made more than 100 thematic maps available on the Internet. These are continually maintained. Some 1000 printed maps also form part of the data we manage, and 13 new ones were published in 2011. Norway Digital is the most important cooperative organisation in Norway as regards management of geographical information. NGU is an active co-player in Norway Digital and the work done to coordinate and make ready national map data, irrespective of who provides the geographical information. In the same way as Norway Digital coordinates and standardises national data, the EU Directive INSPIRE and the Geodata Act makes this possible on a European level.



[More and more geological maps on a 1:50 000 scale are being compiled and Bjørn Ivar Rindstad is satisfied with last year's effort. See and hear more in the film;
scan the code or go to the web address.]

http://bit.ly/wJB6Nn

[The past year has been a record one for ngu.no, and Berte F. Amundsen, the departmental head, thinks this is excellent. See and hear more in the film; scan the code or go to the web address.]

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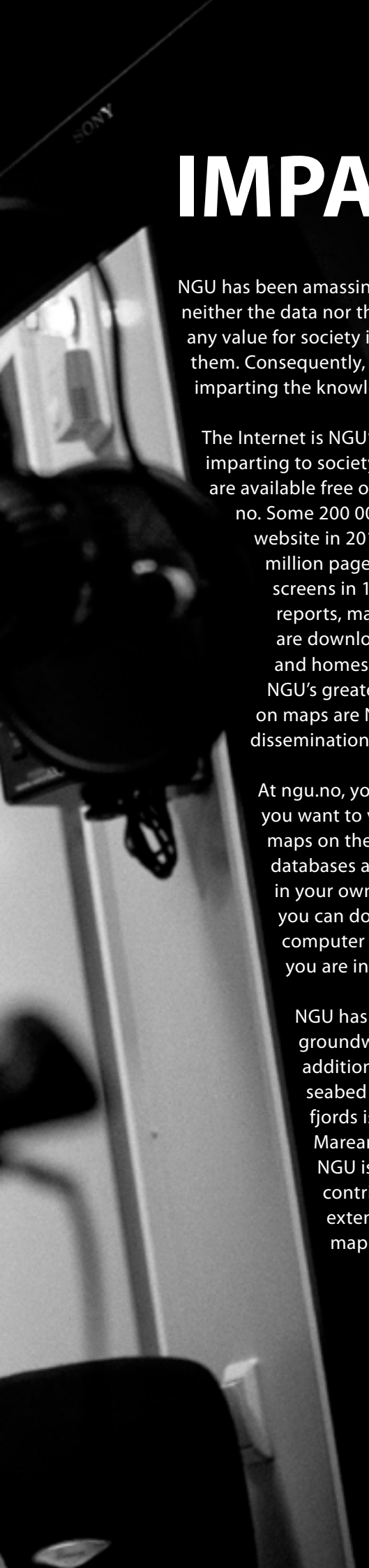


# IMPARTING

NGU has been amassing data since 1858, but neither the data nor their management have any value for society if there is no-one to use them. Consequently, NGU places emphasis on imparting the knowledge to society.

The Internet is NGU's main channel for imparting to society. Information and data are available free on the website, ngu.no. Some 200 000 people visited NGU's website in 2011, and more than one million pages were displayed on screens in 185 countries. Publications, reports, maps, data, images and texts are downloaded straight into offices and homes. Geological data are NGU's greatest asset. Geological data on maps are NGU's most important dissemination asset.

At ngu.no, you decide yourself whether you want to view the geology on our maps on the Internet or link up to our databases and view the same data in your own map programme. Or you can download onto your own computer the dataset for an area you are interested in.

NGU has a separate website about groundwater – grunnvann.no. In addition, NGU's mapping of the seabed along the coast and in the fjords is available through the Mareano.no website, for which NGU is one of the three principle contributors. Data from the extensive national landslide mapping are available from skrednett.no, which will be transferred from NGU to the Norwegian Water Resources and Energy Directorate (NVE) in 2012.

The media have been more interested in NGU in 2011 than in any previous period. The mapping of mineral resources in northern Norway, which is a government priority for a four-year period, has opened the eyes of many large and small media houses. Several hundred newspaper articles have taken up the mineral exploration, and people who are interested in the topic have contributed through reader's columns in newspapers and on social media.

NGU has been more purposeful in the use of Facebook as an imparting channel in 2011. Over 400 persons say that they actively "like" NGU's profile page and want to identify themselves with us through that. The annual NGU Day took place in February, with focus on mineral exploration in the north. Lecturers from Norway and other countries shared their knowledge with a full lecture theatre at NGU. Minerals and mountains were also the topic for NGU's participation in two events, Geology Day and Research Market, which are mainly directed at children and young people, and their families.

Our researchers are responsible for much of NGU's dissemination effort. They travel around the country representing NGU. The sum of all our dissemination helps us to hold our banner and our vision high: Geology for Society.

# PEOPLE

Norwegian filmmakers are planning "Bølgen", an entertainment film with a realistic backdrop. The film will be based on the Tafjord disaster in Sunnmøre in April 1934, when a huge slice of mountainside crashed into the fjord producing a flood wave that devastated the villages and killed 40 people.

Geologists know that entire mountainsides will collapse in the future too. In 1985, it was discovered that Åkneset, across Sunnylvsfjord, was moving, producing fractures in the bedrock. Monitoring of the movements began. In 2006, Norwegian scientists concluded that the unstable segment of mountainside was so large that a landslide could send a tsunami up to 35 metres high onto the village of Hellesylt and further up Geirangerfjord.

Statistically, five to ten large landslides causing loss of life and financial losses can be expected during the next hundred years. Knowledge of the geological processes that lead to landslides, and their consequences, is becoming increasingly important. Commissioned by the Norwegian Water Resources and Energy Directorate (NVE), NGU is continually mapping hazardous sites to safeguard lives and financial assets.

Thanks to skilled geologists, politicians with a sense of responsibility and high-tech equipment, four areas are being continually monitored today: Mannen, Tafjord and Åknes in Møre & Romsdal, and Nordnes in Troms. More than 50 mountainsides are periodically checked and movements measured.

Investment in housing, businesses and infrastructure is closely linked to the shore zone. The local authorities concerned are responsible for protection work and preparing for landslides and their repercussions, but the expertise to assess the hazards and risks is not equally available everywhere. Local authorities and their inhabitants must have good, readily available data on hazards in Norwegian valleys and hillsides to be able to plan, monitor, warn and evacuate.

Should Åkneset slide into the fjord, it will involve over 50 million cubic metres of rock, corresponding to 100 football fields or 38 Cheops pyramids. 3000 people live in the area.

The work done on the unstable portions of mountainside in Tafjord and at Åknes has been positive for people living in the boroughs of Norddal and Stranda. The Åknes-Tafjord Preparedness Centre performs the actual monitoring using radar and laser technology, satellite signals, GPS receivers, tension rods, seismic equipment and meteorological measurements of precipitation, wind and temperature.

The area in the shore zone, where development was put on hold, has now been declared hazard-free and can once again be developed.

It is the company that made the horror film series, "Fritt Vilt", with producer Martin Sundland and director Roar Uthaug, that plans to make "Bølgenh", a film about ordinary people placed in an extreme situation. Perhaps knowledge on geology will reach a new, young group of users? NGU always wants to help to enhance the interest for geoscience.

[As a geologist and mother, Lena Rubensdotter may have other ideas than many other people when buying a house. 2011 was her first summer in a new house. See and hear more in the film; scan the code or go to the web address.]

http://bit.ly/zkHWSN

# SUCCESS WITH CRUSHED ROCK

The idea that sandstone from Bremanger, among other places, might be an interesting export article for the European market was due to the special properties of the rock.

I and several colleagues investigated the sandstone at Bremanger in Sogn & Fjordane in the early 1990s. It was deposited in what we geologists call the Devonian period, around 400 million years ago. NGU has mapped sandstone from this period in several places in western Norway.

The sandstone we found has good crushing and polishing resistibility. It is the contrast between hard and soft minerals that determines the polishing properties, which have a great deal to say for friction on the road surface. After we had studied the rock and mapped its extent, we quickly saw that it was well suited as an asphalt additive on the Continent, where everyone drives without studded tyres and it is important to avoid having a slippery road surface.

Today, Bremanger Quarry AS is one of five large exporters of crushed rock in Norway. The company was founded in 1998 and a large quarry with a quay began operating at Dyrstad in 2001. The company is owned by the Dutch firm, Baumann, and exports the Norwegian sandstone to Holland.

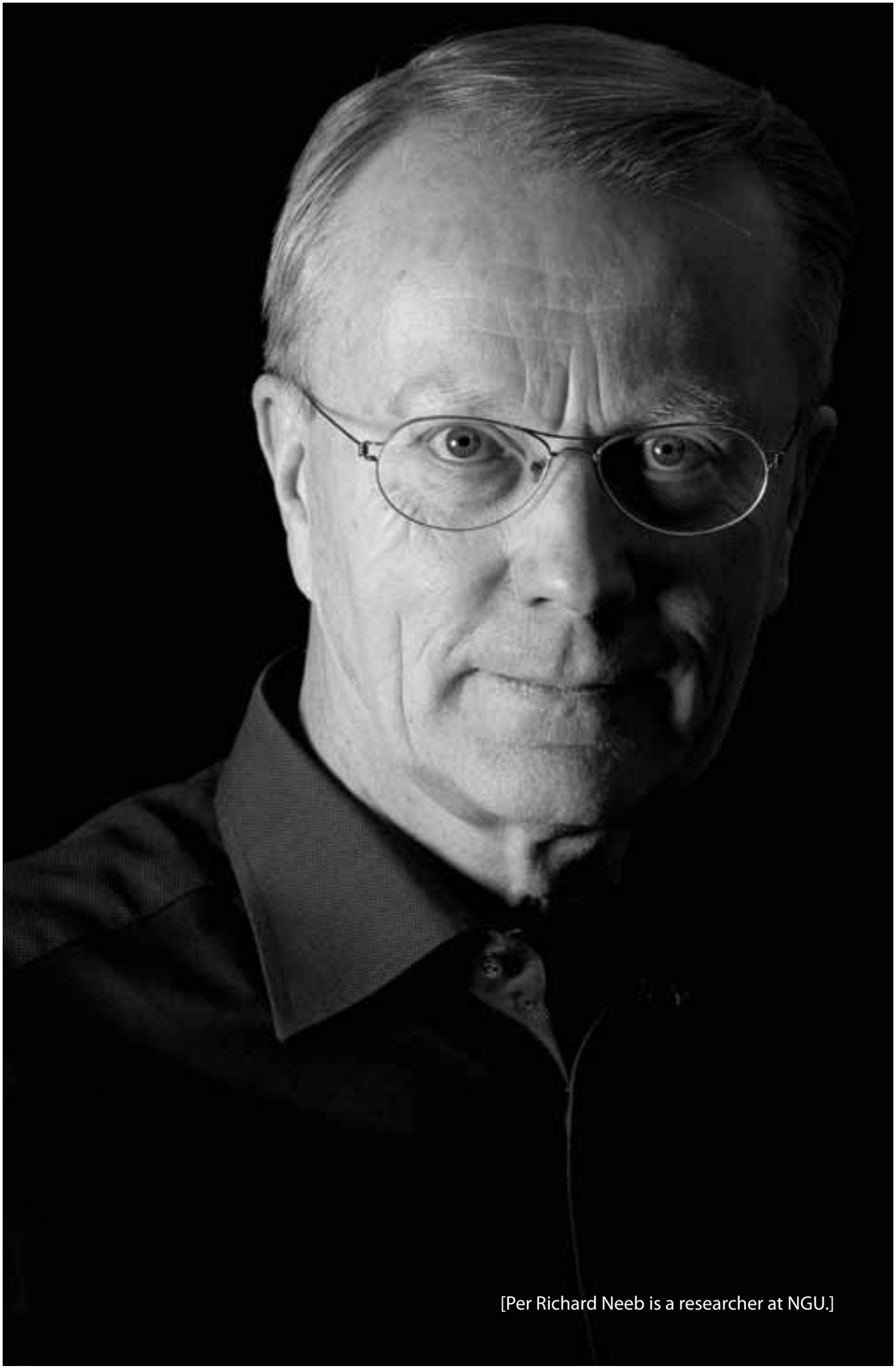
But one thing is having a great deal of good rock, another is infrastructure and profitability. The big crushing plant in Bremanger has advantages on this score. It is located on the coast, out of sight, has a good harbour, is close to the European market and the reserves will last more than 50 years.

Last year, four million tonnes of rock were exported by Bremanger Quarry AS. The company has 53 employees at Dyrstad and has now prepared another quarry. The special, hard Devonian sandstone is used to produce asphalt in the Netherlands, Belgium and Russia, as well as being used for concrete, in railway construction and in various offshore projects.

A similar sandstone quarry is operating a little further south in the county, near Seljestokken in Flora. This has 20 employees and produces asphalt additive for Norway, Poland, Holland and Belgium. The intention is to produce two million tonnes a year.

We at NGU are proud of having been in at the start of this development.

[PS: The total market value of crushed rock and gravel in 2010 was four billion NOK, based on 67 million tonnes of raw material having been extracted and sold. About 2500 people are employed in the industry, spread over 1000 small and large firms.]
Per Richard Neeb is a researcher at NGU.]



[Per Richard Neeb is a researcher at NGU.]

[Marco Brønner is a researcher at NGU.]

# SUCCESS AT DEPTH

The large oil discoveries made recently west of Stavanger are exciting, also for several of we researchers at NGU. Some reservoirs on the Utsira High are actually in weathered basement, a feature we have worked on for several years.

We have used geophysical techniques to study deep weathering of the basement beneath sandstone and limestone, which are often reservoir rocks for oil and gas from the geological periods, Jurassic and Cretaceous. These investigations have been done on land, but we have also tested the method on the Loppa High in the Barents Sea. The only Jurassic rocks in mainland Norway are on Andøya in Vesterålen. There, sandstone occurs in the shore zone and abuts against the basement. 1.6 billion years separates the rocks, just like the bedrock geology out on the continental shelf. We can see that weathering debris dating from the Triassic and Jurassic is preserved in the fractured basement. In some places, like Vestfold and Lofoten-Vesterålen, the deep-weathering zone occurs over large, continuous areas. The bedrock has probably been protected longer in these areas by younger, soft rocks.

Norway had a tropical climate 250 to 150 million years ago. Extremely acid water formed in hot, humid swampy areas. The water penetrated far down along fractures in the bedrock and attacked rocks such as gneiss. Over millions of years, the water succeeded in disintegrating hard minerals to form clay minerals. Despite extensive erosion of the landscape, loose clay minerals still lie protected in fractures.

We do not explore for oil and gas at NGU, but we often discover new geological pieces that fit into the jigsaw puzzle of how this country was formed. By doing so, we have also seen where it is feasible to search for commercial oil deposits in fractured and weathered basement. We are well satisfied with this.

[PS: Last year's gigantic oil discovery, Aldous/Avaldsnes, has been renamed the Johan Sverdrup Field. It is in Jurassic sandstone that was deposited when Norway had a tropical climate and was a swampy landscape with ferns and palm trees, and inhabited by reptiles and dinosaurs.]

[Inger-Lise Solberg is a researcher at NGU.]

# SUCCESS WITH CLAY

It all began some years ago, when I was still studying for a Master's degree. I heard a lecture by a Canadian about how two-dimensional electric resistivity measurements could be used along with geotechnical investigations on the ground. At the same time, a project had started which made it possible to work on this for a doctorate. I thought this was hugely interesting and we had a feeling it might be just the thing for we who were involved in quick clay mapping. It has proved very appropriate.

There is a great deal of quick clay in Norway, but only in areas that were once seabed. The marine clay became dry land due to land uplift after the Ice Age, and in some places the salty sea water in the clay was slowly but surely replaced by fresh groundwater. The lattice structure in the clay then becomes unstable and quick clay is formed. Erosion or loading may then cause the ground to collapse and be transformed into a fluid slide. Since quick clay has poorer conductivity than saline marine clay, 2D resistivity measurements of the ground have a very high potential to distinguish these from each other.

We have been testing this for many years. And it works! We lay out a cable equipped with electrodes which transmit electric impulses through the ground. The data acquired can tell us whether there are indications of quick clay in the ground. Subsequent drilling must be done to confirm this, but the 2D resistivity measurements enable us to limit the number of boreholes and potentially save society large sums of money.

At the point of intersection between geology, geophysics and geotechnology, we have developed a method that is now being used to prevent quick clay slides and to study them afterwards. We at NGU are proud of this!

[PS: Measuring electric conductivity in the ground has several areas of use in addition to mapping quick clay. The method has been used in ore prospecting for many years, and also to reveal zones of weakness in bedrock which may cause problems when building tunnels or in potential landslide sites, for example.]

# ACCOUNTS

### Accounts 2008-2011 (NOK million)

| Income | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|
| Ministry of Trade and Industry | 140,3 | 137,4 | 140,5 | 179,2 |
| Other income | 68,0 | 84,0 | 80,9 | 74,8 |
| **Total income** | **208,3** | **221,4** | **221,4** | **254,0** |

| Expences by type | | | | |
|---|---|---|---|---|
| Salary/ nat. ins.expences | 122,4 | 126,4 | 135,9 | 141,3 |
| Other expences | 79,6 | 81,5 | 79,6 | 103,5 |
| Investments | 10,5 | 10,4 | 8,2 | 8,1 |
| **Total expences** | **212,5** | **218,3** | **223,7** | **252,9** |

### Accounts 2011 by main objective (NOK million)

| Main objective | Total | External finance |
|---|---|---|
| Sustainable added value from geological resources | 77,8 | 21,7 |
| Effective use of geoscience knowledge in land-use planning and development | 88,5 | 33,7 |
| Better knowledge of geological development and processes in Norway | 62,4 | 15,2 |
| Management and dissemination of geological data and knowledge | 24,2 | 2,7 |

### NGU's total production of reports, publications, presentations and maps for 2008-2011

| Product type | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|
| NGU-reports | 85 | 67 | 66 | 67 |
| Articles, refereed journals | 145 | 166 | 138 | 126 |
| Other published articles | 74 | 41 | 32 | 42 |
| Presentations, teaching and posters | 545 | 484 | 542 | 449 |
| forskning.no | 19 | 19 | 16 | 17 |
| Bedrock and surficial deposits maps | 14 | 9 | 12 | 13 |

## NGU's employees

| | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|
| Total number of employees | 222 | 216 | 221 | 222 |
| With Masters Degree | 145 | 142 | 150 | 153 |
| With PhD | 77 | 77 | 81 | 82 |
| Number of foreign employees | 70 | 67 | 72 | 74 |
| Full-time equivalents | 213 | 209 | 214 | 213 |

## Number of appearances in media 2008-2011

| Type of media | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|
| 9 selected national media | 156 | 99 | 134 | 99 |
| 18 selected regional media | 514 | 267 | 310 | 347 |
| All media monitored by Retriever | 1.590 | 1.049 | 827 | 1127 |

## Web usage 2008-2011

| | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|
| ngu.no | 240.000 | 287.500 | 339.000 | 363.000 |
| ngu.no, map services | 130.000 | 123.200 | 135.000 | 174.000 |
| prospecting.no | 3.200 | 2.700 | 2.800 | 3.150 |
| grunnvann.no | 19.700 | 20.300 | 24.000 | 24.764 |

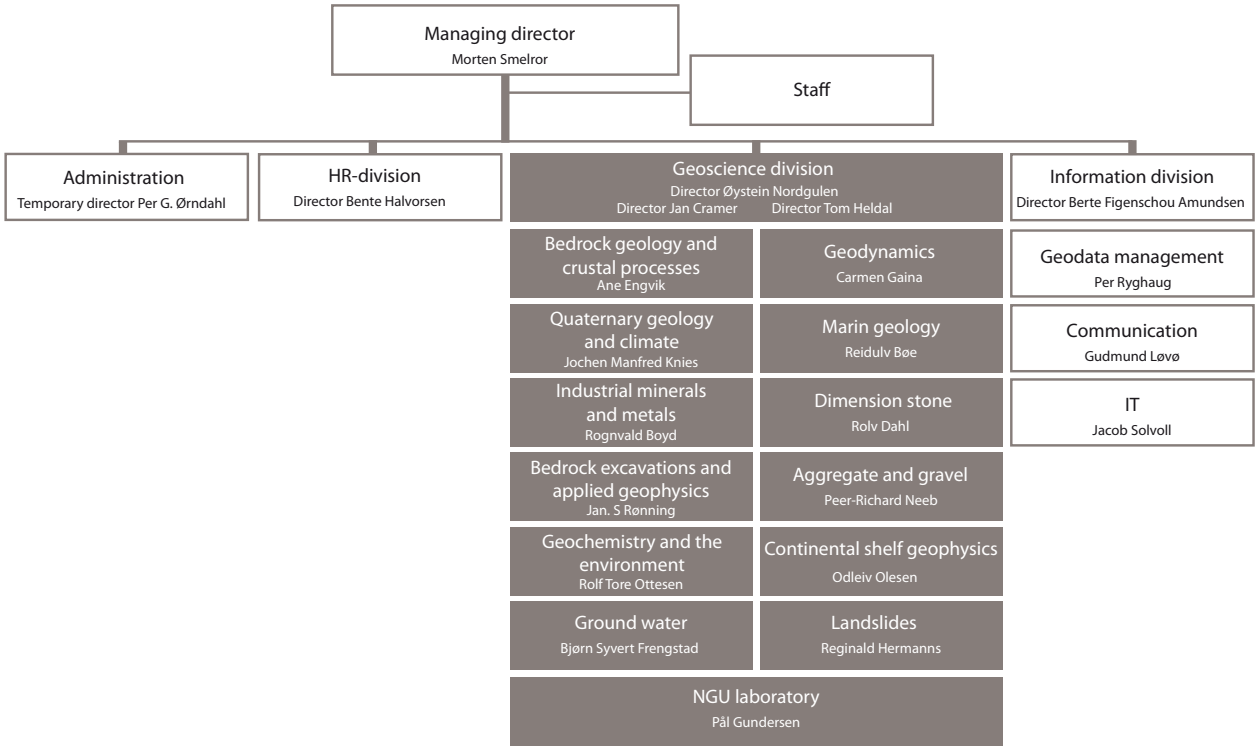
# NGU IN BRIEF

Geological Survey of Norway (NGU) is the leading national institution for knowledge of bedrock, mineral resources, superficial deposits and groundwater. NGU is a government agency under the Ministry of Trade and Industry.

NGU must ensure that geological knowledge is utilised for efficient, sustainable management of the nation's natural resources and environment. NGU's expertise can be used in development aid projects. As a research-based management agency, NGU also advises experts in other ministries on geological matters.

Under the vision "Geology for Society", NGU provides better maps and organises quality-assured geological information in national databases. Its activity is aimed at the following main objectives:

- Sustainable added value from geological resources
- Effective use of geoscience knowledge in land-use planning and development
- Better knowledge of geological development and processes in Norway
- Management and dissemination of geological data and knowledge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Morten Smelror
Staff
Administration
Temporary director Per G. Ørndahl
HR-division
Director Bente Halvorsen
Geoscience division
Director Øystein Nordgulen
Director Jan Cramer
Director Tom Heldal
Information division
Director Berte Figenschou Amundsen
Bedrock geology and crustal processes
Ane Engvik
Geodynamics
Carmen Gaina
Quaternary geology and climate
Jochen Manfred Knies
Marin geology
Reidulv Bøe
Industrial minerals and metals
Rognvald Boyd
Dimension stone
Rolv Dahl
Bedrock excavations and applied geophysics
Jan. S Rønning
Aggregate and gravel
Peer-Richard Neeb
Geochemistry and the environment
Rolf Tore Ottesen
Continental shelf geophysics
Odleiv Olesen
Ground water
Bjørn Syvert Frengstad
Landslides
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