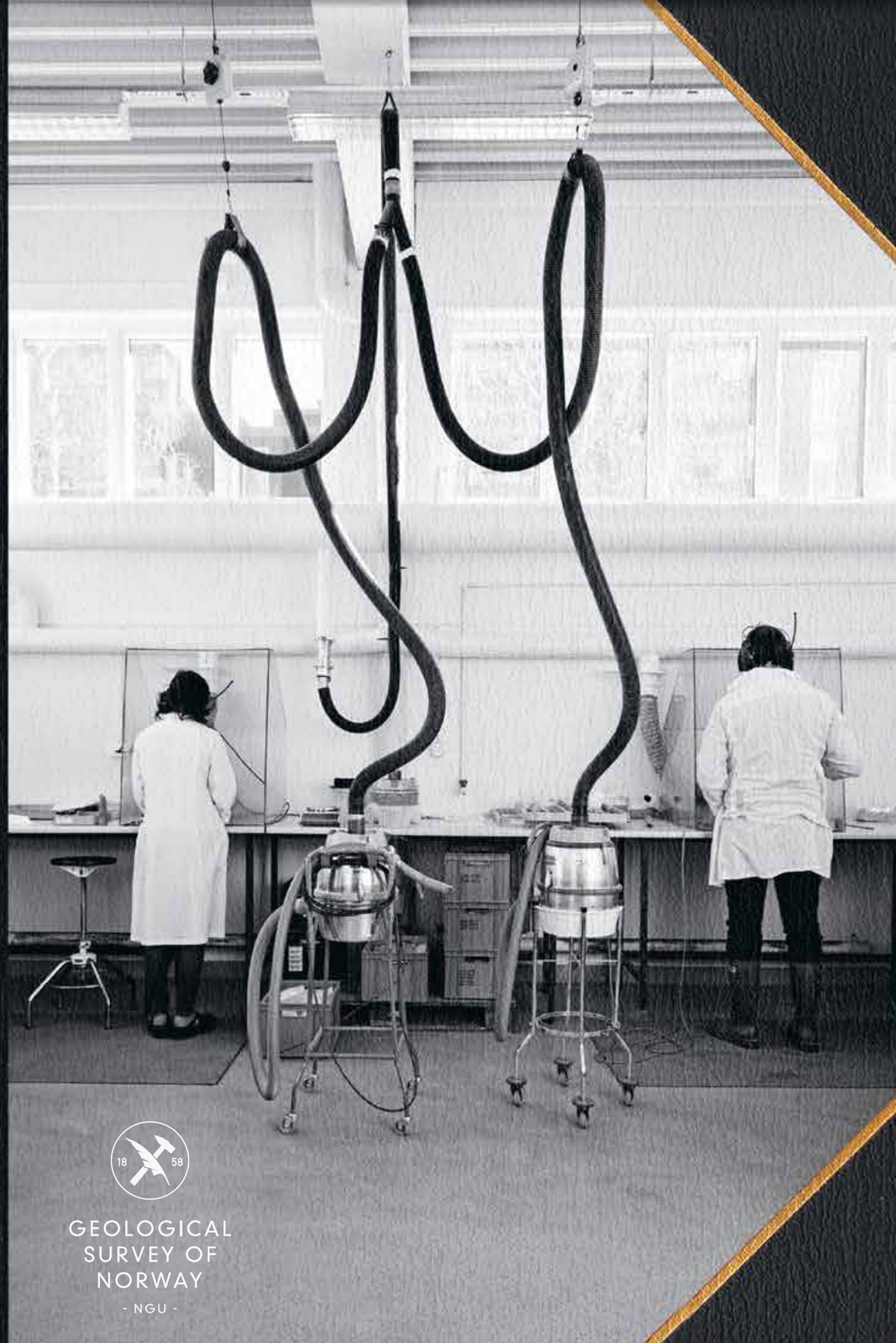
UNCOVERING SECRETS

Annual report 2016



GEOLOGICAL SURVEY OF NORWAY

- NGU -

Annual report 2016

UNCOVERING SECRETS

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GEOLOGICAL
SURVEY OF
NORWAY
- NGU -


Цена 6 р. 75 к.

I

THE LONG ROAD FORWARD

"Global climate and environmental challenges demand a restructuring of society so that growth and development can take place within the limits of nature's tolerance. Society must transition to using products and services that give significantly reduced negative consequences for climate and environment than today. Society must undergo a transition to a greener economy - a 'green shift'. This will be demanding, but certainly possible." This is how the Norwegian government has premised its politics on climate change and the environment. We will realign ourselves to a greener society.

There is no escape from the consequences of climate change. Climate change will have an impact on construction of future housing, on agriculture, and will increase the susceptibility of communities to landslides and flooding. We must map areas that are at risk of landslides and develop models that illustrate how flood and rising sea levels will affect cities and urban centers.

The Paris Agreement stipulates that all countries are obliged to undertake measures to reduce the emission of greenhouse gases. These initiatives will affect many sectors and will change our everyday lives. We must adapt to more energy-efficient industrial production, construction activity and transportation by reducing emissions and decreasing waste.

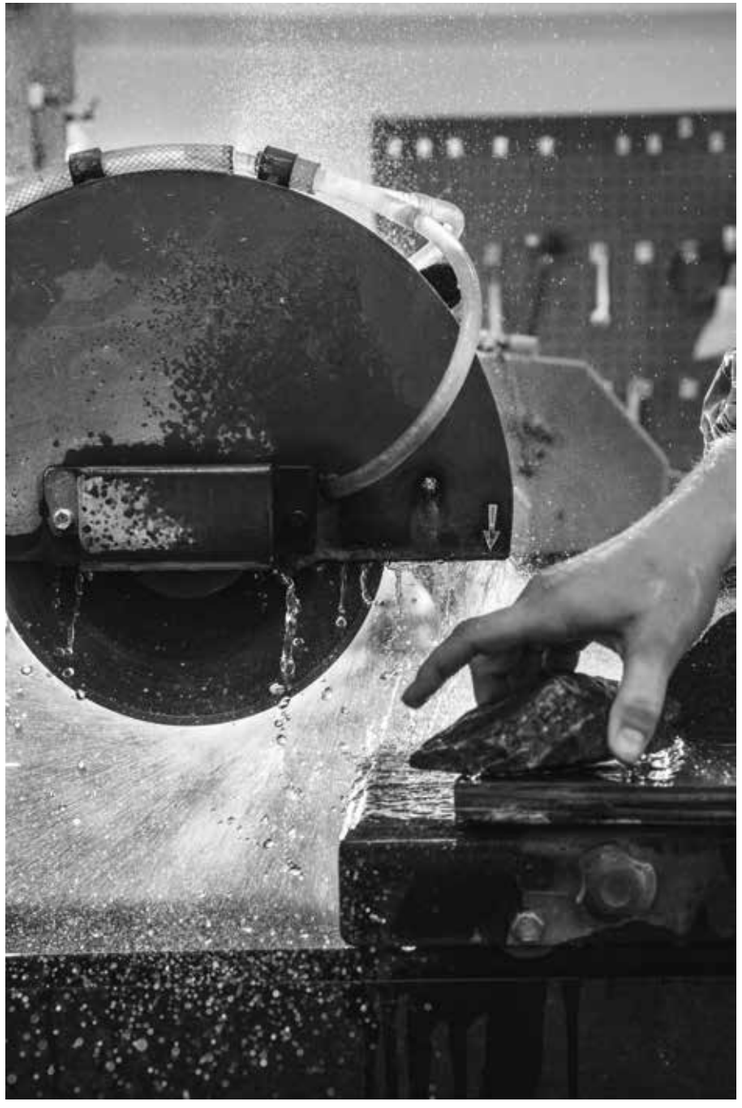
In a greener society, industry will require increased access to a range of rare minerals that are essential in the development of smart, new technological solutions and particularly those technologies that will generate renewable energy. We must invest in exploration for those minerals and metals that will be part of our green "stone age" and we need to develop technologies that ensure the highest mineral extraction rate. In addition, we should recycle more and reclaim minerals for reuse.

Norway's geology is varied and this country is endowed with numerous deposits of metal, industrial minerals and rare earth elements that are required for the technological solutions of the future. The first step is to increase the pace of geological, geophysical and geochemical mapping that will cover regions that will benefit from modern maps and up-to-date data. This would benefit industry and public administrators.

With knowledge of geology in place, along with more efficient methods for extracting resources and improved recycling of metals and minerals, a more environmentally-friendly mineral value-chain can also be developed in Norway.

As we confront the green 'stone age' we can, in many ways, play an active role.

Morten Smelror,
Administrative Director



II

HOW GREEN WILL BE MY VALLEY[1]

The varied geology of mainland Norway provides numerous possibilities for discoveries of a broad spectrum of mineral resources[2]. The actual and potential resource value in the ground may be nearly 2,500 billion Norwegian kroner.

The green shift means moving towards a more efficient and cleaner mineral industry. Greenhouse gas emissions must be reduced, extraction of raw material must become more efficient, and quarry waste must be better exploited. There must be a greener consumption of more locally-sourced materials. Norway and the EU are well-equipped for the green shift. Although mineral industry has advanced towards developing truly sustainable solutions, extensive mining and extraction of new minerals is still required.

Throughout human history, raw mineral resources have been crucial for prosperity and development. Each new economic epoch has been characterised by a new mineral resource becoming available and put into use. The Stone Age was replaced by the Bronze Age, in the same way that green energy will replace fossil fuels. Today, nearly all elements in the periodic table are used and their availability and use will help to advance technological development.

Certain metal and minerals are especially important for the implementation of the green shift. These minerals include those crucial to climate- and environmental-friendly energy production, those used directly in consumer products, those that ensure efficient production of technology and those required for the electrification of transport vehicles.

In 2016, NGU produced a report on the role of minerals in Norway's green shift, which was presented as a background document to participants to the annual meeting of the Norwegian Confederation of Enterprise[3]. In the report, NGU identifies copper, phosphate, graphite, rare earth metals, lithium, titanium, olivine and quartz as examples of 'green' minerals.

Europe's largest onshore wind power plants will require a massive production of ores and rare earth metals. Already planned is the construction of 278 wind turbines at six wind farms in Trøndelag that will produce renewable energy for 170,000 households. Assuming gearless turbines are used, each installation will require 475 metric tons of steel, 36 tons of copper, 2.6 tons of lead, 1.3 tons of aluminum, 400 kg nickel, 400 kg of neodymium and 80 kg of dysprosium.

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1 Reference to "How Green was My Valley", an Oscar winning American drama from 1941 directed by John Ford.

2 The mining industry in Norway has a turnover of more than 12 billion kroner annually and exports account for about half of this amount. Between 95 and 100 million metric tons of mineral raw materials are produced each year. This industry employs approximately 5500 people annually.

The value of sand, gravel and clay is now upwards of 5.9 billion kroner. Natural stone has been valued at of 1.1 billion; industrial minerals are at about 2.5 billion, while metallic ores are valued at about 2.5 billion.

3 NHO stands for the Confederation of Norwegian Enterprise, whose membership is about 25,000.

III

MOST OF IT IS NORTH

In 2016, all the available information on the most important metal and diamond deposits[1] in the Arctic, north of the 60 degrees, was gathered and made available in the report "Mineral Resources in the Arctic." The Geological Survey of Norway (NGU) led the production of this publication, which has involved eight Arctic countries.

During the same period in 2016, NGU's mapping programme "Mineral Resources in North Norway" (MINN) published 11 scientific papers, which included maps, photos and data, in the Norwegian Journal of Geology. These articles represented the results of five years of work in Norway's three northernmost counties.

"This country is long. Most of it is North"[2] wrote poet Rolf Jacobsen. NGU has followed this call. In the last years: We have "walked against the wind, climbed mountains and looked to the North."

"Mineral Resources in the Arctic" comprises a book, maps and a database, and represents the first collection of information on the Arctic's main mineral resources. This collection reveals how large a role the mineral industry has played in Arctic regions over the last century, as well as how the search for mineral resources continues to be a priority today.

Recent years' strong international focus on northern regions, from strategic, military and political perspectives, forms part of the backdrop for this project, which is financed by the Ministry of Foreign Affairs. The overview provided by the project is part of the knowledge base for future, sustainable development of the region.

The Arctic holds numerous, large mineral deposits, which will likely all, in turn, gradually be investigated and mined over the coming years. The EU, in particular, has a strong focus on securing access to regionally and locally sourced metals and minerals.

MINN's publication provides a comprehensive update and depiction of the geological development and potential for mineral resources in northern Norway. Mapping started at Cape Nordkinn, the northernmost point in Norway, southwards to Hattfjelldal in Nordland. The map includes geological, geochemical and geophysical surveys.

The scientific work may be of interest not only to various enterprises, prospecting companies, researchers working on mineral resources in the North, but also for politicians and decision makers.

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1 The spectacular Popigai field in Russia was created by an asteroid impact over 35 million years ago. The asteroid hit an area of bedrock containing graphite, which was converted to small grains of ultra-hard diamond in a minute fraction of a second following the impact, forming a crater with a diameter of 100 km. However, the diamonds found here are not of jewelry quality. Altogether 28 diamond resources are described in the book "Mineral Resources in the Arctic", as well as information on 207 large, very large and potentially large metal deposits.

2 This is an extract from the poem "North" by Rolf Jacobsen [as translated to English by Roger Greenwald (2002) in the collection "North in the World".

IV

TREASURE HUNT [1]

New detailed maps of the seafloor in five municipalities in Southern Sunnmøre were presented in 2016. The new maps around the bird sanctuary Runde Island will benefit the marine and maritime industries in the coastal zone.

New sea bottom maps for the northernmost municipalities in Sogn and Fjordane are currently being produced so that soon this community will have a better overview of its coastal landscape. Rundeskatten has become the name for the valuable cargo carried by the Dutch ship Akerendam on its maiden voyage in 1725. During a heavy winter, the ship sank outside Runde Island, on the west coast of Norway. The treasure was found by a diver in 1972. Now, maps identify areas where new treasures may be found along the coast.

In Southern Sunnmøre, researchers hope to shed light on the characteristics of 600 square kilometers of seafloor, in the south Sunnmøre County. The maps will depict seabed conditions in detail: moraine, shipwrecks, submarine landslides, mud and stone, steep slopes and polished rock. On the research vessel 'Seisma', researchers use video recordings, echo sounders, sampling, and detailed bathymetric data from the Norwegian Mapping Authority, to produce large scale high-resolution maps that reveal the characteristics of the sea bottom. The marine base maps comprise bathymetry and sedimentary maps, and thematic maps that include mooring conditions, slope, diggability and bottom conditions.

This is the way to deliver the maps and the research results it takes to responsibly manage the environment and natural resources in coastal areas. The maps give planners and scientists detailed information on the characteristics of the sea bottom so that guesswork is eliminated entirely. Another example: Once available, these digital maps will assist those on fishing vessels find the best site to cast their lines to catch cusk and cod. The maps will also make it easier to locate optimal sites for aquaculture. Further to this, the maps indicate the optimal anchoring places for shipping vessels and planners can identify the best route for pipes and cables along the bottom of the fjord.

I fjor vart det også presentert ein rapport om spanande geologi og biologi under den kjende Saltstraumen utanfor Bodø. Det undersjøiske kystlandskapet rundt ein av verdas kraftigaste tidevasstraumar er dermed også kartlagt.

Last year, researchers produced a report on the interesting geology and biology under the famous Saltstraumen, outside Bodø. This included a map of the submarine coastal landscape around one of the world's strongest tides.

"All life's a voyage. All the world's an ocean"[2]

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1 Together with the Norwegian Mapping Authority and Ocean Research Institute, NGU wants to map the entire Norwegian coastline through the project entitled "Marine Base Maps for the Norwegian Coastal Zone" (MAGIN). The goal is to map the coastal zone one nautical mile from the shore. MAGIN will give society the basic knowledge required for development and sustainable management of the coastal region, by providing products like a 3D marine base map, habitat maps and maps identifying areas of pollution.

2 Ocean, poem by Kolbein Falkeid

V

SOFT ROCK IS HERE TO STAY

Microscope images of thin sections of soapstone[1] adorned the windows of the Trondheim Art Gallery in 2016. Nidaros Cathedral's soapstone decorated the exhibition. Meanwhile, NGU geologists have actively been searching for sources of soapstone in cooperation with Nidaros Cathedral Restoration Workshop (NDR)[2]. Geological mapping, research, management and dissemination of knowledge are activities that all tie together. Hence, NGU was also happy to work with artist Maja Nilsen to find the source material for her exhibition and assist her to view thin section samples under a microscope. She took many photos and digital material was assembled and arranged to create a stain-glass work.

At the same time, a search was taking place for new soapstone for the world's northernmost medieval cathedral and Norway's national sanctuary. Soap stone supplies at NDR's Workshop are expected to run out soon. Geological expertise is crucial to finding suitable material for this restoration project. At NGU's laboratory in Lade in Trondheim, geologists and stonemasons tested core samples from the Dalhaugen stone quarry in Mosjoen. Samples of soapstone were located and extracted 80 meters below the surface, and could be used to carve the sculptures for the cathedral's walls to endure for centuries to come. However, this depends on the size of the deposit, the depth and the quality of the stone.

The stone must be hard-wearing and strong to ensure it lasts, but at the same time soft, so that the stonemason can easily carve it into various shapes. NDR Workshop has had experience with stone that easily weathers and stone that cracks.

The weathered stone choir wall to the North, constructed of Grytdal soapstone from Støren, and the section known as the "King's entrance" across Archbishop's courtyard[3] are both top priorities for this restoration. NDR is the only stone masonry workshop of its kind in Norway. NDR selects stone from domestic quarries only, and monitors the entire process - from quarry to the cathedral. In addition to ensuring that the soapstone cathedral in Trondheim is well maintained, the government has assigned NDR nation-wide responsibility to guide and advise groups responsible for the conservation and restoration of historically significant stone buildings.

The cathedral is built of soapstone from 20 stone quarries and restoration takes place continually. The last stone will never be set in place.

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1 Soapstone is a soft, smooth metamorphic rock that contains large amounts of the minerals chlorite and talc. The stone holds heat so it is often used to make wood ovens and fireplaces. This soft stone was used in the past to carve a wide range of items, from spindle whorls and fishing sinkers, to kettles and bowls. In medieval times, soapstone was also used for building and as a decorative stone. Deposits are found throughout the country. Many of the old soapstone quarries are protected as national heritage sites, while some are still active and will supply resources to meet future needs.

2 www.nidarosdomen.no/nidaros-domkirkes-restaureringsarbeider/om-ndr

3 The Archbishop's Palace measures at 100 x 100 meters. The building was the home of the Archbishop and served as administrative center in Norway until the Reformation of 1537.

VI

WALK IN THE PARK

Geoparks have become a new way to bring geology to the masses. NGU leads this initiative in Norway, through the Norwegian Committee on Geoheritage and Geoparks, and has published several brochures and pamphlets on the topic.

In 2015 a UN agency, UNESCO[1], formally proposed the designation UNESCO Global Geopark[2] (UGG), and this was quickly ratified by all 195 member countries. By May 2016, the Geoparks network included 120 sites around the world. Each geopark contributes to the story of Earth's long and eventful history.

In Norway, there are currently two Unesco Global Geoparks. In 2006, Gea Norvegica became the first UNESCO Global Geopark in Norway, and includes eight municipalities in Telemark and Vestfold. Moreover, the park was the first in Scandinavia to receive UNESCO approval, and offers geological diversity that is unique on a European scale.

In March 2010 Norway's second geopark, Magma UNESCO Global Geopark in Rogaland, won approval. Located in Dalane and Flekkefjord, the unique landscape of igneous rocks formed nearly a billion years ago.

There are several areas in Norway that may become global geoparks in the near future. At the top of this list is the initiative Trollfjell geopark in Nordland and North Trøndelag. Work has simultaneously begun in Nordland, Hedmark and Western Norway.

Through national regulations such as Norwegian Nature Diversity Act, many areas are protected in Norway. For example, national parks are carefully managed and human activity is restricted. However, Geoparks are not a new category of protected areas. Geoparks are open to the public via footpaths and activity centers accessible to schools and tourists. Geoparks are an important starting point for nature-based tourism.

NGU helps evaluate the quality of the geological information in Norwegian Geoparks. NGU is part of establishing a national geopark network, which will serve as a forum for Geoparks and other projects that work towards developing geological attractions.

The Geological Survey of Norway bears a long history and proud traditions into the future. We have put geological heritage on the public agenda. We intend to follow through.

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1 UNESCO, the UN's organization for education, science, culture and communication

2 A UNESCO Global Geopark is "... a coherent geographical area where the area and landscapes of international geological value are managed in a sustainable manner". In a UNESCO Global Geopark, geological heritage is viewed as part of the Earth's natural and cultural heritage, so that awareness of topics such as resources, climate and natural disasters, may be increased.

VII

A SPACE ODYSSEY

Radar data from Space reveals that a 197-meter high skyscraper in San Francisco, the Millennium Tower, is settling into the ground by several centimeters a year. The sinking is occurring more on one side than the other, so the entire skyscraper has gradually begun to lean.

Over the last years, NGU has participated in a project funded by the European Space Agency (ESA). The project has helped assess the performance of two satellites, Sentinel-1A and Sentinel-1B, which are part of the EU's Copernicus[1] space programme. These satellites acquire new radar images over broad areas, including California, where the Millennium Tower stands. After enough data is gathered, researchers can calculate the rate of movement of both natural terrain and buildings. For quite a few years, NGU has been analysing synthetic aperture radar (SAR) data provided by the satellites. When data is collected over time, changes on the earth's surface - such as potentially hazardous movements of a slope - can be revealed with millimeter precision, using a technique called InSAR. In 2016, NGU opened a center that will monitor all of Norway using these images from space.[2]

This technique demonstrated that the ground was moving under Oslo Central Station and around the Oslo Opera House. The Opera House itself is stable.

The successful use of the InSAR, as in the case of San Francisco and Oslo, gives us justification to use the method not only to monitor smaller objects, but to provide a continuously updated national map service that reveals areas with active sinking and deformation.

The two Sentinel-1 satellites can also use radar images for environmental monitoring. In addition to deformation monitoring, the satellites can assist in mapping and monitoring of ice sheets in the Arctic and the marine environment. Radar data can also be used for mapping of land, forest, water and mountain regions - and support those providing humanitarian assistance in disaster situations.
As it turns out, the reason the Millennium Tower is not stable is that the concrete support columns do not reach right down to the bedrock 60 meters below ground. Most likely, the stability of the ground was misjudged. Is all this "... a countdown to tomorrow, a map of human destiny, a search for the infinite," as mentioned in science fiction film "2001: Space Odyssey"[3] from 1968? The Odyssey NGU leads is not fiction - it is pure science.

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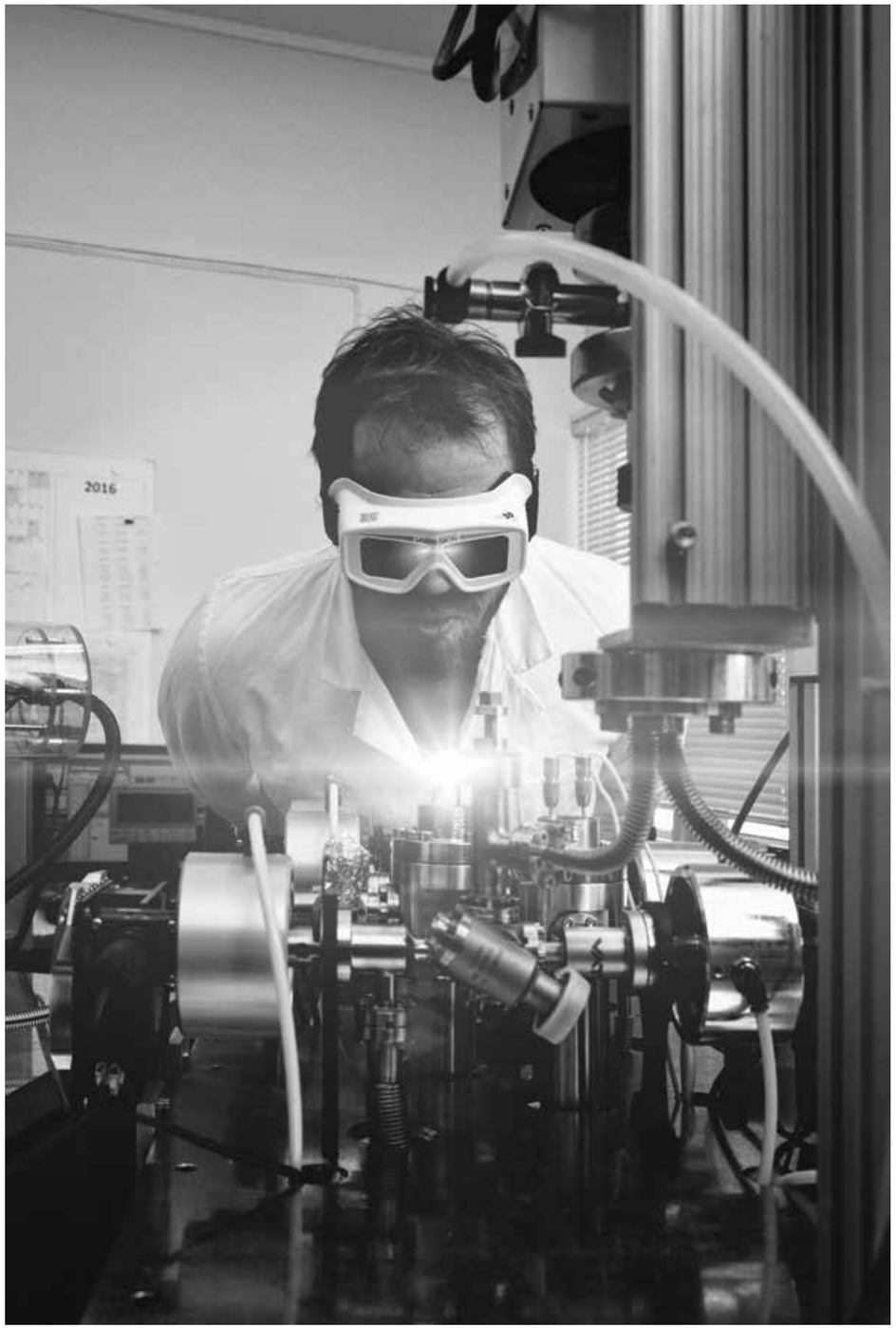
1 Nicolaus Copernicus, Polish clergyman and astronomer, born in Thorn in 1473. He proposed the model of a solar system with earth revolving around the sun.

2 The agreement for a multidisciplinary research and development for the development of the InSAR center was signed between the Norwegian Space Center (NSC), Norway Water Resources and Energy Directorate (NVE) and NGU. The center is primarily funded by the Norwegian Space Center - 14 million kroner over two years. Written into the agreement is the work of the research company Norut in Tromsø, and the Dutch research and development company PPO.labs.

3 Film from 1968, directed by Stanley Kubrick


2016

VIII

FAR OUT AT SEA

NGU researchers study the climate and glacial variations on Jan Mayen that have taken place the last 100,000 years. During the last glacial maximum that occurred about 20,000 years ago, the whole island was covered with ice. This climate research is being funded by the Research Council of Norway, who awarded the application full marks and described it as "exceptional".

Jan Mayen is influenced by southward flowing cold currents and northward flowing warm currents in and out of the Arctic Ocean, which might make the island very sensitive to climate change. Researchers look at the changes and correlations that influence this mysterious island[1] by examining, for example, the sediment from the bottom of the island's only real lake, Nordlaguna.

Jan Mayen, positioned at 70°59′ N., is 377 square kilometers and partly glaciated. Beerenberg, towering 2277 metres above sea level in the northern part of the island, is the world's northernmost active volcano that exists above sea level. Practically the whole of this Norwegian island, which is managed by Nordland County, is protected as a nature reserve. The island has no permanent residents, but 18 people from the Norwegian Meteorological Institute and the Norwegian Armed Forces are always stationed in Olonkinbyen.

The geology of Jan Mayen is not well researched. Therefore, the goal in the long term is to create a quaternary geological map of the island, among other things, to ensure Jan Mayen is responsibly managed as a conservation area.

Far under the surface of the Atlantic Ocean, west of Svalbard, is the 500 kilometer long the Knipovich Ridge[2]. NGU will now improve the knowledge about this ocean floor ridge. This won't be accomplished by diving deep to bottom of the ocean[3], rather this will involve flying over the ridge to collect aeromagnetic data from an aircraft equipped with a magnetometer.

Mid-ocean ridges are created when the ocean floor cracks, lifts and spreads apart over several million years. Along the fracture zone, lava flows from deep below, and cools to form volcanic ridges that can stretch hundreds of kilometers along the seabed. One question to be answered: Why does the Knipovich ridge bend almost 90 degrees when, in theory, it should be spreading quite linearly? How did this transition from a lateral fault to a mid-ocean ridge occur?

Using the aeromagnetic measurements, researchers can reconstruct what actually happened over tens of millions of years. The results may help the country's oil industry to understand uplift and volcanism along the western margin of the Barents Sea.

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1 The Mysterious Island, Jules Verne, Sampson, Low, Marston and Searle, 1875 (translated from L'Île mystérieuse, Hetzel, 1874)

2 Airborne surveys over Knipovich ridge are part of a broad-reaching European geoscientific collaboration. The goal is to monitor the deformation processes deep in the earth - and to map their consequences to the earth's surface. Data is being gathered on events such as earthquakes, volcanic eruptions, tsunami and other deep earth processes. 25 countries, four international organizations and more than 250 research groups are participating in the project. See https://www.epos-ip.org.
Ei verdsomsegling under havet, Jules Verne, Samlaget forlag, 2005

3 Twenty Thousand Leagues Under the Sea, Jules Verne, Sampson, Low, Marston and Searle, 1875 (translated from Vingt mille lieues sous les mers: Tour du monde sous-marin, Hetzel, 1871)

IX

A WORLD OF RESEARCH

In 2016, two new articles were published by NGU researchers in the internationally renowned journal Nature Communications[1]. Fractures and so-called brittle fault zones are the topic of one article, the other deals with dating past methane emissions from the seafloor.

The article on fault zones introduces an innovative approach to help understand the formation of fractures and brittle fault zones. The approach involves detailed structural geological measurements combined with K-Ar dating of a particular clay mineral that formed at the same time the faults were formed.

The results have great significance because brittle faulting can accommodate and absorb momentous and potentially catastrophic deformation. These faults affect and steer processes such as water flow in rock, slope and rock mass stability as well as mineral and oil deposit distribution.

The authors present the results of their investigations on the reactivated fault in Hordaland County in western Norway, known as the Goddo Fault. This fault was first active in the Permian period about 260 million years ago, and was then reactivated in the Jurassic 200 million years ago. The fault was reactivated once again in response to fluids circulating in the Cretaceous period, about 125 million years ago[2].

In another article, NGU geologists tell about ancient methane emissions from the seafloor that are archived in the carbonate crust near the areas of emission. They found that the emissions occurred just after the withdrawal of the ice sheet after the last ice age. These results can help explain what will happens as a warmer climate accelerates the melting of ice and the release of methane currently frozen in seabeds throughout the world.

When ice moved off land onto the continental shelf during the last ice age, increased pressure on the sediment layers resulted in formation of gas hydrates with trapped methane. As the ice receded and the extra pressure disappeared, the melting of hydrates began and methane was released.

It has been difficult to date old methane emissions. Now scientists have succeeded in doing this by using natural radioactive isotopes of uranium and thorium in the analysis work.

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1 Cremiere, A., Lepland, A., Chand, S., Sahy, D., Condon, D.J., Noble, S.R., Martma, T., Thorsnes, T., Sauer, S., and Brunstad, H. 2016. Timescales of methane seepage on the Norwegian margin following collapse of the Scandinavian Ice Sheet. Nature Communications, 7: p. 11509.
Viola, G., Scheiber, T., Fredin, O., Zwingmann, H., Margreth, A., and Knies, J. 2016. Deconvoluting complex structural histories archived in brittle fault zones. Nature Communications, 7: p. 13448

2 the International Chronostratigraphic Chart - www.stratigraphy.org

CASH ACCOUNTS: INCOME AND EXPENDITURES 2011–2016 (MILL. KR)

Income	2011	2012	2013	2014	[1] 2015	2016
Ministry of Trade, Industry and Fisheries	170,3	172,2	186,3	189,2	174,4	149,5
Other income	66,5	79,6	75,3	77	79,2	85,9
Total	236,8	251,8	261,6	266,2	253,6	[2] 235,4
Expenses	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Salaries and related costs	124,9	128,8	135,4	141,9	147,4	140,7
Other expenses	103,2	112,9	111,4	105,7	96,7	81,3
Investments	14,0	7,6	14,6	20,6	5,7	5,5
Total	242,1	249,3	261,4	268,2	249,8	227,5

1 Since 2015, NGU falls under the government's neutral tax scheme. This means that VAT for 2016 is not charged to operating expenses, but is charged to common chapter 1633 in the central government accounts. NGU's VAT in 2016 amounts to 8.1 million kroner compared to 9.2 million kroner in 2015.

2 Of the total income received, approximately 8 million kroner will be transferred to 2017. These are funds linked to activities where all or part of the project revenue has been paid in accordance with the contract in 2016, but work has been delayed to 2017.

ACCRUED BALANCE SHEET FOR 2016 (MILL. KR)

Income	2016
State allocation (annual)	176,8
Income from grants and transfer payments	27,1
Sale and rent income	46,9
Total revenue	250,8
Expenses	**2016**
Salaries and related costs	162,7
Depreciation	9,3
Other operating costs	79,3
Total operating costs	251,3
Driftsresultat	-0,5

OVERALL PRODUCTION OF REPORTS, PUBLICATIONS, PRESENTATIONS AND MAPS FOR NGU 2011–2016

Type	2011	2012	2013	2014	2015	2016
NGU reports	67	80	47	49	66	63
Articles in scientific journals and books	126	173	137	159	142	165
Articles in other publications	42	37	23	21	28	29
Presentations and lectures	449	447	440	417	382	424
Forskning.no	17	15	21	13	14	12
Bedrock and Quaternary maps	13	14	15	10	24	11

X

WHAT THE NUMBERS TELL US

In 2015 NGU met its main objectives and complied with the requirements set forth by the Ministry of Trade, Industry and Fisheries (NFD), all within its budgetary framework and in accordance to financial guidelines. NGU runs on a balanced budget.

About 68% of NGU's financing is direct government grants. In 2016, NGU received a total allocation of 226.1 million towards expenditures, and 1.5 million from the Norwegian Environmental Agency. The total allocation from the NFD comprised a general and an earmarked grant. Around 28.2 million was earmarked for ongoing work to build a marine area database for Norwegian coastal and marine areas. Earlier earmarked allocations to mineral resource mapping were discontinued 2016. As a consequence, NGU drastically cut labour, fixed costs, field work and investments in 2016. As of January 1, 2016, NGU operates under the accrual method of accounting. Hence it difficult to directly compare the figures from the years before, when NGU's accounting basis was the cash principle. Below are the comments on both cash and accrual methods, with historical figures for the cash accounting method.

Cash-based accounting:
NGU had a total income of 235.4 million in 2016. Of this, 85.9 million was external revenue. Of the total received income, approximately 8 million kroner will be transferred to 2017. These are funds linked to activities where all or part of the project revenue has been paid in accordance with the contract in 2016, but work has been delayed to 2017. Total payments to operations and investments amount to 227.5 mill. This represents a decline of 22.3 mill. From the previous year.

Accrual accounting:
Following the accrual accounting method, NGU had a total income of 250.8 million. Total operating expenses totals to 251.3 mills, and resulted in a negative balance of 0.5 mills.

NGU's databases are available through our website www.ngu.no. In addition to the databases, our work is presented in reports, scientific journals and lectures for different audiences. The scientific production of articles at NGU is extremely high compared with similar institutions at home and abroad.

NGU has a low, stable absence rate due to illness. In 2016, the absence rate was 4.9%. For more details, please refer to the NGU's annual report to the Ministry of Trade, Industry and Fisheries (NFD), available through the NFD website.

NGU's main goals:
- Increase mapping geological resources
- Increase the availability of geosciences knowledge that can be used in land-use planning and construction activities
- Increase knowledge of geological processes and how Norway was formed
- Ensure good management and tailoring of geoscientific knowledge
- Strengthen communication and dissemination of geoscientific knowledge

NGU EMPLOYEE STATISTICS

	2011	2012	2013	2014	2015	2016
Total number of employees	222	211	219	225	227	202
With Master's Degree	153	143	153	160	163	148
With PhD Degree	82	72	77	82	80	74
Non-Norwegians (total)	74	66	75	81	84	69