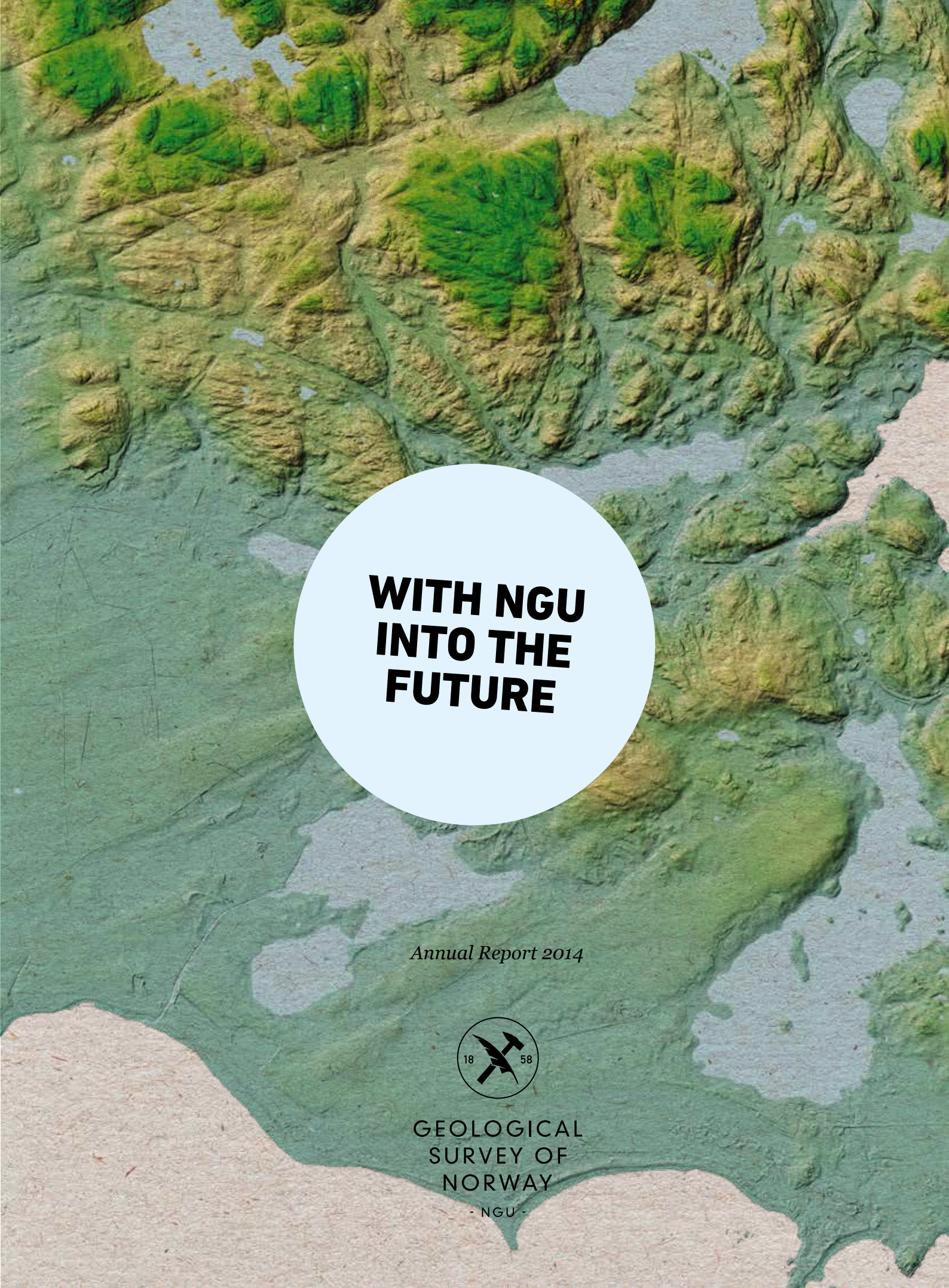

WITH NGU INTO THE FUTURE

Annual Report 2014

GEOLOGICAL SURVEY OF NORWAY

- NGU -

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GEOLOGICAL
SURVEY OF
NORWAY

- NGU -

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The national institution for knowledge about bedrock, superficial deposits, mineral resources, and groundwater.

The Geological Survey of Norway (NGU) carries proud historical traditions into the future. Our knowledge ensures wise and comprehensive decisions for the best of society. We put geology on the agenda. We will continue doing this.

NGU's motto is "Geology for Society".

NGU has the following principal objectives:

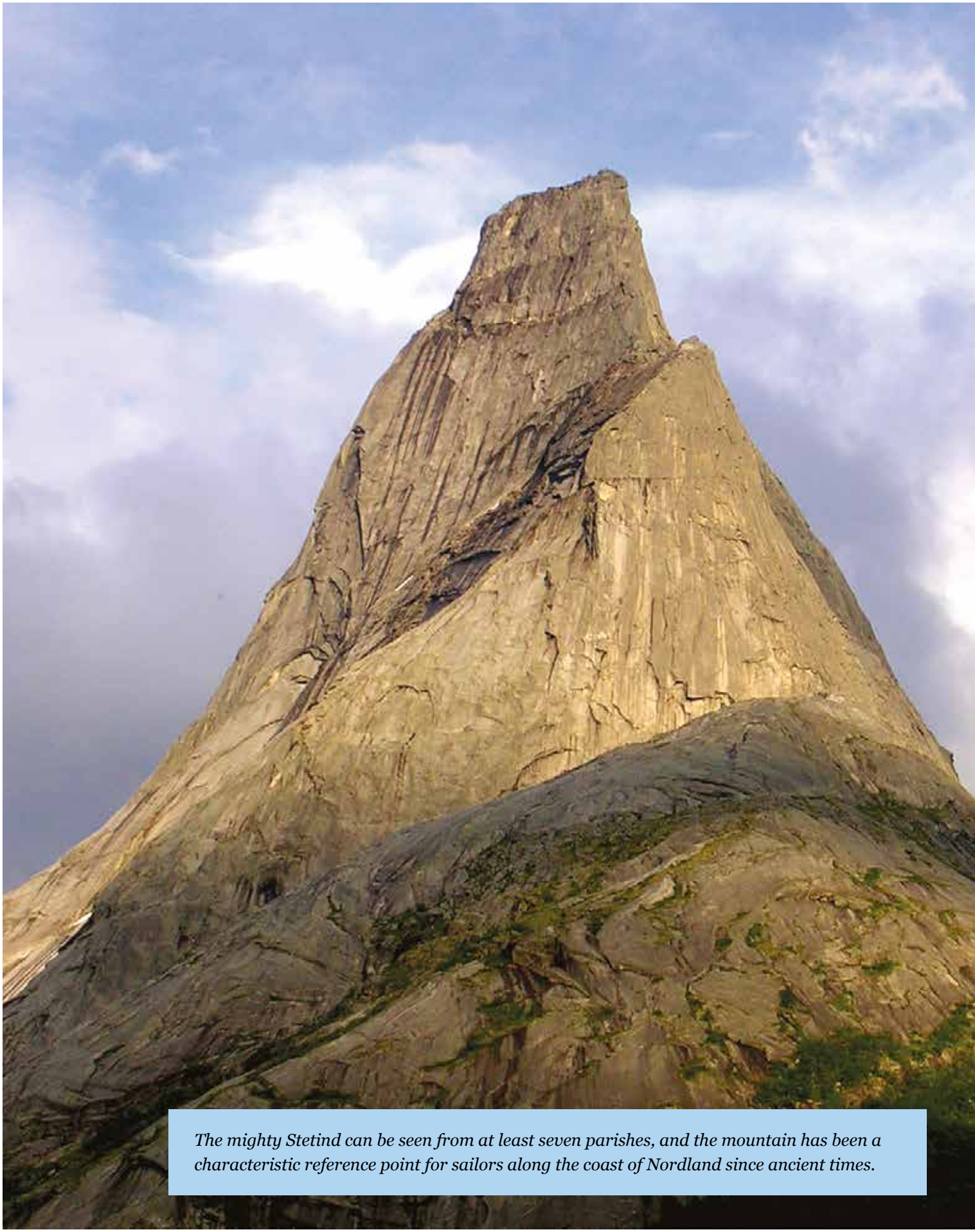
- Create long-term value from geological resources
- Increase the use of geoscientific knowledge in land-use planning and development
- Improve knowledge about Norway's geological development and -processes
- Good management and customization of geological knowledge
- Good communication and dissemination of geological knowledge
- Better attainment of targets through good cooperation

ONLINE PRESENCE

The Geological Survey of Norway is reaching for the top.

CEO Morten Smelror

Stetind



The mighty Stetind can be seen from at least seven parishes, and the mountain has been a characteristic reference point for sailors along the coast of Nordland since ancient times.

Photo: NGU, Rolv Dahl

"...an anvil upon which the gods can hammer". Philosopher and mountaineer Peter Wessel Zapffe described Norway's national mountain Stetind, at 1,392 metres above sea level in Tysfjord in the county of Nordland, as "a giant, titan, majesty and horn of hell".

In several essays and stories, Zapffe has, with subtlety and humour, described his escapades in nature. The classic book Barske glæder (Rugged delights) from 1969 has made many aware of Stetind and of other mountains and peaks in Northern Norway.

"Our knowledge ensures wise and holistic decisions for the good of society."

At the Geological Survey of Norway (NGU), we also want to reach for the top. We aim to create the world's best geological mapping service - and we are well on our way. We will negotiate future challenges and have a strong online presence.

Our databases and publications are already easily accessible on mobile platforms. In 2014, almost 250,000 unique users visited www.ngu.no. More than 292,000 visits were registered for the mapping services and the number of page views was well in excess of a million. The number of downloaded data sets has grown exponentially.

We have launched a new and modern web portal, devised a new graphic profile and modified our logo. We have drawn on our proud past by bringing back the hammer and quill pen, and created a modernised version of the logo, which was introduced in NGU's first publication series in 1891.

NGU was established in 1858. Few institutions in Norway have as long a tradition and history as NGU. When Hans Henrik Reusch took over as head of the institution in 1888, NGU was given its own emblem. Reusch was a prolific researcher, and his studies of landscape features and weathering remain highly relevant today, such as in connection with the tunnel collapse in Vestfold or the oil reservoirs in the Utsira High in the North Sea.

Basic knowledge of resources and risks never goes out of fashion. Restructuring and modernisation require new knowledge on mineral resources, groundwater, biodiversity and exploitation of renewable energy. Such knowledge also contributes to more effective and safer development and the sustainable and safe use of land.

We procure knowledge, share it, and ensure that it is used for the common good; it is our social mission and the foundation of our vision "Geology for society." We proudly carry historical traditions into the future. We put geology on the map. Our knowledge ensures wise and holistic decisions for the good of society. We intend to continue in this vein.

Even the legendary British mountaineer William Cecil Slingsby failed in his 1904 attempt to be the first to climb the granite mountain Stetind, which he described as "The ugliest mountain I ever saw." But someone did reach the summit on July 30th, 1910: the Norwegian climbing trio of Schjelderup, Bryn and Rubenson.

Geologist John Dehls

IN TIME AND SPACE

Nature cannot be tamed, but it can be monitored.

The sheer walls of the western part of Jutulhogget are over 100 metres tall. Further east they are between 220 and 240 metres tall. At the top, the width is between 150 and 400-500 metres.

Photo: NGU, Harald Sveian

A dam of ice burst. A flood of melt water crushed the bedrock and excavated one of Northern Europe's longest gorges. In no time at all, the landscape had changed totally in a 2.4 km stretch eastwards of Alvdal and through the mountains into Rendalen.

Jutulhogget was formed in the blink of an eye 9,000 years ago. Earthquakes, landslides and volcanic eruptions are examples of other enormous geological forces that very quickly can pose a threat to people, buildings, bridges, dams, roads and railways.

Nature cannot be tamed, but it can be monitored.

In 2014, the EU's Copernicus programme provided for an enhanced satellite-based monitoring of areas in Norway that are prone to landslides. The surveillance satellite, Sentinel-1A, which was launched from the space centre near Kourou in French Guyana, provides detailed data every 12 days. Data are used to effectively map the whole country for surface movements and for periodic measurements of unstable mountain areas. From 2016, Norway will have access to data every 6 days, allowing to also catch landslides that develop very quickly.

Satellites have proven to be a very effective tool for identifying areas where large or small parts of a mountain are moving. By comparing series of images collected over days, months and years, scientists can see movements, compactions and depressions in the landscape.

Sentinel-1A is also used to track shipping, oil spills, icebergs, sea ice, glaciers, volcanoes and floods. The satellite can see through clouds and cover vast areas in a short time. The results make it safer for people and help to strengthen the framework for social and economic development in exposed areas.

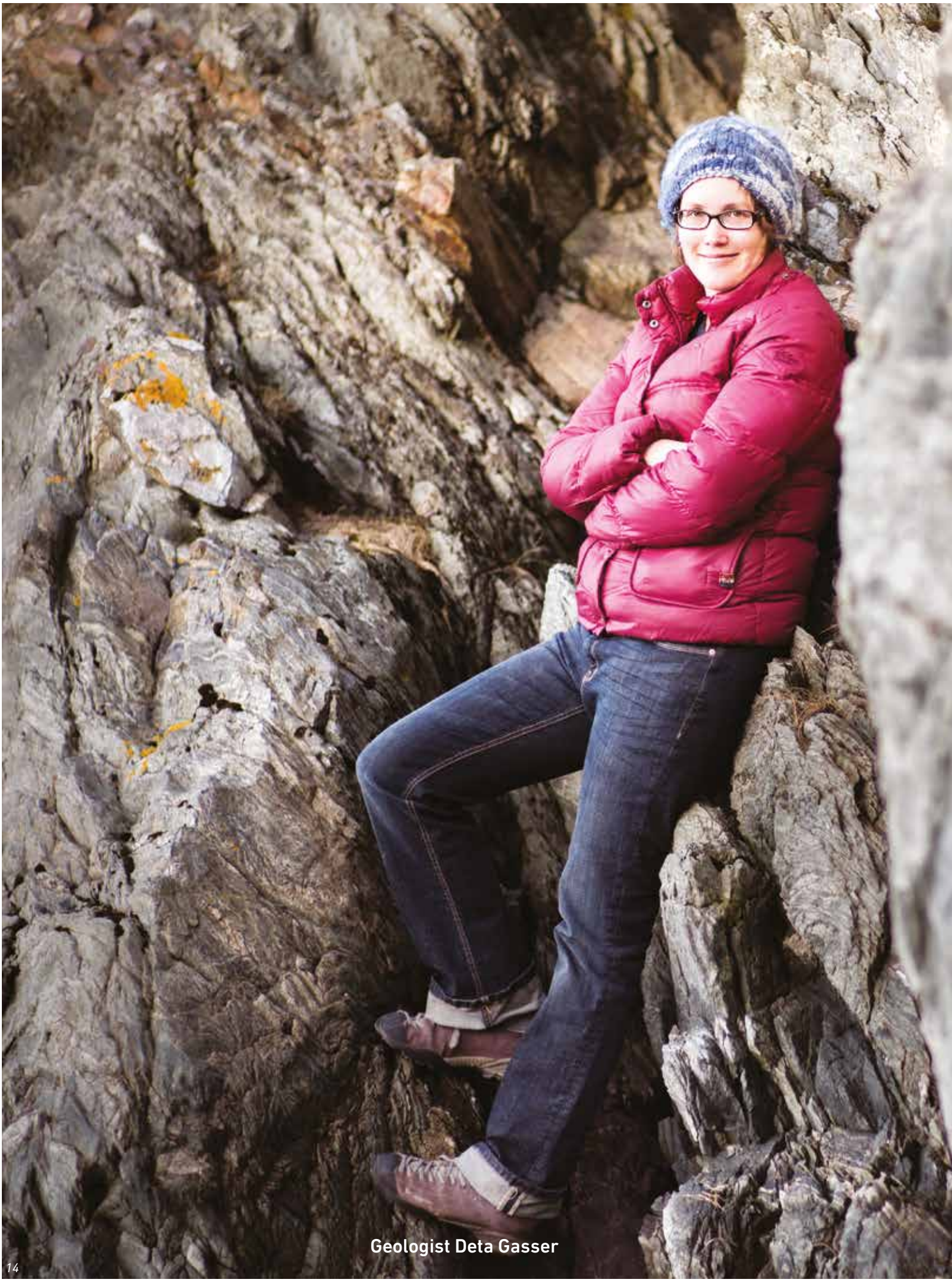
Major landslides have led to some of the worst natural disasters in Norway. Historical documentation shows that Norway has had two to three large disasters related to landslides and tidal waves every 100 years. One of the great dangers of landslides in Norwegian fjords is the tidal waves that follow.

"Satellites have proven to be a very effective tool for identifying areas where large or small parts of steep mountains are moving."

The Norwegian Water Resources and Energy Directorate (NVE) has been assigned national responsibility for the prevention of damage caused by landslides. NGU has extensive experience in mapping unstable mountainsides, and carries out this work on behalf of NVE.

Mapping landslides uses a variety of methods and data sets. To date, three counties and some smaller areas in other parts of the country have been mapped. Four mountainsides in Norway are under continuous surveillance.

How Jutulhogget was formed is the subject of various myths, the most famous of which concerns repressed hostility and a brutal battle between the giant from Rendal and the giant from Elvdal. Reality, however, is just as incredible.



Geologist Deta Gasser

HARD FACTS

The more we know about the bedrock underneath us, the closer we get to understanding how the landscape and the Earth have evolved, and how this will continue.

Five hundred million years ago, lava rose up from the Earth's interior, solidifying and forming new oceanic crust along the margin of what was then North America. Later, during the formation of the Caledonian mountain range, a piece of this crust was torn loose and pushed along towards our continent.

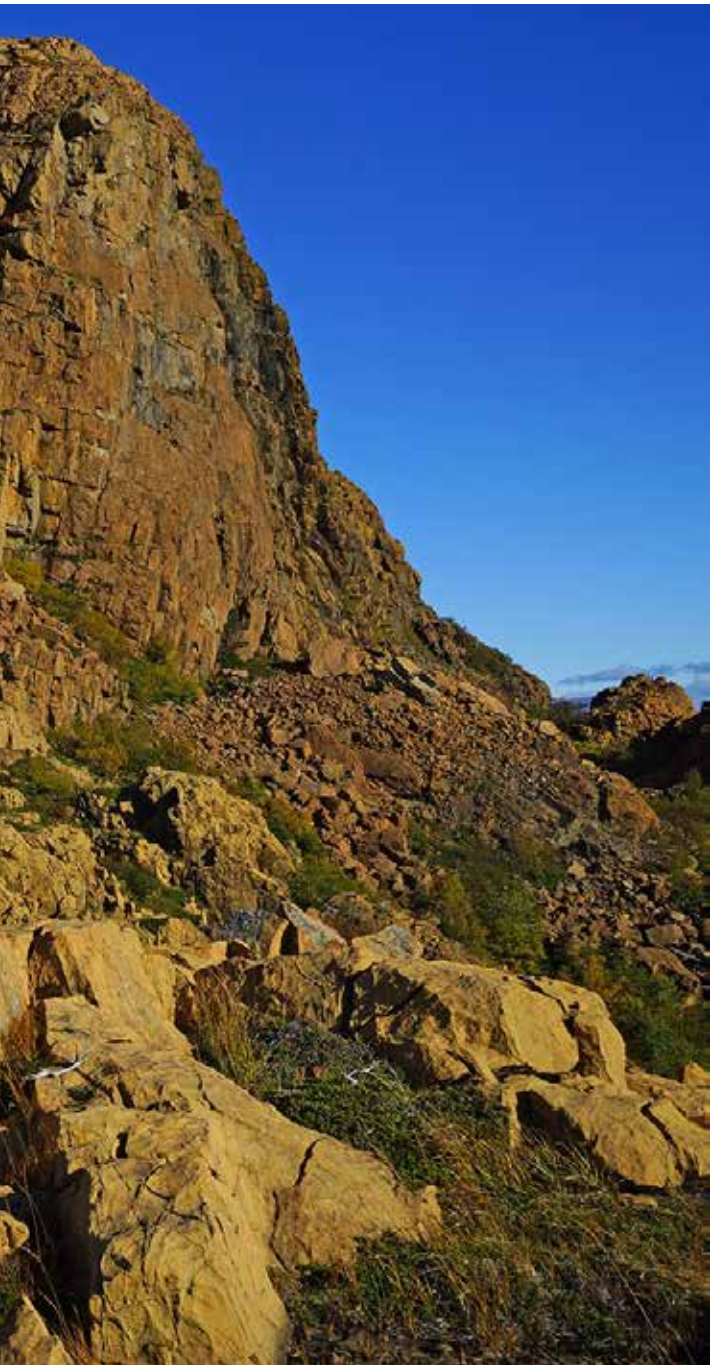
Today this piece of crust constitutes the island of Leka in Nord-Trøndelag – Norway's national geological monument. This piece of old oceanic crust was turned on its side during its journey, so that today on Leka you can walk on the mantle, which is normally far below the Earth's surface.

Steinstind on Leka is a classic example of the Earth's crust having turned over. The mountain top consists of mantle material from the Earth's interior, and is a well-known landmark on the island.

Photo: Trollfjell Geopark

The island is one of the few places in the world where you can see a cross section of the rock types and the border between the Earth's mantle and crust.

Knowing which rocks lie underneath our feet is essential for those searching for minerals or planning land-use, roads and tunnels. Moreover, the more we know about the bedrock underneath us, the closer we get to understanding how the landscape and the Earth have evolved, and how this will continue.



"Mapping the types of rocks that exist - on Leka as in the rest of the country - has always been one of NGU's main activities."

In 2014, NGU's geologists carried out bedrock mapping at various locations in Norway, such as in Vesterålen, Kongsberg, Modum and Rogaland. Trøndelag has been one of the priority areas this past year: the map for Orkanger is just about finished, and Støren is underway.

Modern bedrock mapping often starts with studies of NGU's airborne geophysical measurements. The maps for gravity, electric conductivity, magnetism and radioactive element content in the bedrock are becoming steadily more sophisticated and precise. They tell us also a great deal about how things look underneath the vegetation and soil. Mapping the types of rocks that exist - on Leka as in the rest of the country - has always been one of NGU's main activities.

However, digital aids and advanced airborne measurements are not enough. Fieldwork and the geologist's well-trained eye are still the key factors. Getting out into the terrain and on to the outcrops is absolutely vital to producing an accurate and detailed map. In 2014, NGU's bedrock geologists spent much of the summer in the great outdoors.

NGU's bedrock maps on a scale of 1:250,000 currently cover the entire country, but they are not detailed enough for many purposes. It is therefore important to produce bedrock maps on a scale of 1:50,000. To date, 55% of Norway is covered by such maps, which can be downloaded from NGU's website.

Geologist Jochen Knies

THE ICE AGE

The ice could disappear during our lifetime. Scientists can "read" how ice movement has occurred through geological time, and tell us what we can expect from the climate at the turn of the next century.

Bigganjarga: lithified moraine in Varangerfjorden became protected in January 1967

Photo: NGU, Rolv Dahl

Ice has ravaged the Earth over and over again during millions of years. Right at the shoreline innermost in Varangerfjord, 100 km west of Kirkenes and 30 km east of Tana Bru, lies testimony to this. Bigganjarga is a lithified moraine – a tillite – that bears witness to the fact that virtually the entire Earth was covered in ice 600-700 million years ago: a "snowball Earth".

It was NGU's second director, Hans Henrik Reusch, who mapped Bigganjarga and interpreted the tillite as confirmation of what he called the Varanger Ice Age. Reusch was a sharp observer and an outstanding communicator of Norway's geology and landscape.

The ice has come and gone, even after life was established on Earth. If we raise our eyes up from the Varanger peninsula in Finnmark, we can look north towards the Arctic Ocean. What is happening out there now? We have had sea ice - as we know it today - for the last 2.6 million years in the vast area around the North Pole,.

We could see it disappearing during our lifetime.

"NGU's research is of great international interest because today's global warming is strongly linked to the shrinking ice cover in the Arctic Ocean."

In 2014, NGU scientists and international partners were able to establish that the sea-ice border in the Arctic was much farther north four-to-five million years ago compared with today. A maximum ice-coverage occurred for the first time around 2.6 million years ago. A deep well northwest of Spitsbergen was the starting point for the research. Stored in the layered sediments are biomarkers: plant fossils of the same type that the scientists find in these waters today. Scientists can thus "read" how ice movement has occurred through geological time.

In our time, the latest report from the Intergovernmental Panel on Climate Change (IPCC) shows that the Arctic ice coverage has seen a rapid decline since the 1970s, with the smallest coverage in 2012. NGU's research is of great international interest because today's global warming is strongly linked to the shrinking ice cover in the Arctic Ocean.

The findings show how the sea ice in the Arctic Ocean developed before all the large ice sheets in the northern hemisphere were established. This new information can be used to improve future climate models - what we can expect from the climate at the turn of the next century.

The work has been carried out in a collaboration between scientists at NGU, UiT The Arctic University of Norway in Tromsø, and Spanish and British universities. NGU also draws on its participation in the Centre for Arctic Gas Hydrate, Environment and Climate (CAGE), which is studying gas hydrates in the Arctic in order to map the effects it can have on the marine environment and the future global climate.

From Bigganjarja to the Arctic Ocean, from past to future. Sharp observers at NGU have always sought new knowledge. We intend to continue.

PEOPLE'S FAVOURITE

Geological attractions are scattered throughout all of Norway. In 2014, we launched a database in which we have collected exciting geological information.

Geologist Anna Bergengren

Preikestolen

The popular hiking destination Preikestolen, formed by strong geological forces, hangs over Lysefjorden and overlooks the beautiful Norwegian landscape.

Photo: Visit Norway, Andreas Gruhle

Tourists have flocked to Preikestolen ('the Pulpit') during more than 100 years. Not for listening to readings from the holy script, but perhaps the feeling of being raised above others - similar to a preacher in a church - can conjure up certain associations? There is well over half a kilometre of air below Preikestolen's mountain plateau in Lysefjorden.

The popular hiking destination, formed by strong geological forces, overlooks the beautiful Norwegian fjord landscape. In 2014, more than 200,000 people visited this geological attraction.

Geological attractions are scattered throughout all of Norway. The mountains and fjords are beautiful! There are also spectacular sites such as Torghatten, Trolltunga and Jutulhogget. NGU disseminates information on our natural heritage and makes it available for nature enthusiasts and anyone else who is curious. In 2014, we launched a database in which we have collected exciting geological information, which is shown on maps at www.ngu.no.

The "Geological natural heritage" map shows recorded geological localities which we think are of interest to tourists, schoolchildren and nature managers. Some of the material is quite old and we would like help from users to further develop the content.

The database is part of an ambition to put geological diversity on the map, so to speak. Mapping, managing and providing information on geological diversity is crucial to developing nature-based tourism, the teaching of science, and managing our complex nature in a robust manner.

"The "Geological natural heritage" map shows recorded geological localities which we think are of interest to tourists, schoolchildren and nature managers."

Our website gives free access to geological data and maps for the whole country. You can view maps, download data to use in your own GIS tools, or link to our data via WMS services. Several decades worth of databases and almost 20 different thematic maps are freely available online.

In addition to maps showing the geological natural heritage, we also worked in 2014 with the National Database for Ground Surveys (NADAG). The database provides information on boreholes in the form of locations where ground surveys have been conducted. The database currently contains borehole information for a limited area, but this is being expanded. NGU also launched several other map services in 2014, including services for unconsolidated sediments and the marine limit.

Nature has always been an important part of Norwegians' lives. Throughout history it has been a vital source of food, with its fish, meat and berries, and a resource providing stone for tools and buildings. Today nature is also a treasure trove for rerecreation and good experiences, as, for example, the majestic and beautiful Preikestolen is ready to welcome mountaineers and tourists in Rogaland.

PAPERLESS

How we map unconsolidated sediments with the emphasis on new (3D and laser) technology.

Geologist Ola Fredin

Kvitskriuprestein

Geological "priests" at Otta in Gudbrandsdalen.
Unconsolidated sediments after the Ice Age, shaped by the rain. A rare attraction.

Foto: NGU

The priests gaze proudly across the valley at Otta in Gudbrandsdalen, dressed in white and majestic with a hat on top. 'Kvitskriuprestein', as they are called in Norwegian, are a rare attraction. The columns consist of loose material deposited from the ice but are shaped by rain.

Tonnes of ice pressed the moraine deposits together, fine material mixed with larger stones. Over the years, the rain has washed away much of the fine material, while the "stone hats" have acted as umbrellas and protected the towering Kvitskriuprestein.

NGU has mapped the extent and properties of unconsolidated sediments in Gudbrandsdalen over a number of years. In 2014, mapping focussed on the area surrounding Vinstra and Fronbygdene. Here, the geologists used a new tool: laser scanning from the air. Using laser measurements, we can construct a detailed, digital elevation model of the terrain. Forest can be removed from the model before it is shaded, so that both large and small contours in the terrain become visible. The geologists now use laser data combined with field surveys and aerophotographs to map the extent and properties of the unconsolidated sediments. The resulting Quaternary geological maps show us the most recent geological development in the area - from the Ice Age to the present.

NGU's geologists have also worked intensely in Vest-Agder during the past five years. Unlike Gudbrandsdalen and other inland areas, Vest-Agder has limited deposits of unconsolidated sediments with most of the terrain consisting of exposed bedrock. However, there are important exceptions, such as thick, fine-grained marine deposits, which are important for agriculture but which can also be prone to landslides. Many of the valleys are filled with several tens of metres of thick glaciofluvial deposits from the last Ice Age. These are important both as gravel resources and arable soil. Here laser measurements were also an important aid to geologists. New technology combined with experience and knowledge has yielded results.

A nationally important natural monument was left behind in Vest-Agder when the ice melted. The great end moraine called the Ra spans the entire county of Vest-Agder. NGU has adopted newly developed dating methods to determine the Ra's age. The results show that the Ra in Vest-Agder was formed by multiple advances of the ice over a period of 3,000 years, and not during one brief glacial surge as previously thought.

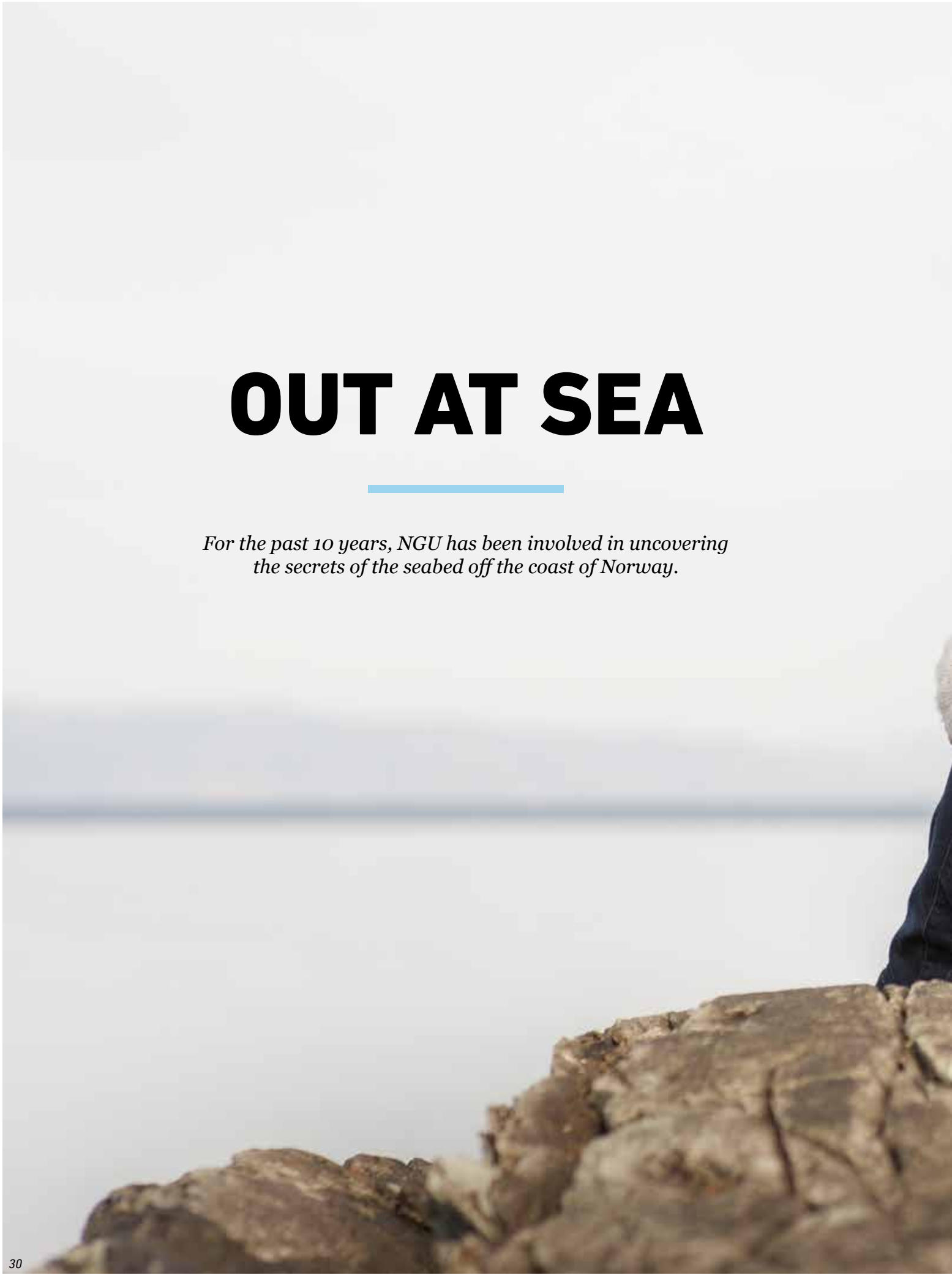
"Using laser measurements we can construct a detailed, digital elevation model of the terrain."

Data from similar age determinations for Lista shows that the ice there had already disappeared 19,000 years ago: 4,000 years earlier than originally estimated by geologists and archaeologists. The likely reason for this is a sudden collapse of the large ice flow in the Norwegian Trench. This new information is vital to understanding how the ice sheets react to climate change. Now we also know that plants, animals and humans were all able to find a footing on ice-free land in Norway far earlier than we had realised.

The Vest-Agder project marks an important distinction in NGU's history. For the first time, a mapping project has been conducted with a fully digital workflow. All observations are continuously stored directly in a robust laptop out in the field. All preparatory work, data-processing, interpretations and corrections have taken place in GIS, both in the field and in the office. Following a last quality assurance, the final data is entered in the database and made freely available on www.ngu.no. Environmentally friendly and paperless.

OUT AT SEA

For the past 10 years, NGU has been involved in uncovering the secrets of the seabed off the coast of Norway.



Geologist Lilja Rún Bjarnadóttir

The North Cape plateau with its famous monument at the edge of the cliff. On the seabed north of the North Cape, NGU has found a large area consisting of shell sand.

Photo: NGU, Rolv Dahl

At the northernmost point on Magerøya in Finnmark lies the North Cape plateau: one of the country's greatest tourist attractions. Around 200,000 people stand at the edge of the cliff every year and look over the seemingly endless blue surface 307 metres below: the Barents Sea. Very few of the tourists are aware that the waters hide a fascinating landscape, full of resources and interesting nature.

For the past 10 years, NGU has been involved in uncovering the secrets of the seabed off the coast of Norway. We have seen wide plateaus and deep gorges, gas leaks and landslides, corals and animals in places where no one has ever set foot. The mapping forms part of the large, national co-operation programme MAREANO.

MAREANO aims to develop a marine spatial database for Norway's maritime territory, and for the past 10 years has been mapping the seabed from Central Norway to far north in the Barents Sea.

In the summer of 2014, we were on a mission off the North Cape and found large deposits of shell sand at a depth of 300 metres. This resource has many applications, such as soil improvement, an additive to poultry feed for strengthening egg shells, and for cleaning up river systems. Shell sand can consist of crushed shells that are several thousands of years old. Perhaps the name Knivskjellodden ('razor shell point') on the mainland of the North Cape is linked to this "invisible" resource?

Marine geologists participated on several cruises last year. Through the MAREANO programme, mapping was undertaken in areas north of Finnmark and in the previously disputed areas in the Barents Sea along the border with Russia. Also, off the coast of Central Norway, traces of one of the world's largest submarine landslides, Storeggaraset, were scrutinised. Storegga is a popular fishing area among fishermen because of its abundant fish resources. MAREANO has also mapped a large number of beautiful coral reefs on the continental shelf off the coast of Central Norway.

The findings so far have provided a good basis for better management of the large and valuable resources in the Norwegian waters. Perhaps the future will take the scientists even farther out to sea, to the vast plains of the deep sea off the continental shelf?

NGU's own research vessel FF Seisma mapped several coastal areas in 2014, including Saltstraumen near Bodø, and Søre Sunnmøre, where highly detailed marine base maps will be produced. Saltstraumen is the world's strongest tidal current, and the crew onboard Seisma had an exciting task on their cruise there last autumn.

NGU has previously mapped several coastal areas and fjords in our elongated country, and several more are lined up for 2015 and the years ahead. In these projects we have close collaboration with local, regional and national administrations, as well with industrial partners along the coast.

Geologist Fredrik Høgaas

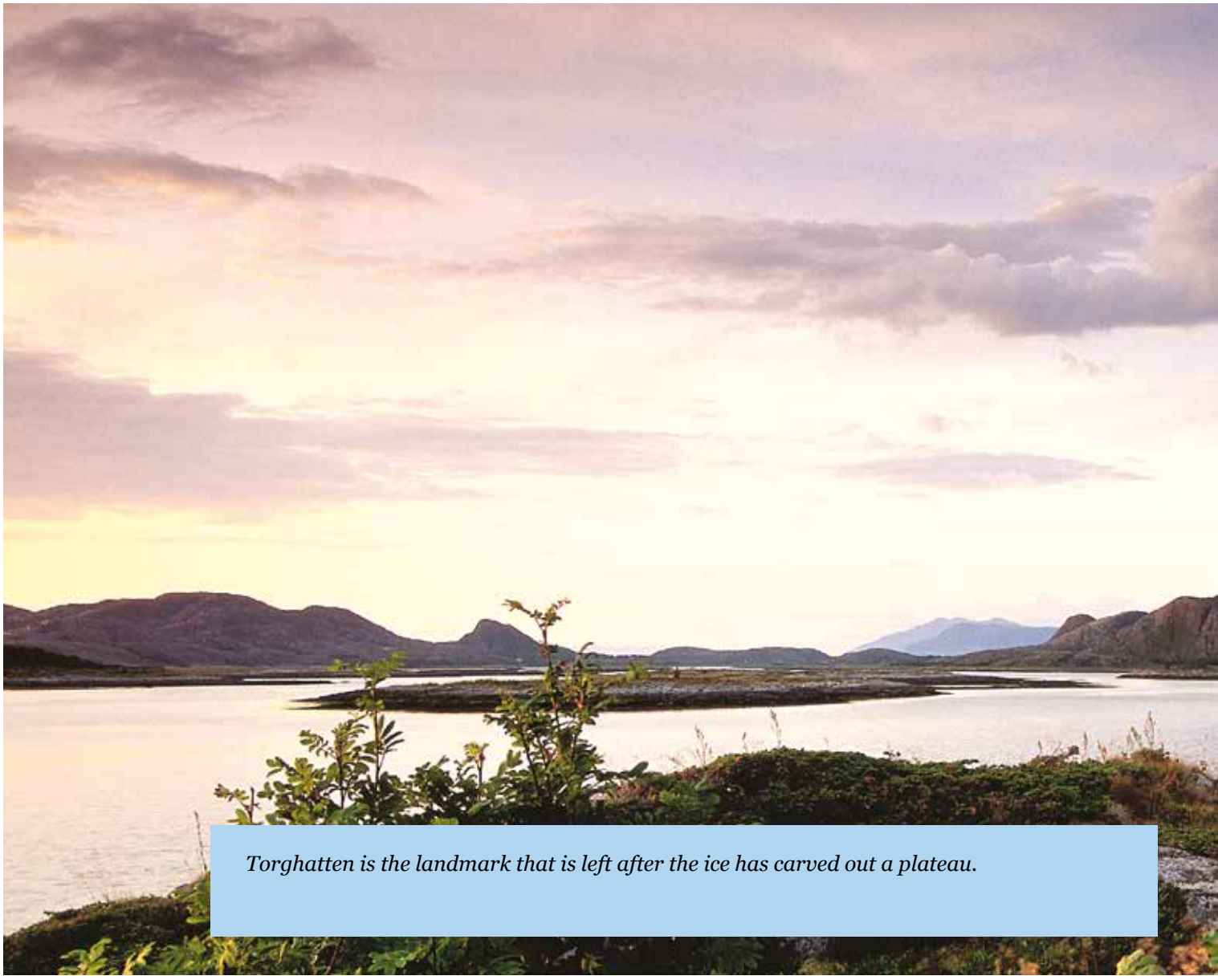
THE GEOLOGICAL RIDDLE

How has nature managed to create a strandflat that is so long and wide, and that is not found anywhere else in the world?

Strandflats are one of our most beautiful and admired attractions. The more than 50 km wide plateau, which takes up a large part of the Norwegian coast, has been carved out in the bedrock over millions of years. From this flat plateau, islands and steep mountains rise up above the sea.

The Helgeland coast in central Norway is the most characteristic part of the strandflat. If you take the national coastal road, Kystriksveien, to Brønnøysund, you will meet the popular landmark Torghatten. Every summer, thousands of people take a trip up to the hole in this mountain. The strandflat has always been a mystery to geologists: how was it really created - and when? How has nature managed to create a surface that is so long and wide, and that is not found anywhere else in the world?

In 2014, NGU's scientists presented new findings suggesting that deep weathering has played a key role - and that the basis for the formation of the strandflat was laid as early as 200 million years ago.



Torghatten is the landmark that is left after the ice has carved out a plateau.

Photo: Per Eide/EdelPix

“While the ice helped to carve out the strandflat, it also pressed down the Earth’s crust significantly.”

At that time, Norway was located at southern latitudes not far from the Equator, characterised by tropical rainforests and a hot and humid climate. The acidic water from the rainforests broke down – deeply weathered – the rock, turning it into loose material such as gravel and clay, also known as saprolite. This was then gradually covered by thick layers of mudstone and clay stone. Much later, when Norway had moved to northern latitudes, the Ice Age came and all of this was easy prey to waves and ice, and the masses were broken down into the strandflat we see today.

Through measurements of magnetism and electrical resistance, NGU scientists have mapped large amounts of saprolite on the strandflat in Lofoten and Vesterålen. This supports the theory of deep weathering.

These new findings also entail a method for mapping brittle and weathered bedrock below the sea. This helps in the planning and risk prevention for tunnels to be excavated in rock below the sea.

The oil industry is also interested in these results, knowing that it is precisely in such zones with fractured and weathered bedrock that oil reservoirs can be formed. The Edvard Grieg oil field, which was discovered in 2007 at the Utsira High off the coast of Rogaland, is a classic example.

While the ice helped to carve out the strandflat, it also pressed down the Earth’s crust significantly. When the glaciers retreated, the sea flooded the landscape, and the sea level changed. NGU’s mapping of the Helgeland coast gives a good indication of this: here we find traces of a high marine limit (marking the highest level the sea has reached). In some places, this limit is as high as 120 metres above today’s sea level.

Mapping how high the sea has reached can tell a great deal about ground conditions in the area, such as where it will be natural to find clay and beach gravel. This information is important in agricultural planning, the use of resources and infrastructure development, and in pinpointing where there may be a risk of landslides.

Geologist Hans de Beer

GROUND CONDITIONS

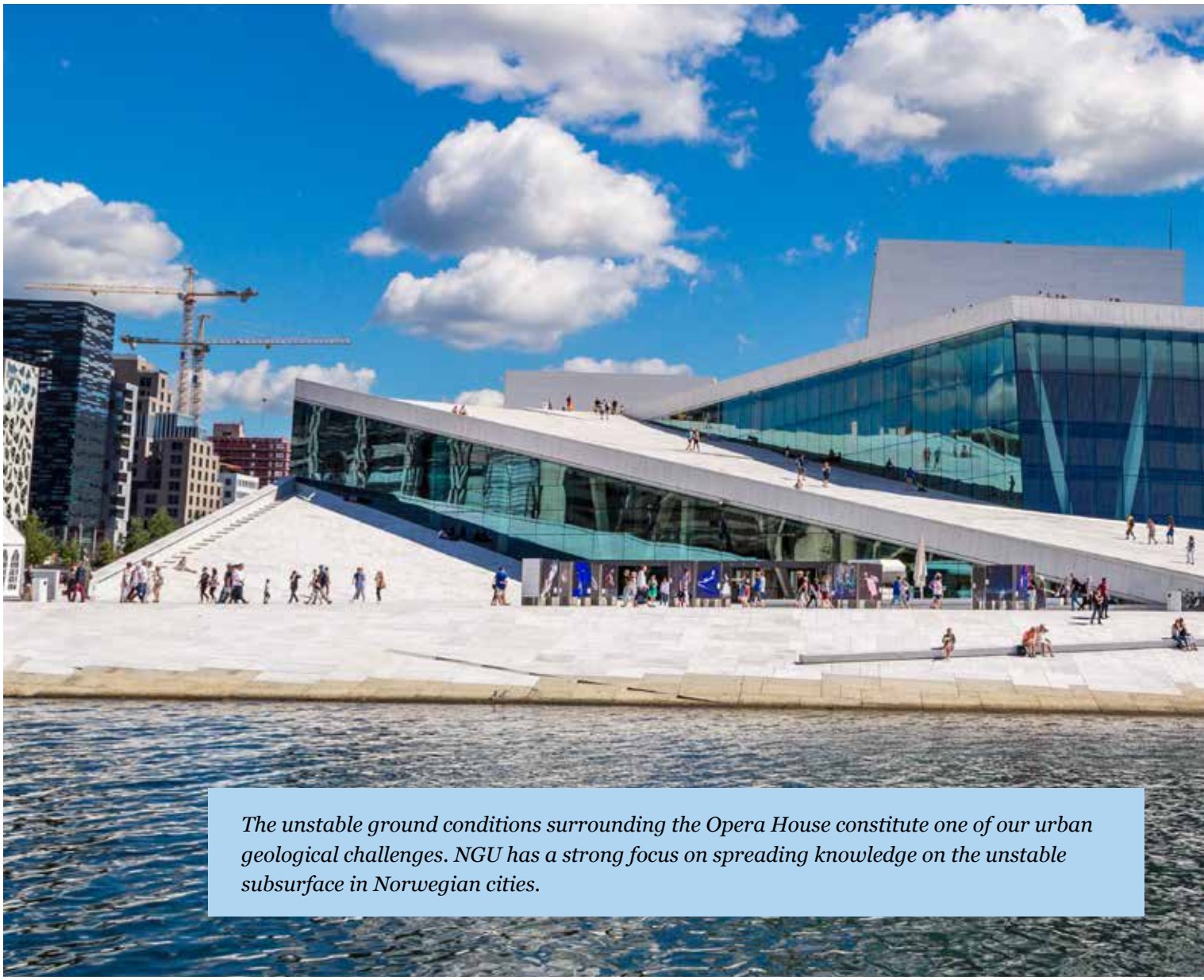
The aim is to obtain a complete overview of ground conditions in big urban centers.

The Opera House in Oslo has become one of the capital's most popular landmarks. The stone building towers over Bjørvika, with Italian marble and granite from Rennebu in the walls.

However, the geology at the tourist attraction in Bjørvika is more than just marble and granite. The ground underneath consists of both marine sediments, quick clay, and man-made deposits, and investigations show that the areas around the opera are sinking faster than anticipated.

Oslo centre is a giant with clay feet, and the intense urban development encounters new geological challenges.

Urban geology has become a discipline of great interest at NGU. A few years ago, NGU's geologists played a major role in the efforts to secure the ground under Bryggen in Bergen. We also provide expert advice to Oslo municipality in its efforts toward more sustainable use of the subsurface and toward preventing damage from subsidence in the city's east side.



The unstable ground conditions surrounding the Opera House constitute one of our urban geological challenges. NGU has a strong focus on spreading knowledge on the unstable subsurface in Norwegian cities.

Foto: Colourbox

In 2014, we were given the green light to carry out the very first urban-geological mapping in Bergen. NGU will perform this work in collaboration with Bergen municipality and the Directorate for Cultural Heritage.

The aim of the mapping is to obtain a complete overview of the ground conditions in the middle of a city. Special emphasis will be placed on the medieval town of Bergen because it is most vulnerable. We will map the material masses and the groundwater, and create a 3D model of the subsoil.

The result is going to be very important for the conservation and development of the city. Information on groundwater and subsoil will enable the right measures to be implemented, facilitate planning of land use, and regulate urban development and water pumping.

“Oslo centre is a giant with clay feet, and the intense urban development encounters new geological challenges.”

The work is of course about preventing damage from subsidence and the risk of landslides, but preserving important cultural relics is also an important element. The anthropogenic deposits in the subsurface tell an interesting story about a bygone age.

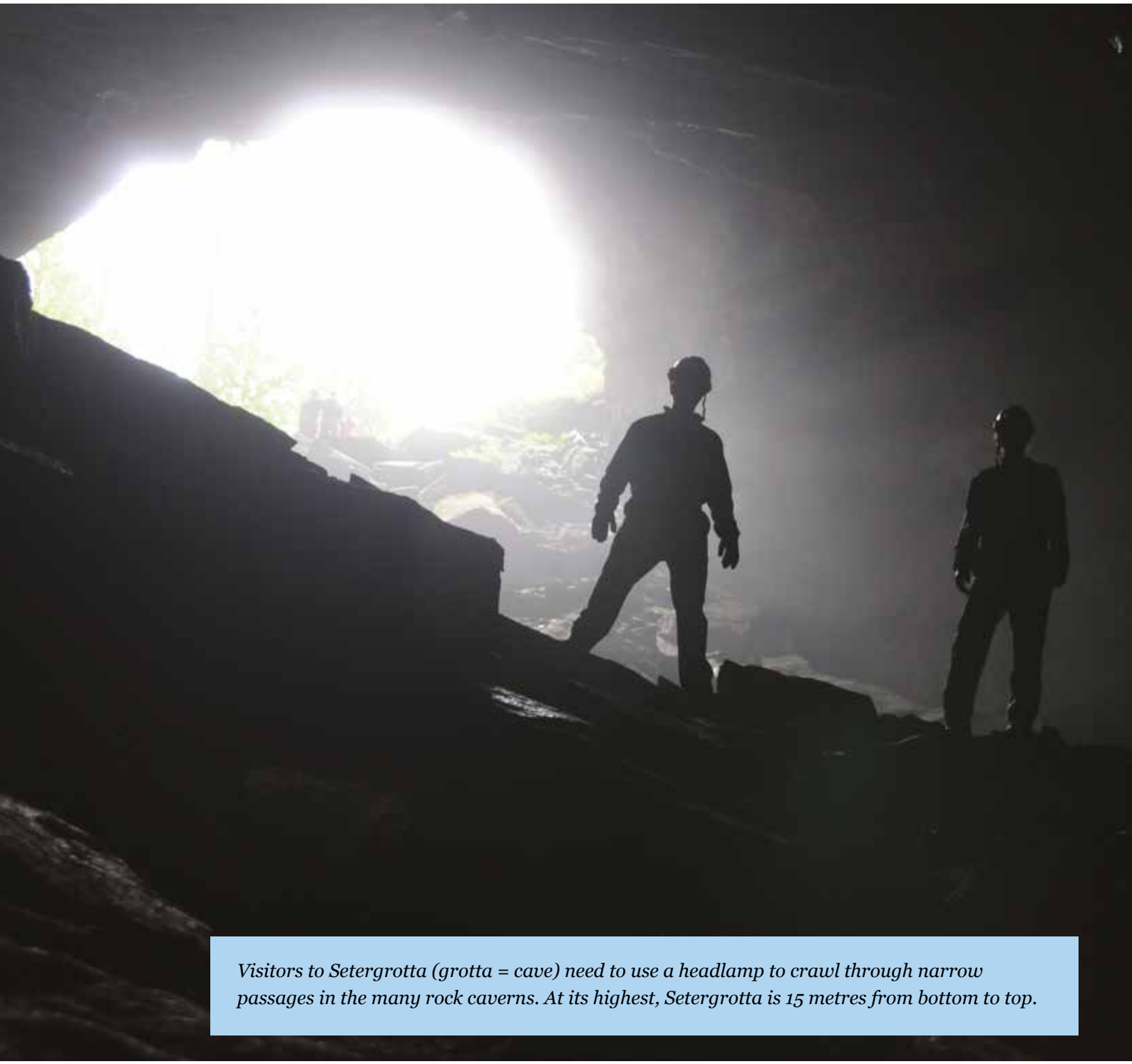
NGU’s international collaboration is aimed at developing knowledge about urban geology. The Netherlands and Germany have made good progress in their work. In Helsinki in Finland, a 3D city plan of the ground conditions has been created. This will be a valuable aid.

This work is also becoming more and more important in all Norwegian towns and cities. Extensive building activity leads to increased pressure on the urban subsurface, and most of our cities are located on anthropogenic backfill and natural-clay deposits. More and more people are moving to the cities, and the need for housing and commercial buildings, roads and tunnels is increasing. The results from NGU’s urban geological mapping will therefore be important to protecting buildings and streets of cities throughout the country.

HIDDEN TREASURES

The limestone caves are a tourist attraction, but limestone is also an important mineral resource.

Geologist Kari Aslaksen Aasly



Visitors to Setergrotta (grotta = cave) need to use a headlamp to crawl through narrow passages in the many rock caverns. At its highest, Setergrotta is 15 metres from bottom to top.

Photo: www.setergrotta.no

One of Norway's longest limestone caves is Setergrotta in Rana in the county of Nordland. This cave, situated about 20 km north of Mo i Rana, is part of a large cave system totalling 8.4 km and has a height differential of 273 metres. The cave has been a popular tourist destination for over a hundred years.

Limestone caves are part of our protected biodiversity, but limestone is also a valuable resource. As a research-based administrative agency, NGU has a two-fold public duty: to keep one eye on our diverse geological heritage and the other on our mineral resources.

Limestone is a material that is "born". When organisms with scales or calcareous shells die, they are gradually buried and cemented together on the seabed. The sand and clay settle on top as new layers, and the result is three sedimentary - or deposited - types of rock: sandstone, shale and limestone. Limestone that has been subjected to high pressure and high temperature over a long period of time transforms into marble, just like the innermost walls in Setergrotta.

Through the programmes Mineral Resources in Northern Norway and Mineral Resources in Southern Norway, NGU has also in 2014 mapped the potential for finding industrial minerals - such as lime, quartz and graphite – as well as other valuable mineral resources such as gold, copper, nickel and iron.

Geophysical measurements collected by airplanes and helicopters constitute the greatest part of NGU's focus in these programmes. Subsequent geological studies on the ground are carried out in numerous locations, including geochemical analyses of thousands of samples of moraine deposits. The processed data are published as soon as they are ready.

"Overall, the Norwegian mining industry's turnover for mineral resources has a primary value of around NOK 13 billion a year."

The paper industry is the largest consumer of limestone. The finely ground mineral is used to make the paper whiter, smoother, more receptive to ink, lighter and cheaper. Limestone is also used in cement production, in the plastics, rubber and paint industry, in agriculture and in the pharmaceutical , chemical and metallurgical industries, in sugar refineries and as an acidity-regulator.

Fourteen companies, with a total of almost 400 employees, produce limestone in Norway. Brønnøy Kalk is the largest producer of limestone for filler. The filler is sent to Hustadmarmor in Møre, where limestone slurry is manufactured for the paper industry. There is also considerable lime production for other purposes at Verdalskalk, Norcem, Visnes Kalk and Franzefoss Miljøkalk. Overall, the Norwegian mining industry's turnover for mineral resources has a primary value of around NOK 13 billion a year. Processed products constitute a considerably greater value.

All in all, the mineral industry will gradually become an increasingly important industry in Norway in the years ahead. New initiatives can lead to increased prospecting, new finds and gradual development within the business sector.

Meanwhile, you should plan to visit one of the magnificent limestone caves in Nordland.

Accounts 2010-2014 (mill. NOK)

Income	2010	2011	2012	2013	2014
Ministry of Trade and Industry.	124,5	170,3	172,2	186,3	189,2
Other income	82,7	66,5	79,6	75,3	77,0
Total income	207,1	236,8	251,8	261,6	266,2

Expenses	2010	2011	2012	2013	2014
Salary/nat.ins.expenses	119,3	124,9	128,8	135,4	141,9
Other expenses	78,9	103,2	112,9	111,4	105,7
Investments	9,0	14,0	7,6	14,6	20,6
Total expenses	207,2	242,1	249,3	261,4	268,2

NGU´s total production of reports, publications, presentations and maps for 2009-2014

Type	2009	2010	2011	2012	2013	2014
NGU-reports	67	66	67	80	47	49
Articles, refereed journals	166	138	126	173	137	157
Other published articles	41	32	42	37	23	21
Presentations and teaching	484	542	449	447	440	417
forskning.no	19	16	17	15	21	13
Bedrock and surficial deposits maps	9	12	13	14	15	10

NGUs employees

	2009	2010	2011	2012	2013	2014
Total number of employees	216	221	222	211	219	225
With MSc Degree	142	150	153	143	153	160
With PhD Degree	77	81	82	72	77	82
Non-Norwegian citizens	67	72	74	66	75	81

For the most part, NGU achieved its objectives in 2014 and complied with its owners' (the Ministry of Trade, Industry and Fisheries) requirements and guidelines. This was done within our budget framework and economic guidelines. NGU received an allocation of NOK 189.2 million in 2014. Together with NOK 7.2 million transferred from 2013, this constitutes NGU's total operating appropriation from the Ministry.

This includes a basic appropriation and three earmarked appropriations: NOK 25.6 million to continue developing a marine spatial database for Norway's marine territory, NOK 25 million for mapping mineral resources in Northern Norway and NOK 10 million for a corresponding mapping programme in Southern Norway.

External revenues totalled approximately NOK 77 million. This is an increase of around two percentage points from the previous year.

Payments from the Norwegian Water Resources and Energy Directorate (NVE) totalled NOK 18 million and are linked to NGU's work programme for landslide-risk mapping.

In 2014, NOK 20.6 million was used for various investments. The largest investments were for new instruments for NGU's laboratory.

NGU's databases are accessible on our website - www.ngu.no. In addition to the databases, our work is published in reports, scientific journals and talks to different target groups. NGU's production of scientific papers is high compared with similar institutions both in Norway and abroad.

NGU has a stable and low rate of sick leave. For all of 2014 sick leave was 4.6 per cent.

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