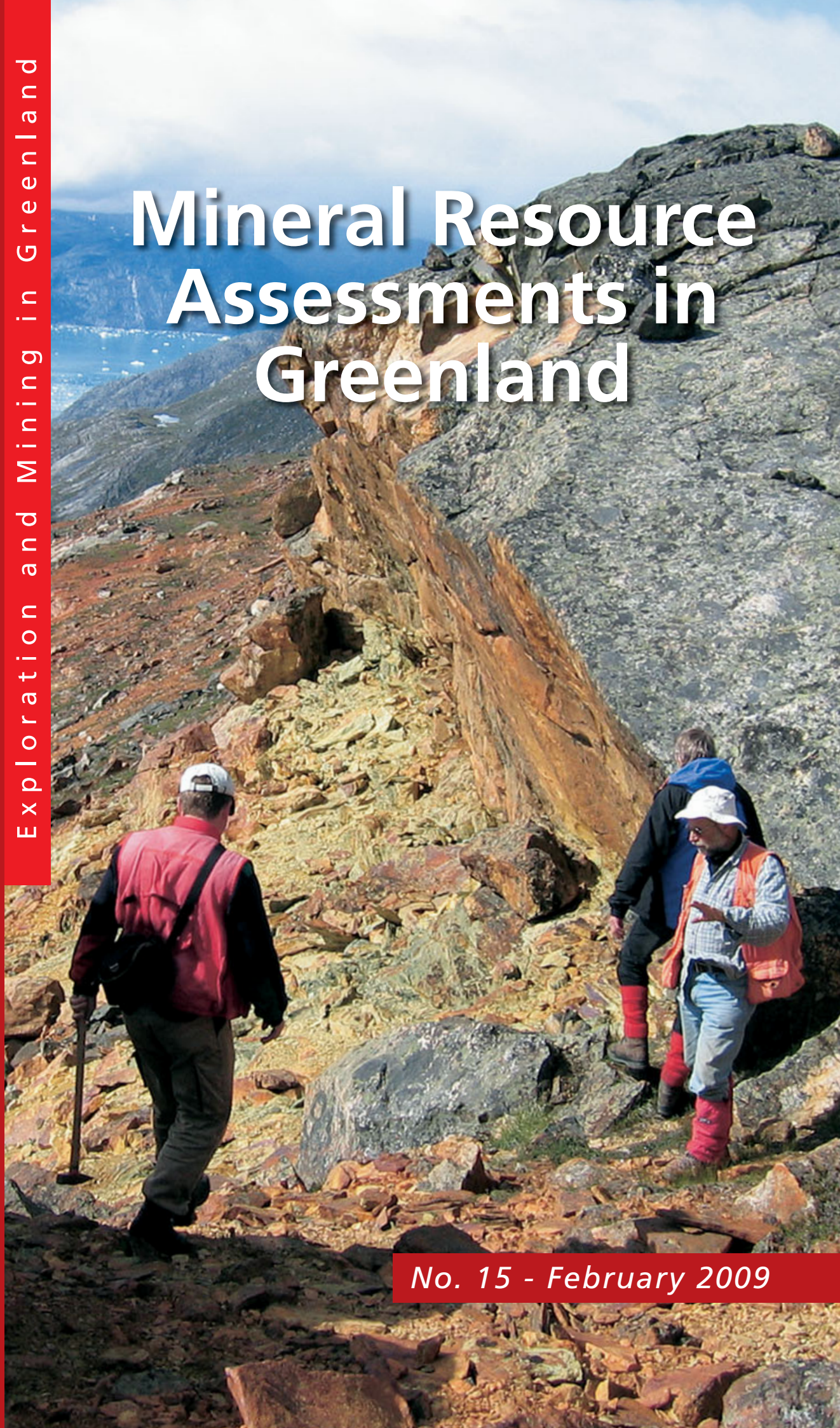
GEOLOGY AND ORE

Exploration and Mining in Greenland

Mineral Resource Assessments in Greenland



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Mineral Resource Assessments in Greenland

Throughout the world, effective and successful exploration is the result of multidisciplinary approaches integrating the latest in exploration concepts with new technologies. For this to be possible, access to solid geological background information and large amounts of geoscience data are required. Through determined and planned efforts, the Bureau of Minerals and Petroleum (BMP) and the Geological Survey of Denmark and Greenland (GEUS) have been intensively involved in the geological investigation of Greenland, and during the last couple of decades with increasing emphasis on regional mineral resource assessments involving all disciplines of earth sciences. Very large amounts of data and information have been acquired, compiled and interpreted in various assessment projects.

The search for mineral resources in Greenland

The motivation and for geological investigations in Greenland have since the early 18th century been the search for exploitable minerals. The first successful mine was opened in the mid-19th century and exploration continued, with some quiet periods. Government-financed, systematic geological investigations aimed towards 'the next discovery' have always provided part of the drive; with the Self-Governance in Greenland just round the corner, the mineral resources in Greenland are still very much on the political agenda. Today, BMP and GEUS co-operate in the effort to open Greenland to the international exploration and mining industry. A governing principle for the co-operation has been to acquire, organise and make available the many types of geoscience data and at the same time publish maps and papers describing the geological evolution of Greenland and the potential for mineral resources. In a series of projects over the last two decades, the facilities, methods, presentations and subjects have been developed and refined, greatly helped by the development in computer sciences. This magazine briefly describes the development from thematic maps on paper to maps and data in true GIS environment taken for granted by today's explorationists.

More than 100 years of mining. ***Upper:*** *Sailing ships (1898) waiting to be loaded at the Ivittuut Cryolite Mine in South Greenland. The open pit mine was active from 1854 to 1987.* ***Lower:*** *Bulk-carrier (2006) alongside the deep-water pier at the Minelco Olivine Mine at the Seqi olivine deposit in southern West Greenland. The deposit is located in a dunite body with 95–99% olivine with a high fostertitic content. The olivine is shipped to European and North American markets and used as a first-rate additive in various metallurgical applications.*

At the same time, understanding of the potential for mineral resources in Greenland has been advanced significantly, not least through the efforts of the many exploration companies. However, it remains true that major parts of Greenland have

Coverage of the thematic map series.

been only superficially explored and may be regarded as true juvenile 'greenfields', calling for much more investigation. The activities of BMP and GEUS will continue into to the benefit of the mining industry in Greenland.

From thematic maps to regional GIS models

During the first half of the 1990s a series of thematic maps were published. This was initiated by GEUS (the then Geological Survey of Greenland, GGU) to make the large collections of data more readily available. It was the first attempt to publish comprehensive sets of regional data on selected areas in Greenland in a standard scale and format. Most of the information had not previously been compiled or published. By using the new computer methods, many maps (50–60) could be compiled showing all the different types of geo-data for the same region. The objective was to facilitate the identification of trends and boundaries important for the recognition of favourable environments for ore genesis. The maps were published in paper format. The thematic map series was discontinued in 1996, but by then the GIS methods and programs had been sufficiently developed and widespread to make it possible to replace the thematic paper maps with digital maps in a GIS environment. The first such regional GIS compilation or GIS model for mineral resource purposes was published in 1998, by transferring the last thematic map series of Inglefield Land into a new digital version in the GIS environment. Since then, similar compilations have been produced for four other regions from the Disko Bugt in central West Greenland to Kap Farvel, South Greenland. Within the next few years, also South-East Greenland will be covered as part of the upcoming mineral resource assessment programme of that region.

It all starts with data

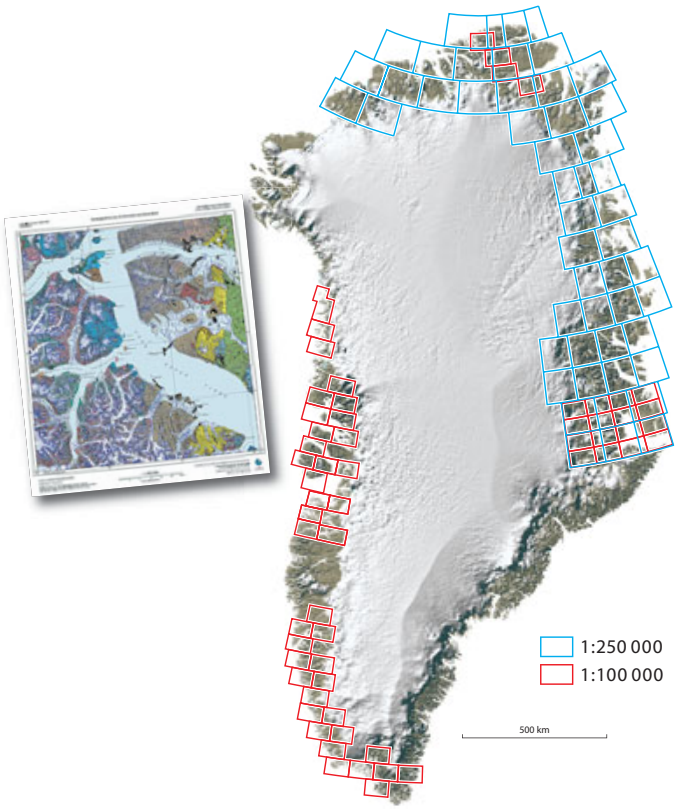
BMP and GEUS wish to make data easily available for distribution, but before that can happen, enormous amounts of data have to be quality controlled, positioned on newer maps, assessed, displayed and analysed. It was the initial step in the compiling of thematic maps, and still is when constructing GIS-models today, to ensure that all data become available for future users. New data acquired in many public surveys, sampling and mapping campaigns and research programmes are also made immediately available to the exploration industry.

Geological mapping data

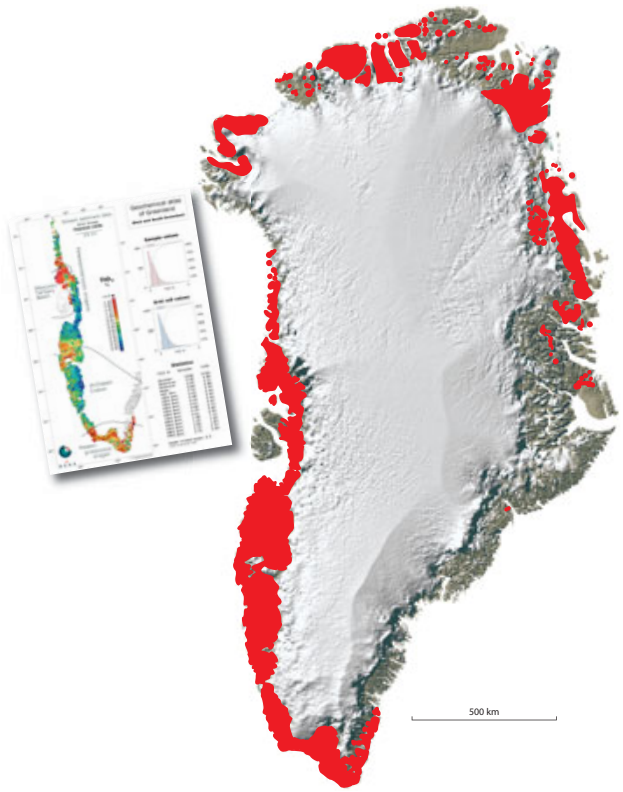
The year 2005 was a milestone in geological mapping; full coverage of Greenland in scale 1:500 000 was achieved. Published maps in other scales cover more than half of the ice-free parts of Greenland, providing basic and essential data, increasingly in the form of digital maps. In addition, the detailed field-maps made by the mapping geologist during the various campaigns are stored at GEUS in digital format. The mapping of new areas and the digital updating of existing maps are ongoing processes and provide valuable material for the GIS models produced for the mineral resource assessment programmes.

Geochemical data

In Greenland, regional stream sediment geochemical mapping with an approximate sample density of one sample per 30 km^2 was initiated in the early 1970s. In 2001, a digital release of the 'Geochemical Atlas of Greenland – West and South Greenland' was presented. GEUS' databases contain still more stream sediment geochemistry data from the other parts of Greenland –



Coverage of 1:250 000 and 1:100 000 scale geological maps.



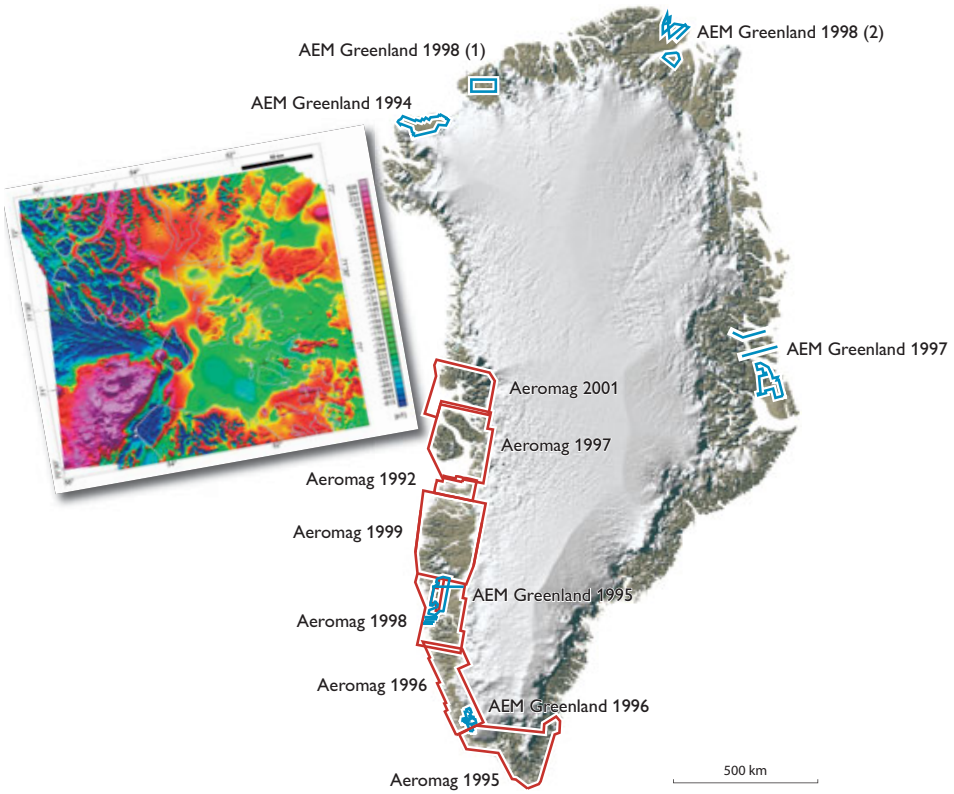
Coverage of regional geochemistry data from stream sediment.

especially data from North, North-East and northern East Greenland have been systematically acquired, and further geochemical surveys are planned, as South-East Greenland in 2009 and 2010. Other compiled geochemistry datasets have been released, e.g. the 'Diamond exploration data from West Greenland' on DVD. This compilation presents more than 96 000 mineral analyses from more than 15 200 samples of till or stream sediment samples from West Greenland, public data as well as company data extracted from released, non-confidential company reports of field work campaigns. GEUS' lithogeochemical database for Greenland contains geochemistry of all analysed rock samples collected during various Survey campaigns in Greenland. All these data are included in the mineral resource assessment programmes and are available to the public.

Geophysical data

Airborne geophysical surveys of onshore areas were utilised by companies in the 1960s and GGU in the 1970s. The onset of the nineties marked the beginning of more than a decade of systematic modern regional geophysical data surveys in various parts of Greenland financed by BMP and GEUS. The AEM Greenland 1994–1998 project produced high resolution detailed multi-parameter surveys (electromagnetic, magnetic and partly radiometric) in each of the years from 1994 to 1998 producing a total of 75 000 line kilometres. The AEROMAG projects encompassed high-resolution magnetic surveys conducted in 1992, each of the years from 1995 to 1999 and in 2001 producing a total of 515 000 line kilometres. The geophysical datasets can be purchased from GEUS, and are extensively used in the mineral

Geologists collecting sediment samples for geochemical analysis.



Coverage of modern regional, airborne onshore magnetic data.

resource assessment programmes. Additional onshore airborne surveys are being considered for the near future.

Remote sensing data

The 1990s also marked the serious onset of remote sensing investigations in Greenland, which have been ongoing since then and in the later years have continued with the gathering and analysis of hyper-spectral data from several parts of Greenland. The often excellent rock exposure in Greenland makes processing of remote sensing data a very interesting tool for the search for mineralising systems and a very effective method, when addressing large juvenile regions.

Mineral occurrence data

GEUS continuously compiles information about mineralised sites in a mineral occurrence database. Mineral occurrence descriptions are based on Survey field work and subsequent analyses of data and on review of existing Survey data as well as released non-confidential company reports and data. Furthermore, other geo-data on the occurrence, such as geophysical, geochemical and structural data are examined. If possible, the mineral occurrence is placed in a geotectonic context and a genetic model is suggested. The on-line GIS facility GMOM (Greenland Mineral Occurrence Map – www.geus.dk/gmom) is updated from the database, providing direct public access to information about a large number of localities, relevant from a mineral resource assessment point of view.

Company mining and exploration data

All companies doing exploration and mining in Greenland must hand in reports to BMP. These reports are on file at GEUS and once released, they are always made accessible to the public. Currently, the reports are being scanned and arranged in an on-line database DODEX (www.geus.dk/dodex). Several mining and exploration companies, formerly active in Greenland, have donated their entire data collections to GEUS. These data are, however, not available on-line and therefore enquiries by telephone or e-mail to GEUS are necessary. The above sources provide a unique collection of data for the assessments of mineral sites, prospects, former mines and regions.

Modern assessments using digital data

More and more data become available in digital format and technologies/software have developed considerably. The regional mineral resources assessment programmes in Greenland have, since 1996, been carried out based on multidisciplinary digital data compilations, which have been made generally accessible in a GIS environment, published on CD-ROMs or DVDs. The digital data are supported by detailed descriptions of mineralised sites, and all this makes it possible for exploration companies to access the geology of Greenland following their own exploration strategies. GEUS also uses the data to develop advanced, general geological models viewed and interpreted in the framework of geotectonic and mineral deposit models. All mineral resource assessments have been accompanied by intensive field work programmes, in which results from analyses and interpretations of the region in focus have been followed up and further elucidated. This includes gathering of new datasets and new mapping. The field work has often been conducted in co-operation with exploration companies active in the regions. Thus, very useful and large datasets have become readily available for newcomers to Greenland. Some of the digital datasets usually included in the GIS models are:

- Topographic base map and digital elevation model
- Geological map (scanned and digital vectorised maps, published maps and unpublished field maps)
- Remote sensing data – e.g. Mosaic of Landsat TM and Aster scenes, hyper-spectral data
- Airborne magnetic, electromagnetic and radiometric maps
- Gravity maps
- Sample locations and descriptions
- Lithogeochemistry
- Stream sediments and heavy mineral concentrate geochemistry maps
- Mineral occurrence sites with descriptions
- Mineral potential maps from integrative data analyses
- Key-photos of rock types and mineral occurrences

- Overview of exploration licences through time
- List of existing maps
- Bibliography, including company reports

New methods for mineral resource assessment

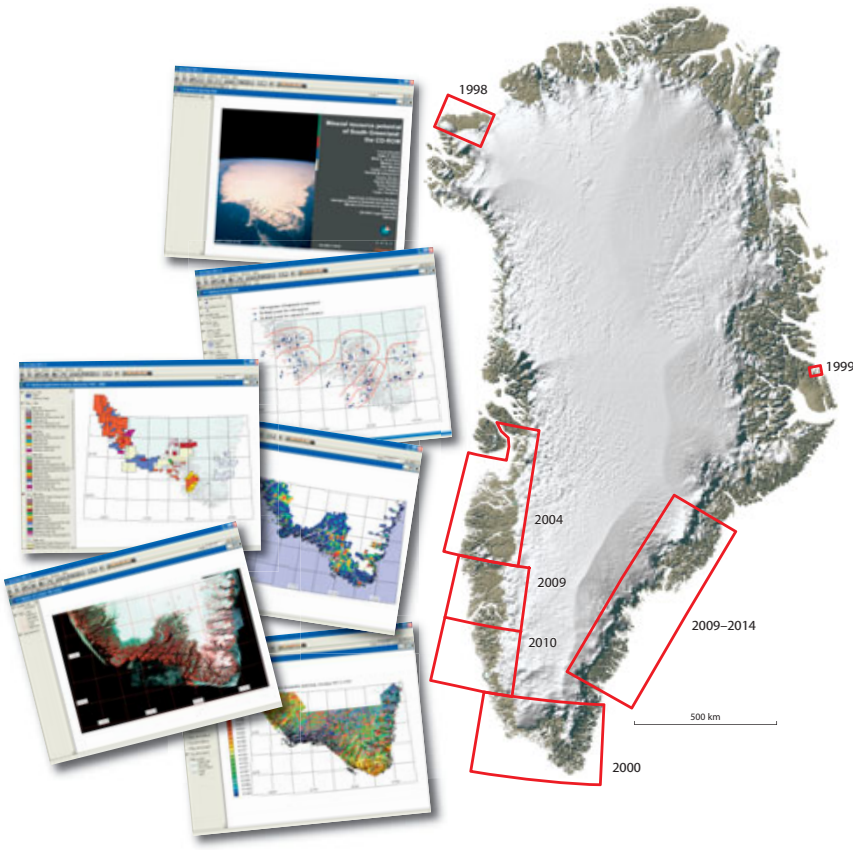
In the modern quest for the acquisition and analyses of geo-data, the traditional approach to the assessment is further strengthened by the application of several new methods. This ensures that the full benefits of the geoscience data become apparent; the users are provided with an insight that is not directly discernable in the single data type but only becomes visible by integration of many types of data. Some of the new approaches employed are described here.

Holistic approach to the assessment of mineral resources

Today, GEUS and BMP are making integrated assessments including all acquired data, information, and analyses are made using a number of methods. Processing of hyper-spectral data, 3-D modelling and lithogeochemistry go hand-in-hand with traditional mapping, modern geochronology, etc. In the holistic approach all results are being considered jointly and integrated to build geological models. The overall objective of the assessment is still to understand the crustal composition and evolution, and to recognise environments favourable for ore genesis, but the number of methods that are utilised and the depth of the analyses have changed. This holistic approach is the firm basis for GEUS' ability to improve the geological knowledge of Greenland through continued field work, acquisition of data, applied scientific work and resource evaluations.

Quantitative integrated data analysis

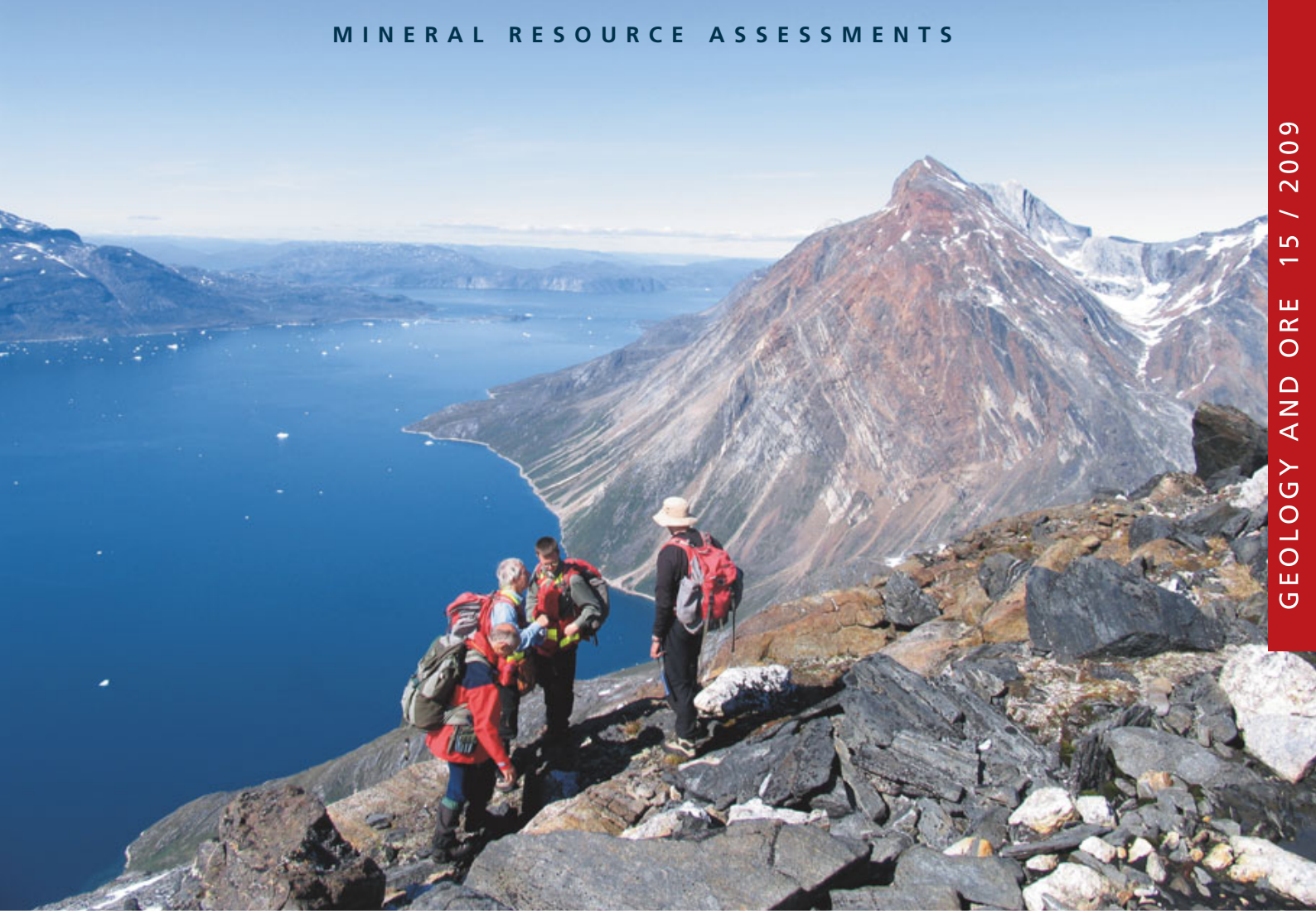
As a part of the holistic approach to mineral resource assessment, quantitative analyses of multivariable data are becoming a central theme in the work with geoscience data. Not only do such methods allow the identification of quantitative relations, which previously in most cases



Coverage of modern regional, mineral resource assessments in GIS models.

Modern regional mineral resource assessments carried out or planned

Region	Year	Geological province	Potential commodities
North-West Greenland	1998	Palaeoproterozoic Inglefield Land mobile belt	Gold, silver, copper, zinc and iron
Central East Greenland	1999	Neoproterozoic to Permian rocks	Gold, silver, copper, lead, tungsten, uranium
South Greenland	2000	Palaeoproterozoic Ketilidian mobile belt	Well-known metallogenetic province for gold and uranium as well as potential for platinum group elements, copper, titanium, vanadium, zirconium, rare earth elements, niobium, tantalum, graphite
Central West Greenland	2004	Palaeoproterozoic Nagssugtoqidian orogen and Archaean Disko Bugt	Gold, copper, iron, nickel, graphite, niobium, uranium, phosphate, gemstone, diamond
Nuuk region, southern West Greenland	2008–2009	Archaean terranes of the North Atlantic craton	Gold, platinum-group elements, nickel, tungsten, iron, industrial minerals (olivine), gemstone
Southern West Greenland	2010 (ongoing)	Archaean terranes of the North Atlantic craton	Gold, chromium, vanadium, titanium, platinum-group elements, ruby, gemstone
South-East Greenland	Ongoing (2009; 2014)	Archaean terranes of the North Atlantic craton and Palaeoproterozoic Ammassalik mobile belt	Very poorly known part, with a potential for gold, copper, platinum-group elements, nickel, gemstones, diamonds

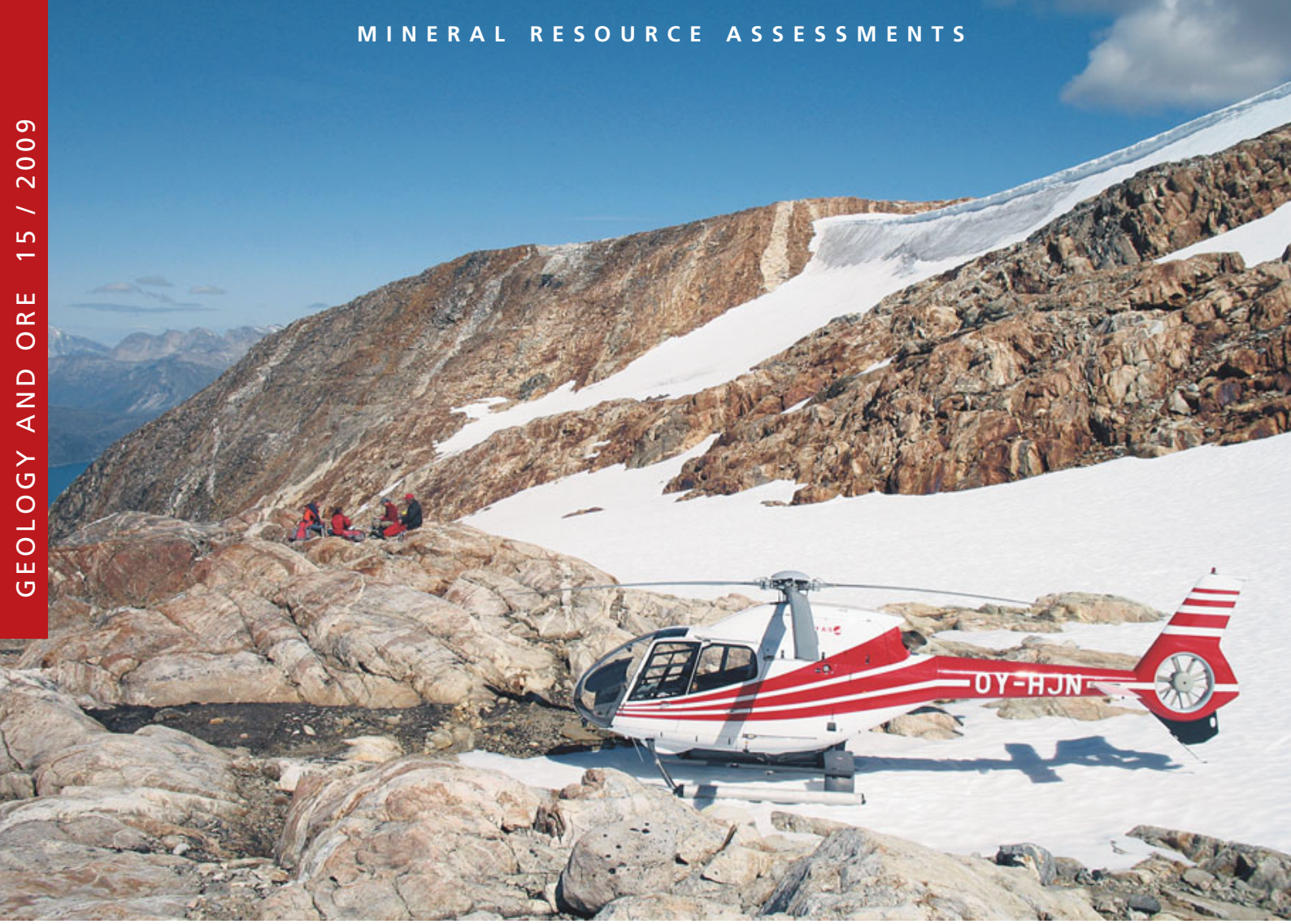


The Storø Gold Prospect in the central part of Godthåbsfjord, southern West Greenland. Courtesy: NunaMinerals A/S.

could only be expressed visually; they also allow the extraction of trends or signatures that formerly could not be recognised. In the integrative data analysis, relationships between large and diverse datasets, which otherwise can be incomprehensible, are being analysed systematically. The analyses are carried out using probabilistic, statistical and data-mining models and are always used in combination with other approaches; the results are validated statistically and geologically. This allows a quantification of geological features, which can be utilised in the formation of geological models. In addition, the integrative analysis allows predictions of e.g. certain mineralising systems. The predictions are made from the relationships of data signatures for sites with known mineralising systems, which are used in the search for similar signatures in unexplored areas. Alternatively they come from a search for specific data signatures and relationships, which by comparison with established mineral deposit models are found to be characteristic of the mineralising system.

Major discoveries made during public financed resource assessments

Region	Discovery
South Greenland	Metallogenetic province for gold and uranium Kangerluluk gold occurrence Stendalen copper-nickel-titanium occurrence Illorsuit uranium occurrence Kvanefjeld REE-uranium deposit Motzfeldt Sø tantalum-niobium deposit
Southern West Greenland	Fiskenæsset chromium occurrences Ivisaatoq tungsten occurrences Qussuk gold occurrence Tikiusaaq carbonatite complex
Central West Greenland	Sarfartoq niobium-REE-uranium occurrence Attu gold occurrence Eqi East gold occurrences Saqqaq gold occurrence Black Angle lead-zinc deposit
North-West Greenland	Melville Bugt iron province 'North Inglefield Land gold belt' – Cu-Au occurrences Minturn iron occurrence Moriusaq titanium occurrence
North Greenland	Washington Land zinc-lead-silver occurrence Navarana Fjord zinc-barite occurrence
East Greenland	Malmbjerg molybdenum deposit Blyklippen lead-zinc deposit



Extensive zone with hydrothermal alteration and mineralisation south of Ameralik, southern West Greenland, visited by GEUS geologists during the mineral resource assessment programme in 2008.

Integrative data analyses of this type have successfully been used for e.g. gold occurrences in the Nuuk region, southern West Greenland. In this region, 69 different dataset were used including location of gold occurrence and data from geological maps, stream sediment geochemistry, aeromagnetic data, aeroradiometric data and data from lineament analyses. The integrative analyses resulted in the identification of three distinct groups of gold occurrences with different characteristic data signatures and data relationships. Statistically validated, predictive prospectivity maps where constructed. Several of the predicted most prospective areas were subsequently investigated during GEUS field work. In two out of six visited areas, geologists were able to confirm a gold potential, based on sampling of rock and/or sediments with elevated gold values.

The integrative data analyses are often carried out in co-operation with other similar international programmes. BMP and GEUS are involved in for instance the 'Global Mineral Resource Assessment Programme' carried out by the United States Geological Survey, in which mineral resources in the first kilometre of the crust are being estimated. Similarly, there has been co-operation with the Canadian Geological Survey and other international research groups.

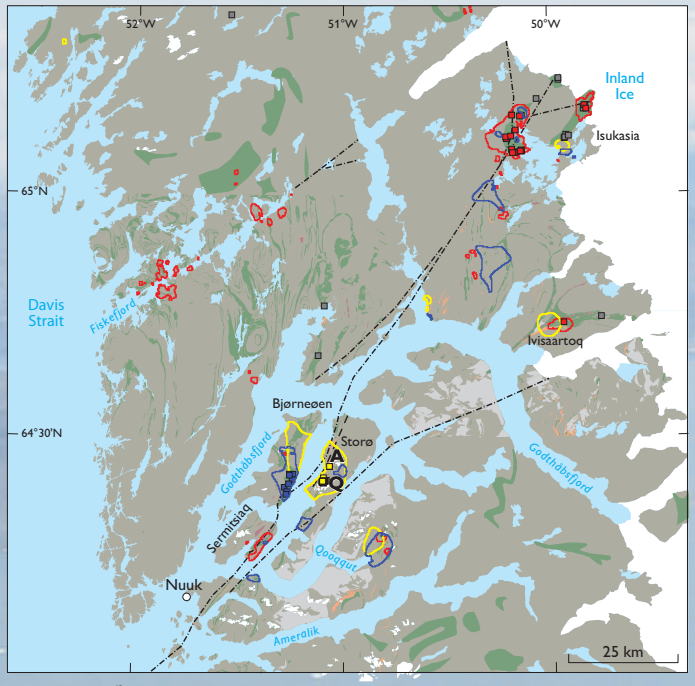
Modern remote sensing

The high-tech development of instruments for the acquisition of airborne and satellite borne hyperspectral data and the improved processing methods for such data have lead GEUS, through EU and BMP projects, to maximise the gain of remote sensing data for mineral exploration purposes. It is now common practice to use remote sensing data from e.g. the Aster satellite to prepare for coming field work, giving the field geologists much more targeted information. The processing and interpretation of remote sensing, especially hyperspectral data, are based on the use of extensive spectral libraries covering a range of inorganic and organic natural materials. A comprehensive library for Greenland has been established and is being expanded continuously. The results from processed hyperspectral data have been used in the search for kimberlites in central West Greenland and have lately resulted in the identification of a large anomaly that is similar to the anomaly observed at the well-known Malmbjerg molybdenum deposit in central East Greenland.

3-D geological modelling

Many years of geological research and GEUS' extensive archives of data allow the construction of digital 3-D geological models of mineralising system, regional geological structures and overall crustal

Principles of mineral potential mapping



Ice
Gneiss
Amphibolite
Metasediment
Ultramafic rock
Late Archaean granites
Fault and shear zones

Isua showings
Bjørneøen showings
Storø showings
Ungrouped showings

The top 137 km^2 most favourable areas for:

Isua gold group
Bjørneøen gold group
Storø gold group

Simplified geological maps with the top rated 137 km^2 (1% of the analysed area) outlined as most gold favourable area for the three groups of gold showings (Isua, Bjørneøen and Storø groups). Outlines of the rock units are from digital versions of 1:100 000 and 1:2 500 000 scale geological maps published by GEUS.

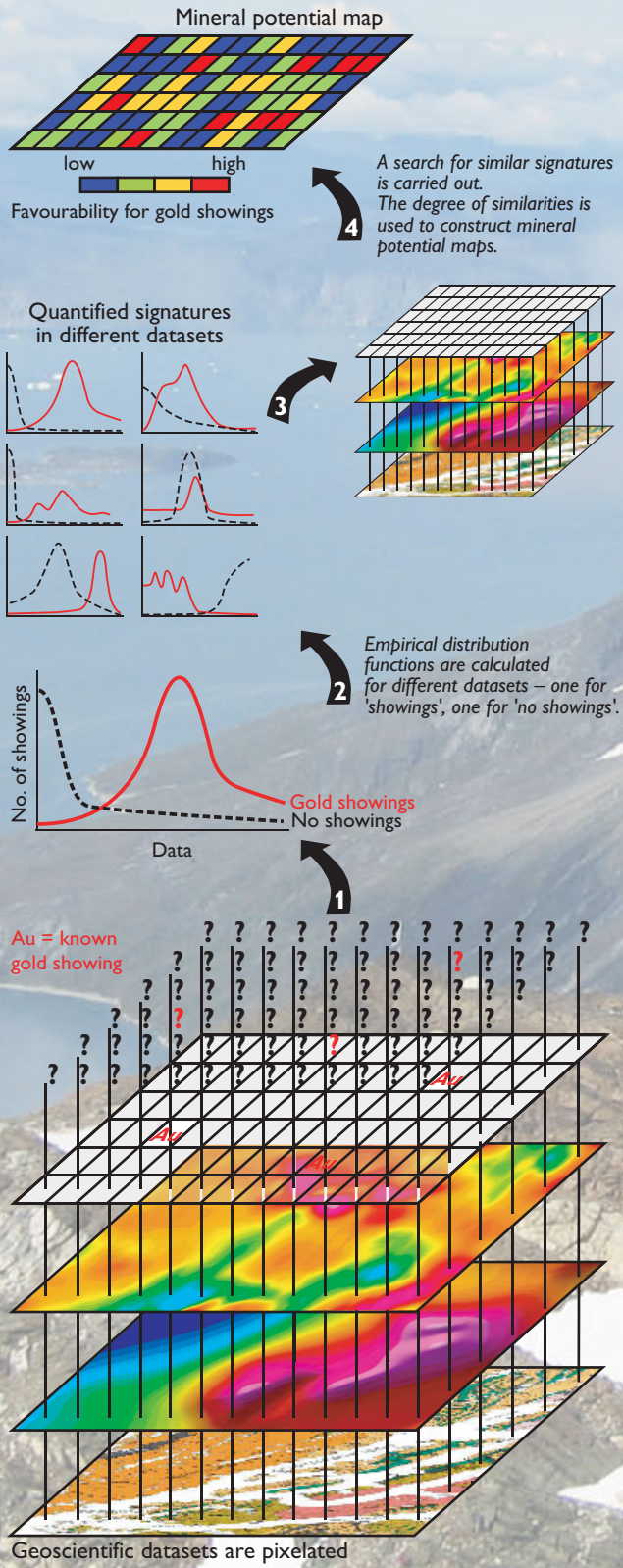


Illustration of the principal steps in a statistical approach to mineral potential mapping:

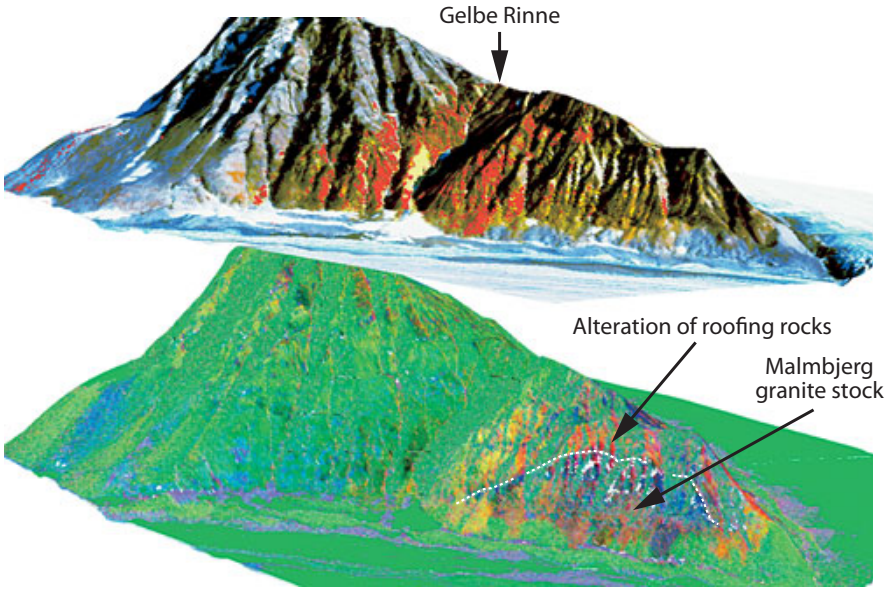
1: Regional datasets and gold showings (Au) are referred to a common grid with fixed cell size: a pixel.

2: Empirical distribution functions for pixels with and without known gold showings are used to establish the signatures of the showings in each dataset.

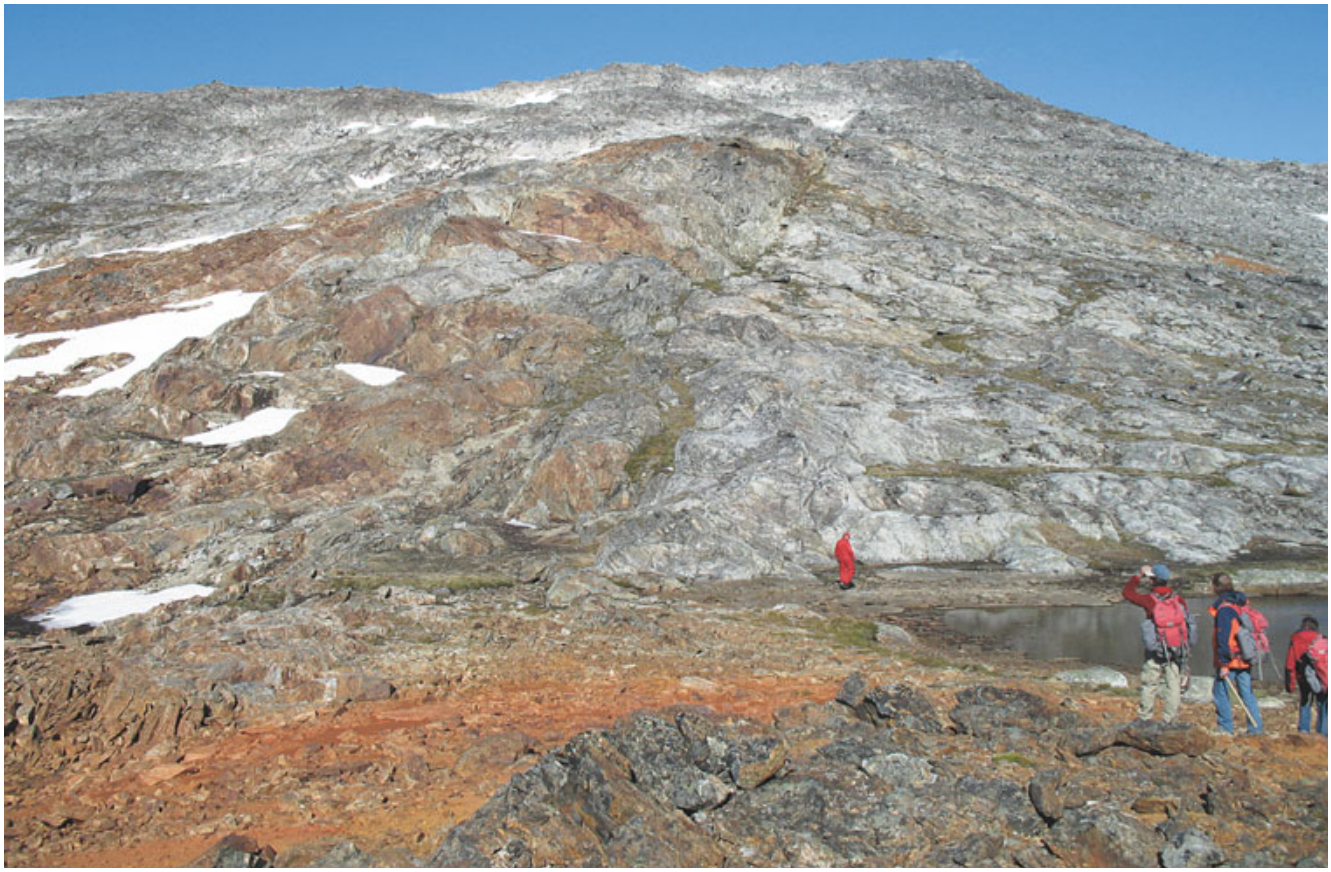
3: Ratio functions for all datasets are calculated on the basis of the two previous functions, expressing the likelihood of a showing. Groupings of gold showings are based on constructed mineral potential maps for each showing. Pixel by pixel, these maps outline the predicted favourability for data signatures similar to the selected showing, i.e. the potential for a similar showing.

4: Finally, mineral potential maps are calculated for each identified group of showings. These maps are based on the signatures found to be indicative for each of the different groups.

composition. As mineral deposit models advance and data analyses improve 3-D visualisation and interpretation becomes more important. Furthermore, with a few exceptions, only the geology expressed near the surface has been searched for mineral deposits in Greenland. As the exploration and mining industry deepens the search for concealed deposits, the sub-surface never-explored Greenland and thus the future 3-D geological models in the mineral resource assessments will be of greater importance.



Perspective view of the Malmbjerg molybdenum deposit seen from the south-west, no vertical exaggeration (granite stock indicated by the dotted line).
Upper: *Colour composite of HyMap data R (band 28), G (band 18), B (band 2) draped on the terrain model. The granite stock is surrounded by a zone of propylitic alteration ('Gelbe Rinne', red = illite and goethite; yellow = jarosite).*
Lower: *Colour composite of transformed shortwave, infrared HyMap reflectance, illustrating the exposure of the Mo-mineralised granite. Note the extent of the hydrothermally altered wallrocks (hues of yellow and orange). The roof zone of the granite stock is characterised by the greisen developments as outlined by topaz-enriched rocks (white).*

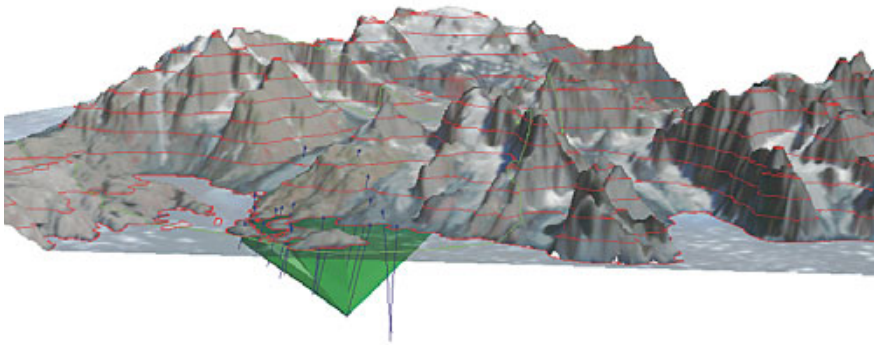


Hydrothermal alteration zones north of Buksefjorden visited by GEUS geologists during field work in 2008. Two soil samples from the area run 107 and 378 ppb Au respectively. A potential for gold in this area has until now not been known.

A GEUS geologist performs digital data capturing of field observations during the Survey's mineral assessment programme in 2008, 75 km east of Buksefjord, southern West Greeenland.

Future prospects

The content of this magazine shows the involvement of public authorities in the development of the mining industry. The authorities have spent many man-years and funds to ease the way for the exploration industry, providing easy access to data, knowledge and geological know-how accumulated over the generations. Soon the new Self-Governance of Greenland will be a fact and the successful and safe use of natural resources will remain a central topic for Greenland society.



Three-dimensional geological model of the Skaergaard layered intrusion in East Greenland – a potential world-class, multi-element deposit with the main commodities being PGEs and Au. The digital elevation model is draped with Aster scenes. The outline of the intrusion is indicated. Locations of drill holes released to the public are shown in blue. One of the modelled bowl-shaped, PGE-bearing layers (Pd5) within the layered intrusion is shown in green. The green line indicates the outline of the intrusion at the surface. 200 m contour lines are in red. Modelling by GEUS.

Field registration of kimberlite dyke in the Maniitsoq area, southern West Greenland.

Key literature

Appel, P.W.U., Garde, A.A., Jørgensen, M.S., Moberg, E., Rasmussen, T.M., Schjøth, F. & Steenfelt, A. 2003: Economic potential of the greenstone belts in the Nuuk area. General geology and evaluation of compiled geophysical, geochemical and ore geological data. Danmarks og Grønlands Geologiske Undersøgelse Rapport **2003/94**, 140 pp. + DVD. (Price: DKK 700.)

Jensen, S.M., Secher, K., Rasmussen, T.M. & Schjøth, F. 2004: Diamond exploration data from West Greenland: 2004 update and revision. Danmarks og Grønlands Geologiske Undersøgelse Rapport **2004/117**, 90 pp. + DVD. (Price: DKK 1000.)

Pedersen, M. 1999: GIS compilation of geoscience data: an ArcView GIS version of partly unpublished data from Wegener Halvø, central East Greenland. Danmarks og Grønlands Geologiske Undersøgelse Rapport **1999/37**, 14 pp. + CD-ROM. (Price: DKK 300.)

Rasmussen, T.M., Thorning, L., Stemp, R.W., Jørgensen, M.S. & Schjøth, F. 2001: AEM Greenland 1994–1998–summary report. Danmarks og Grønlands Geologiske Undersøgelse Rapport **2001/58**, 46 pp. + CD-ROM. (Price: DKK 300.)

Schjøth, F. & Thorning, L. 1998: GIS compilation of geoscience data: an ArcView GIS version of previously published thematic maps from Inglefield Land, North-West Greenland. Danmarks og Grønlands Geologiske Undersøgelse Rapport **1998/107**, 59 pp. + CD-ROM. (Price: DKK 300.)

Schjøth, F. & Steenfelt, A. (eds) 2004: Mineral resources of the Precambrian shield of central West Greenland (66° to 70°15´N). Part 1. Compilation of geoscience data. Danmarks og Grønlands Geologiske Undersøgelse Rapport **2004/16**, 45 pp. + appendices and DVD. (Price: DKK 700.)

Schjøth, F., Garde, A.A., Jørgensen, M.S., Lind, M., Moberg, E., Nielsen, T.F.D., Rasmussen, T.M., Secher, K., Steenfelt, A., Stendal, H., Thorning, L. & Tukiainen, T. 2000: Mineral resource potential of South Greenland: the CD-ROM. Danmarks og Grønlands Geologiske Undersøgelse Rapport **2000/57**, 36 pp. + CD-ROM. (Price: DKK 1000.)

Steenfelt, A. 2001: Geochemical atlas of Greenland – West and South Greenland. Danmarks og Grønlands Geologiske Undersøgelse Rapport **2001/46**, 39 pp. incl. maps or CD-ROM. (Price: DKK 300.)

Steenfelt, A., Thorning, L & Tukiainen, T. (eds) 1990: Regional compilations of geoscience data from the Nuuk–Maniitsoq area, southern West Greenland. Thematic Map Series Grønlands Geologiske Undersøgelse **90/1**, 9 pp., 57 maps. (Price: DKK 2600.)

Stendal, H., Nielsen, B.M., Secher, K. & Steenfelt, A. 2004: Mineral resources of the Precambrian shield of central West Greenland (66° to 70°15´N). Part 2. Mineral occurrences. Danmarks og Grønlands Geologiske Undersøgelse Rapport **2004/20**, 212 pp. (Price: DKK 350.)

Tukiainen, T. 2006: Mapping of kimberlitic rocks in central West Greenland using airborne hyperspectral data. Danmarks og Grønlands Geologiske Undersøgelse Rapport **2006/68**, 30 pp. + DVD. (Price: DKK 450.)

Tukiainen, T. & Krebs, J.D. 2004: Mineral resources of the Precambrian shield of central West Greenland (66° to 70°15´N). Part 4. Mapping of kimberlitic rocks in West Greenland using airborne hyperspectral data. Danmarks og Grønlands Geologiske Undersøgelse Rapport **2004/45**, 39 pp. + appendices and DVD. (Price: DKK 600.)

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Front cover photograph

Assessment of iron-sulphide accumulation in the Ivisaartoq Greenstone Belt, inner Godthåbsfjord, southern West Greenland.

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