

PGE deposits in Greenland

The Platinum Group Element (PGE) resources in Greenland encompass mineralisation in Precambrian to Palaeogene environments. The PGE accumulations in Greenland attracted interest already in the 1960s and have been part of Greenland exploration since the 1970s.

Geological environment for PGEs

Traces and showings of PGE mineralisation are numerous in the Precambrian terrains of Greenland. Another focus of PGE exploration is the Palaeogene settings.

Archaean and Palaeoproterozoic settings

Fiskenæsset anorthosite complex

The Archaean Fiskenæsset anorthosite complex, with a strike length of > 200 km, is hosted in high grade tonalitic gneiss. The chromitite layered complex has been repeatedly deformed and metamorphosed under amphibolite – and locally granulite facies conditions.

Exploration

PGE exploration has been limited – it started in the 1970s with the exploration for Merensky type platinum deposits. In 1991 GEUS investigated the critical bronzitite layer and a few other parts of the anorthosite complex. The bronzitite gave 74 ppb Pt and 115 ppb Pd. In other parts of the anorthosite complex, several-hundred-metre-thick lenses of ultrabasites with small amounts of sulphide have been found.

Sillisanguit Nunaat - Maniitsoq Norite Belt:

The Norite Belt (15 x 75 km) is located east of Maniitsoq and hosts a suite of irregular bodies of basic rocks intruding into the regional gneiss complex of the Akia terrane. The age of the Norite Belt is uncertain, but is probably around 3.0 Ga. The bodies vary in size from 2 x 4 km down to 10 x 20 m. They are predominantly composed of gabbro-norite and leucogabbro, collectively referred to as norite. Primary textures, such as igneous layering, are locally preserved.

Mineral accumulations

Elevated PGE numbers are found in norites and amphibolites related to zones enriched in sulphides. Rust zones and gossans identify zones enriched in sulphides. The sulphides occur as disseminations, veinlets, interstitial fillings and as more massive lenses. The mineral assemblage is rather uniform, with pyrrhotite as the predominant mineral accompanied by chalcopyrite and pentlandite. The average sulphide content in the mineralised rocks is around 2 vol.% and locally up to 25 vol.%.



Mineralised sequences in the Skaergaard intrusion, SE Greenland.

The Ni-Cu sulphide occurrences show a rather uniform Pd/Pt, but the absolute concentration is dependent on the sulphide content. The high concentration, up to 2.7 ppm, is believed to be the result of remobilisation.

Fiskefjord–Amikoq: Ultramafic intrusions

Several layered mafic to ultramafic intrusions are embedded in a supracrustal belt within the Archaean gneiss terrain. Igneous layering is common, despite strong deformation.

Exploration and ore composition

The Fiskefjord licences have been explored since 2005.

Analysis of whole-rock samples has returned values up to 4.5 ppm PGE (combined) and samples show high Pt/Pd ratios. Whole-rock samples are Pt-dominated with Pt/Pd ratios around 2.7.

Tasiilaq: Ammassalik Igneous complex

The syntectonic norite complex is located within the northern half of the Ammassalik Mobile Belt. The belt consists of alternating reworked Archaean rocks, with tectonically interleaved sheets of quartzo-feldspathic orthogneisses and early Proterozoic supracrustal rocks including komatiitic ultramafics.

Exploration

The Ammassalik Igneous complex in the Tasiilaq area is enveloped by supracrustal gneisses and has been the object of exploration since 1995.

Systematic surface sampling of the lens showed an average of 0.98% nickel, 0.33% copper, 553 ppm cobalt and 510 ppb combined Au-PGE.

Amitsoq-Nanortalik peridotite intrusions

Four PGE-bearing ultramafic hornblende peridotite intrusions have been recorded on the Nanortalik peninsula and the island of Amitsoq in South Greenland. The ultramafic plugs in the Nanortalik region may be related to an appinite suite observed throughout the Ketilidian orogen across the southern tip of Greenland. Two small plugs of layered ultramafics occur on the south shore of Søndre Sermilik.

A hornblende peridotite body is exposed five km south of the Ippatit valley. It hosts the 'Waldorf' PGE showing. Grab samples showed up to 280 ppb platinum and 330 ppb palladium, and drill-core samples yielded up to 100 ppb Pt and only 40 ppb Pd.

A hornblende-peridotite intrusion occurs on central Amitsoq, from where traces of gold, platinum and palladium have been reported.

Palaeogene settings (West and East coast)

Disko Island

The area hosts flood basalt related Palaeogene Ni-sulphide occurrences with PGE (Noril'sk type). The known occurrences in the Disko Bugt region are mainly hosted in contaminated lavas, and in dykes at the base of the volcanic succession.

Palaeogene picrite and basalt lavas overlie thick Upper Cretaceous and Palaeogene sediments. Most of the voluminous onshore volcanics were deposited in a short period of time 61–59 Ma ago. The Palaeogene dyke intrusions, such as the Hammer Dal complex on northwest Disko, contain nickel-bearing pyrrhotite and native iron formed by processes akin to Noril'sk type Ni-Cu-PGE deposits. The Hammer Dal complex is the richest metallic iron deposit on Disko, implying the existence of a large intrusion at depth.

The amount of deposited iron typically reflects local conditions of deposition rather than the general potential of the intrusive system. Apart from native (metallic) iron (and alloys), pyrrhotite and pentlandite are common. Sulphide-enriched basalt (together with accumulated, metallic iron) shows > 1% Ni and elevated PGE contents, up to 0.5 ppm.

East Greenland Palaeogene layered gabbro intrusions

More than sixty intrusions are recorded in the province hosts the world-class Skaergaard PGE and Au deposit.

Exploration and resources

Drilling in the Skaergaard intrusion has delineated a



1500 million tonnes, multi-element (platinum group elements, gold, silver, copper, titanium and vanadium) occurrence. The intrusion is currently modelled as a box-like magma chamber c. 11 by 7.5 km in surface area.

The mineralisation has a low sulphide content (<0.5 vol.% bornite and chalcosite). The precious metal grains occur in sulphide droplets in liquidus minerals or groundmass or as free precious metal droplets in the groundmass of the Ti-, V- and Fe-rich host rock.

A 44 m profile across the deposit indicates average contents of 6.6% TiO₂, 1300 g/t V₂O₅ and 19% Fe₂O₃ in the host rock of the precious metal accumulation. The lowest Pd-level (Pd5) is the main source of PGE and estimated to contain 104 million tonnes with of 0.11 g/t Au, 1.91 g/t Pd and 0.16 g/t Pt.

Concluding remarks

The magmatic provinces in Greenland's geology cover all periods of crustal evolution. Today PGE exploration can benefit from dedicated exploration efforts for precious elements and an increased search for nickel, which has been carried out in recent years within a variety of magmatic provinces.

Greenland has promising PGE deposits of world-class scale, as well as smaller scale occurrences, some with a proven PGE potential, and others not yet fully explored.

Key references

- Appel, P.W.U. 1993: Gold and platinum-group element anomalies in the Fiskenæsset stratiform anorthosite complex, West Greenland. Open File Series Grønlands Geologiske Undersøgelse **93/6**, 24 pp.
- Nielsen T.F.D. 2004: The shape and volume of the Skaergaard intrusion: implications for mass balances and bulk composition. *Journal of Petrology* **45**, 507–530.
- Schönwandt, H.K. 1971: Mineralised ultramafic rocks in South Greenland. Rapport Grønlands Geologiske Undersøgelse, **35**, 30–31.
- Secher, K. Appel, P. & Nielsen, T.F.D. 2007: The PGE potential in Greenland. *Geology & Ore* **8**, 12 pp.



Bureau of Minerals and Petroleum
(BMP)

Government of Greenland
P.O. Box 930
DK-3900 Nuuk
Greenland

Tel: (+299) 34 68 00
Fax.: (+299) 32 43 02
E-mail: bmp@gh.gl
Internet: www.bmp.gl



GEUS

Geological Survey of Denmark
and Greenland (GEUS)
Øster Voldgade 10
DK-1350 Copenhagen K
Denmark

Tel: (+45) 38 14 20 00
Fax: (+45) 38 14 20 50
E-mail: geus@geus.dk
Internet: www.geus.dk

Authors

K. Secher, P. Appel and T.F.D. Nielsen

Editor

K. Secher, GEUS

Layout

Henrik Klinge Pedersen, GEUS

Photographs

GEUS unless otherwise stated

Printed

December 2010 © GEUS

Printers

GEUS

ISSN

1602-8171