The lead and zinc potential of the Franklinian Basin in North Greenland

The Palaeozoic Franklinian Basin extends for 2500 km E–W through the Canadian Arctic Islands and northern Greenland. In Greenland, the basin borders the Arctic Ocean and is nearly 1000 km long and up to 200 km wide. Reconnaissance mineral exploration in the 1990s has demonstrated widespread lead-zinc mineralisation and the basin is now believed to offer an excellent potential for sedimentary lead-zinc deposits.

Geological setting

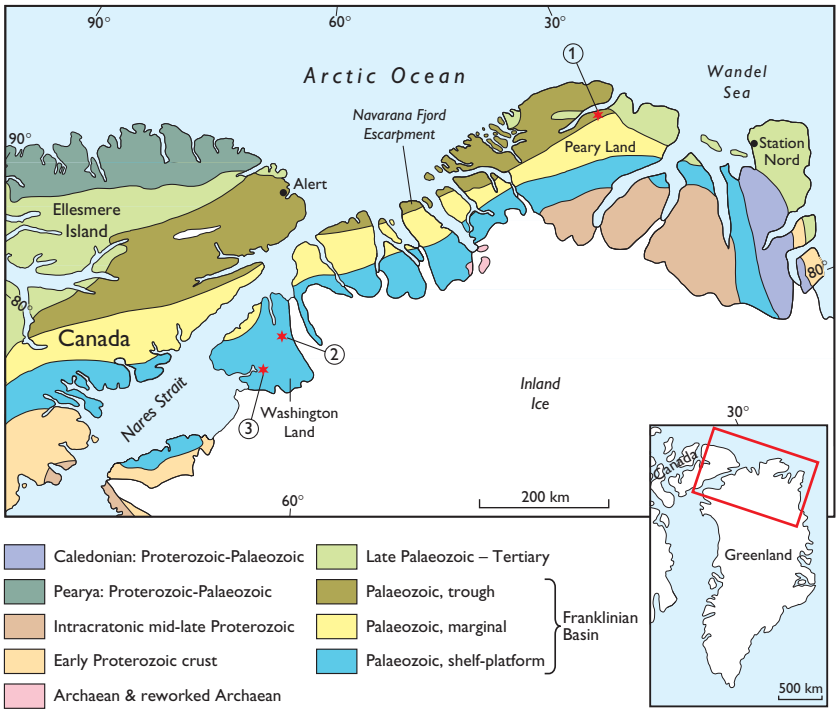
The Greenland part of the Franklinian Basin was mapped systematically by the Geological Survey of Greenland in the period 1978–85. Throughout the Early Palaeozoic, the basin was divided into a southern shelf and slope and a northern deep-water trough. The shelf succession dominated by carbonates reaches 4 km in thickness whereas the trough deposits that are dominately siliciclastic rocks have a composite thickness of c. 8 km. The boundary between shelf and trough facies shifted position with time and southerly basin expansion in the Silurian resulted in a final foundering of the shelf. This facies border, the so-called Navarana Fjord Escarpment, was a dominant E–W palaeo-topographic feature with a relief of over 1 km. Stream-sediment zinc anomalies are associated with this structure. Sedimentation was brought to an end by the late Devonian–early Carboniferous Ellesmerian orogeny. The resulting orogenic belt is characterised by E–W- to NE–SW-trending folds, with deformational effects most intense in the north, and broadly parallel to the main facies boundaries within the basin. Only in the northern part of Peary Land have rocks been affected by low-grade regional metamorphism.

Lead-zinc mineralisation

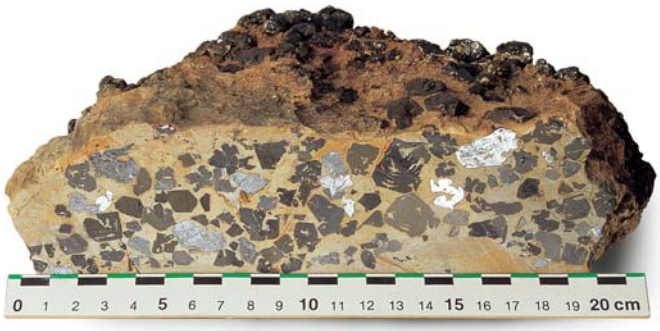
The remote region of northern Greenland has seen very little commercial activity. Encouraged by the results obtained in the Canadian part of the basin, especially the opening of the Polaris lead-zinc mine in 1982, Platinova A/S and partners reconnoitred the Greenland part in 1992–1999. The main exploration effort was on the Citronen Fjord deposit of Peary Land discovered in 1993. It appears that lead-zinc mineralisation occurs in both deep-water and shelf facies.

Deep-water trough

The deep-water clastic sediments have so far been the main target for exploration and host the only in-detail investigated occurrence, the Citronen Fjord stratiform massive sulphide deposit. This comprises four separate areas with pyrite, sphalerite and silver-poor galena mineralisation. The sulphides occur in three main levels within a 200 m thick sequence of Ordovician black shales and chert. Investigations by Platinova in 1993–1997 comprised geological mapping, gravity and electromagnetic surveys, and the drilling of 143 exploration holes totalling 32,400 m. Total sulphides are estimated to exceed



Geological map of North Greenland and north-eastern Canada showing main lead-zinc occurrences: 1. Citronen Fjord Deposit, 2. Petermann Prospect, 3. Cass Prospect.



Cass Prospect: galena crystals in a pale dolomitic matrix etched out on the weathered surface. Cut surface shows variety of crystal forms, some with skeletal growth structures.

Citronen Fjord Deposit: 3.6 cm wide drill-core showing fine-grained laminated pyrite and sphalerite in black mudstone. Zinc concentration in the upper sulphide layer is 25–30% and in the lower layer 1–3%.

350 million tons with an estimated 20 million tons grading 7% Zn and 1% Pb. A high-grade zone of 1.1 million tons diluted and recoverable ore with 9.4% Zn and 0.6% Pb has been determined in one area.

Platform, shelf and slope facies

Mineralisation occurs in various settings in the shallow-water facies. In the folded marginal shelf and slope Cambro-Ordovician sequence, minor zinc-lead-barium mineralisation, often related to carbonate debris flows, is common in the central and western part of the basin. The mineralisation appears to be controlled by the high permeability of pyrobitumen-bearing, partly silicified breccias.

In undeformed Cambro-Ordovician platform carbonates, mineralisation is best known from the western part of the basin, where GEUS discovered the Petermann Prospect in 1997. This comprises pyrite-sphalerite-smithsonite-galena mineralisation associated with dolomite alteration of the hosting Ordovician limestone and is traceable for 19 km along an E-W fault zone. Grab samples yielded up to 41% Zn, 13% Pb and 211 ppm Ag, but 925 m diamond drilling revealed no zones of economic grade; the most significant intercept was 23 metres of barren massive pyrite. The Cass Prospect, 50 km to the SW, comprises five areas of sphalerite-galena-barite mineralisation hosted by dolomitised Cambrian limestones over a 4 km structural zone open to the east and west. The one hole drilled has a best interval of 1.2 m grading 8.4% Zn, 0.04% Pb and 94 ppm Ag.

Finally, Silurian reef carbonates in the western part of the basin may host sphalerite-pyrite-galena-fluorite-barite mineralisation in zones of calcite veining in organic-rich carbonate rocks. The maximum strike length of zones with intermittent mineralisation is about 1400 m.

Concluding remarks

The lead-zinc mineralisation of the Franklinian Basin is of SEDEX-type in the clastic trough sediments and of Mississippi Valley-type in the platform and shelf carbonates. The under-explored basin is believed to be an excellent target for lead-zinc exploration, especially since the shrinking ice cover of the Arctic Ocean will probably facilitate sea transportation in the not to distant future, thereby lowering exploration and exploitation costs.

Key references

Andersen, E.O. 2001: Mining concept for the Citronen Fjord zinc deposit, NE Greenland. In: Olsen, H.K., Lorentzen, L. & Rendal, O. (eds): Mining in the Arctic, 51–60. Lisse, The Netherlands: A.A. Balkema Publishers.

Dawes, P.R. 2004: Explanatory notes to the Geological map of Greenland, 1:500 000, Humboldt Gletscher, Sheet 6. Geological Survey of Denmark and Greenland Map Series 1, 48 pp. + map.

Peel, J. & Sønderholm, M. (eds) 1991: Sedimentary basins of North Greenland. Bulletin Grønlands Geologiske Undersøgelse **160**, 164 pp.

van der Stijl, F.W. & Mosher, G.Z. 1998: The Citronen Fjord massive sulphide deposit, Peary Land, North Greenland: discovery, stratigraphy, mineralization and structural setting. Geology of Greenland Survey Bulletin **179**, 40 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

Author
B. Thomassen, GEUS

Editor
K. Secher, GEUS

Layout
C.E. Thuesen, GEUS

Photographs
GEUS unless otherwise stated

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