Zinc mineralisation at Navarana Fjord, central North Greenland

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A 5–7 m wide vein of calcite intersecting Cambrian dolomite at the west coast of Navarana Fjord contains a 1 m wide breccia zone in which massive sphalerite constitutes the matrix. The mineralisation is hydrothermal and related to tectonic movements. Bitumen occurs in the breccia zone and it is suggested that the zinc and the hydrocarbons were transported together in the mineralising fluid. The sphalerite mineralisation is seen as one expression of a major zinc mineralising event indicated by a reconnaissance stream sediment survey.

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The zinc mineralisation is associated with a large vein of calcite which is exposed in the cliffs on the west coast of Navarana Fjord, at approximately 82° 35′N (fig. 1). The vein fills a vertical fracture in the southern flank of the Navarana Fjord anticline (see Soper & Higgins, 1985), and it strikes 088°, parallel to the axis of the anticline.

The vertical exposure of the vein measures 60 m from the top of the scree to the top of the

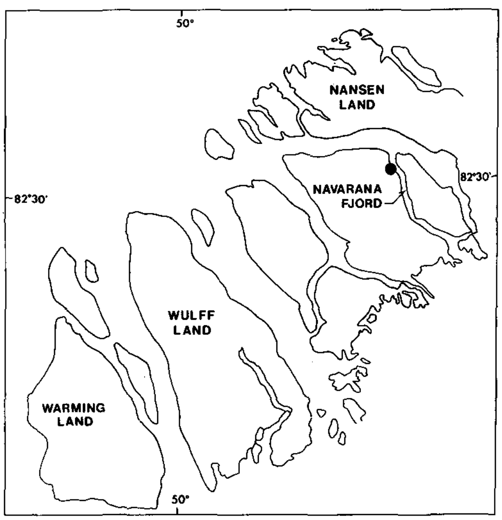

Fig. 1. The location of the zinc mineralisation at Navarana Fjord.

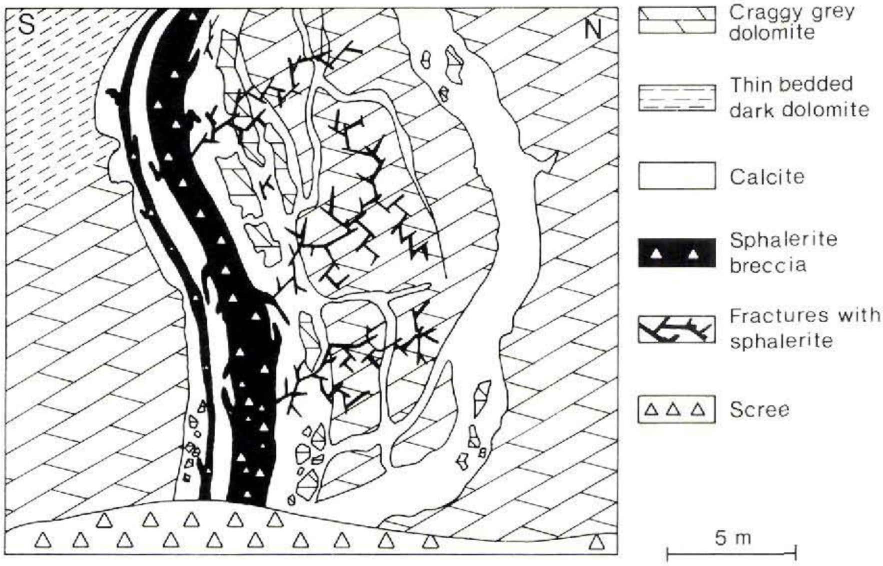

Fig. 2. Diagrammatic sketch of the calcite vein at Navarana Fjord.

cliff. Towards the west the vein outcrops intermittently in the soil covered slope over a distance of 200 m. There is no sign of the vein in a stream valley section 0.8 km further to the west and the analyses of soil samples collected along the strike also suggest that the vein is discontinued after 200 m, i.e. either wedges out or is displaced by a fault.

Fig. 2 is a diagrammatic sketch of the vein as it is seen in the cliff exposure. The wall rock is dolomite of the lower Cambrian Portfjeld Formation. The south side contains the boundary between grey craggy dolomite and overlying thin bedded dark dolomite, whereas the craggy dolomite continues to the top of the cliff face on the north side. This implies that the south side is downfaulted in the order of at least 50 m.

The vein itself is 5 to 7 m wide and has a slightly irregular vertical boundary against the south side while the north side is characterised by numerous small apophyses and one large. Angular fragments of the craggy dolomite are present in the (calcite) vein indicating that the calcite precipitated while the fracture was expanding.

Two breccia zones with sphalerite as matrix material occur in the vein. The larger is about one metre wide and is exposed over the entire vertical extension of the vein. The sphalerite content of the breccia zones is estimated at 40 to 60%. In addition, sphalerite is found as fracture filling in the calcite as well as in the wall rock in the vicinity of the main vein as indicated on fig. 2.

Mineralogy

The calcite vein

The gangue mineral is calcite deposited in at least two generations. A very coarse-grained (2–10 cm) white variety makes up the major part of the vein and finer grained (up to 0.5 cm), also white, calcite occurs as radiating crystals rimming the dolomite xenoliths and as cavity or fracture fillings. The calcite grains are frequently tectonised and calcite forms the clasts of the zinc mineralised breccia zones.

Minor amounts of Cu-minerals are seen in calcite. Chalcocite, covellite and malachite are closely associated in 2 to 5 cm wide stringers or veins. Chalcocite is fine-grained and has a rim of malachite in which covellite occurs. Chalcopyrite is found in the calcite as well as in the craggy dolomite wall rock, as disseminated euhedral crystals up to 5 mm across and fringed by malachite. Galena was observed in the western part of the calcite vein, as dispersed crystals less than 1 mm in size.

The breccia zone

The matrix of the breccia zone consists of intimately associated sphalerite, quartz and bitumen. The sphalerite is very fine-grained and of a light brown colour. The grains are often tectonised. In ultraviolet light secondary hydrozinkite was seen on the surface of the sphalerite.

Quartz occurs as fine-grained aggregates intergrown with sphalerite and calcite. In places the quartz is seen to partly replace calcite and even form pseudomorphs after calcite crystals.

Bitumen as disrupted grains or smeared stringers are ubiquitous in the matrix of the zones and gives it a dark coloration. The bitumen appears to have been deposited in the breccia zone largely contemporaneously with the sphalerite and quartz. Patches within grains of bitumen show high reflectance and anisotropy in polished section indicating initial graphitisation.

Fracture fillings

The fine-grained sphalerite in fractures differs from the sphalerite in the breccia matrix by its dark brown colour (as opposed to light brown). Sphalerite grains in fractures within the calcite vein are often tectonised while the grains in fractures in the wall rock are unaffected.

Discussion

The repeated deposition of minerals in the fault and the widespread brecciation and tectonism of grains show that the mineralisation formed in several phases, and responded to repeated tectonic movements. This is in agreement with the character of the surrounding area where minor faults with vertical displacements in the order of 20 to 100 m are common. However, calcite filling or mineralisation with Zn or Cu in fault fractures was not observed elsewhere in this western part of the Navarana Fjord anticline.

Based on the field observations and preliminary laboratory studies a generalised model of the formation of the mineralisation is presented and illustrated by fig. 3. The model comprises four stages:

(1) During the folding, faults and fractures developed parallel to the fold axis of the Navarana Fjord anticline. A hydrothermal solution percolated through one of the fractures and calcite plus subordinate Cu-minerals precipitated from it filling the fracture while it opened gradually.

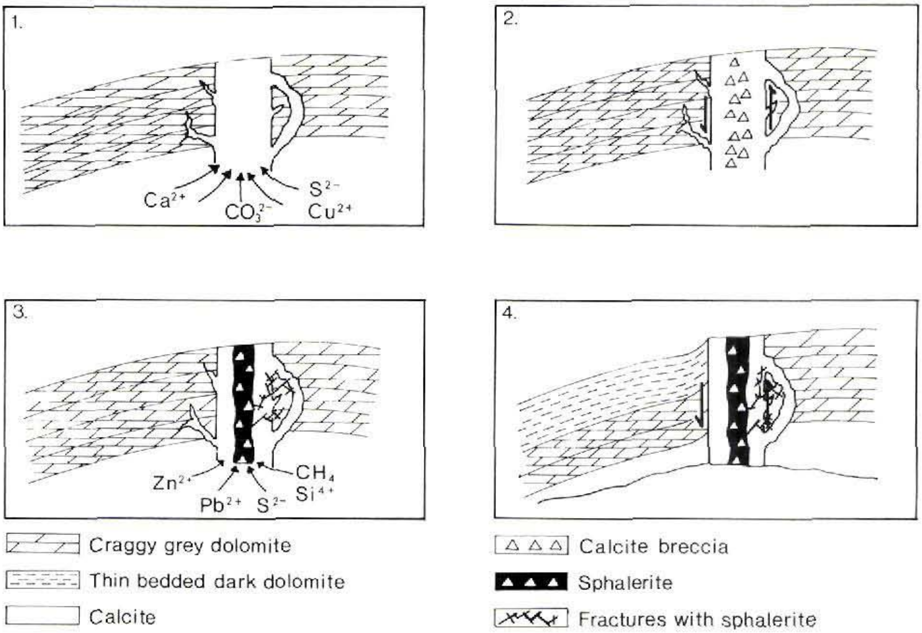

Fig. 3. Main stages in the development of the calcite vein and zinc mineralisation at Navarana Fjord. 1. Precipitation of $CaCO_3$. 2. Brecciation of the vein. 3. Precipitation of mainly sphalerite in the breccia zone. 4. Tectonic movements resulting in downfaulting of the southern flank.

(2) Repeated tectonic movements resulted in brecciation in the calcite vein.

(3) A solution containing Zn, Pb, S, Si entered the breccia zones and precipitated quartz, sphalerite and galena. Small fractures were filled with sphalerite. It is believed that hydrocarbons in volatile and fluid forms were introduced at this stage.

(4) Repeated tectonic movements affected the vein. Grains were disrupted and crushed and small new breccia zones formed with clasts of all previous vein material. One of the movements resulted in the downthrow of the southern wall. The sliding plane for this fault might be a huge vertical fracture seen in the cliff exposure. The northern side of the fracture has a well-developed slickenside parallel to the strike of the vein.

While it is obvious that the calcite vein and the zinc mineralisation were deposited from hydrothermal fluids, the origin of these fluids is not as obvious. At this early stage of investigation the authors prefer not to discuss the various possibilities, but only draw attention to the association of the zinc with hydrocarbons, which points to a sedimentary source of the fluids. High contents of zinc (up to 1092 ppm) are encountered in stream sediment samples taken 500 m to the south of the calcite vein (Steenfelt, 1985), in a stream draining dolomitic mudstones of the Ordovician un-named starved basin sequence (Higgins & Soper, 1985). The zinc mineralisation in the calcite vein and the indicated zinc mineralisation of the Cambro-Ordovician mudstone may well be related and could both be expressions of a major zinc mineralising event.

References

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