DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2013/61

Quartz veins and hydrothermal alteration in Kangerluarsuk, Narsaq, South Greenland: Prospecting for gold-quartz vein mineralisation in a sample of the Ujarassiorit 2011 mineral hunt

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Content

Abstract

A quartz vein sample with visible gold was sent to the Bureau of Minerals and Petroleum (BMP) in 2011 to be included in the “Ujarassiorit 2011 mineral hunt” competition in Greenland (2011-0033). The committee including officers from BMP and the Geological Survey of Denmark and Greenland (GEUS) recommended that the area from which the sample was collected should be further investigated before a final decision is made. On 24th August 2013, Drs Jochen Kolb (of GEUS) and Leon Bagas (of CET) visited the Kangerluarsuk area northwest of Narsaq in South Greenland in order to briefly assess the potential of the area for gold mineralisation hosted by quartz veins. Although visible gold was not identified during our visit, several arrays of quartz veins with minor carbonate and chlorite were identified on the northern shore of Kangerluarsuk. The veins are surrounded by chlorite, epidote, pyrite, hematite and goethite alteration, which is typical for orogenic gold mineralisation in the region and elsewhere in the world. Based on this observation, it is very likely that the sample sent in 2011 for evaluation (2011-0033) comes from the Kangerluarsuk area.

In addition, malachite staining of granite and widespread epidote-quartz-magnetite alteration was recognised in the area assessed, indicative of copper (and gold) mineralisation in the area. These new observations suggest that the Kangerluarsuk area has a high potential for economic mineral deposits and should be investigated in more detail. Due to the outdated (from 1960-1970s) geological data presently available, detailed modern geological investigations by GEUS researchers are recommended in order to produce detailed structural, geochemical, geomagnetic and hyperspectral maps. The emphasis here is to better understand the structural evolution of the area, which will help focus on target zones prospective for economically viable copper and gold mineralisation and future mining.

Introduction

The north shore of Kangerluarsuk to the northwest of Narsaq in South Greenland was investigated during a half-day expedition on 24th August, 2013, by Jochen Kolb (Geological Survey of Denmark and Greenland, GEUS) and Leon Bagas (Centre for Exploration Targeting, University of Western Australia) from the boat Juvel (Fig. 1). The aim was to identify and verify the location of gold-quartz veins in an area where visible gold was reported to be located, which was submitted to the 2011 “Ujarassiorit mineral hunt” competition (2011-0033, BMP sample number). Even though visible gold in quartz might be common in a region, it is not always possible to locate such mineralisation during a half-day expedition, but there are clues to the presence of such mineralisation in the types of alteration and indicator minerals in such an area. Therefore, two experienced geologists with scientific backgrounds in studying gold deposits investigated the area for such signs of mineralisation.

Regional geology

The area north of Narsaq is characterized by Palaeoproterozoic (ca. 1800 Ma) hornblende- or biotite-bearing granites (Fig. 1; Garde et al., 2002). The granite forms part of the Julianehåb Batholith in the Ketilidian Orogen, which is interpreted as the deeper section of a volcanic arc that was active during Palaeoproterozoic subduction dipping northward (Garde et al., 2002).

The granite in the Kangerluarsuk area is medium-grained, equigranular and contains plagioclase, K-feldspar, quartz and hornblende. This is the typical rock that is found along the northern shore between Qingatsiaq in the east and Qeqertaussaq in the west. Fine- to coarse-grained, < 5 m wide granitic sills crosscut the host granite. These sills typically dip shallowly to the north and are K-feldspar-rich containing lesser proportions of plagioclase, quartz and minor biotite.

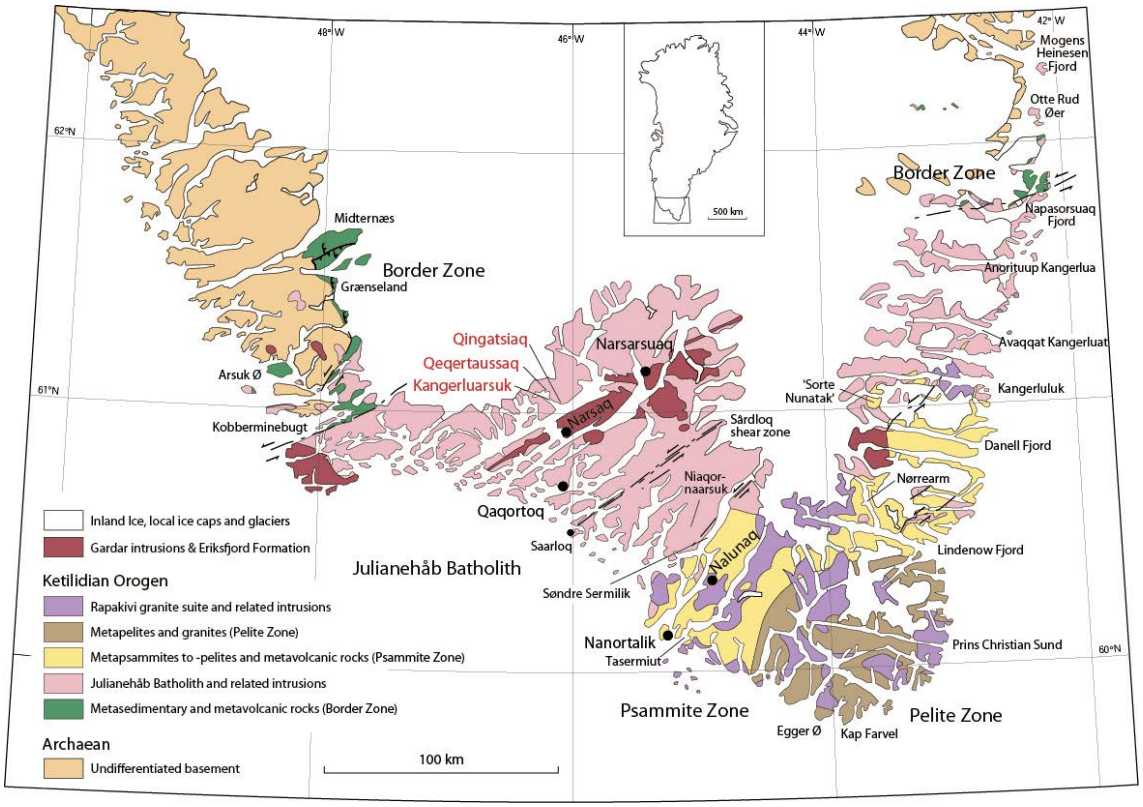

Figure 1. *Geological map of the Ketilidian Orogen in South Greenland and the location of Kangerluarsuk fjord to the northwest of Narsaq (modified after Garde et al., 2002).*

Quartz veins and hydrothermal alteration

Quartz veins in the Kangerluarsuk fjord form several closely spaced arrays in 50-150 m wide shear zones (Fig. 2). The veins are typically < 5 cm wide and contain blocky to comb-textured quartz and minor pyrite, hematite and chlorite (Fig. 3). Abundant goethite is also present, which indicates weathering of sulphides. In addition, milky quartz veins intersect the granitic sills and have a pronounced hematite alteration (Fig. 4). The milky quartz veins are intersected by laminated blue-grey to milky quartz-carbonate veins with local open space filling by quartz and chlorite. The latter vein type forms a conjugate set dipping either steeply west or steeply east, suggesting horizontal E-W extension. The veins have a < 5 cm wide hydrothermal alteration halo consisting of chlorite, epidote, pyrite, hematite and goethite with a sulphide content of ~3 vol.%.

Figure 2. *White quartz vein intersecting granite wall rock at the northern shore of the Kangerluarsuk fjord, forming part of a larger set of veins. The outcrop is ~4 m high.*

Figure 3. *Milky white quartz vein with fine-grained alteration halo including greenish chlorite and epidote (greenschist facies) in the Kangerluarsuk fjord.*

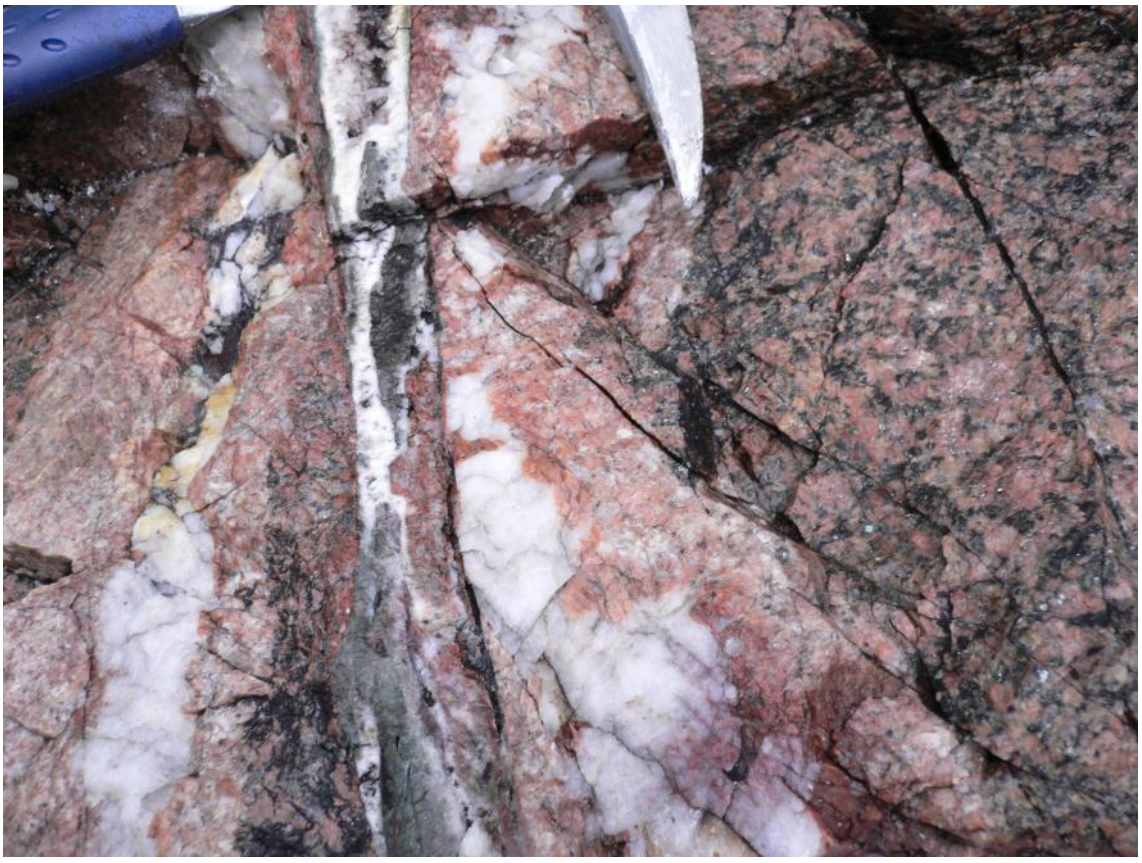

Figure 4. *Pronounced hematite alteration halo around a milky quartz vein in the Kangerluarsuk area. The greenish grey colour is characteristic of chlorite alteration commonly found in association with gold mineralisation in other parts of the world (e.g. Goldfarb et al., 2005). Note the presence of open-space filling in the quartz vein close to the hammer.*

The characteristics of the narrow quartz-carbonate vein arrays with epidote-chlorite-pyrite-hematite alteration and a sulphide content of ~3 vol.% are typical of orogenic gold mineral systems (e.g. Goldfarb et al., 2005) and is also found in gold-mineralised Archaean rocks of South-West and southern West Greenland (Kolb et al., 2013). In only a couple of hours prospecting time, we were not able to identify visible gold in the veins, but it is not unlikely that visible gold can be found in these veins. The 2011-0033 sample shows gold and sulphides on the photograph as well as greenish and reddish alteration, which could stem from chlorite and hematite alteration and which was observed in the quartz veins of the Kangerluarsuk fjord (Fig. 5). Our conclusion is that the gold-quartz vein Ujarassiorit sample from 2011 could have been collected from the area.

Figure 5. *Photograph of the sample collected from the Kangerluarsuk fjord in 2011 (2011-0033). Note, the quartz vein with visible gold and sulphides, and the reddish and greenish (chlorite-hematite) alteration at the bottom of the sample (photograph: A. Clausen, BMP).*

Epidote-quartz-magnetite alteration and copper mineralisation

During our investigations, green malachite staining after chalcopyrite was observed along joint planes in a fine-grained granitic sill (Fig. 6). The sill is < 15 m wide and consists of quartz, epidote, K-feldspar, plagioclase and hornblende. Other ore minerals include ~7 vol.% magnetite, and fine-grained sulphide (pyrite, chalcopyrite and others). At this site, the host granite is intersected by a complex array of dykes and sills, and is characterized by an extensive green-grey epidote-chlorite alteration, which can be observed for several hundred metres along the entire cliff wall of the Kangerluarsuk fjord.

The hydrothermal alteration assemblage includes quartz-epidote-magnetite-pyrite(-chalcopyrite-chlorite). This type of alteration and its large aerial extent are typical for magmatic hydrothermal systems of copper mineralisation (e.g. Sillitoe, 1997).

Figure 6. *Malachite staining (after chalcopyrite) along joints in quartz-magnetite-sulphide altered granite in the Kangerluarsuk area.*

Recommendation

The 2011 Ujarassiorit sample (2011-0033) of the gold-quartz vein and the observation of hydrothermal quartz-carbonate veins and associated alteration illustrates that the Kangerluarsuq area of South Greenland is highly prospective for gold and copper mineralisation. In addition, stream-sediment geochemical data confirm that the area is anomalous in gold (Steenfelt, 2000). Furthermore, the recognition of malachite staining (after chalcopyrite) together with typical alteration of magmatic hydrothermal copper mineral systems confirms the potential for multiple commodities in the area.

We, therefore, recommend:

- closing the area for exploration license application;
- reinvestigation of the 2011 Ujarassiorit sample;
- analysis of the material collected by field work the 24th August 2013 (petrography, geochemistry);
- properly assess GEUS' existing stream sediment geochemistry data for the area;
- complete detailed fieldwork in 2014 by GEUS and CET geologists, mapping structures hosting gold mineralisation, copper mineralisation, and associated alteration;
- regional geochemical and isotope-geochronological study in order to outline major structural breaks and characterize geochemical anomalies; and
- discussion of further actions such as: conducting detailed aeromagnetic surveys preferably at a 200 m spacing (or less) in order to identify host structures for possible gold-quartz veins; detailed hyperspectral mapping in order to identify large-scale hydrothermal alteration; and locating gold and copper mineralisation.

The last detailed geological investigations of the Kangerluarsuk area date to the 1960s and 1970s, and included broad regional mapping. This work was done before orogenic and granite-related mineral systems were properly understood. For example, orogenic gold deposits are now known to be hosted by deep-seated structures and so a clear understanding of structural geology is necessary in predicting the location of such deposits. However, the understanding of structures is a skill that has largely evolved since the 1970s. We therefore regard structural mapping and the understanding of the structural evolution to be a minimal prerequisite for successful mineral exploration in the area, in addition to detailed geological mapping, geochemical and isotope characterization and interpretation of detailed geophysical data at a maximum line spacing of 200 m. As pointed out above, a detailed structural, geochemical, geomagnetic and hyperspectral map are considered necessary for targeting potential copper and gold mineralisation that would have the potential for future mining.

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