DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2007/78

Assessment of the gold mineralisation on Storø, Godthåbsfjord, southern West Greenland

Mineral resource assessment of the Archaean Craton (66° to 63°30'N) SW Greenland Contribution no. 5

Claus Østergaard & Jeroen A.M. van Gool

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G E U S

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Introduction

A gold prospect on the island of Storø, is presently investigated by NunaMinerals in cooperation with GEUS. Storø is located within the central part of the Godthåbsfjord, West Greenland and lies within the greater Godthåbsfjord region which is the subject of a geological research, mapping and mineral assessment project of GEUS and the Greenland Bureau of Minerals and Petroleum (e.g. Hollis et al. 2004, 2006b; Hollis 2005; Stendal 2007). This report presents an overview of the gold mineralisation on Storø. The geological framework in which the prospect occurs is presented in more detail by van Gool *et al.* (2007).

Figure 1. *View from the western slopes of Aappalaartoq towards the south-west. The gold mineralised part of Qingaaq is on the left hand side, behind the person in the foreground. To the right is Godthåbsfjord with Bjørneøen, Sermitsiaq and Store Malene in the background.*

Storø is located *c.* 50 km north-east of Nuuk, the capital of Greenland. The prospect described here is located on the northern part of Storø, on the northern slope of the mountain Qingaaq, and on the southern slope of the mountain Aappalaartoq, 4 km further north (Fig. 1). The primary commodity prospected for is gold, which occurs in amphibolite-facies supracrustal rocks within fold hinges and along lithological contacts and related vein systems. Mineralisation occurs at several locations within a *c.* 20 km^2 area on the central and northern part of the island, approximately 1–1.5 km from the coast of Godthåbsfjord, at elevations between 450 and 1100 m above sea level (Fig. 2) The geology on Storø is well exposed with moderate to high relief (up to 1616 m above sea level) and limited vegetation (Fig. 1). The climate is moderate arctic with temperature means of 8°C in the summer and –5°C in the winter. The fjord is ice-free all year round and the island can be accessed by boat through the fjord system or by helicopter from the local airport in Nuuk.

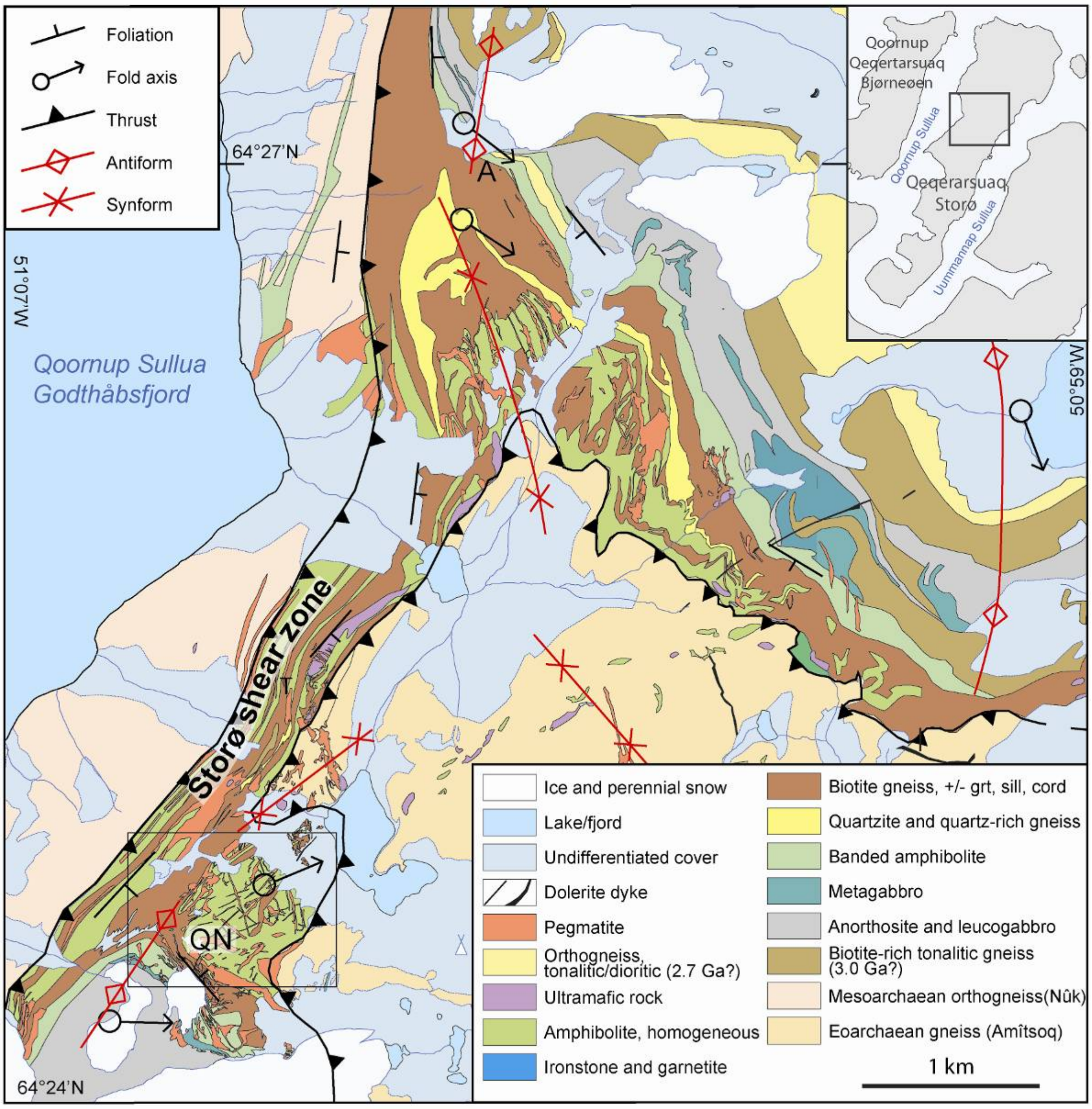

Figure 2. *Geological map of the area around the gold prospects on northern Storø, after Østergaard & van Gool (2005, unpublished map at 1 : 10 000). The square at Qingaaq north face indicates the position of the maps in Figs 5 and 6. QN = Qingaaq north face, A = Aappalaartoq.*

Exploration history

Previous work on Storø includes regional geological mapping and reconnaissance geochemistry by the former Geological Survey of Greenland (GGU, in 1995 amalgamated with the Geological Survey of Denmark, DGU, to form GEUS) and stream sediment sampling by Kidd Creek Mines (see Appel *et al.* 2003 and references therein). NunaOil visited the area in 1990, and increasing company activity the following years, including mapping, rock- and sediment sampling, resulted in a drilling program in 1995 (13 holes totalling *c.* 2900 m; Fig. 3; Trepka-Bloch 1996). Encouraging results justified a continued exploration and drilling program in 1996 (8 holes totalling *c.* 2000 m; Skyseth 1997). Furthermore, the mineralisation and geology also became the focus of a Ph.D. project by a student at Aarhus University (Pedersen 1996). Nevertheless, due to decreasing gold prices and changing NunaOil's project priorities, the license was given up in 1998.

Figure 3. *Drill rig near the foot of Qingaaq north face. View to the east.*

In 2002, NunaMinerals A/S (formerly NunaOil) regained the Storø license and initiated a new exploration programme. At this time, the company, in collaboration with GEUS, had demonstrated that the Godthåbsfjord region and especially Storø showed similarities to well known gold districts such as Timmins Gold camp, Abitibi sub-province (Poulsen *et al.* 2000). Here, the best prospects are located adjacent to the Porcupine-Destor crustal scale fault zone associated with secondary syncline-pericline structures. Gold occurs within quartz-veined systems hosted by intensely altered Meso-Archaean greenstone rocks (*c.* 2.7–2.8 Ga) mainly consisting of mafic volcanic rocks in contact with sedimentary argillites and greywackes. A similar geological framework occurs on Storø and mineralisation was viewed in a new geological and economic context. Promising results and minor drilling in an untested area in the southern part of the license, including the discovery of a new mineralised horizon in 2003, resulted in an extensive drilling program in 2005 (24 holes totalling *c.* 3900 m; Østergaard 2006). Drilling continued in 2006 (14 holes totalling *c.* 2800 m; Østergaard 2007) and 2007 (12 holes totalling *c.* 1800 m; Østergaard 2008) mainly focussing on extending the known occurrences outlined in the previous years (Fig. 4). Furthermore, in 2007 the company collected 1.2 tonnes of ore material for metallurgical studies from different Gold mineralised zones as part of the continuing assessment of the project. A considerable part of the ore at Storø occurs as "coarse-gold" grains, which may be up to 3 mm wide and indicate a significant “nugget” effect in the sample material. As a result, gold grains are unevenly distributed in the rock causing large grade variations in the analysis results of the mineralised zones.

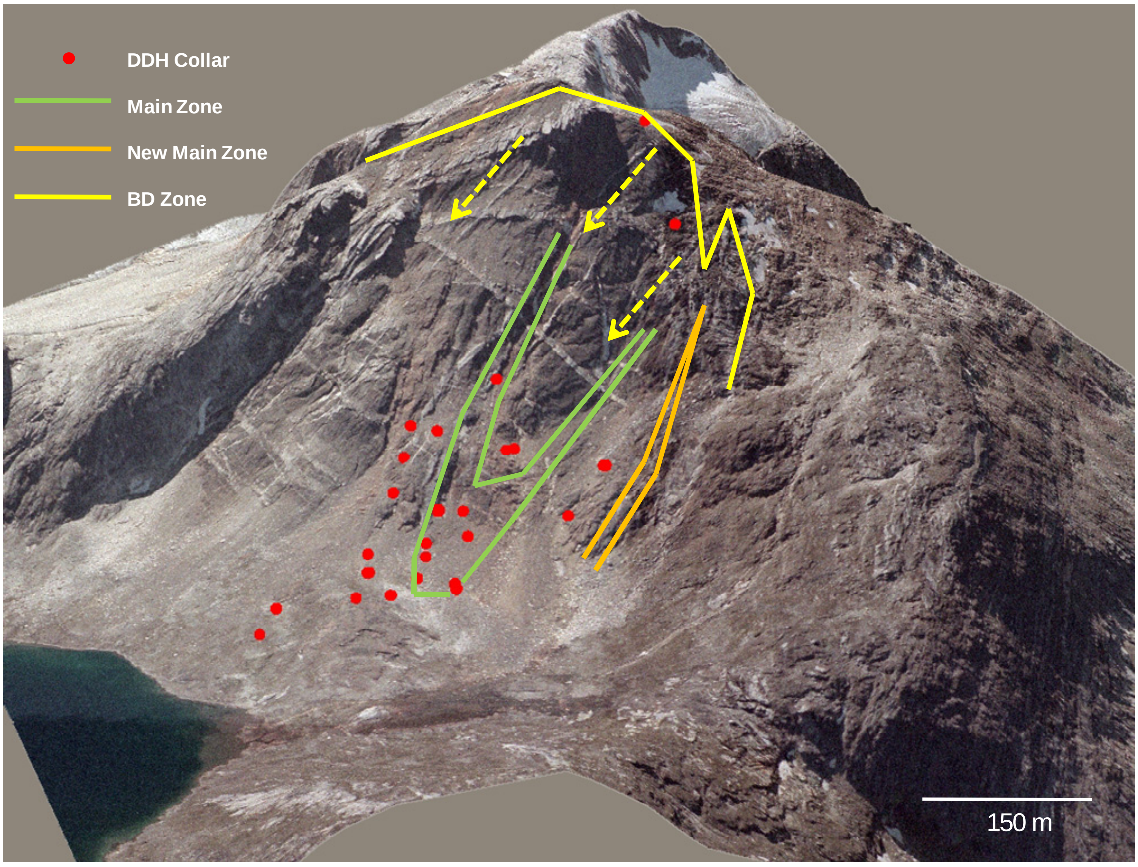

Figure 4. *Three dimensional model of Qingaaq north face and top (orthophotograph draped over a digital terrane model) showing the three main mineralised zones and drill hole locations. Yellow arrows show the continuation of the BD zone in the sub-surface. Viewed from the north, at c. 1100 m altitude. The highest drill platform is 560 m above the level of the lake.*

Geology

Regional setting

The Nuuk region comprises some of the largest areas of exposed early Achaean crust in the world, as well as vast domains of middle and late Archaean crust. Collectively, these regions make up part of the North Atlantic Craton, which is correlated with Archaean gneisses of the Nain Province in Labrador, Canada. The geology of the Nuuk region is dominated by grey orthogneisses formed during several episodes of crustal growth. These gneisses can be subdivided into several continental crustal terranes of distinct ages, which were amalgamated during the Neoarchaean (*c.* 2.7–2.6 Ga). The individual terranes are separated by, often complex, deep-seated tectonic boundaries. Supracrustal belts, made up of predominantly metavolcanic rocks and minor metasedimentary rocks occur within or between these different crustal blocks.

The gold prospect on Storø is hosted by the Neoarchaean Storø supracrustal belt, which is situated in what was formerly known as the Akulleq terrane (McGregor *et al.* 1991), but which now is subdivided into the early Archaean Færingehavn and Isukasia terranes, the Mesoarchaean Kapisillit terrane and the Neoarchaean Tre Brødre terrane (Friend and Nutman 2005). The Færingehavn and Tre Brødre terranes occupy much of the central and southwestern part of the Godthåbsfjord (Friend *et al.* 1987; 1988; Nutman *et al.* 1989; Friend *et al.* 1996).

The Storø supracrustal belt

The supracrustal rocks on Storø (Figs 2 and 5) comprise a deformed sequence of mafic to intermediate amphibolite, ultrabasic rocks, garnet-mica-sillimanite schist and fuchsite-bearing quartzite (Hollis *et al.* 2004; Knudsen *et al.* 2007; van Gool *et al.* 2007). The sequence is most extensive and coherent on the central/northern part of Storø around the mountains Qingaaq (1616 m) and Aappalaartoq (1440 m), but it can be followed for over 60 km from the Kangaarsuq peninsula north of Storø to west of Kobbefjord in the south.

The Storø supracrustal belt is bound to the west by the Storø shear zone (Fig. 2), which separates the supracrustal belt from the *c.* 3.05 Ga orthogneisses of the Akia terrane in the footwall, which are exposed along much of northern Storø's western coast (Hollis *et al.* 2004; Hollis 2005; van Gool *et al.* 2007). To the east, the supracrustal rocks are overlain by Eoarchaean orthogneisses of the Færingehavn terrane, underneath the supracrustal belt to the north occur interleaved gneisses of Eo- to Neoarchaean age. The Storø supracrustal belt consists predominantly of metavolcanic and metasedimentary rocks of Neoarchaean age (Hollis *et al.* 2004, 2006a, b; Knudsen et al. 2007; van Gool *et al.* 2007).

The area was affected by amphibolite-facies metamorphism, with sillimanite being the dominant alumino-silicate. Metamorphic zircons in the Neoarchaean supracrustal rocks are predominantly 2630 Ma, but older, *c.* 2700 Ma and younger *c.* 2600–2550 Ma metamorphic ages have also been recorded (Hollis *et al.* 2006a, b; Knudsen *et al.* 2007; Nutman *et al.* 2007; van Gool *et al.* 2007). Petrographic observations of gold inclusions in garnet have shown that gold mineralisation occurred prior to peak metamorphism (Juul-Pedersen *et al.* 2007). However, post peak metamorphism gold, associated with retrograde sericitisation and epidotisation, predominantly in and near quartz veins, has also been observed, suggesting later remobilisation (Juul-Pedersen *et al.* 2007; van Gool *et al.* 2007). This is confirmed by a 2635 Ma age of zircon inclusions in arsenopyrite, associated with the gold mineralisation (Nutman *et al.* 2007).

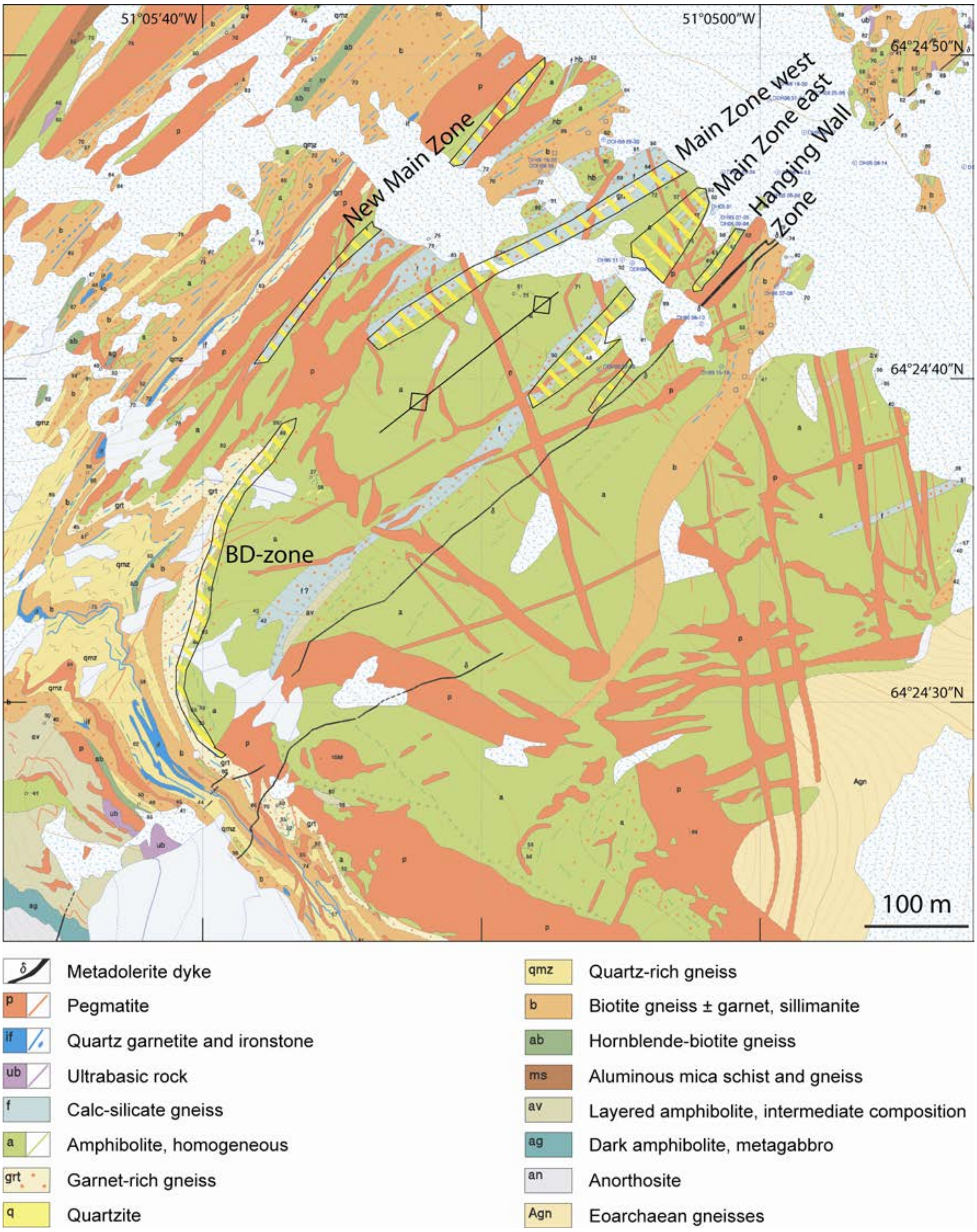

Figure 5. *Detailed geological map around the Qingaaq prospect. The main mineralised zones are indicated with the yellow line pattern. After van Gool (2007 unpublished map at 1 : 2 500).*

Tectono-stratigraphic sequence

The lowest unit within the supracrustal belt overlies anorthosite and meta-gabbros, and consists of 150 m banded grey heterogeneous amphibolites, which are laminated on mm–cm scale and highly sheared at Qingaaq. The protolith of these rocks is uncertain but inferred to originate as intermediate and basic tuffs. Pillow structures are reported from east of Aappalaartoq (Grahl-Madsen 1994).

The banded amphibolite is overlain by 100–200 m of heterogeneous brown quartzo-feldspathic and aluminous gneisses, which include quartzo-feldspathic garnet-sillimanite-biotite gneisses, quartzitic gneisses and massive garnet-rich units with variable amounts of muscovite, graphite and minor staurolite. The uppermost part of this succession consists of a 10–50 m wide poorly-foliated unit of highly aluminous rocks consisting of garnet, sillimanite, mica and feldspar. Based on their geochemistry, these rocks are unlikely to be metasediments, but may rather be the result of pre-metamorphic alteration (sericitisation?) of a basaltic or more felsic volcanic precursor (Knudsen *et al.* 2007; van Gool *et al.* 2007). The rocks near this upper contact of this aluminous rock type with the overlying amphibolites are referred to as the BD zone (see below).

Within the garnet-biotite gneisses, up to 10 m thick layers of garnet-magnetite-rich ironstone and garnetite occur. This rock unit forms irregular, laterally discontinuous layers that are interleaved with garnet-biotite gneisses and isoclinally folded (Fig. 5). They consist of garnet-magnetite-biotite-quartz assemblages, containing locally over 80% garnet.

On the western, eastern and southern slopes of Aappalaartoq, a 300–400 m thick unit of quartzitic fuchsite-bearing gneisses and massive, fuchsite-bearing quartzite occurs in a synformal hinge near the top of the mountain. A similar, but much thinner unit of quartz-rich gneisses is exposed in the upper part of the metasedimentary unit on Qingaaq, interleaved with the garnet-biotite gneisses, and usually folded by late F3 folding of the Storø shear zone. Where the unit is thickest, on Aappalaartoq, it was subdivided into a lower sillimanite-fuchsite bearing member and an upper muscovite-fuchsite bearing member (J.S. Petersen, *in* Grahl-Madsen 1994).

The uppermost tectono-stratigraphic unit in the sequence comprises homogeneous, fine to medium-grained black amphibolites, which can be up to 250 m wide. It contains several thin sheets of rusty garnet-biotite schist, garnetiferous, amphibole-, diopside-, and pyrrhotite-bearing gneiss and zones of calc-silicate veining. The majority of gold mineralised zones occur in alteration zones within this upper amphibolite unit.

The largest exposures of the upper amphibolite unit are located on the southern slopes of Aappalaartoq and the northern slope of Qingaaq (Fig. 5). However, in both areas the dip slope exaggerates the thickness of the amphibolites in the map pattern. These amphibolites probably originate as mafic flows, but locally contain deformed clasts indicating a volcaniclastic protolith.

Calc-silicate alterations are common within the amphibolite, and probably represent synvolcanic, pre-metamorphic spilitic alteration characterised by abundant diopside and epidote, locally also garnet or calcite (Eilu *et al.* 2006). More extensive garnet-calc-silicate gneiss layers are assumed to be intensely altered and subsequently metamorphosed parts of the basaltic sequence. More important with respect to gold mineralisation is the presence

of younger biotite-garnet alteration domains, which may be up to *c.* 50 m wide and enclose most of the auriferous quartz veins. These domains involve a progressive increase in the modal concentrations of biotite, garnet, quartz, diopside and sulphides (pyrrhotite and arsenopyrite) towards the gold enriched zones (Eilu *et al.* 2006). Most of the alteration zones are intensely deformed, they possess an S1 foliation, and have metamorphic mineral assemblages, which indicates that they predate the earliest deformation and metamorphism.
Lenses of ultramafic rocks occur throughout the sequence, but are most common at the top, along the contact with structurally overlying Eoarchean gneisses (Amîtsoq gneisses), where they can form bodies up to one hundred metres wide. They are predominantly ultrabasic schists, consisting of actinolite-tremolite-phlogopite. The presence of these ultrabasic rocks throughout the tectono-stratigraphic sequence is in accordance with an interpretation as ultramafic dykes (Hollis *et al.* 2004).

Geochronology

Detrital zircons from garnet-mica-sillimanite gneisses and quartzites on Storø indicate two distinct populations. The zircons in the garnet-biotite-sillimanite gneisses show ages of *c.* 2.82–2.92 Ga (Hollis 2005; Hollis *et al.* 2006a, b; Knudsen *et al.* 2007; van Gool *et al.* 2007) probably derived from an immature sedimentary precursor formed in a volcanic arc. The quartzites have significant proportions of older zircons showing ages of *c.* 2.9–3.1 Ga, with a peak around 3.07 Ga, as well as few detrital zircons of >3.6 Ga (Hollis *et al.* 2006a, b; Rink 2006; van Gool *et al.* 2007), which may represent a more mature sediment formed as an erosional product of an older continent. These ages correspond well to zircon populations from Mesoarchaean and Neoarchaean supracrustal belts other places in the Godthåbsfjord region. Few metavolcanic rocks of the Storø belt yield U-Pb zircon ages between 2.80–2.85 Ga, which are interpreted as potential volcanic protolith ages (Hollis 2005). Many samples yield a metamorphic age of *c.* 2.63 Ga, while some samples contain metamorphic zircons of 2.55–260 Ga (Hollis 2005; Nutman e*t al.* 2007; van Gool *et al.* 2007). The metamorphism around 2.63 coincides with thrusting on the Storø shear zone, representing a phase of crustal thickening. The younger metamorphic ages overlap with intrusion of the Qôrqut granite south of Storø.

Structural setting

The structural setting of the gold prospect on central Storø is dominated by kilometre-scale folds in the hanging wall of the Storø shear zone (Fig. 5). The latter is a 300–400 m wide ductile shear zone with oblique reverse movement, which traces the north-western slopes of the island. The shear zone and the folds overprint earlier structures.
The main foliation in the area (S1) was formed prior to peak metamorphism, since it is overgrown by garnet porphyroblasts. Locally, especially near the lower contacts of the supracrustal belt with the gabbro-anorthosites, the S1 has a mylonitic character, with an intense extension lineation. This foliation is folded in metre-scale tight and isoclinal F2 folds, and rarely larger-scale folds. Kilometre-scale antiform and synform pairs (F3) overprint these meso-scale folds, and they have axial planes parallel to the fabric in the shear zone. The fold geometry suggests that they are formed as hanging wall anti- and synforms at

ramps in the Storø shear zone (van Gool *et al.* 2007). Both the shear zone and the folds have a WNW vergence. F3 fold axes are variable, but plunge predominantly east-north-east around Qingaaq, and south-east around Aappalaartoq. They are either re-oriented frontal ramp structures, or lateral ramp structures on either side of a thrust nappe, moving up the Storø shear zone. Outcrop-scale F3 folds occur within the shear zone and its hanging wall, becoming progressively tighter towards the core of the shear zone. In the shear zone and 200–300 m above it, a new S3 mylonitic foliation occurs, which locally overprints garnet porphyro-blasts. A smaller F3 antiformal hinge (main zone antiform, on the scale of several hundreds of metres) on the north slope of Qingaaq (Fig. 5) occurs in the hanging wall of a local minor shear zone. Pegmatites occur in several sets, and are variably deformed, both cutting shear zones and folds, and being deformed by them. The majority of these pegmatites (both deformed and undeformed) have an age of *c.* 2.63 Ga (Hollis 2005), which defines the age of the shear zone and the associated folds. One slightly younger pegmatite was dated at *c.* 2550 Ma and is presumably associated with the nearby Qôrqut granite complex (Nutman *et al.* 2007).

Mineralisation

Gold mineralisation at Storø occurs at several tectono-stratigraphic levels within the upper part of the supracrustal belt and comprise high-grade zones of quartz veins and disseminated sulphides and sulpharsenides (up to 52 g/t Au over 2), which extend for several hundred metres and can be up to 12 metres wide (Figs 5 and 6). Gold also occurs within sulphide-rich garnetite units primarily consisting of almandine garnet (>60%), biotite and pyrrhotite (up to 21 g/t Au over 2 m), which are associated with the high-grade zones. These zones occur both within larger low-grade domains (0.1–1g/t Au) of altered amphibolite and within sillimanite-mica-garnet gneisses, which may be up to 50 m wide and are characterised by biotite and garnet enrichment. The mineralised zones are broadly sub-parallel to the lithological contacts and with the planar mineral fabric of the host rocks. However, in detail, the auriferous quartz veins are at a small angle to lithological contacts. Furthermore, some zones are clearly folded and displaced by the late stages of deformation within the Storø shear zone. At present the observations suggest that there is both an early phase of gold mineralisation, prior to peak metamorphism (e.g. gold inclusions in garnet), and likely due to a syn-genetic phase of alteration, and a later remobilisation of the gold during peak and retrograde metamorphism (e.g. in sericitised and epidotised plagioclase; see discussion by van Gool *et al.* 2007).

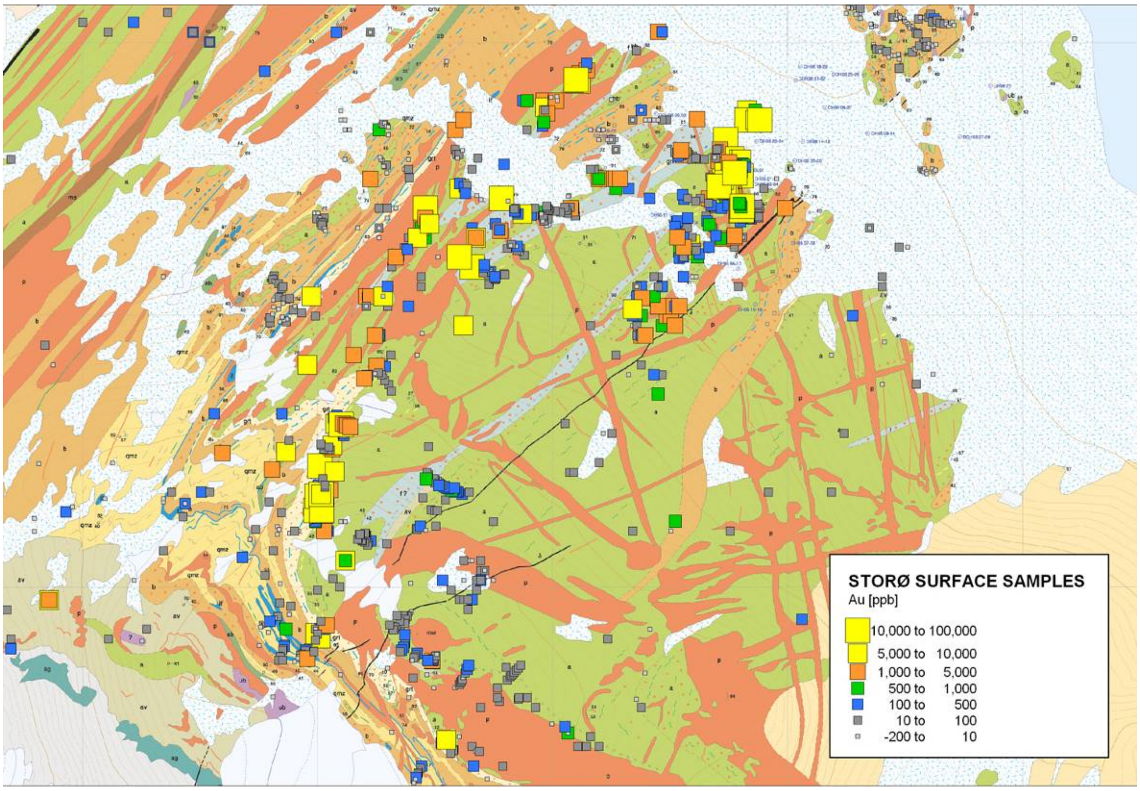

Figure 6. *Geological map of the Qingaaq prospect with results of assay analyses for gold of surface samples in the area.*

The most promising gold targets occur in the Qingaaq area (Fig. 6), whereas mineralisation on Aappalaartoq is poorly constrained. However, anomalous gold grades and mineralised lithologies can be mapped continuously between these two areas suggesting that mineralisation on Qingaaq and Aappalaartoq formed in the same geological setting. The highest gold grades occur in both areas in similar pairs of fold hinges in the hanging wall of the Storø shear zone (van Gool *et al.* 2007).

Qingaaq

Three significant targets crop out on the Qingaaq north face located at two separate stratigraphic levels.

BD Zone

Mineralisation developed along the contact between the upper amphibolite and the underlying sillimanite-garnet gneiss. The BD type discovery outcrop was located in 2003 on upper Qingaaq (Fig. 5), but similar styles of mineralisation also occur at the same contact on Aappalaartoq. Gold mineralisation occurs within both rock types up to 20 m away from the contact, mainly within or next to sections of sheeted quartz veins, which are sub-parallel or weakly cross-cutting to the contact (Fig. 7). The quartz veins and the contact itself are locally folded by F3 folds. Visible gold is frequently observed within coarse-grained arsenopyrite-rich quartz-hornblende–garnet–biotite–assemblages. On Qingaaq, the BD zone is exposed at 700–1050 m elevations, and can be followed for 700–800 m along strike. Extensive channel sampling in this area has returned grades up to 20 g/t Au over 2.5 m (true width). Three-dimensional modelling of the BD zone based on surface geology and drill core information shows that the zone dips to the NE underneath the Qingaaq north face, and defines a major folded mineralised plane structurally below the Main Zone (Fig. 8). It gets progressively shallower (dipping *c.* 45° at depth) down from the exposures near the top of the Qingaaq north face. The fold geometry gets progressively more complex towards the north (downhill). In drill holes at the foot of the Qingaaq north face, the BD plane has been recognised as deep as 300 m elevation (150–200 m below surface, Fig. 8), giving a minimum known length of the BD horizon of *c.* 1000 m.
Gold grades in drill core samples range up to 30 g/t Au over 2 m (10 g/t Au over 4 m) and preliminary evaluation of more than 40 mineralised sections (minimum 2 m sample length) indicate a mean gold grade of 8.3 g/t Au at a 3.0 g/t Au cut-off and 5.1 g/t Au at a 1.0 g/t Au cut-off.

Main Zone

Discovered in 1994 and the best-known occurrence on Storø to date. The Main Zone is located at the foot of the Qingaaq north slope, structurally above the BD Zone within altered amphibolites. It occurs within a large, ENE-plunging F3 antiformal hinge (Main Zone s.s.) with an eastern flank (Main Zone east and Hanging Wall Zone) and a western flank (Main Zone west) that each can be followed uphill for approximately 400 m on surface (Fig. 5). Rock samples return up to 91 g/t Au in this area with common visible gold in both surface and drill core samples (Figs 6 and 9). The mineralisation has been traced to 150 m below the surface in drill holes. The lower part of the hinge area is covered by scree, and the exact dimensions and geometry of the mineralisation in this area is thus only indicated from drill hole data. High-grade gold mineralisation occurs as a series of presumably discontinuous lens-shaped bodies (2–12 m wide), within a larger, low-grade alteration envelope dominated by garnet-hornblende-biotite-diopside-rich rocks (10–50 m wide). The area is partly disturbed by late pegmatites. Gold grades in drill samples range up to 52 g/t Au over 2 m (12.67 g/t Au over 12 m) and preliminary evaluation of more than 130 gold bearing intersections (minimum 2 m sample length) indicate a mean gold grade of 9.7 g/t Au at a 3.0 g/t cut-off and 5.1 g/t Au at a 1.0 g/t cut-off.

Figure 7. *Gold bearing quartz vein system at the northern-most exposure of the BD zone.*

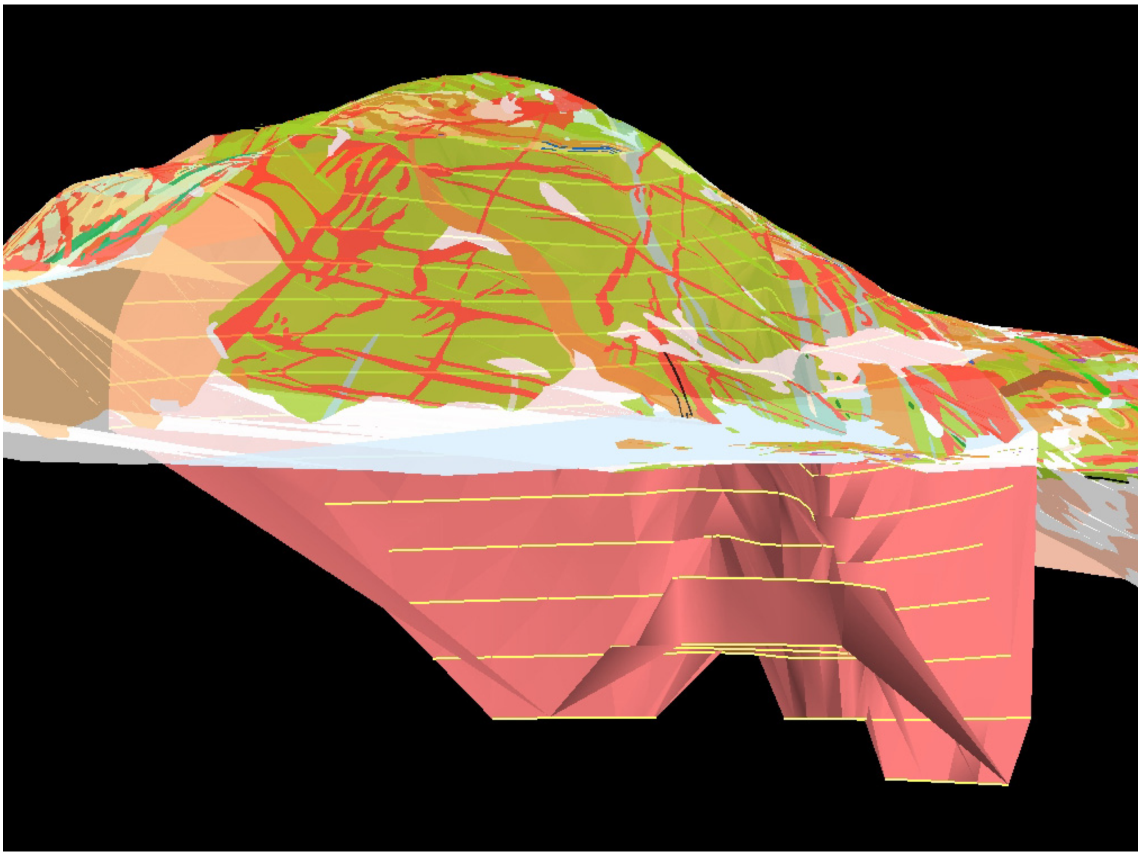

Figure 8. *Three dimensional model of Qingaaq north face with the geological map draped over the terrane model. Underneath the slightly transparent surface the geological contact at the BD zone is visible in red with yellow contour lines at 50 m interval. Viewed from the ENE, at c. 300 m altitude (i.e. below ground surface).*

New Main Zone

Discovered in 1996, and located to the west of Main Zone West, and approximately at the same elevation on Qingaaq north slope. The mineralisation is located immediately west of a NE–SW trending ductile thrust plane. West-directed thrusting was accompanied by voluminous pegmatite intrusion, which displaces the mineralised zone. New Main Zone occupies a narrow quartz veined domain (2–10 m wide) within altered amphibolite, which can be traced uphill for *c.* 400 m. Gold is generally associated with swarms of quartz veins, often rich in arsenopyrite. Channel samples return up to 7.6 g/t Au over 3.27 m.

Figure 9. *Visible gold in a quartz vein in drill core from Main zone. Au = gold, Hbl = hornblende, Po = pyrrhotite, Qz = quartz.*

Aappalaartoq

Two potential targets have been recognised on Aappalaartoq mountain.

SE-face (BD Zone)

BD Zone mineralisation also occurs on Aappalaartoq along the same contact as the BD Zone on Qingaaq. Several high-grade boulder and surface samples have been collected (up to 50 g/t Au), whereas a systematic channel sampling program so far has been inhibited by steep topography and lack of detailed maps. The exact nature of mineralisation on Aappalaartoq is thus unclear. High gold grades mainly occur within altered amphibolite immediately above the contact to sillimanite-garnet-biotite gneisses. The best grades occur in sheeted quartz-veins with disseminated arsenopyrite. A few drill holes aimed at the BD Zone type mineralisation in 1995 and 1996 only encountered moderate grades and was highly disturbed by pegmatite veining.

East ridge

Gold mineralisation occurs within altered amphibolite and rusty beds at 700–900 m above sea level on the ridge east of Aappalaartoq mountain. The dominating sulphide is arsenopyrite within discontinuous quartz lenses (1–6 g/t Au). The extent of mineralisation has not been defined.

Timing of mineralisation

Petrographic observations indicate that gold is associated with two phases of sulphide mineralisation. To test this model of two stages of mineralisation, two arsenopyrite samples were collected at the BD zone and Main zone for Re-Os age determinations. The arsenopyrite in both locations is associated with gold mineralisation, and thus provides a means of directly dating the mineralisation. The data show that the former has a poorly constrained age of 2714 Ma ± 53 Ma, while the latter has a well constrained age of 2636 ± 23 Ma (van Gool *et al.* 2007). The latter date overlaps with the 2635 Ma U-Pb age of a zircon inclusion within arsenopyrite from Main zone (Nutman *et al.* 2007) and is interpreted as the age of mineralisation. The older age shows that already by *c.* 2714 Ma the area had been affected by an earlier phase of mineralisation. Initial ratios suggest that the Os in the arsenopyrite (and by inference also the gold) is crustally derived. The Re-Os data suggests that at least some of the mineralisation in the BD zone is older (pre-metamorphic) than that in Main zone (syn-metamorphic).

Discussion and genetic model

The gold mineralised intermediate and basic metavolcanic and metasedimentary rocks of the Storø supracrustal belt probably formed in a volcanic back-arc environment (Knudsen *et al.* 2007). This interpretation is consistent with the geochemical data, and the presence of several distinct detrital zircon populations within garnet-mica-sillimanite gneisses and quartzites that include one dominant population with ages between 2800 Ma and 2850 Ma, likely representing a nearby arc, and, mainly in quartzites, a series of older age peaks down to Eoarchaean, which likely represents a nearby continental source (Hollis *et al.* 2006a; Knudsen *et al.* 2007; van Gool *et al.* 2007).

Petrography and the Re-Os data indicate that mineralisation took place in two stages. The gold mineralisations occur within zones of intense alteration, most of which are pre-metamorphic and intensely deformed. These alteration zones, and thus the earliest mineralisations, could be syn-volcanic, in an arc environment (*c.f.* Qussuk), or associated with an early shearing event at low metamorphic grades. The gold may be derived/concentrated from a nearby volcanic source, potentially the volcanic protolith to the upper amphibolite sequence. The earliest gold occurred thus pre-metamorphic, and part of this mineralisation is bound to the lower contact of the upper amphibolites (BD Zone).

However, the highest gold concentrations occur in and near the antiformal hinge of Main Zone, at a hanging wall thrust ramp in the Storø shear zone, associated with folds in massive anorthosite rocks. The highest known gold values at Aappalaartoq occur in a similar structural setting. Presumably, the gold in these settings was (partially?) remobilised during folding, into areas of low strain in the fold hinges. The fractures hosting the quartz veins may have been the main conduits for the mineralising fluids.

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