Quartz pods: an exploration guide to iron oxide-copper-gold mineralisation?

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Quartz pods have been identified throughout most of the Lufilian Arc (Zambia and Namibia).

Improved field identification and an increased understanding of their physico-chemical features may aid in the exploration of IOCG mineralisation.

The term 'quartz pod' is an informal name coined by the author for massive and/or sugary quartz units of varying dimensions (figs 1, 2, 3 and 6). Most quartz pods consist of white quartz, but colour varies greatly, from milky white to dark-grey, smokey tones through to light-pink or yellow tints (Figs 4 and 5). Both translucent and milky quartz occur together. Different portions of a single quartz pod may be saccaroidal and/or massive.

Quartz pod outcrops

Fig 1. Surface expression of a quartz pod located east of Solwesi, Zambia, along the main road, as indicated on Fig 12. The boulder in the foreground is 3.5 m long. Those in the background are much larger. The diameter of quartz pods in this region is a few hundred meters.

Fig 2. Typical outcrop of a quartz pod to the west of Lusaka, Zambia. The round outcrop has 200 meters in diameter. Host rocks are Katangan carbonates of the Lusaka Formation. The outcrop is made of milky white quartz, with very rare inclusions of hematite-martite crystals, 2-3 cm in diameter (Fig 9). Small fragments of quartz make the outcrop. Individual fragments vary greatly in size, from several meters to a few centimeters in diameter.

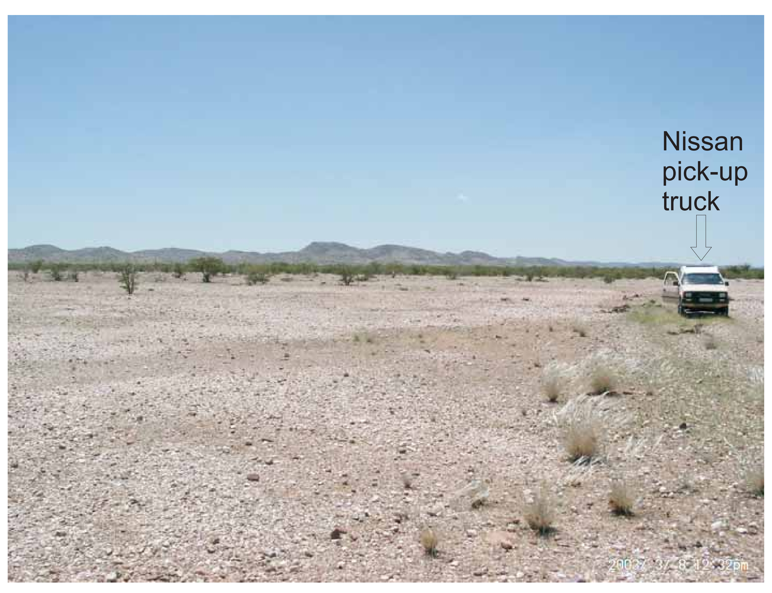


Fig 3. Surface expression of a very large quartz pod, on the way to the Oas Farm, Khorixas inlier, northwestern Namibia. Ground here is exclusively made of quartz fragments that were eroded from the underlying quartz pod. This surface extends for tens of kilometers.

Fig 4. Close-up view of a fragment from a quartz pod. Pink color is due to small particles of hematite in the quartz. The sample was taken from a round outcrop, 80 meters in diameter. The thumb is 2.2 cm wide.

Fig 5. Massive quartz from a quartz pod. It shows minor iron oxide veinlets. This is the way most quartz pods are seen on outcrops. Marks every 2mm.

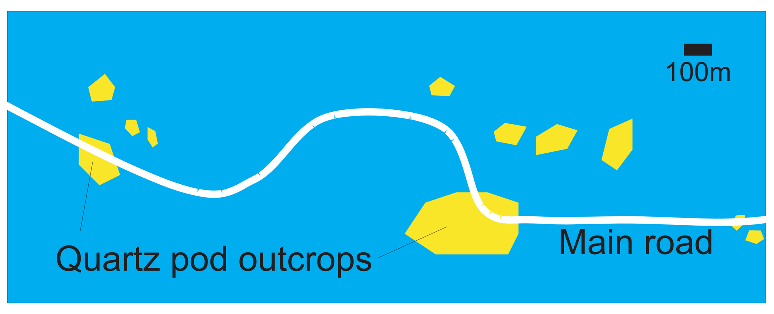


Fig 6. Several dozen quartz pods were intersected along the main roads during field work for another research project. The points of intersection were recorded with GPS and some perimeters were mapped. Samples of representative outcrops were collected. In that way, we have a first approximation to size, abundance and composition of quartz pods in the Greater Lufilian Arc.

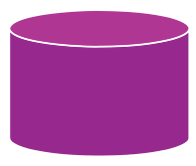
This chance sampling is definitely not representative, but is all available at the time of writing this report.

At some locations, large quartz pods contain isolated cubic or spherical magnetite and/or hematite inclusions that vary in size from 1.5 to 10 cm (Figs 8, 9 and 10).

Quartz pods occur in many different types of rocks including limestones,dolostones, granitoids, various schists and gneisses. In places, rare xenoliths of any rock type are included within quartz pods; shapes of these xenoliths vary greatly.

Quartz pods differ from veins and pegmatitic quartz units, particularly in geometry; outcrops of undeformed bodies are typically round to elliptical, and vary from a few metres to several-hundred metres in diameter. Outcrops of some quartz pods exceed 4 km (Fig 7) and there is geophysical evidence of even larger ones.

Quartz pods are thought to be roughly cylindrical.



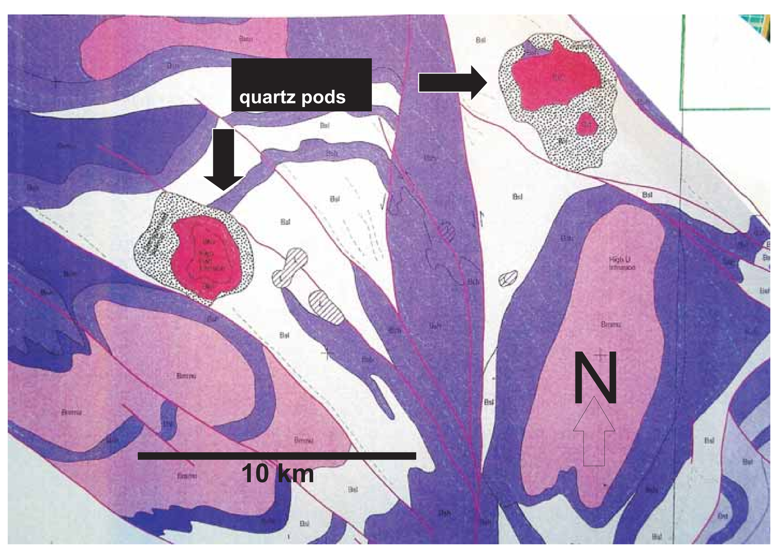


Fig 7. Interpreted airborne magnetic + radiometric image of two quartz pods (red color). This site is located east of Kitwe, Zambia. The white triangular portion of the map is located in the Democratic Republic of Congo. The map was kindly supplied by Peter Mann, past exploration manager of the AngloAmerican office in Zambia. The sites were visited and sampled.

A drill hole through a 500-m-diameter quartz pod at Egue farm, NE of Otjiwarongo, Namibia, in the environs of the Otjikoto iron-oxide-Cu-Au (IOCG) deposit (Fig 26), intersected only quartz with minor disseminated pyrite and some schist blocks along its entire 325-m length.

The spatial association with IOCG mineralisation systems and intrusive bodies is common (Figs 23, 24, and 26). In many locations, quartz pods host IOCG mineralisation.

The brittle character of quartz renders quartz pods a suitable host for massive iron-oxides and associated sulphides, braided or sub-parallel sheeted veinlet systems (Figs 21 and 22) and stockworks (Figs 15, 16, 17 and 18). Numerous field examples consist of hydrothermal breccias, where quartz is brecciated within quartz (Figs 19 and 20).

Iron oxide inclusions in quartz pods

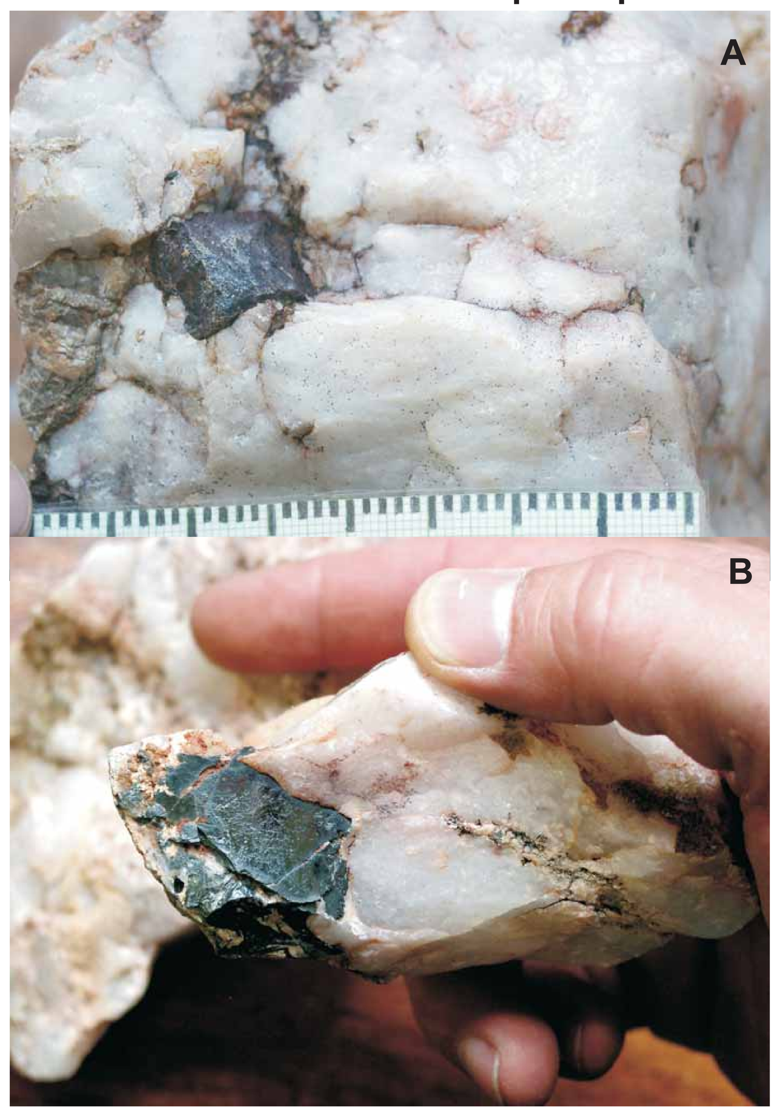


Fig 8. Isolated, cubic magnetite crystals hosted by quartz pods. Scale marks every millimeter.

Fig 9. Corroded hematite-martite crystal hosted in a quartz pod.This type of inclusion is not common. The hematite crystal is not euhedral as in other cases (Fig 8), but displays irregular rims. Scale in mm.

Fig 10. Sub-rounded magnetite crystal found inside a quartz pod. This is an uncommon feature. The largest crystals observed are 8 cm in diameter and were found in the Egue site, NE of Otjiwarongo, Namibia (Fig 26). The origin of these iron oxide crystals is not well understood. Magnetite phenocrystals seem to have formed in a space that allowed free ion migration, possibly in gel state, but definitely before the quartz was solid. Maybe the quartz flowed and euhedral magnetite crystals were transported along. Scale marks every 2 mm.

Quartz pods typically occur in rift environments but their origin is not yet completely understood. In places, the country rock is deformed upward around the quartz pods, as if they were emplaced forcefully in a fashion similar to that of diapirs (Fig 11).

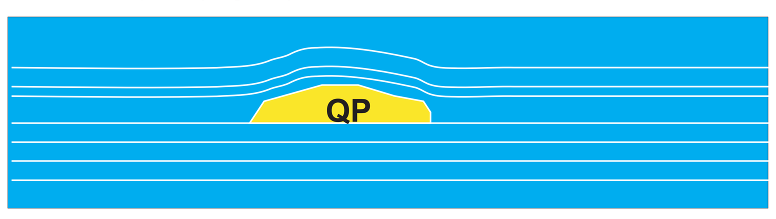


Fig 11. Idealized diagram of host rock folding around massive quartz pods (QP). Some working hypotheses for the field evidence may be: a) differential compaction around the quartz pods, and b) forceful emplacement of the quartz pods (diapir-like).

Quartz pods are rarely noted on published geological maps of Zambia and Namibia, and very few are documented in the literature. They have been documented by the author over an extensive area of roughly 2000 km by 300 km; and they probably outcrop in SE Angola, the Katanga province of the D.R. Congo and NW Botswana (Fig 23).

Many parts of the Lufilian Arc have a four-fold rock association including small bodies of: a) gabbro or diorite; b) red-tinted felsic intrusive rocks; c) massive iron-oxide bodies (magnetite and/or hematite); and d) quartz pods.

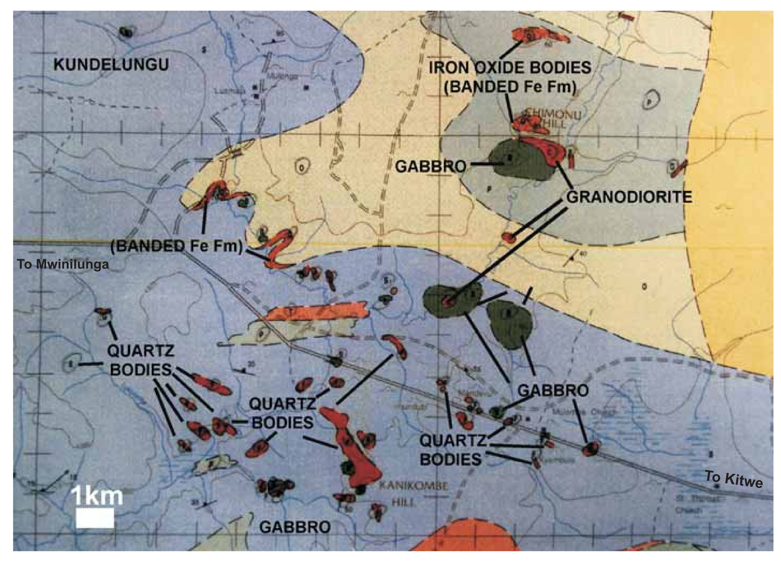


Fig 12. Quartz pods, gabbros, felsic granitoids and iron oxide bodies that outcrop together east of Solwesi, Zambia. Massive iron oxide bodies were mapped as banded iron formations, but they have a hydrothermal origin. These four types of small bodies of rock occur together in many locations of the Greater Lufilian Arc. They seem to be a feature of rift environments. Host rocks in this case are Katangan carbonates and siliclastic units. For scale, tick marks are separated 1km. Interpreted from public 1:100,000 scale geological map sheet published by the Zambian Geological Survey Organization, Lusaka.

The genesis of quartz pods is an unsolved mystery. Many hypotheses for their occurrence come to mind; they may be: a) a rarely documented type of silica alteration; b) the result of precipitation of silica that has been dissolved elsewhere by hyper-alkaline fluids; c) produced from extremely alkaline, HF-rich fluids that dissolved silica from the country rocks replacing it by iron oxides; or d) possible remnants of quartz-only magmatic rocks or 'quartz-olites'. Fig 13 illustrates a potential origin for quartz pod.

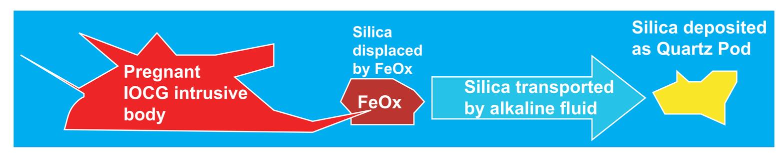


Fig 13. Possible process that leads to formation of the quartz pods. Fluids from a pregnant iron oxide copper-gold -related intrusive body dissolve silica in country rock to emplace large, massive iron oxide bodies (magnetite/hematite). The silica is transported outward from the mineralized IOCG system to deposit massive quartz pods in suitable sites.

The fact that quartz pods are spatially related to IOCG mineralised systems is very significant. Confirmation of their genetic association with IOCG systems would provide a major breakthrough in mineral exploration. Comparison of the chemical signature of quartz pods from mineralised IOCG systems and that of outcropping quartz pods may help identify a geochemical characteristic that can be used in exploration.

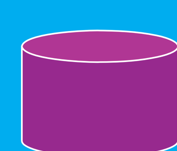
In arid regions, circular areas of abundant white quartz float (Such as Fig 3) may be detected easily on black-and-white air photographs and other remotely sensed images including ASTER.

Improved identification in the field and an increased understanding of their physico-chemical features may aid in the exploration of IOCG mineralisation.

Fig 14. Slab of a densely-mineralised quartz pod. Massive hematite with minor pyrite progressively overprint quartz to leave very little of the original quartz. Scale in mm.

Conclusions

1. Quartz pods = massive/sugary quartz body



roughly cylindrical in shape
round to elliptical outcrop
diameter = few to 100's meters
some >4 square km

2. Occur on or around IOCG
3. Probably related to hyperalkaline, F-rich hydrothermal fluids
4. Quartz pods may be new exploration tool for IOCG mineralisation