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Radiate, bladed quartz from Zimbabwe

BOULDERS of quartz displaying textures which are thought to be previously undescribed for pure quartz rocks occur in the Lower Zambezi valley of northern Zimbabwe (15°48'S 30°12'E). They have thus far only been found as float in small high-gradient streams near their headwaters and are therefore presumed to be close to outcrop. The locality lies between the Zambian and Zimbabwean bounding faults of a basin thought to be a pull-apart complex (Orpen *et al.*, 1989). Although the quartz rock is yet to be found *in situ*, it is thought to occur within extensional tension

gashes of high angle normal and strike-slip faults. These faults occur within the Chewore Complex basement inliers and within part of the poorly exposed tectonic contact between the Chewore Complex and a new formation of the Karoo Supergroup, the Kondo Pools Formation (Tromp, in preparation), of Permian age. The former is predominantly biotite–hornblende gneiss while the Kondo Pools Formation is here mainly a massive pebbly greywacke facies of a submarine fan.

The buff coloured boulders, which are up to

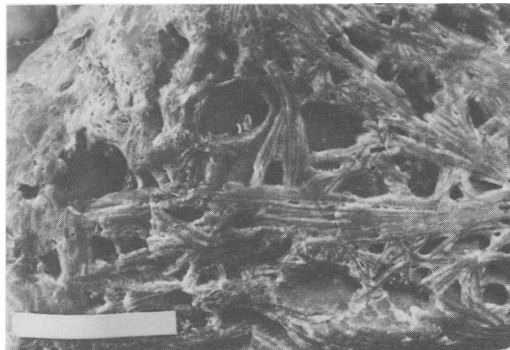


FIG. 1. Hand specimen of radiate, bladed quartz illustrating aggregates of plates and abundant vugs. Scale bar: 4 cm.

50 cm across and are generally prolate to bladed, are characterised by lines on all surfaces which alternate in colour between buff and brown (Fig. 1). These lines are the intersections of flat plates of crystalline quartz with the surface of the boulder. Individual plates may reach 10 cm long and 4 cm wide but are rarely more than 2 mm thick. The plates which comprise the whole rock are arranged in radiating aggregates and there is no intervening matrix. Near the centres of radiation the individual plates are so tightly clustered that they are frequently less than 1 mm thick; however further from the centres, the plates reach a maximum thickness of 2 mm and as they diverge further, narrow angular vugs occur between them. There is considerable overlap between adjacent aggregates and both abrupt terminations and cross-cutting relationships occur where two sets of plates intersect; these can be clearly seen in three dimensions where two intersecting plates occur within an open vug. The

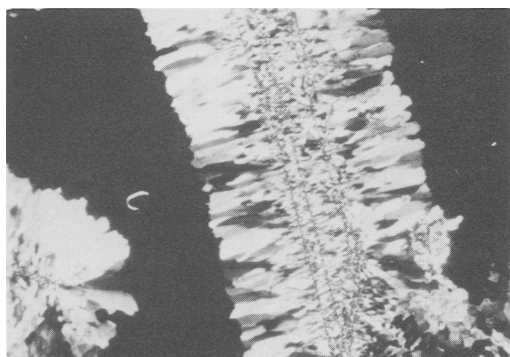


FIG. 2. Thin section of a plate within a vug, with elongate quartz crystals developed orthogonally to four central zones. Field of view: 3.8×2.6 mm.

vugs are angular, up to 1 cm wide, and are lined with quartz crystals up to 1 mm across. The abundance of the vugs gives the rock a density of 2.48 g cm^{-3} . This was calculated by measuring the density of a number of different sized specimens and extrapolating the results to obtain a value for an infinitely large sample. In this way the effect of the vugs exposed at the surface was removed from the density measurement. As the rock only comprises quartz, very minor hematite plus vugs, this indicates that the vugs account for 6% of the rock.

The detail of the structure of the plates is revealed in thin section (Fig. 2) particularly when a full wave plate is added. Each plate comprises a central zone (10–20 μm thick) of small irregular shaped and randomly orientated quartz crystals. This is flanked by quartz crystals up to a maximum of 0.7 mm long which have grown orthogonally away from the central zone, with their *c* axes orientated in this orthogonal direction. It is frequently the case that a number of plates occur in parallel close proximity, with their central zones typically about 1 mm apart. In such a case the orthogonal crystals from the two central zones have grown outwards and are in contact along a line equidistant from the two zones. In addition there are a number of cases where a single plate contains two or three central zones separated by 20–30 μm rather than the more normal one. Where two plates intersect, the orthogonal quartz crystals from both central zones are in contact along a line which bisects the angle between the central zones, indicating simultaneous growth of both sets of orthogonal crystals.

The brown colour results from a scattering of an amorphous mineral, possibly hematite which is concentrated in (1) the central zone, (2) the contact between two sets of orthogonal quartz crystals, (3) the surface of the crystals lining the vugs, and (4) along minor irregular late-stage cross-cutting veins.

The radiating plates, cross-cutting features and their relationship to the vugs could not possibly have been formed by any process of slow deposition from a liquid. The distinctive texture which is superficially reminiscent of the spinifex texture in some komatiites suggests growth from a limited number of nucleation sites. However in spinifex textured komatiites the plate-like shape of the olivines (or more rarely pyroxenes) results from the growth of single skeletal crystals from a supersaturated liquid (Donaldson, 1982). In this quartz rock the plates are not single crystals, so their thin planar geometry cannot have a crystallographic control. It is difficult to envisage how such a perfectly planar geometry can be imparted

to a structure comprising hundreds of thousands of individual sub-millimetre crystals of quartz by any mechanism of growth from a liquid. It is therefore suggested that the plates developed along fractures which formed during the dehydration of a silica gel according to the following mechanism.

Following its injection into a cavity in the country rock, the silica gel would begin to cool, dehydrate and subsequently contract. In a similar way to the formation of columnar joint patterns in basaltic lava flows, the contraction would result in individual 'cells' which would contract as separate units. Within each of these cells fractures would have developed in response to the contraction. It is interesting that all the plates which subsequently developed along these fractures are perfectly planar with no evidence of curvature, so the fracturing behaviour of the gel must be different to that of other non-crystalline solid materials such as glass in which conchoidal fractures would be expected. The fractures would have provided pathways for the ingress of aqueous solutions (perhaps containing hematite in suspension) and promoted the crystallisation of thin central zones of randomly orientated quartz crystals. Once a central zone was formed, the quartz would act as a nucleation centre for the recrystallisation of the remaining silica gel and quartz crystals grew orthogonally from the central zone, their orientation being controlled by the simultaneous growth of many crystals outwards from the same plane. However as quartz has a higher density than the silica gel, there would be further contraction towards the crystallisation centres, ultimately resulting in the development of vugs. During the recrystallisation of the quartz between two central zones any hematite present

in the gel could not be incorporated in the crystalline quartz and would be pushed ahead of the growing crystals (Sweetman, 1988). This accounts for the concentration of hematite on the surface of quartz crystals lining the vugs and along the line where two rows of orthogonal crystals meet. The central position of the contact of the two sets of quartz crystals from adjacent central zones indicates simultaneous equal growth away from the two central zones, and the cross-cutting relationships indicate that all the central zones formed prior to the growth of the orthogonal quartz. The overall reduction in volume resulting from the crystallisation of the gel would account for the abundance of the vugs, and the average density of the whole rock (2.48 g cm^{-3}) may give an indication of the anhydrous density of the original gel.

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Staurolite from a metabasite and its paragenesis

THIS study deals with the gedrite–staurolite assemblage from a metabasite (amphibolite) in the Vinjamuru area (Lat $14^{\circ}50'$ and Long $79^{\circ}35'$) of the Nellore granite–greenstone terrain of S.

India. The rocks of the study area have been classified into an older Vinjamuru schist complex and a younger Udayagiri Group (Vasudevan *et al.*, 1977). Metapelites (quartz–mica–