By Duncan Miller

Minerals from the Vredendal Dolomite Quarry

Introduction

For the past ten years members of the Mineralogical Society of Southern Africa in Cape Town have been visiting the Cape Lime Company dolomite quarry at Vredendal regularly to collect quartz crystals. During this time various other minerals have been found in this quarry. With their identification the list of aesthetic and collectable specimens from this locality has grown. This article briefly describes the local geology, and the occurrence and nature of the minerals themselves.

Geology

The Cape Lime Company dolomite quarry is really a series of quarries excavated into the rocky bluffs on either side of a shallow gorge cut by the Wiedo River as it approaches the town of Vredendal. These hillsides have been terraced in various places by the mining activity, exposing the blue-grey dolomite rock, which is extracted and crushed for use in high temperature resistant refractory ceramics. Production is in the region of 150 000 tons per year (De Beer et al. 2002), so the quarrying continually exposes new rock faces.

The dolomite forms part of the Widouw Formation of the Gifberg Group, now believed to be part of the Gariep Supergroup, with most of its rocks exposed much further north in the Richtersveld. These rocks were deposited in a marine basin around 700 million years (Ma) ago. This ancient sea closed up due to tectonic activity around 575 Ma, plastering the marine sediments onto the African continental margin (Gresse 1992). In the Vredendal area the sedimentary rocks underwent extreme compression and deformation, with estimated pressures around 3 to 5 kbar (about 3000 to 5000 atmospheres) and temperatures up to 500 ºC (De Beer et al. 2002). The recrystallized dolomite rock is fine grained and mostly very homogeneous, with only about 2 % calcite in an X-ray diffraction analysis (Gresse 1992). This means that the bulk rock is a calcium magnesium carbonate with a composition very close to $CaMg(CO_3)_2$.

A massive blue-grey dolomite rock would not be of interest to mineral collectors if it did not contain anything else. In one particular quarry there are at least two parallel quartz veins which host all the interesting mineralization (Fig. 1). No productive mineral veins have been found in the adjacent quarries so far. The veins in the "quartz" quarry are about 1 m apart, and dip approximately 30º in a northerly direction. They undulate somewhat, and vary in thickness from a few centimetres to pockets up to 0,4 m in diameter. The pockets contain the well-crystallised mineral specimens, while the intervening vein material is often very sheared, with the appearance of being crushed. When they have been excavated, it is clear that the pockets are elongated pod-shaped features within the veins, with their long axes orientated in a westerly direction. Because of this, exposure of the pockets is best in quarry walls with a north-south orientation, although the veins can be traced in east-west quarry face walls and even on the rocky floor of the flat bench above the present quarry walls. The veins must be younger than the dolomite rock, but they are of unknown age. They appear to represent more than one episode of hydrothermal activity, with partial chemical erosion of some of the earlier formed minerals and subsequent crystallization of others. The quartz veins also underwent both shearing and tension, to create the voids, which

Figure 1: *The mineralogically interesting dolomite quarry face with the parallel quartz veins dipping to the right.*

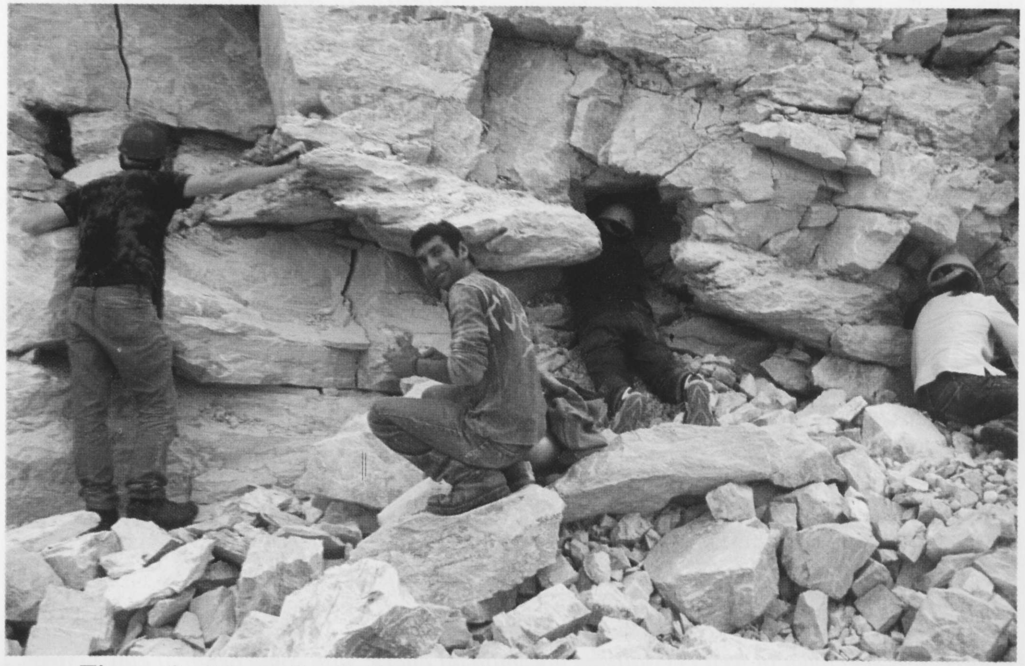

Figure 2: *Marsiglio Gallon and daring diggers, extracting quartz crystal clusters from the clay filled pockets in the quartz veins.*

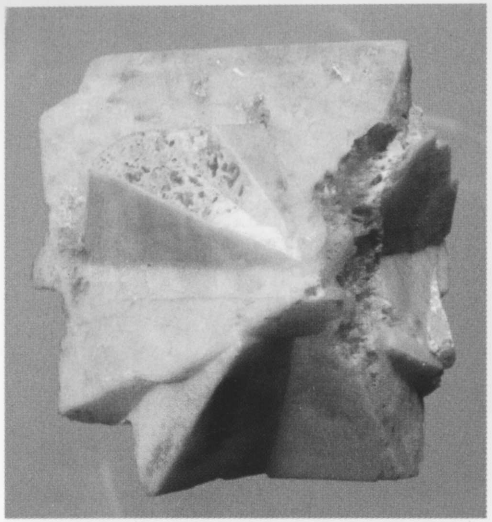

Figure 4: A polycyclic adularia feldspar twin, 10 cm across.

Figure 3: A typical quartz crystal cluster before cleaning

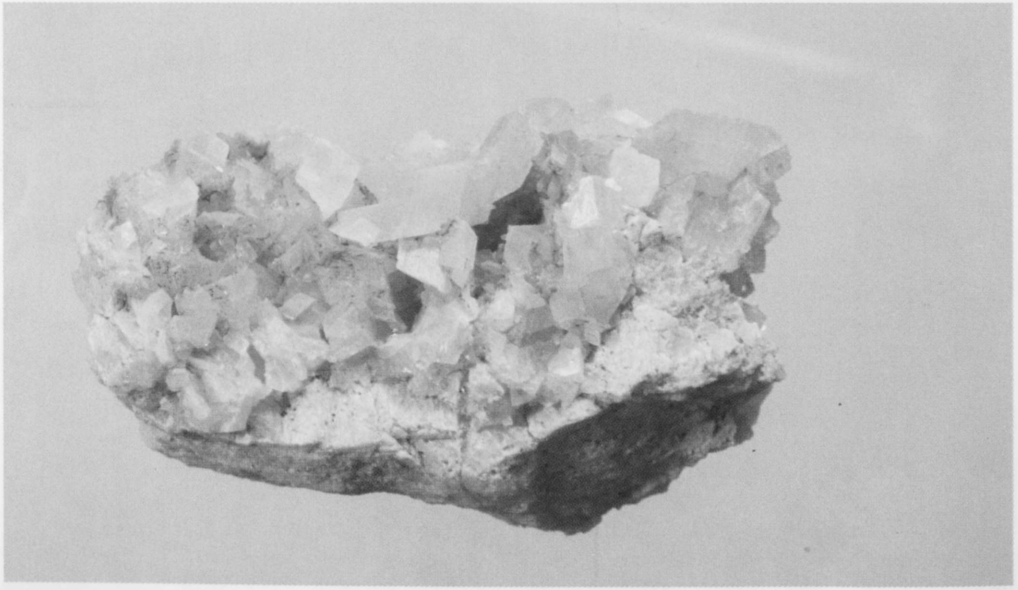

Figure 5: A specimen of well crystallised dolomite on quartz with some original clay matrix still adhering. The specimen is 10 cm long

subsequently formed the crystal pockets. The pockets themselves are filled with orange sandy clay into which crystals project from the walls, with some "floaters" or loose doubly terminated (euhedral) crystals in the clay itself.

Excavation of the pockets is hazardous because the rock above the veins is severely fractured by explosives used to break open the face. In some places the vertical quarry walls are several tens of metres high, so the risk of falling rocks is considerable, especially with people working on the face at various levels. It is mandatory that anyone working on the quarry face must wear a hard hat. The pockets may be narrow, but some of them reach at least 2 m in length and diggers sometimes can only be identified by their shoes (Fig. 2). The soft sandy clay is dug out using a variety of tools, including discarded pieces of iron found around the quarry. Loose crystals are recovered from the clay itself, while crystal clusters must be prised off the pocket walls.

Description of Minerals

Quartz (SiO_2) crystals are the most common finds, with clusters of milky to clear crystals reaching several kilogrammes. Of course, smaller crystals are far more common. Many of the euhedral floaters are doubly terminated; some of them with primary double terminations, others with one end "healed", representing regrowth after the crystal had been dislodged from the pocket wall at some time in the distant geological past. The quartz crystal clusters often consist of very well formed, hexagonal, prismatic crystals with symmetrical terminations (Fig. 3). Smaller pockets in the quartz veins might also have euhedral quartz crystals, small crystal clusters sometimes showing parallel growth of the individual crystals, and very thin "flatties" perhaps related to the shearing in these veins. Many of the quartz crystals are coated with a thin layer of iron oxide, which can produce a colourful iridescent effect. Others have been found coated thickly with powdery black manganese oxides. The largest quartz crystal clusters are most impressive display specimens, but there is plenty of interest in the diversity of features in the smaller specimens.

The clearer quartz crystals sometimes sport red, golden, or black rutile (TiO_2) needles. Mostly these are single needles running through the quartz, but sometimes rutile forms sprays in a part of a crystal. Rarely, rutile needles actually project beyond the margins of the host crystal, producing specimens that are difficult to remove and transport successfully. Densely rutilated pieces of quartz are uncommon here. Rutile also occurs in the vein rock as disseminated, small, prismatic crystals, with characteristic red colour and adamantine lustre.

The quartz grew in intimate association with feldspar. The feldspar crystals, many of them also euhedral, are the orthoclase variety adularia ($KAlSi_3O_8$), typically found in low temperature hydrothermal veins (Hurlbut 1971). Many of the quartz crytal clusters have prismatic adularia crystals either adhering to them, or sometimes even intergrown with the quartz. The adularia crystallizes in its typical habit, with four prismatic faces and terminal pinacoids making the smaller crystals look like calcite rhombs. Most of the larger adularia crystals are twinned. A single pair of Baveno twins can form a neat pseudo-pyramid with the line of the twin plane clearly visible on one diagonal of the base. Polycyclic twinning can produce complex palm-sized rosettes with multiple re-entrant angles (Figs. 4 & 6). The terminal pinacoidal faces tend to be etched and pitted, but the smoother broad prism faces often are decorated with scatters of tiny clear quartz crystals, sometimes also with rutile needles. The larger adularia crystals are almost clear inside but most have a yellowish rind and some iridescent iron oxide stains.

Many of the quartz veins are lined with dolomite ($CaMg(CO_3)_2$) crystals, mostly forming colourless, simple rhombohedra (Fig. 5).

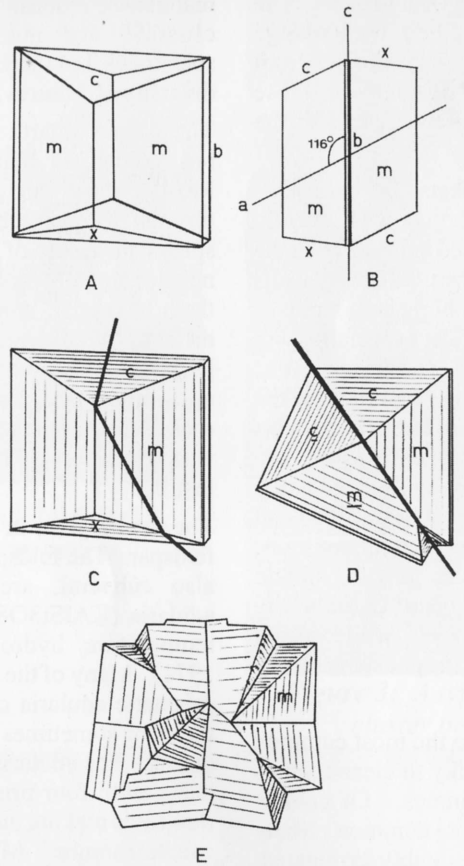

Figure 6: Illustration of the formation of a complex polycyclic twin in adularia feldspar. A: Diagram of an idealised monoclinic adularia single crystal viewed obliquely from the right, showing the narrow side pinacoid b, the broad prism faces m, the basal pinacoid c, and the second-order pinacoid x. B: Diagram of the adularia crystal viewed from the side, showing the crystallographic axes. The c-axis is vertical, the b-axis emerges perpendicularly from the page, while the a-axis is inclined by 116° to the vertical plane bearing the b and c-axes. The basal pinacoid c is parallel to the inclined a-axis, and the prism faces m and side pinacoid b are parallel to the vertical c-axis. C: Drawing of the adularia single crystal viewed obliquely from the right, showing the approximate trace of the {021} Baveno twin plane, as a thick line, on the crystal faces. The right hand portion of the crystal is mirror reflected through the twin plane to produce the pyramidal twin illustrated in D, viewed from above. Polycyclic twinning, involving four twin pairs like those in D, can be visualised as four-fold rotation of the Baveno twin around the shared a-axis, represented by the line joining the upper two c faces. This produces the complex cyclic twin sketched in E, viewed from above, from a real example found by Lesley Bust. The corner fishtail grooves can be on either the upper or lower surface, depending on the relative development of the basal pinacoid c and the second-order pinacoid x faces. This particular example also has some evidence of reflection twinning across the {100} plane, parallel to the vertical plane containing both the b and c-axes of the untwinned crystals, so three different twin laws are involved here.

These may be up to a few centimetres on an edge, but most are smaller. The dolomite crystals can be found in clusters intergrown with quartz, adularia, and exposed rutile needles, making very showy but delicate specimens. Also present with the dolomite, but quite distinct, are isolated crystals of calcite (CaCO3). These crystals are stubby hexagonal prisms terminated by three rhombohedral faces, and are colourless to pink, often grading to darker pink towards the prism faces. The calcite crystals are somewhat corroded but quite distinctive both in colour and habit compared to the dolomite.

Conclusion

The quartz veins in the Vredendal dolomite quarry produce some very beautiful quartz and feldspar specimens, worthy of being better known. Well formed dolomite crystals generally are uncommon and their co-occurrence with calcite even more so. Each visit turns up new combinations of minerals or new habits of crystallization. As Maurice Conradie has put it, we have only scratched the surface mineralogically at Vredendal. Please note that the owners of the quarry do not wish to be inundated with visitors disturbing operations. Cape Lime Company has entered into an agreement that visits will be organised exclusively by the Mineralogical Society of Southern Africa. Anyone wishing to join a collecting trip should contact Charlie Scharfetter by telephone on 0837006777 or by e-mail to charliescharfetter@yahoo.com for details of the next field trip.

References

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