Canadian Mineralogist,
Vol. 12, pp. 226-228 (1973)

THE SIGNIFICANCE OF SOME PORPHYRITIC TEXTURES IN CARBONATITES

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While phase equilibrium studies have made enormous contributions to the understanding of natural magmas and rock-forming processes, few instances have been reported where natural rock textures have been produced artifically. In some carbonatites there is a close similarity between textures observed in synthetic melts and some naturally occurring prophyritic textures.

In carbonate systems the phase which is in equilibrium with liquid below the liquidus generally consists of well-rounded single crystals whereas the quenched liquid is a very fine-grained crystalline mass sometimes showing dendritic crystallization. The appearance of a charge from the system CaF_2-$CaCO_3$-$Ca(OH)_2$ (Gittins & Tuttle 1964) which has been crushed and dispersed in index oil for optical examination is shown in Figure 1.

A rock with a very similar texture outcrops as a ring dike in the Dorowa carbonatite complex of Rhosedia and has been described by Johnson (1961, 1966) as a porphyritic beforsite (dolomite carbonatite). It consists of well rounded single crystals of clear, colourless dolomite 1 to 3 cm across set in a fine-grained matrix.

On this basis it seems reasonable to conclude that the porphyritic beforsite of Dorowa represents a quenched liquid that carried carbonate crystals in suspension at the time of its intrusion as a ring dike when it was quickly chilled.

A rather similar if less perfectly developed texture is found in the carbonatite of the Firesand complex in Ontario, Canada, and was first mentioned by Parsons (1961). The rock consists of generally rounded single crystals of calcite ranging in size from a few mm to about 2 cm.

Many more examples of the same type of porphyritic texture can be gleaned from the literature although they were not originally described as such.

A variant of the commonly rounded carbonate phenocrysts has been described from porphyritic carbonatite lava flows from the Maimech-Kotui region of Siberia by Zhabin & Cherepivskaya (1965). The phenocrysts are described as tabular and 1.5 by 1.5 by 0.3 mm, set in a micro-granular mesostasis of calcite, dolomite and apatite, and are distinctly rhombohedral in the published photographs.

A possible explanation of this can be seen in carbonatites from the James Bay Lowlands of Ontario, Canada (James Bay North in Gittins, MacIntyre & York 1966, but now known as the Argor carbonatite complex).

A section of calcite-dolomite-apatite carbonatite consists of rhombohedral dolomite crystals

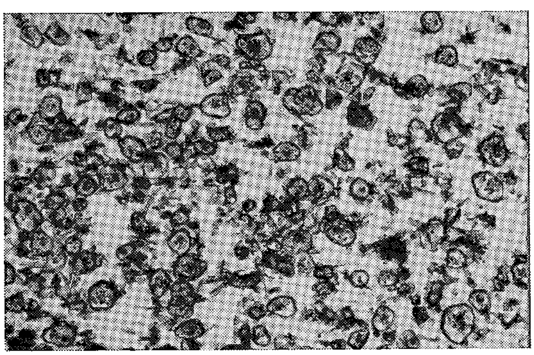


FIG. 1. Crystals of calcite (average diameter 0.1 mm) set in a dispersed matrix of calcite, fluorite and portlandite. Calcite is the primary liquidus phase. This is a charge from the system CaF_2—$CaCO_3$—$Ca(OH)_2$.

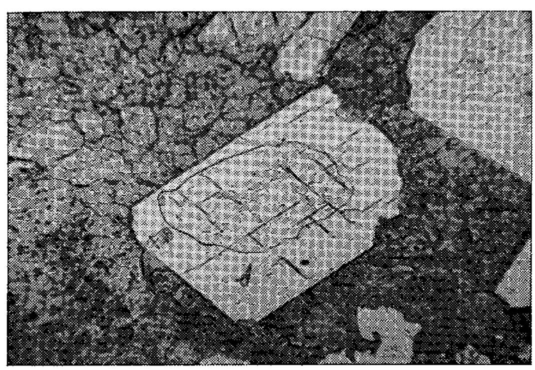
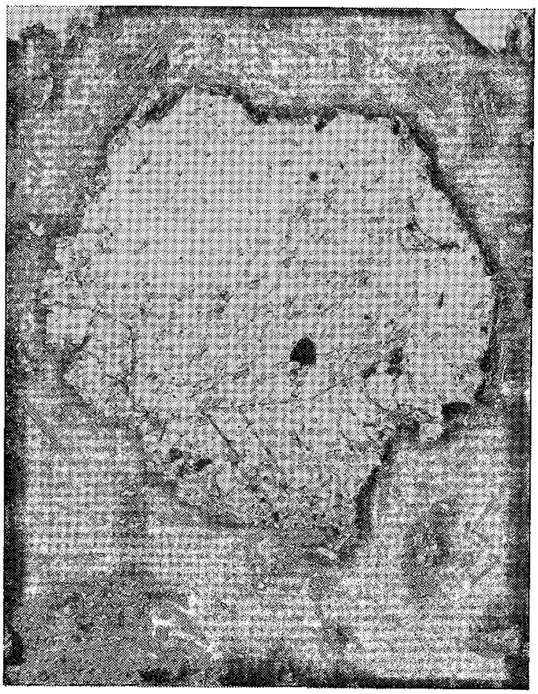


FIG. 2. Rhombohedral dolomite crystal about 1 mm in length consisting of a rounded core with a few minute blebs of calcite, surrounded by clear dolomite forming a rhombohedron. The rest of the rock is calcite.

which, without exception, each contain a rounded dolomite crystal (Fig. 2). These dolomite rhombs are set in a rock composed of calcite grains from which a considerable amount of dolomite has exsolved, largely as vermicular intergrowths and occasionally as coarse lamellae. In the rounded dolomite cores a few specks of exsolved calcite can be seen whereas the rhombohedral margin is clear dolomite without any exsolved calcite. Presumably the rock represents an original carbonatite liquid in which rounded crystals of dolomite and apatite formed during cooling. Upon further cooling to the eutectic temperature the liquid crystallized as a calcite-dolomite solid solution. During further cooling through the solvus of the system the small amount of calcite in solid solution in the dolomite exsolved as small specks and the relatively large amount of dolomite in the calcite exsolved as vermicular intergrowths; some of the dolomite that exsolved from the calcite migrated to the rounded dolomite nuclei where it formed rhombohedral crystalline overgrowths.

The existence of porphyritic textures in carbonatites is particularly interesting in the light of von Eckermann's studies of the Alnö carbonatite complex. Von Eckermann, (1961, 1966) attached considerable significance to kimberlitic rocks with "globules" of carbonate from 0.75 mm to 2 mm in diameter (von Eckermann 1961, 1966). These are all well-rounded and at least one of those illustrated is a single crystal. Two of these are reproduced in Figures 3 and 4. They are explained by von Eckermann (1966) as representing "a fluid phase of carbon and fluorine compounds" which rose through melilite basalt magma and on the way became saturated with alkalies, lime, magnesia and iron thus generating kimberlite in the lower part of the magma column and developing an accumulation of carbonatite at the top.

In view of the similarity of the Alnö texture to the porphyritic texture previously described it is much more likely that the Alnö 'globules' are really phenocrysts that represent crystals of carbonate that were in equilibrium with a melilite basalt magma. This detracts considerably from the scheme of carbonatite genesis which von Eckermann chose to emphasize in his last writings on Alnö.



0 1mm

FIG. 3. "Globule" in melitic kimberlite, surrounded by phlogopite and partly altered melilite crystals. Reproduced from von Eckermann (1966).

0 1mm

FIG. 4. "Globules" of calcite (mottled white) and ankeritic dolomite (grey) surrounded by rims of small melilite-pseudomorphs containing no secondary calcite. Reproduced from von Eckermann (1966).

Acknowledgements

The observations on which this note is based began at the Pennsylvania State University during the tenure of a post-doctoral fellowship with Professor O. F. Tuttle financed by the National Science Foundation and continued in Canada during research financed by the National Research Council of Canada and the Ontario Research Foundation. Research support from all these sources is gratefully acknowledged.

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Manuscript received June 1973, emended August 1973.