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Note: Porphyroblastic K-feldspar from low-grade marbles of the Northern Zone of the Damara Orogen, Namibia

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Introduction

The presence of K-feldspar with an "adularia habit" in limestones and low-grade marbles is a feature well known to mineralogists (Baskin, 1956; Kastner, 1971; Smith, 1974, p. 258-261; Hearn *et al*., 1986), but has been little studied by sedimentary petrologists. The term "adularia habit" (Smith, 1974; p. 260) indicates that the crystals of K-feldspar exhibit a rhombohedral habit, yielding diamond- and hexagonal-shaped cross sections, and does not imply a specific structural state. These crystals are generally extremely small and rarely exceed 1 mm (Reynolds, 1929; Baskin, 1956; Glover and Hoseman, 1970; Kastner, 1971; Hearn *et al*., 1986). Mallick (1965), however, described porphyroblasts of K-feldspar up to 10 mm long from marbles in the Late Precambrian Katanga Sequence in Zambia. The origin of these crystals is generally ascribed either to authigenesis (Kastner, 1971; Kastner and Siever, 1979) or to circulating high saline brines (Hearn *et al*., 1986). The term "authigenic" is here taken to mean *in situ* formation between deposition of the sediment and a subsequent episode of low-grade metamorphism (Kastner, 1971).

Generally, authigenic albite is more common than K-feldspar in carbonate rocks (Kastner, 1971; Kastner and Siever, 1979). This note describes the occurrence and chemical composition of porphyroblastic K-feldspar from a new locality in low-grade marbles of the Pan-African Damara Sequence in the Outjo District, Namibia.

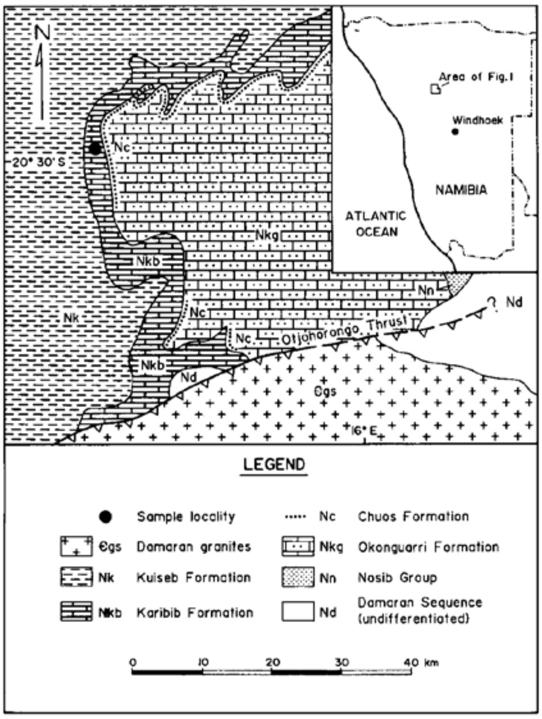

Fig. 1: Locality map showing the locality of the K-feldspar occurrence and regional geology of the area (after 1:1 000 000 geological map of SWA/Namibia).

Occurrence and Petrography

The porphyroblasts are found in a sequence of deformed, low-grade marbles which have been correlated with the Karibib Formation of the Damara Sequence (Geological map of SWA/Namibia, 1980; Fig. 1). These marbles, which are dominantly dark blue with minor interbedded white marble and meta-chert horizons, have been interpreted as metamorphosed sediments deposited by debris flows and turbidity currents (Swart, 1985). The host lithology is comprised of 80 - 95 % calcite with minor quartz, mica, scapolite and idioblastic pyrite. The K-feldspar porphyroblasts are found in both the blue and white marble layers, but in the white layers they are often located within dark carbonaceous bands. In the latter bands the porphyroblasts are dark blue to black in hand specimen, but pale forms are found in horizons where there is no carbonaceous material present.

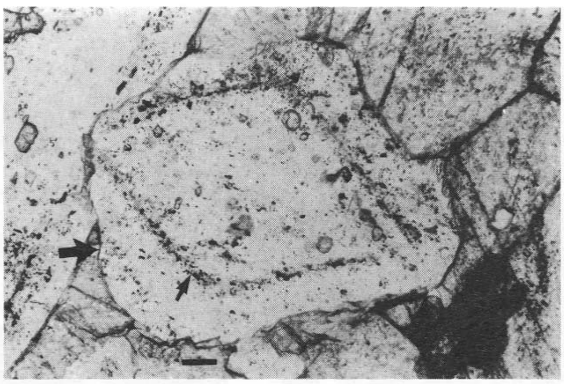

Fig. 2: Photomicrograph of K-feldspar crystals with minute inclusions defining diamond-shaped outlines (small arrow). The irregular margin indicates later overgrowth (large arrow; sample mcl-5). Scale bar is 0.1 mm long.

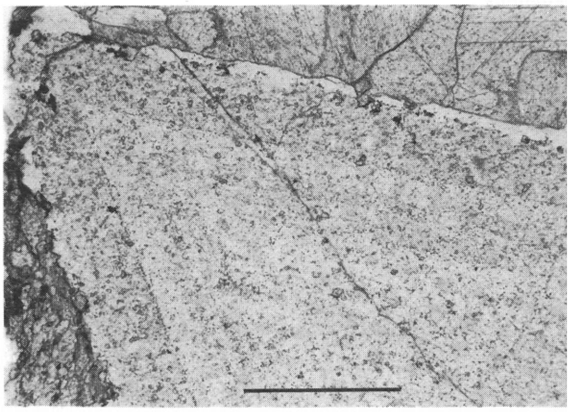

Fig. 3: Zoning emphasised by inclusions of opaques, mica quartz in K-feldspar crystals (sample mcl-4). Scale b

It is therefore probable that the colouration is imparted to the crystals by the presence of impurities, possibly graphite.

While K-feldspar crystals are subidioblastic to idioblastic and commonly diamond-shaped in section (Fig. 2), their margins are typically irregular. The maximum long dimension recorded is 10 mm. Twinning is well developed, inclusions are common, and an inclusion zoning, defined by minute specks of opaque minerals, mica and quartz, is present (Fig. 3). Inclusions of irregularly distributed carbonate also occur.

No evidence for the development of these grains as overgrowths on detrital cores as described by Baskin (1956), Mallick (1965) or Kastner (1971) was observed. However, clear, untwinned overgrowths are found on some crystals. These overgrowths contain rare inclusions of calcite, which are much larger than those found in the cores (Fig. 4). Mallick (1965) and Kastner (1971) both reported that K-feldspars nucleated on carbonaceous bands, but no evidence for this type of nucleation could be found in the Damara marbles despite their close association with carbonaceous bands. The photomicrograph of carbonaceous bands described by Mallick (1965, his Fig. 1a) appears to show stylolites, which is not the case in this occurrence. Stylolites have also been reported by Kastner (1971) as cutting across authigenic microcline grains, indicating that the feldspars crystallised before stylolitisation. Within the study area, well developed pressure shadows are located on the margins of some K-feldspar crystals, thereby suggesting early crystallisation as well.

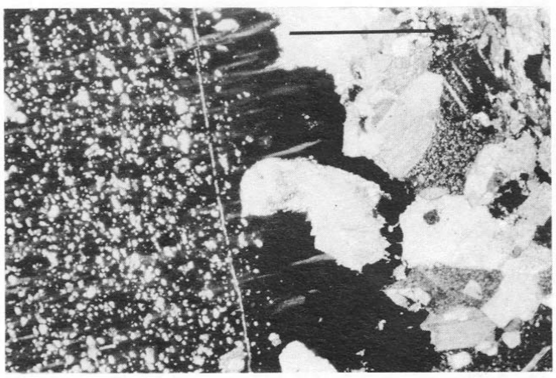

Fig. 4: Large inclusion of calcite in K-feldspar overgrowth (centre of photograph); inclusion-rich K-feldspar porphyroblast (left). Matrix (right) is made up of calcite (sample mcl-4). Scale bar is 1 mm long.

Chemistry

The major element chemistry of the K-feldspar crystals is remarkably uniform (Table 1) and is compared with analyses of authigenic K-feldspar crystals presented by Kastner (1971; Table 2). The samples analysed in this study, which have a composition of Ab_6Or_{94}, are not as pure as those reported by Kastner (1971; Ab_1Or_{99}), but they are still purer than average K-feldspar from igneous rocks (Deer *et al*, 1966; their Table 30). No chemical zoning was detected despite the presence of inclusion zoning and overgrowths.

Discussion

The relatively pure nature of the K -feldspar crystals, the presence of inclusions of the same composition as the matrix, the idiomorphic nature and the lack of chemical or optical evidence for a detrital core all strongly suggest that the K-feldspar is a true porphyroblastic mineral. Furthermore, the presence of pressure shadows indicates that the porphyroblasts are pretectonic. The small proportion of Ab present suggests

TABLE 1: Average, range and standard deviation of 23 chemical analyses of K-feldspar crystals in Damaran marbles.

	Average	Range	Standard deviation
SiO_2	64.74	64.09 - 65.77	.42
Al_2O_3	18.21	17.85 - 18.4	.15
FeO	0.01	0 - 0.04	.01
Na_2O	0.64	0.47 - 0.8	.09
K_2O	16.24	15.14 - 16.73	.43
CaO	0.01	0 - 0.05	.01
TOTAL	99.85		
Ab	5.63		
Or	94.31		
An	0.05		

TABLE 2: Selected analyses of authigenic microcline grains in limestones (from Kastner, 1971; Table 3B).

Sample no.	M-201 -NM	M-203 -NM	M-251 -GF	M-659 -PO	M-692 -OP
SiO_2	64.80	64.70	64.90	64.80	65.00
Al_2O_3	18.65	18.60	18.45	18.94	18.72
Na_2O	00.10	00.10	00.10	00.10	00.05
K_2O	17.02	16.98	16.90	16.96	16.94
CaO	00.01	-	-	-	00.01
TOTAL	100.58	100.38	100.35	100.80	100.70
Ab	0.89	0.94	0.95	0.89	0.45
Or	99.01	99.06	99.05	99.11	99.45
An	0.10				0.01

that the composition of the crystals are partly the result of circulating high-saline brines which caused slightly impure compositions (Hearn *et al.*, 1986). Two stages of growth are suggested by the untwinned overgrowths of the same composition as the K-feldspar, and the presence of larger inclusions within these overgrowths. These overgrowths could post-date the metamorphic recrystallisation of the carbonate since the inclusions are larger than those found in the cores.

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References

Baskin, Y. 1956. A study of authigenic feldspars. *J. Geol*., **64**, 132-155.

Deer, W.A., Howie, R.A. and Zussman, J. 1966. *An introduction to the rockforming minerals*. Longman, London, 528 pp.

Geological map of South West Africa/Namibia. 1980. Scale 1: 1 000 000. Geol. Surv. S. Afr.

Glover, J.E. and Hoseman, P. 1970. Optical'data on some authigenic feldspars from Western Australia. *Mineralog. Mag*., **37**, 588-592.

Hearn, P.P., Lindholm, R.C. and Sutter, J.F. 1986. Authigenic potassium feldspar in ribbon rocks of the Cambrian - Conococheague Limestone, western Maryland. *In*: Mumpton, F.A. (Ed.), *Studies in diagenesis*. U.S. Geological Survey Bulletin 1578, 183-196.

Kastner, M. 1971. Authigenic feldspars in carbonate rocks. *Am. Miner*., **56**, 1403-1442.

Kastner, M. and Siever, R. 1979. Low temperature feldspars in sedimentary rocks. *Am. J. Sci.*, **279**, 435-479.

Mallick, D.I.J. 1965. Porphyroblastic adularia from Shimabala, Zambia. *Mineralog. Mag*., **35**, 401-407.

Reynolds, D.L. 1929. Some new occurrences of authigenic potash feldspars. *Geol. Mag*., **66**, 390.

Smith, J.V. 1974. *Feldspar minerals - Volume 2 - Chemical and textural properties*. Springer-Verlag, Berlin, 690 pp.

Swart, R. 1985. Report on reconnaissance geological mapping of a portion of the Damara Orogen (Area 2015D). *Communs geol. Surv. S.W.Africa/Namibia*, **2**, 27-37.