

in the inclusions and the absence of Cr_2O_3 in the host rock is firm evidence that these inclusions have not been derived from the basanite magma.

The course granular texture of the inclusions, coupled with the relatively high Al_2O_3 content in the spinel as well as in the pyroxenes and the low content of Cr_2O_3 in spinel, are indications of high-temperature equilibration. Further evidence is provided by the high value of the distribution coefficient of Mg between the two coexisting pyroxenes.

The results obtained in this study have confirmed that the Bayuda spinel-lherzolite inclusions are accidental in origin and must have been incorporated in the host rock from a source within the upper mantle. Since these inclusions occur in an area that had undergone volcanic eruptions, it is more likely that they have been brought to the surface by the basanite magma.

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Idocrase from the Boutadiol Valley, near Qu rigut, France

THE main purpose of this note is to record the analysis (Table I) of idocrase from contact rocks in the Boutadiol Valley, near the southern border of the Qu rigut granite. At this locality light-greenish-grey idocrase is found in calc-silicate hornfels exposed near an old magnetite prospect that had been described briefly by Lacroix (1900) during his classic studies of the Qu rigut granite and its contact rocks. The calc-silicate rocks consist of clinozoisite, diopside, idocrase, calcite, and apa-

tite, accompanied by minor quartz, sodic plagioclase, and microcline. Apatite is locally present in two samples in which it forms largely monomineralic areas up to 5 mm across. Typical samples of the calc-silicate rocks, collected by Dr S. O. Agrell and, later, by W. A. Watters, are held in the Department of Earth Sciences, Cambridge (catalogue numbers 61305 and 61633); a small duplicate sample and thin sections are held in the N.Z. Geological Survey collection as no. P16014. Physi-

TABLE I. *Chemical analysis and spectrographic data on idocrase from Boutadiol Valley, near Quérigut, southern France*

wt. %		Ions on basis of 76 (O, OH, F)		Spectrographic data ($\mu\text{g/g}$)	
SiO ₂	37.19	Si	17.676		Cr 121 Sr 248 Cu 7 Ni 50 Co 8 Ga 22 Ge 5 Be 807 V 127
TiO ₂	0.42	Al	0.324	18.00	
Al ₂ O ₃	17.92	Al	9.713		
Fe ₂ O ₃	1.74	Fe ³⁺	0.622	13.04	
FeO	2.60	Ti	0.151		
MnO	0.22	Be	0.251		
MgO	1.67	Mg	1.182		
CaO	34.84	Fe ²⁺	1.033	18.11	
BeO*	0.22	Mn	0.088		
Na ₂ O	0.18	Ca	17.736	7.76	
K ₂ O	0.03	Na	0.166		
Li ₂ O	0.10	K	0.017	18.11	
F	2.00	Li	0.188		
H ₂ O+	1.50	F	3.006	7.76	
H ₂ O-	trace	OH	4.756		
P ₂ O ₅	0.01				
	100.64				
-O \equiv F	0.80				
	99.84				

Gravimetric analysis by W.A.W., spectrographic data by R.R.B.
* Be determined spectrographically.

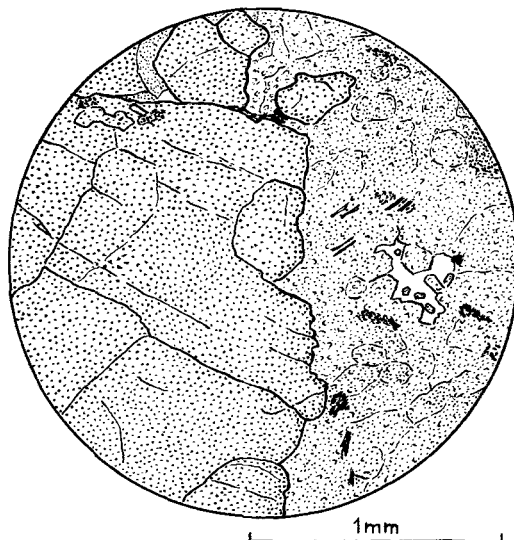


FIG. 1. Sketch of idocrase-rich contact rock, Boutadiol Valley, showing fine-grained apatite, on right-hand side, against idocrase. Other minerals shown are minor fine-grained clinozoisite, forming narrow prisms within the apatite-rich area, calcite (at top left, in fine stippling), and quartz interstitial to euhedral apatite.

cal properties of the idocrase are: colourless in thin section; ω 1.703, ε 1.697; dispersion slight; imperfect prismatic cleavage (fig. 1).

The apatite (ω 1.634, ε 1.630) forms small irregular masses made up of numerous tiny prisms between 0.02 and 0.25 mm in width, locally accompanied by minor quartz, microcline, clinozoisite, and calcite (fig. 1). The texture gives no certain indication of the time of formation of the apatite relative to idocrase, but from the irregular boundary of the apatite-rich areas against the ends of some of the idocrase crystals (fig. 1) the apatite is judged to be the later.

The structural formula of the idocrase (Table I) corresponds more closely to the ideal formula of Machatschki than to that of Warren and Modell (Deer *et al.*, 1962, vol. 1, p. 114), although the figure for the X group (Ca etc.) is low. Deer *et al.*, 1962, *op cit.* and Ito and Arem (1970) point out that the idocrase structure can accommodate significant amounts of various other elements, for example Be. The beryllium and lithium recorded in the present sample were probably introduced from the nearby granite during the crystallization of the idocrase-bearing contact rocks.

Braitsch and Chatterjee (1963) emphasized the wide range of temperature and pressure conditions over which idocrase can form in nature. Later Ito and Arem (1970) showed that under favourable conditions idocrase can crystallize at temperatures

as low as 360°C at 0.5 kbar. Apatite can likewise form over a considerable temperature range (cf. Deer *et al.*, 1962, vol. 5, pp. 329–30), although its lower temperature stability limit is considerably lower than that of idocrase. Thus Steiner (1977, pp. 56, 90) recorded small amounts of hydrothermal apatite in the zone of high-rank alteration at Wairakei, New Zealand, at temperatures of little more than 260°C and at a depth corresponding to about 0.3 kbar. The minor apatite in the Boutadiol calc-silicate rocks would thus be consistent with later crystallization relative to idocrase, as suggested by the textural relations, and probably formed during pneumatolytic alteration of the earlier contact rocks with falling temperature. In its relationship to the calc-silicate rock it may be compared with the pneumatolytic apatite found in the Meldon, Devon, aplite and its associated rocks (McLintock, 1923).

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Variscite from Hensbarrow china clay works, St. Austell, Cornwall

HENSBARROW china clay works is situated in the Hensbarrow granite mass, and is approximately 1 km west of the village of Stenalees in the parish of St. Austell. The pit is traversed by several NNE-SSW trending quartz-tourmaline veins (known as stent by the quarrymen) carrying a little cassiterite and wolframite, and the well known Bunny tin mine is adjacent. Wavellite occurs in these veins as delicate creamy-white fibrous crystallized crusts lining cavities, together with local infillings of turquoise and varlamoffite. Pegmatite lenses and irregular veins also occur, and these are particularly common in the eastern part of the adjoining Gunheath china clay works, where they carry quartz, tourmaline, apatite, microcline, orthoclase, zinnwaldite, gilbertite, and topaz, with small amounts of wolframite, cassiterite, stannite, arsenopyrite, columbite, varlamoffite, opal, and torbernite.

The variscite was found as aggregates of sharp pale green transparent orthorhombic crystals to 3 mm in diameter, with individual crystals being

slightly less than 1 mm in size. It occurred implanted on the top of a large radiating spray of creamy-white wavellite crystals showing transparent terminations in a cavity in quartz, with large sheaves of zinnwaldite mica and fragments of partly kaolinized granite. It was not unfortunately found *in situ*, being in an irregular pegmatite lens in a large boulder of altered granite lying loose in the bottom of the pit. It is possible that the boulder derived from the neighbouring Gunheath pit, as much overburden had recently been bulldozed from there into Hensbarrow pit.

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The determination of ferrous and ferric iron in rocks and minerals: addendum

IN a contribution earlier in this volume (Hey, 1982) I referred (p. 115) to a discussion of the rate of breakdown of ferric *o*-phenanthroline solution. The relevant section was unfortunately omitted, but is appended here.

The decay of the ferric o-phenanthroline complex. In view of the observation that, when a solution containing 2 mg Fe³⁺ as *o*-phenanthroline complex was extracted repeatedly with 1% oxine in CHCl₃, 125 µg Fe²⁺ were found in the aqueous