

SHORT COMMUNICATIONS

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On the occurrence of Chlorapatite at the Emerald Mine, Rajagarh village, Ajmer

THIS paper describes the mineralogy, chemistry, X-ray, and trace element study of a chlorapatite (asparagus stone) collected from the rocks exposed at the emerald mine, near the village Rajagarh, Ajmer. The mica schists and gneisses of Aravalli age (Archaean), constitute the country rocks in the area. The schists are associated with altered peridotites and intrusive granite and pegmatite. The asparagus stone occurs at the contact of schists and pegmatite. A few crystals of chlorapatite, which were first mistaken for emerald, were collected from the contact zone during the course of a geological excursion.

The crystals measured $1\frac{1}{4}'' \times \frac{3}{4}''$, yellowish-green, semi-transparent with uneven to sub-conchoidal fracture and vitreous lustre; the specific gravity 3.17.

A crystal was broken, crushed to -80 mesh, and separated to remove any associated gangue mineral, using Clerici's solution of varying dilutions. The mineral separated was almost pure (99 %) excepting the minute inclusions of sericite, which could not be separated. In order to estimate the amount of sericite, grain mounts of the separated mineral were studied using refractive index liquid of 1.645, with the help of a point counter. The sericite inclusions were estimated at 0.93 %.

Optical study: The mineral is colourless in thin section, with acicular and fluid inclusions(?); optically negative, it displays a pseudo-biaxial figure ($2E 12^\circ$), probably due to strain. The refractive indices were determined by immersion method: $\epsilon = 1.642$, $\omega = 1.649$, slightly higher than the values for common apatite, and comparing well with the values cited for chlorapatites by Deer *et al.* (1963). The birefringence is low, 0.008.

X-ray study: The material was scanned in a diffractometer using Cu-K radiation from 0° to 60° at $1^\circ/\text{minute}$; the d -values and intensities compare well with the Powder Diffraction File values for chlorapatite (Table I).

Chemistry: CaO and P_2O_5 were determined by gravimetry; fluorine and chlorine by volumetry; alkalis by flame photometry and the rest by atomic-absorption spectrophotometry. Water was determined, following a suggestion by Dr. M. H. Hey, by igniting the mineral with about 4 times its weight of freshly ignited CaO, at about 900°C , and determining the loss in weight. The analysis compares fairly well with the published analysis of chlorapatite, with slight variations: it contains less Mn, F, and Cl, and more CaO. The analysis and atomic ratios are given in Table II.

Trace element study: The several trace elements determined are presented in Table II. The elements V, Yt, Zr, and Ce were determined by emission spectroscopy and the results are semiquantitative. The trace element study was undertaken to decide

TABLE I. *X-ray powder data for a chlorapatite (chlorian hydroxyapatite) from Ajmer, India. Indexed on a cell with a 9.598, c 6.739 Å, c/a 0.702*

<i>hkl</i>	d_{calc}	d_{meas}	<i>I</i>	<i>hkl</i>	d_{calc}	d_{meas}	<i>I</i>
11 $\bar{2}$ 1	3.913	3.917	7	22 $\bar{4}$ 2	1.956	1.950	58
0002	3.372	3.420	18	31 $\bar{4}$ 2	1.905	1.900	23
10 $\bar{1}$ 2	3.125	3.100	10	32 $\bar{5}$ 1	1.837	1.853	56
21 $\bar{3}$ 1	2.850	2.850	85	41 $\bar{5}$ 0	1.816	1.800	18
30 $\bar{3}$ 0	2.774	2.768	100	40 $\bar{4}$ 2	1.770	1.768	8
20 $\bar{2}$ 2	2.620	2.643	25	0004	1.686	1.686	15
30 $\bar{3}$ 1	2.565	2.540	8	41 $\bar{5}$ 2	1.599	1.600	10
—	—	2.110	7				

TABLE II. *Chemical analysis and atomic ratios for a chlorapatite from Ajmer, India*

		Trace elements in p.p.m.		Atomic ratios to 26 (O, OH, F, Cl)	
P ₂ O ₅	41.50			P	6.01
CaO	55.69			Ca	10.15
MnO	0.09	Si	2200	Mn	0.01
MgO	0.11	Al	1300	Mg	0.03
FeO	0.10	Mn	700	Fe	0.01
Na ₂ O	0.10	Mg	665	Na	0.03
F	0.45	Sr	284	F	0.24
Cl	1.31	Cu	5	Cl	0.38
H ₂ O ⁺	0.73	Ni	5	OH	0.85
H ₂ O ⁻	0.02	V	10	O	24.53
Others*	0.76	Zr	10		
Sum	100.86	Yt	{ > 500 < 1000		
Less	0.48	Ce	{ > 250 < 500		
O≡F, Cl					
Net sum	100.38				

* SiO₂, Al₂O₃, and K₂O present as sericite.

whether the mineral is igneous or metamorphic in parentage (Cruft, 1966). The trace element distribution compares very well with the trace elements of apatites from pegmatites and granitic pegmatites cited by Cruft (1966, p. 380) (samples 9, 10, 22 and 23). According to Cruft 'many apatite samples from granitic pegmatites contain high Mn, a high ratio of Y to Ce+La and a low total rare earths in contrast with samples from plutonic and igneous intrusives and metamorphic environments'. The high amount of manganese and the predominance of yttrium over cerium and the low

content of strontium indicate that the present mineral belongs to the granitic pegmatite. Further, when the cerium and silicon (in ppm) are plotted on the diagram given by Cruft (1966, p. 393), the point falls in the field given for pegmatitic apatites.

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REFERENCES

- CRUFT (E. F.), 1966. *Geochimica Acta*, **30**, 375-98.
DEER (W. A.), HOWIE (R. A.), and ZUSSMAN (J.), 1963. *Rock Forming Minerals*, **5**, 98. London (Longmans).

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Helvine in the gondite of Kajlidongri, Madhya Pradesh, India

THE gondite wall-rock around the epigenetic veins of Kajlidongri, Jhabua District, Madhya Pradesh, India ($22^{\circ} 57' N.$, $74^{\circ} 28' E.$), contains dark brown well-developed dodecahedral grains filling fractures at the crest of antiforms, and ranging in diameter from 1 to 2.5 mm; occasionally they exhibit traces of poorly developed {111} cleavage. Chemical tests showed that they contain iron, manganese, zinc, and beryllium. Because of the very small size of the included quartz grains, it is extremely difficult to obtain a pure sample of the mineral for analysis; a partial chemical analysis of two samples estimated to contain about 10% impurity by microscopic examination gave: MnO 29.56, 30.50, FeO 14.05, 14.67, ZnO 4.15, 4.49%, with refractive index 1.74, 1.76 ± 0.001 and cell-size a 8.16 and 8.18 Å. The only other sulphur-bearing mineral in and around the epigenetic veins in the area is baryte, forming fracture-filled veins in a gondite composed of porphyroclasts of quartz and recrystallized grains of spessartine and alurgite. The gondite in this area includes many textural types of different permeabilities, and the baryte is restricted to gondite wall-rocks of considerable porosity, while helvine is restricted to gondite with recrystallized quartz where the intergranular permeability is almost absent. Presumably a higher f_{O_2} is responsible