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AN OCCURRENCE OF GEIKIELITE

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Geikielite, the magnesium-analog of ilmenite, has been found *in situ* in some highly metamorphosed magnesian-marbles in the Santa Lucia Mountains, Monterey County, California, and this is the fourth *in situ* occurrence of geikielite thus far described. Dick (1893) identified bluish- to brownish-black pebbles in the gem sands of Ceylon as geikielite, which he believed was a magnesium analog of perovskite. Crook and Jones (1906) also described geikielite from a collection of Ceylon gem sands during a general study of such materials.

Kashin (1937) found geikielite associated with chlorites in the chrome-spinel deposits of the southern Ural Mountains, USSR, whereas Murdoch and Fahey (1949) reported an occurrence of this mineral in metamorphosed magnesian-limestones near Riverside, California. In the latter occurrence geikielite is associated with calcite and brucite, although spinel and geikielite are concentrated in certain zones. An analysis of this geikielite showed 1.4% FeO and 31.8% MgO.

Geikielite with 12.30% FeO, 2.8% Fe_2O_3, and 21.75% MgO occurs as rare inclusions in chromian-chlorites in a serpentinized body of dunite (Efremov, 1954) near Mount Jemorakly-Tube, North Caucasus, USSR.

Occurrence

The geology of the Santa Lucia Mountains, California, includes large massifs of metamorphosed rocks of the sillimanite zone. The original rocks were mostly sediments with some limestones and magnesian-limestones in ranging states of purity. During metamorphism of the impure magnesian-limestones, coarse grained marbles have formed with associated phlogopite, clinohumite, forsterite, spinel, and occasionally geikielite.

Geikielite occurs as small (0.01 mm. to 0.10 mm.), black and opaque, irregular to occasionally rounded grains, closely associated with rutile and spinel. If rutile is present, it is always in juxtaposition with geikielite, and powder photographs of apparently pure material show a mixture of the two minerals. Spinel is also closely associated with the geikielite.

In the associated ferro-magnesian minerals the amount of iron is notably small:

The spinel contains 5.2% of $FeAl_2O_4$, which was determined through (1) chemical analysis, in which FeO = 2.4%; (2) comparison of the cell edge (a_0 = 8.092 Å) with that of pure artifical spinel (a_0 = 8.080 Å, Swanson and Fuyat, 1953); (3) comparison of the refractive index (1.721) with that of pure spinel (1.719, Palache, et al., 1944, p. 690).

The phlogopite contains approximately 19% annite, determined through (1) refractive index, $\gamma=1.600$, indicating 20% annite (Wones, 1958a or 1958b); (2) $d_{060}=1.537$ Å, indicating 18% annite (Wones, 1958a or 1958b); (3) the intensity ratio of 004/005 is 0.49, corresponding to 19% of the octahedral positions filled by iron (Gower, 1957).

The clinohumite is practically the pure magnesium end-member, since the refractive indices give a mean refractive index of 1.646 (Sahama, 1953). The olivine contains from 2% to 5% fayalite, which was determined from $2V_x=97°$ to 94° (Winchell and Winchell, 1951).

Geikielite was also found in a locality in the same marble layer but about 800 yards to the south. Sample #2 is that from the southern locality, while Sample #1 is from the main area studied.

Mineralogy and Paragenesis

The geikielite can best be separated from the associated minerals, especially rutile and spinel, by passing 250-mesh material through a Frantz magnetic separator set at 0.6 amps with $7\frac{1}{2}°$ tilt and 15° slope (spinel is separated at 0.9 amps, leaving the rutile).

Powder photographs of the geikielite from both localities were taken and are compared with the pattern of artificial $MgTiO_3$ (Table I). The cell dimensions, as calculated from the powder patterns, are given in Table II.

The principal point of distinction between geikielite and ilmenite patterns is the appearance of reflections for the planes (003) and (101) in the geikielite patterns. Although the powder patterns appear to be distinctive, geikielite has at times been mistaken for ilmenite.

The *d*-spacings and cell dimensions of Sample #2 are larger than those in Sample #1, and these data suggest that the former has a higher amount of iron. This supposition was borne out by qualitative density determinations. The density of grains from Sample #1 average about 4.2, while most of the grains from Sample #2 would float in Clerici's Solution (density 4.2). Pure geikielite has a density of 4.05 and ilmenite, 4.79 (Palache, et al., 1944, p. 536). Since the material was too scarce and usually too impure for a chemical analysis, the amount of iron can only be estimated from the approximate density, electromagnetic properties, and cell dimensions. The limits may be set at 25% and 40% $FeTiO_3$.

The abundance of magnesium and scarcity of iron in the rock may be the reason for development of geikielite instead of ilmenite, since underlying the marbles a biotite-plagioclase schist contains bands of calcite, pale-green pleonaste, and ilmenite with some rutile and sphene. The formation of spinel results from the low amount of silica in the system, and this fact probably accounts for the formation of geikielite in place of

TABLE I. POWDER-DIFFRACTION DATA FOR THE SANTA LUCIA GEIKIELITE

Radiation CuKα=1.5418 Å and CuKα_1=1.5405 Å. Camera diameter 114.59 mm.

hkl	Sample #1		Sample #2		*d* Å ($MgTiO_3$)
	d (meas) Å	I	*d* (meas) Å	I	
003	4.67	10	4.67	10	4.64
101	4.19	5	4.19	5	4.18
102	3.723	30	3.70	30	3.703
104	2.735	100	2.742	100	2.722
110	2.536	40	2.542	60	2.527
113	2.226	45	2.232	40	2.218
202	2.0	d*			2.090
204	1.859	45	1.861	30	1.852
116	1.714	65	1.718	60	1.708
108			1.627	10	1.6148
214	1.4993	10	1.502	30	1.4938
030	1.4650	10	1.466	30	1.4592
208	1.3628	5			1.3606
1·0·10	1.3280	5	1.334	15	1.3247
220			1.2695	5	1.2634
128			1.204	d	1.1978
2·0·10			1.180	5	1.1735
134			1.1525	5	1.1462
226			1.1155	5	1.1093
2·1·10			1.0715	5	1.0642
324			0.970	d	0.9646
140			0.958	d	0.9552
			0.920	d	
			0.889	d	

* Diffuse line.

sphene in such a calcium-rich environment. Sphene was formed in less magnesian layers of the marble associated with minor amounts of quartz and diopside. The existence of rutile as excess TiO_2, may (but not

TABLE II. CELL DIMENSIONS FOR $MgTiO_3$, SANTA LUCIA GEIKIELITE, AND ILMENITE (BASED ON THE HEXAGONAL CELL)

	a_0 Å	c_0 Å
$MgTiO_3$ (Swanson, *et al.* 1955)	5.054	13.898
Sample #1	5.072 } ±.005	13.950 } ±.005
Sample #2	5.080 } ±.005	13.895 } ±.005
Ilmenite (United Steel Co., Sheffield)	5.079	14.135

necessarily) result from a deficiency of magnesia at the time of the formation of geikielite.

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CERIANITE, CeO_2, FROM POÇOS DE CALDAS, BRAZIL

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Cerianite has been identified as a secondary mineral from Morro do Ferro on the Poços de Caldas plateau, Minas Gerais, Brazil. The cerianite occurs in soft, weathered materials lying within a radioactive zone on the southeastern slope of Morro do Ferro. Samples of these materials were collected in July, 1956, by T. C. Marvin, Geologist for the Union Carbide Ore Co., during a visit to the locality in company with Helmuth Wedow, of the U. S. Geological Survey, who had made a detailed study of the geology of the mountain. The samples containing cerianite were taken from a small, irregular zone, a few inches in width, of especially high