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PSEUDOMORPHES AFTER DATOLITE, PREHNITE AND APOPHYLLITE FROM EAST GRANBY, CONNECTICUT

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Introduction

In the spring of 1958, during the annual spring field trip of the Boston University Geology Department, one of the stops of the group was at the East Granby, Connecticut, trap rock quarry of Materials Service, Inc. During the quarry examination, the group was met by Mr. Stephen Ridel, one of the employees in the quarry, who makes a practice of collecting a completely representative suite of minerals in the quarry. Following the exploration of the quarry, the group was invited to visit Mr. Ridel's personal collection at his home. Through the years, the quarry has produced some outstanding specimens of the usual trap rock minerals Mr. Ridel presented two specimens for identification which could not be immediately recognized, and specimens were kindly made available for study in the Boston University Mineralogy Laboratories. Specimens studied are shown in Fig. 1*a*, 1*b*.

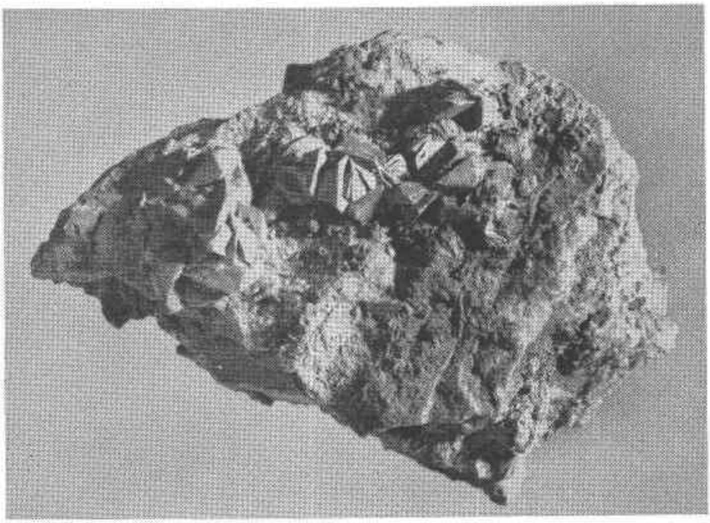

Fig. 1*a*. Chlorite pseudomorphs after datolite on veined pocket filling. Specimen 6 inches wide.

DESCRIPTION OF SPECIMENS

The trap rock quarry at East Granby is of the typical Triassic basaltic variety. At the time the authors were examining the quarry, there were but few evidences of cavities or extensive calcite or quartz veination. Pockets with mineralization, according to Mr. Ridel, are occasionally discovered, and it was from one of these that the materials herein described were removed.

The outstanding feature of the material considered herewith is the abundance of chlorite. The materials show signs of successive shearing and vein filling with calcite as the predominant vein filler with minor amounts of clear and slightly smoky quartz crystals lining some of the shear openings. Maximum length of these quartz crystals in the specimens at hand is about 4 mm. Rosettes of both white and green prehnite, up to 1 cm. across, are common in the material, Fig. 1*b*.

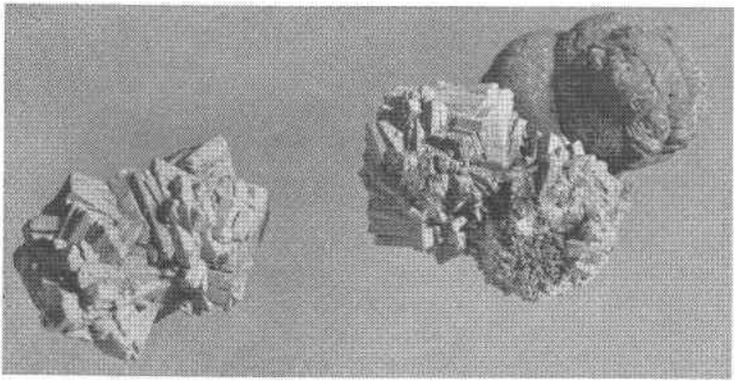

FIG. 1*b*. Chlorite pseudomorphs after apophyllite and prehnite on veined pocket filling.

ALTERATION

The material of particular interest in this paper is a series of specimens with strange satiny luster and green coloration, typical of chlorite pseudomorphs after adularia, and a tentative identification of the crystals as adularia was made. The crystals were studied under the polarizing microscope, which quickly disclosed their pseudomorphic character. At least two substances are present in the crystals, but the grain size of individual units is too small to permit accurate determination by optical means. The optical data were adequate, however, to leave no doubt that the replacing material is chlorite.

The precise sequence of alteration in the matrix of the altering medium cannot be certainly determined from the data at hand. The most important change has been the extensive addition of Fe^{+2} in the process. Since zeolites and associated minerals are low density, water-bearing minerals, rich in sialic constituents, it appears that they are formed under low pressures and temperatures, probably due to the migration of meteoric water through the rocks. This water dissolves out the sialic constituents which are in turn precipitated in the gas cavities. A subsequent and deeper burial of the lavas with a rise in temperature and pressure would subject the zeolites and associated minerals to unstable conditions. Under these conditions a 2-phase migration of ions would take place with the sialic ions migrating upward and iron and magnesium ions migrating downward. The pseudomorphic alteration is visualized as being essentially due to this substitution of iron and magnesium for calcium, sodium and potassium.

MORPHOLOGICAL CRYSTALLOGRAPHY

On the basis of the crystallographic measurements, it was decided that two of the substances had originally been datolite and apophyllite. The pseudomorphs after prehnite were determined from the usual growth habit of prehnite. A comparison of the measured angular values with those listed in the Dana 1892 *System of Mineralogy* is given below.

Comparison of Interfacial Angles

	Datolite (Dana)		*Datolite Pseudomorphs*
$n\wedge n'$	$111\wedge 1\bar{1}1$	$59^\circ 4\frac{1}{2}'$	60°
*$(n\wedge n'$	$111\wedge 1\bar{1}1)$		
$a\wedge n$	$100\wedge 111$	$38^\circ 55'$	40°
$(c\wedge n$	$001\wedge 111)$		
$a\wedge m$	$100\wedge 110$	$32^\circ 23\frac{1}{2}'$	36°
$(c\wedge M$	$001\wedge 011)$		
$\epsilon\wedge\epsilon'$	$\bar{1}12\wedge\bar{1}\bar{1}2$	$48^\circ 19\frac{1}{2}'$	48°
$(\epsilon\wedge\epsilon'$	$\bar{2}11\wedge\bar{2}\bar{1}1)$		

* Letters and indices in parentheses refer to orientation with $c<a$.

The optical goniometric measurements of the datolite gave very diffuse signals, and readings were to the nearest degree. These measurements were then plotted on the Wulff net, and the interfacial angles were measured thereon. Four crystals were measured in all, and there was a complete consistency of results. The data given above were those from one crystal. Figure 2 represents this crystal in the orientation $c<a$ but with Dauber's (Dana) unit.

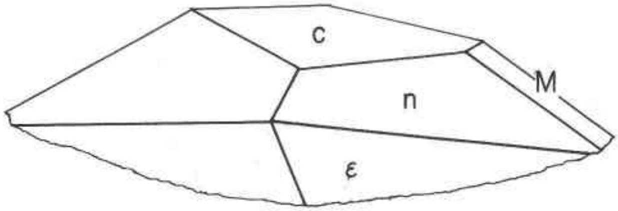

FIG. 2. Typical chlorite pseudomorph after datolite crystal.

Comparison of Interfacial Angles

	Apophyllite (after Dana)		*Apophyllite Pseudomorphs*
$p \wedge p'$	$111 \wedge 111$ $*(011 \wedge 101)$	76°0′	73°
$c \wedge p$	$001 \wedge 111$ $(001 \wedge 011)$	60°30′	60°

* Indices in parenthesis refer to structural orientation which is used in Fig. 3.

The measurements of the apophyllite were done by the use of the contact goniometer and were completely adequate to demonstrate the identity of the pseudomorphs. Figure 3 shows the typical habit of the individual apophyllite crystals which actually occur in clusters. It should be noted that the (111) of Dana is actually (101) of the structural cell.

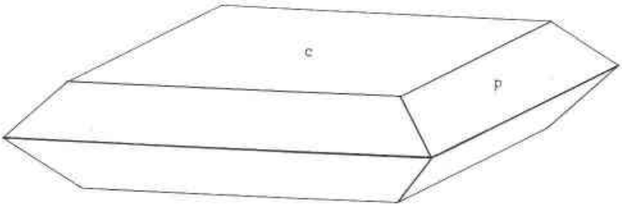

FIG. 3. Typical chlorite pseudomorph after apophyllite crystal.

The variation in density of the pseudomorphs as compared with the original crystals gives some suggestion as to the degree of replacement by chlorite. It was impossible to get a precision determination of the chlorite composition, but a specific gravity of roughly 2.8 seems reasonable in terms of the final densities. A comparison of the altered and unaltered crystals appears below.

Comparison of Specific Gravities

Datolite (after Dana) 3.0	*Datolite Pseudomorphs* 2.885
Prehnite (after Dana) 2.8–2.95	*Prehnite Pseudomorphs* 2.89
Apophyllite (after Dana) 2.3–2.4	*Apophyllite Pseudomorphs* 2.51

It will be noted that whereas the datolite pseudomorphs have a lower specific gravity than the original, the specific gravity of the apophyllite has increased. Prehnite with the original gravity comparable to the substituted chlorite has not undergone a significant change in gravity.

X-ray powder patterns of the various pseudomorphs show dominant lines of the original minerals indicating that the degree of chlorite substitution is certainly less than 50%. A secondary optical examination disclosed that some of the crystals had undergone far less alteration than others, and although the unaltered portions were extremely minute, their optical properties were clearly those of the original minerals herein named. It would have been impossible to identify the substances directly by optical means, but with other data at hand the optical inspection proved fruitful.

ACKNOWLEDGMENTS

The authors are particularly grateful to Mr. Stephen Ridel for his offering the specimens for study and for his patient waiting for results. They also wish to thank Mr. Robert A. Lancaster for his crystal drawings and Mr. Phokian Karas for his photographs of the specimens. We are also very grateful to the officers of the Materials Service, Inc. for the privilege of visiting the quarry.

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ERRORS IN POINT-COUNTER ANALYSIS

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The extension of modal analysis to sawn surfaces (Jackson & Ross, 1956; Plafker, 1956; Emerson, 1958; Fitch, 1959) increases interest in the effects of rock-coarseness, sample area and count length on precision. A comment on Dr. F. Chayes' recommendations with regard to these three factors is therefore offered.

In the course of his exhaustive study of point-counter technique, Chayes (1949; 1951; Chayes & Fairbairn, 1951) has clearly shown the presence of two sources of variance: one lies in using a point-count as a sample of a rock section, and the other lies in using a rock section as a sample of a specimen. In his most recent publication on the subject, Chayes (1956) sets out to compare the sizes of the two variance components but does not pursue this course to a conclusion (p. 89). It is the purpose of this note to suggest—