DOLOMITE PSEUDOMORPHOUS AFTER CRYSTALS OF ARAGONITE*

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Abstract

The flat hexagonal crystals from the Big Horn Basin, Wyoming, locally called "Indian Pennies," are shown to consist of dolomite pseudomorphous after crystals of aragonite.

Introduction

Dolomitization of rock calcite (as limestone) is a common geologic phenomenon. Hewett,[1] for example, has called attention to its widespread occurrence.

Pseudomorphs of dolomite after crystals of calcite (that is, as a mineral) seem to be very rare. Hintze[2] lists only a single recorded example, although a long list of other minerals have been recorded as pseudomorphs after calcite. Pseudomorphs of other minerals after aragonite likewise are rare. Hintze[3] lists only calcite (paramorphs), copper, and deweylite, although the silica pseudomorphs of quartz or chalcedony after aragonite, found along the Canadian River in Oklahoma, have long been known. Pseudomorphs of dolomite after aragonite, though not listed by Hintze, were described by Breithaupt[4] in 1863. He describes a crystal of aragonite four inches long and one-half an inch thick, from Kolosoruk near Bilin, Bohemia, which has changed to dolomite with less than the normal quantity of magnesia. The pseudomorphous crystal is built up of small rhombohedra of dolomite in various orientations. Cornu[5] in 1904 described parallel fibered aragonite, filling cavities in the basalt of the Bohemian Mittelgebirge, which has changed to yellowish-white dolomite. His analysis: 34.09 CaO, 18.11 MgO, 0.90 FeO, 47.30 CO_2, gangue 0.06, with traces of SrO and Al_2O_3, total 100.46, indicates the presence of a slight excess of $CaCO_3$. The change is ascribed to the effects of meteoric water containing magnesium bicarbonate in solution.

Dolomite pseudomorphous after aragonite occurs in abundance in

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[1] Hewett, D. F., Geology and ore deposits of the Goodsprings Quadrangle, Nevada: *U. S. Geol. Survey, Prof. Paper* **162,** 57–67 (1931); Dolomitization and ore deposition: *Econ. Geology,* **23,** 821–863 (1928).

[2] Hintze, Carl, *Handbuch der Mineralogie,* Band **1,** Abt. 3:1, p. 2893 (1930).

[3] *Op. cit.,* pp. 2985–2986.

[4] Breithaupt, August, Pseudomorphosen, *Berg-und Huettenmaennische Zeitung,* Band **22,** 118 (1863).

[5] Cornu, F., Pseudomorphose von Dolomit nach Aragonit: *Tschermak's mineralog. und petrogr. Mitteil.,* Band **23,** 217–218 (1904).

Wyoming. The occurrence is well known but it seems not to have been recognized that the flat hexagonal crystals are now dolomite. The occurrence was recently described.[6]

Occurrence and Distribution

During the course of geologic investigation of the northeast side of the Big Horn Basin of Wyoming and Montana, from 1935 through 1939, D. A. Andrews collected numerous flat tabular pseudohexagonal crystals to which his attention had been directed by residents of the area who called them "Indian Pennies", although no record of their tribal or ceremonial use by the Crow Indians who occupied this area can be found.[7]

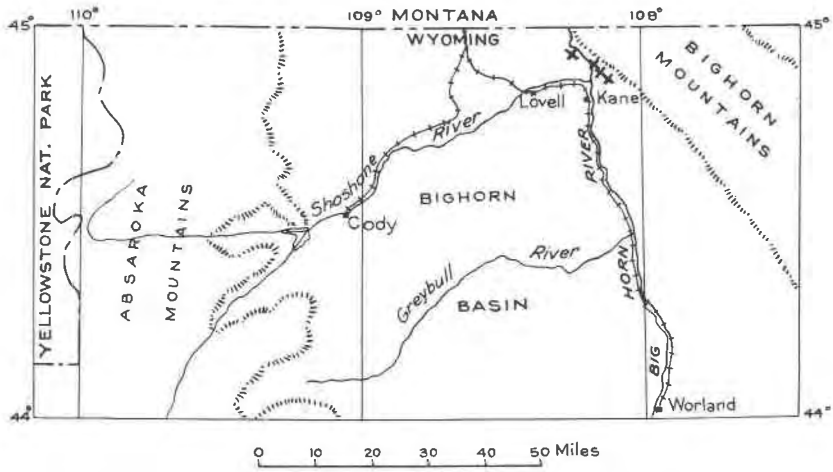

Fig. 1. Location of dolomite pseudomorphs after aragonite.

These crystals were found near the Big Horn River where it enters the Big Horn Canyon across the northern end of the Big Horn Mountains. The locality (Fig. 1) is easily reached by car from Lovell, Wyoming, by following the paved road eastward from Lovell to Kane, then northward four miles and northwest three miles to the locality. The crystals occur near the base of the red beds on the south side of a saddle between two small gravel terraces 300 feet above the river. This locality is about one-half mile south of the Abercambie dredge and quarry. Other localities can be visited by continuing eastward from Kane on the paved highway one and one-half miles across the Big Horn River, then following the

[6] Goldring, E. D., Aragonite crystals from Wyoming: *The Mineralogist (Oregon)*, **9,** 16 (1941).

[7] Lowie, R. H., *The Crow Indians.* Farrar and Rinehart, New York (**1935**).

well marked trail northeastward along a gravel slope three miles to the foot of the mountain slope where the base of the red beds is exposed, and following this horizon northwestward toward the Big Horn River.

The crystals are found in a bed of gypsum at the base of the Chugwater formation and directly on top of the uppermost limestone of the Embar formation. The red beds of the Chugwater type interfinger with the gray cherty limestones of the Embar formation, and the contact between the two formations is here arbitrarily drawn at the top of the uppermost limestone. Some of the red beds in central Wyoming are Triassic in age but most of the limestones in this part of the Big Horn Basin have yielded fossils of Permian age. The red beds at this locality are 600 feet thick.

The crystals are embedded in the upper part of this gypsum bed. Because of surficial changes of structure in the gypsum bed it is difficult to ascertain the exact position or occurrence in the bed itself. They are usually found in the upper few inches of the gypsum bed, but it cannot be stated positively that they are not present throughout the gypsum bed. In one place the crystals were lying flat roughly one on top of another forming a stack of eight or ten crystals much like a stack of poker chips.

Structurally the beds in this vicinity are dipping southwest along the western flanks of the Big Horn Mountains. This area is north of the major uplift and here the Big Horns rise in a series of three monoclines with dips of 20° to 25° common on the steeper portions of the monoclines, flattening abruptly to less than 5° on the more gentle portions. About 10 miles to the southeast the Big Horns rise abruptly from the Basin in one slope with dips up to 90°.

Aragonite is commonly associated with gypsum deposits so that its presence here requires no explanation. The unusual feature is the replacement of the aragonite by dolomite. If the gypsum were deposited by evaporation of normal marine waters a source of magnesium might be expected in the salts last deposited by such waters. Two arguments can be readily advanced against this source. First, none of the gypsum in the Big Horn Basin, either in the overlying Chugwater formation or in the underlying Embar formation, has been reported to be associated with any other salts.[8] Secondly, if the magnesium salts gave rise to the solutions producing the replacement why has not this replacement been reported more commonly because aragonite and magnesium sulphate are in common occurrence with gypsum. It seems far more likely that the replacement is due to the same factors that produced extensive dolomiti-

[8] Lupton, C. T., and Condit, D. D., Gypsum in the southern part of the Big Horn Mountains, Wyoming: *U. S. Geol. Survey, Bull.* **640,** 139–157 (1916).

zation of the limestones in the underlying Carboniferous formations along and adjacent to the Big Horn Mountains.

Description of Pseudomorphs

The flat hexagonal crystals, a group of which is shown in ½ natural size in Fig. 2, range in size from about one to two inches across, averaging about an inch and a half. They are rather uniformly about a quarter of

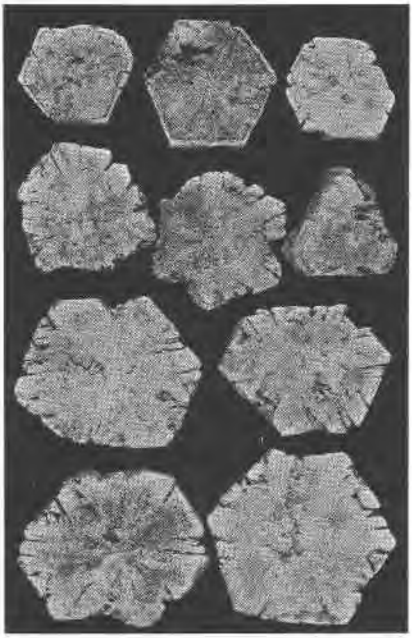

Fig. 2. Dolomite pseudomorphous after cystals of aragonite. ½ Natural size.

an inch thick. In color they range from nearly white through light gray to light brown where slightly stained by iron oxide. They have a dull luster, and are pitted with small holes and with lines following the crystallographic directions of the original aragonite. Inspection with a hand lens readily shows that the crystals are now composed of many small crystallographic units, variously oriented and closely compacted. Lining some of the small pits are individual rhombohedra not sharply outlined.

Some of the crystals, as shown in the top row of Fig. 2, are framed by a narrow border of the same material, slightly lighter in color and more compact. A thin section, parallel to the base, shows the heterogeneous orientation of the individual grains of dolomite, as shown in Fig. 3.

The shape of the crystals, the indentations around the border, and the markings on the base, are all typical of the common twinned crystals of aragonite of this tabular habit. Only one crystal (shown in Fig. 2) out of about a hundred collected shows a symmetrical trigonal development but this is believed to be very unusual for the occurrence.

Small areas of fine-grained gypsum are scattered irregularly through the pseudomorphous crystals, as seen in thin section. On the basis of the percentage of SO_3, the gypsum amounts to about two per cent.

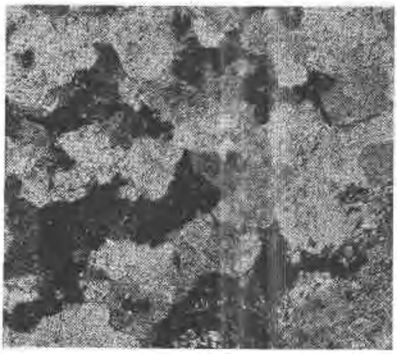

FIG. 3. Thin section, parallel to the base, of a pseudomorph, showing the heterogeneous orientation of the individual grains of dolomite. Nicols crossed. ×48.

Tested by the staining method, using ferric chloride and ammonium sulphide, as described by Sherman and Thiel,[9] the crushed material remained white (as does dolomite and magnesite) whereas aragonite and calcite stain black. There were a few isolated small black areas in the material tested which may be residual aragonite but more probably are enclosed gypsum. Tests with various forms of gypsum showed that this mineral is not stained black but all the samples of gypsum tested showed a few small black areas, probably due to some ferric chloride entering minute cleavage openings and not being washed out before the fragments were treated with ammonium sulphide.

The material does not effervesce with cold 1:1 HCl and the ω index of refraction is 1.680. Analysis of part of one of the crystals gave the following results:

[9] Sherman, G. D., and Thiel, G. A., Dolomitization in glacio-lacustrine silts of Lake Agassiz: *Bull. Geol. Soc. Am.*, **50**, 1540 (1939).

Analysis of Dolomite Pseudomorphous after Aragonite

[W. T. Schaller, analyst]

CaO	30.60
MgO	21.12
CO_2[a]	45.65
SO_3	0.98
P_2O_5	Trace
Insol.	0.28
R_2O_3[b]	0.18
H_2O-	0.33
H_2O+	0.89
	100.03

[a] Determined by J. G. Fairchild.

[b] Chiefly Fe_2O_3, limonitic impurity.

After deducting for gypsum, the ratio of CaO:MgO is 1.02:1.00.

Note. Since this paper was prepared, very similar examples of dolomite pseudomorphous after crystals of aragonite were collected by W. F. White, Jr., Water Resources Branch, Geological Survey, from just south of Dunlap, De Baca County, New Mexico. These crystals are slightly darker in color and do not show the twinning striations on the base. Otherwise they are very similar to the pseudomorphs from Wyoming.