

SPHERULITIC CONCRETIONS OF DAHLLITE FROM ISHAWOOA, WYOMING

DUNCAN MCCONNELL, *Stanford University, California*

During the summer of 1934 some unusual concretions were shown to the writer but they were not examined in place because their mineralogical nature was not fully appreciated until they were later examined in the laboratory, and because their location in the field was inaccessible. They occur in abundance in the basal part of the Thermopolis formation (Upper Cretaceous), and are useful as stratigraphic markers in the region near Cody, Wyoming.¹ The ones examined by the writer were collected about ten miles southwest of Ishawooa, Park County, Wyoming.

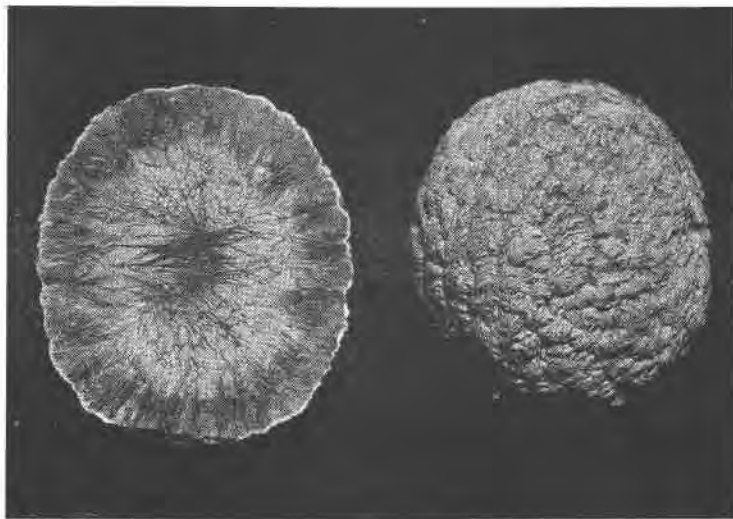


FIG. 1. Polished cross section showing dark center and very narrow border of incipient weathering. The peculiar external surface is shown. $\times 4/3$.

MEGASCOPIC OBSERVATIONS

Some of the concretions are compound, i.e., composed of several interpenetrating spheres. Many, however, are approximately spherical in shape and average about 3 cm. in size. They are phosphatic nodules and are unusual, first, in their spherulitic structure

¹ Private communication from Mr. E. H. Stevens, of the University of Chicago.

(Figs. 1 and 2) and secondly, in consisting essentially of dahllite which, although probably a frequent constituent of phosphate nodules, generally does not predominate. The exterior has a peculiar texture, which usually shows a slight amount of weathering (Fig. 1). The color of the weathered surface is light gray. Immediately within the weathered zone the material is brown, grading inwardly to light yellowish-gray. The center of the concretions is different in texture and composition; it is very dark in color.

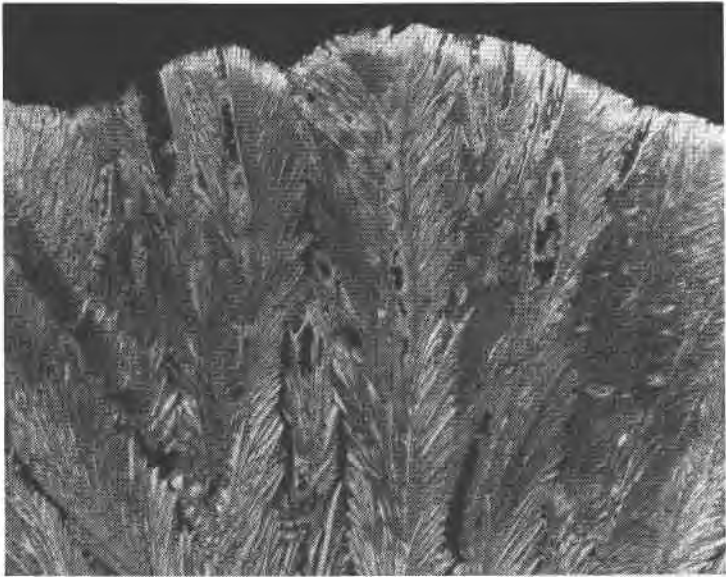


FIG. 2. The plumose fibers of the spherulitic structure containing numerous small cavities and filled cavities. (Oblique reflected illumination.) $\times 8.8$.

The dahllite effervesces in cold dilute acid and gives water in the closed tube, besides producing microchemical tests for phosphate and calcium ions.

MICROSCOPIC OBSERVATIONS

The spherulitic concretions are composed of two types of fibers (Fig. 3). The more apparent fibers are the broad type and these are aggregates of well defined microcrystals whose elongation is transverse to the length of the fibers. The more predominant, the

narrow type, are composed of microcrystals whose length is parallel to the length of the fibers. The microcrystals of these fibers are poorly defined and the fibers are interrupted throughout their length. In both types of fibers the optical orientation of the microcrystals is length-fast.

When the sensitive red plate is inserted between crossed nicols in a position such as to cause the retardation produced by the broad type of fibers to increase, the retardation produced by the narrow type decreases, while still other portions remain at extinction. The portions at extinction are intimately associated with the

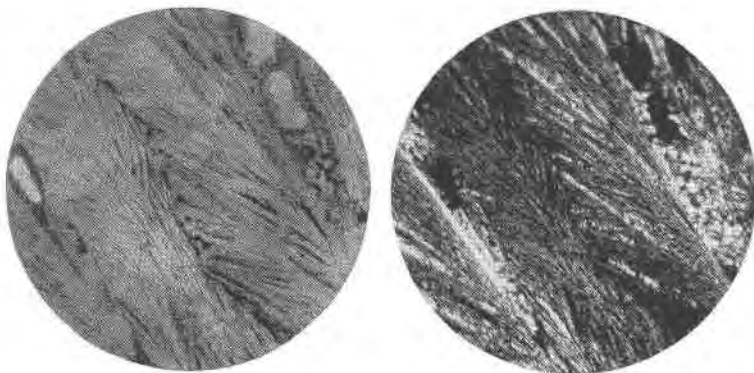


FIG. 3. Fibers, cavities, and small patches of the dark material which forms the center. $\times 22$. Same with crossed nicols showing narrow and broad types of fibers, spherulites, and partial spherulites. $\times 18$.

fibers of the narrow type and seem to indicate a poor orientation of the microcrystals composing them.

Very minute secondary spherulites and partial spherulites occur at the margins of numerous small cavities or within a cryptocrystalline material which has filled some of the cavities (Fig. 3). Associated with the filled cavities are aggregates of small euhedral crystals of dahlite (average 30μ – 40μ in length—maximum 70μ), which are prismatic in habit and show well defined hexagonal basal sections (10μ across). The cryptocrystalline ground mass filling the cavities varies from colorless to yellowish-brown. Its composition is not known but it is probably a member of the kaolin group.

The small euhedral crystals have γ parallel to c and refractive indices:

$$n_{\alpha} = (\epsilon) = 1.627 (\pm 0.003)$$

$$n_{\gamma} = (\omega) = 1.635$$

$$\Delta = 0.008 (\pm 0.002)$$

The only observed forms were the prism and pinacoid.

The dark material in the center of the concretions (Fig. 1) is translucent in thin sections and contains iron and a small amount of manganese, as indicated by microchemical and blowpipe tests, but it cannot be referred to any mineral species and probably represents a mixture of oxides. Within this material calcite occurs, filling interstices, and in the dahllite, calcite occurs at the margins of cavities to a lesser extent. The dark material seems to be later than the dahllite and the calcite is probably still later.

Examination of a polished surface disclosed that minute crystals of pyrite occur in the dark material of the center and also in the dahllite. Most of these specks of pyrite show alteration and many of them are cross-cut by stringers of oxides.

No organic remains (sponge spicules, bones, shell fragments, etc.) were found in the thin sections. This suggests that the fibrous dahllite did not directly replace organic matter. The concretions may represent replacement of some other material but, if this be the case, the replacement was quite complete, because no relicts of the replaced material were found. It is possible that the dahllite represents a crystallization product of amorphous calcium carbonate-phosphate, and it is further possible that collophane is intermixed with the microcrystals of the narrow fibers, although none could be detected with certainty.

NOTES ON DAHLLITE

The apatite group may be considered as being composed of:

fluor-apatite	$\text{Ca}_{10}\text{F}_2(\text{PO}_4)_6$
chlor-apatite	$\text{Ca}_{10}\text{Cl}_2(\text{PO}_4)_6$
hydroxy-apatite	$\text{Ca}_{10}(\text{OH})_2(\text{PO}_4)_6$
oxy-apatite or voelckerite	$\text{Ca}_{10}\text{O}(\text{PO}_4)_6$
carbonate-apatite or dahllite	$\text{Ca}_{10}\text{CO}_3(\text{PO}_4)_6$

The above formula is that accepted for dahllite by Rogers,² Eitel,³

² Rogers, A. F., Dahllite (podolite) from Tonopah, Nevada, voelckerite a new calcium phosphate; remarks on the chemical composition of apatite and phosphate rock: *Am. Jour. Sci.*, vol. 33, pp. 475-482, 1912.

³ Eitel, W., Über Carbonatphosphate der Apatitgruppe: *Schr. Königsb. gelehrt. Ges., Naturw. Kl.*, 1924, pp. 159-177.

and Brauns.⁴ With the addition of a combined molecule of water it is the one accepted by Washington,⁵ and by Schaller.⁶ Other authors accept either the original formula, $2\text{Ca}_3(\text{PO}_4)_2 \cdot \text{CaCO}_3 \cdot \frac{1}{2} \text{H}_2\text{O}$, or one of several slight modifications involving the amount of water. In general, those who contend that the calcium phosphate to calcium carbonate ratio is two to one consider that podolite is a distinct species, while those who consider the three to one ratio as correct for dahllite regard podolite as identical with dahllite. The probability of error in determining the small amount of fluorine, which is frequently present, together with lack of concordance in the determinations of water permit sufficient margin for the differences of opinion.

Dahllite usually occurs in phosphorite, as fibrous incrustations frequently showing colloform structure, where it is commonly associated with collophane. This is the mode of occurrence in Quercy.⁷ It has been reported as a secondary mineral filling small fractures in feldspar-poor alkali basalt in Odenwald⁸ and in naujaite in Greenland.⁹ At the locality from which dahllite was originally described it was associated with apatite.¹⁰ It occurs at Tonopah, Nevada, in the oxidized zone associated with iodyrite, hyalite, quartz and manganese dioxide.¹¹ At Cerro Mercado, near Durango, Mexico, dahllite is associated with martite and goethite.¹² It is also occasionally found in fossil bone.¹³

⁴ Brauns, R., Über den Apatit aus dem Laacher Seegebiet, Sulfatapatit und Carbonatapatit: *N. Jahrb. Miner., B. B.*, vol. 41, pp. 60–92, 1917.

⁵ Washington, H. S., Dahllite from St. Paul's Rocks (Atlantic): *Am. Mineral.*, vol. 14, pp. 369–372, 1929.

⁶ Schaller, W. T., The probable identity of podolite with dahllite: *U. S. Geol. Surv., Bull.* 509, pp. 96–97, 1912.

⁷ Lacroix, A., Sur la constitution minéralogique des phosphorites françaises: *Compt. Rend.*, vol. 150, pp. 1213–1217, 1910. Lacroix, A., *Minéralogie de la France*, vol. 4, pp. 555–558, 1910.

⁸ Nieland, H., Carbonatphosphate (Dahllit, Quercyit usw.) vom Katzenbuckel im Odenwald: *N. Jahrb. Miner., B. B.*, vol. 59, A, pp. 205–222, 1929.

⁹ Böggild, O. B., Dahllit från Kangerdluarsuk: *Meddel. om Grönl.*, vol. 51, pp. 434–443, 1915; also *Z. Krist.*, vol. 55, pp. 417–425, 1920.

¹⁰ Brögger, W. C., and Bäckström, H., Über den Dahllit, ein neues Mineral von Ödegården, Bamle, Norwegen: *Öfv. Akad. Stockh.*, vol. 45, p. 493, 1888.

¹¹ Rogers, A. F., *Op. cit.*

¹² Foshag, W. F., Mineralogy and geology of Cerro Mercado, Durango, Mexico: *U. S. Nat. Mus., Proc.* 74, art. 23, p. 12, 1928.

¹³ Rogers, A. F., Mineralogy and petrography of fossil bone: *Geol. Soc. Amer., Bull.* 35, p. 549, 1924.

The refractive indices of dahllite have been reported to vary from $n_\alpha = 1.591-1.631$ and $n_\gamma = 1.598-1.635$ with $n_\gamma - n_\alpha = .004-.019$. Although the mineral is usually uniaxial negative it has been reported as showing optical anomalies. The habit may be either prismatic or tabular; showing, most frequently, the simple prism and pinacoid but also the unit bipyramid.

The mineral collection of Stanford University contains phosphate concretions from Podolia, U.S.S.R., and comparisons of hand specimens and thin sections have shown them to be somewhat similar to those from Wyoming. The concretions from Russia, however, are larger, darker in color, have a worn exterior surface, show a lesser development of the plumose structure and contain glauconite, quartz, and chalcedony intermixed with the fibers and anhedral crystals of dahllite. It is probable that these concretions may have come from the locality from which podolite was described.¹⁴

Although the concretions from Wyoming are somewhat similar to those found in Podolia they exemplify a rare type of concretionary structure, and this occurrence of dahllite in the United States seems noteworthy.

ACKNOWLEDGMENTS

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¹⁴ Tschirwinski, W., Über Podolit, ein neues Mineral: *Centrb. Mineral.*, 1907, pp. 279-283.