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Mono Lake from the west. Paoha is the larger, lighter colored island.

STRUVITE FOUND AT MONO LAKE

By J. F. Cooper, Jr. and G. E. Dunning

The March 1966 issue of this magazine carried an article entitled "Newberyite and monetite from Paoha Island, Mono Lake," by P. H. Ribbe and L. Cohen. In that article, they stated their suspicion that, judging by crystal morphology, many of the newberyite and monetite crystals were once struvite, although they did not, at that time, find any struvite crystals.

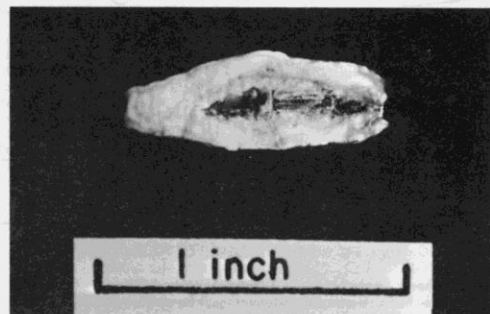
In this article, Messrs. Cooper and Dunning present a predicted sequel: struvite is, indeed, present in this unusual locality. . . . Edit.

In 1966 P. H. Ribbe and L. Cohen described an occurrence at Mono Lake of newberyite and monetite, two minerals previously unknown in California. Since then, more than 200 specimens of the monetite-coated newberyite have been collected from the Paoha Island locality and examined in the laboratory. Five of the 200 were found to have a residual core of grayish transparent material that showed a layered structure resembling gypsum. The five crystals having this core differed greatly in specific gravity from those that were completely replaced by monetite and newberyite. The crystal structure, hardness, cleavage, and brittle nature of the material indicated it to be struvite. Qualitative chemical analysis showed the presence of phosphate, ammonia, and magnesium—again, indicating struvite. A later X-ray examination of the material confirmed it as, indeed, struvite, $Mg(NH_4)(PO_4) \cdot 6H_2O$ —adding yet another mineral not previously known to occur in California.

The struvite is associated with monetite-coated newberyite pseudomorphs in an impure, silty, varved diatomite that is blocky where standing in cliffs, but in the area where the three phosphate minerals occur, is thin bedded and loose. The struvite crystals are as much as 7.5 centimeters in length and 3.8 centimeters in width, although some of the monetite-coated fragments of newberyite, which are pseudomorphous after struvite and therefore must indicate the original size of some of

the crystals, are as much as 30 centimeters long. The struvite crystals, which are partially replaced, show a nearly parallel retreat of the crystal faces, and the largest one found showed remnants of an original crust nearly 6 millimeters thick. Most of this crust had been removed, probably by wind abrasion. Due to chemical decomposition, the struvite crystals are heavily pitted, but maintain their crystal form quite well.

Evidence at the diatomite outcrop indicates that the embedded phosphate minerals were exposed by the wind, which removes the surrounding diatomite, leaving the heavier pseudomorphs in place. Because struvite alters to newberyite so readily even at low temperatures, it is probable that the struvite crystals found were only recently exposed—perhaps during the winter and spring months—and that alteration to newberyite had not yet been completed. Since complete alteration to newberyite would probably take place quite rapidly at the high temperature and low humidity common at Mono Lake in the summer and fall months, one can not expect exposed crystals to remain unaltered for long. Two of the crystals had



Struvite crystal partially replaced by newberyite.

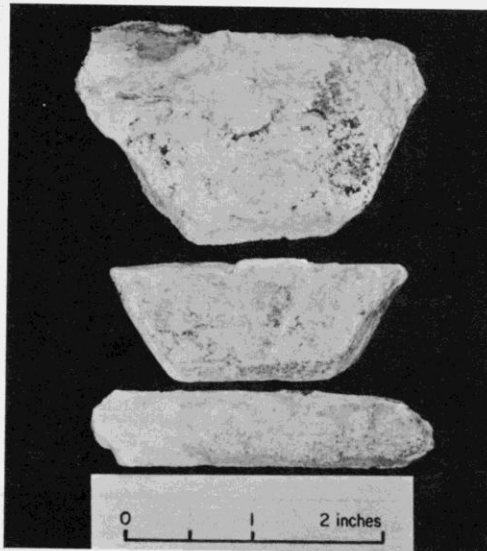
a thicker newberyite crust on those parts where they were not insulated by the diatomite beds, but were exposed to the weather.

No monetite shell was found on any of the struvite crystals, perhaps because it was removed by wind. If a monetite shell had been present, and had remained intact, it is to be expected that the struvite would have altered slowly, allowing bladed crystals of newberyite to form. If such bladed crystals had formed, a relatively stable pseudomorph would result. If no monetite shell is present, rapid alteration to newberyite is to be expected, resulting in a powdery mass, having no crystal form discernible with the naked eye.

References

- Ribbe, P. H. and Cohen, L. 1966. Newberyite and monetite from Paoha Island, Mono Lake. *Mineral Information Service*, vol. 19, no. 3, March 1966, p. 46.
- Cohen, L. H., and Ribbe, P. H. 1966. Magnesium phosphate mineral replacement at Mono Lake, California. *American Mineralogist*, vol. 51, pp. 1755-1765.
- Blanc, R. P. and Cleveland, G. B. 1961. Pleistocene lakes of southeastern California, Parts I and II. *Mineral Information Service*, vol. 14, no. 4, April, pp. 1-7; no. 5, May, pp. 1-7.
- Palache, C., Berman, H., and Frondel, C. 1951. The [Dana] system of mineralogy, vol. II. John Wiley and Sons, Inc., New York, pp. 715-717.

Struvite crystals showing typical habit and development of thin powdery newberyite crust.



REVIEWS

Books

Interpretation of leached outcrops. By Roland Blanchard. 1968. 196 pp., 22 color plates, 105 figs., 8 tables. Published by the University of Nevada, Mackay School of Mines, as Bulletin 66. Price, cloth bound, \$7.50, from Nevada Bureau of Mines, University of Nevada, Reno, Nevada, 89507.

This book, surely a bargain in today's publishing world, is a summary of known facts about the production of limonite through the oxidation of other minerals. It is a basic tool for the "foot" prospector, and, although data can be refined in the laboratory, knowledgeable use of a hand lens is all that is ordinarily required. By careful study of the differences in limonite derived from different minerals, particularly of the variations in cellular structure and other physical characteristics, the observant investigator should be able to distinguish between limonite that is a product of sulfide minerals and that that is a product of gangue minerals. To quote from the introduction:

Granting that limonite products of different origin possess individually distinguishable characteristics which in one manner or another may be established through field observation, the task for the observer is so to familiarize himself with those characteristics that, irrespective of the degree of oxidation and leaching involved, he may recognize them with assurance under a wide variety of conditions, even though they may be mixed with, become partly obscured by, or grade insensibly over short distances into other products which they superficially resemble; in other words, that he be able to recognize his acquaintances unerringly, even amidst the crowd, in a fog.

National atlas

Congressional districts for the 90th congress (includes re-districting actions to September 1, 1966). 1968. Scale 1:7,500,000 (1 inch = 118 miles). Sheet number 360 of the National Atlas. Price, separately, \$1.00. Order from the U. S. Geological Survey, 1200 South Eads Street, Arlington, Virginia 22202.

Book from the GSA

Saline deposits: A symposium based on papers from the International Conference on Saline Deposits, Houston, Texas, 1962. By Richard B. Mattox, Editor, W. T. Holser, H. Ode, W. L. McIntire, N. M. Short, R. E. Taylor, and D. C. Van Sicken, Associate Editors. 1968. 701 pages, 7 foldouts, 37 plates, 207 figures, 34 tables. Issued as Special Paper 88 of the Geological Society of America. Price, paperbound, \$19.00. Available from the Geological Society of America, Colorado Building, P. O. Box 1719, Boulder, Colorado 80302.

Purpose of the conference was to review the present state of knowledge concerning the distribution and physical properties, deposition and geochemistry, and deformation of rock salt deposits; to delineate the frontiers of geological research on salt; to recommend methods for advancing knowledge about salt; and to set a pattern for international conferences on geologically oriented subjects. Since salt occurs in beds, and since it can be easily deformed, it is of considerable interest tectonically. In addition, salt is an economic mineral deposit, and salt beds are of value for many other economic reasons, including their potential use as radioactive dumps and as testing sites.

The moon

Lunar atlas. Dinsmore Alter, editor. 1968 reprint of 1964 edition. Prepared by the Space Sciences Laboratory of the Space Division of North American Aviation, Inc. 343 pp., 154 plates. Published by Dover Publications, Inc., 180 Varick St., New York, N. Y. 10014. Price, paperbound, \$5.00.

Consists of photographs taken by the Lick Observatory, Mt. Wilson, Palomar, Yerkes Observatory, McDonald Observatory, and by French and Russian observers, almost all printed one to a page. They include views of the moon in crescent, full, and waning phases; of the waning and waxing half moon; and of the full moon, as well as many details of surface features. The "dark" side of the moon, as photographed by Russia's Lunik III, is also included.

A very browsable compendium of the moon as we saw it before any landings were made.