ART. XXXIV.—*Notes on the Microscopic Structure of Oolite, with analyses*; by ERWIN H. BARBOUR and JOSEPH TORREY, JR.

WHILE making notes the past autumn and winter preparatory to a thorough study of the oolite of Iowa, several points were noted which seemed to the writers to be of sufficient interest to be presented here. Ordinary oolite occurs in this State in deposits of considerable extent, but it is not proposed at this time to do more than to describe the microscopic structures and to give analyses of two forms. The following are analyses of two varieties of the Iowa river oolite:

1.		2.	
<i>Oolite with concretionary structure.</i>		<i>Oolite with brecciated granules.</i>	
Silica	2·10	Silica	4·56
Oxide of aluminium -- }	3·20	Oxide of aluminium -- }	3·40
Oxide of iron		Oxide of iron	
Calcium carbonate	85·99	Calcium carbonate ...	84·33
Magnesium carbonate..	8·52	Magnesium carbonate..	7·50
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99·81		99·79	
Specific gravity ----	2·619	Specific gravity ----	2·632

Figs. 1, 2.—Micro-sections of Iowa River Oolite; magnified 10 diameters.
1. Showing concretionary structure. 2. Showing granular structure of spherules.

The kind shown in fig. 1 is the familiar concentric type, the other, shown in fig. 2, illustrates one with a sort of brecciated spherule, each being composed of a mosaic of exceedingly small fragments cemented together about a center. Though differing so widely under the microscope, these two are essentially alike, showing only slight external and chemical differences. Other aspects of these and other specimens will be fully considered at another time.

While examining these specimens, a *siliceous* oolite was received from eastern Pennsylvania, which merits description. Popularly the name oolite presupposes a calcareous rock, yet we have at hand several characteristic oolites which are not calcareous; these include an iron-oxide form, a strictly siliceous kind, a silica-lime, and a lime-silica form. The last two seem to be transitional forms between the true lime or calcareous oolite on the one hand and the siliceous on the other. In the siliceous oolite the roe and matrix are so intimately united, both being nearly pure silica, that the conchoidal fractures, in the denser sorts, pass alike through spheres and cement, as if it were a homogeneous quartzite. In the more friable sorts the concretions pull away intact from the matrix, and present to the eye the familiar fish-roe appearance of oolite proper, for which it could easily be mistaken by a careless observer. A second glance, however, reveals certain superficial differences, in hardness, color, etc. In the siliceous oolite, the concretions—which are noticeably uniform in size and spherical in form—are considerably darker than the surrounding matrix, being almost black in some specimens. On the other hand, those in the true oolite are generally of a much lighter color than the calcareous cement. A fractured surface of the siliceous variety exposes the component spherules in section, showing their concretionary structure—their concentric coats of alternately lighter and darker color, deposited around real or imaginary centers. In many, organic remains are the nuclei; in others, crystals or fragments of inorganic matter.

A polished surface of this oolite slightly etched with hydrofluoric acid shows to perfection these agatized bands; and a microscopic section brings them out to still greater advantage. In such a section, under a low power, it is interesting to notice the numerous rings of various widths and colors arranged around their respective centers, and to further observe how this concentric arrangement continues on into the matrix of the interstices not unlike the coast lines on a map. Often the interspaces are filled with aggregations of minute spherules (not visible to the eye), which also show concentric rings (see figs. 5 and 6). In several instances, lines of faults run through

the specimens, pulling the spherules apart, displacing and distorting them in an interesting manner.

One of our most suggestive specimens of this oolite—an intermediate form between the lime and the siliceous varieties—shows two distinct bands, marked by a strong dividing line (see fig. 4).

FIG. 3.—Portion from which the micro-section of fig. 4 was cut, at *a*. FIG. 4.—Pennsylvania Oolite, Lso, Lime-Silica Oolite; Slo, Silica-Lime Oolite magnified ten diameters.

<i>Analysis of Lime-Silica Oolite (Lso).</i>		<i>Analysis of Silica-Lime Oolite (Slo).</i>	
Silica	3.70	Silica	56.50
Oxide of aluminium ..	1.42	Oxide of aluminium ..	1.50
Oxide of iron		Oxide of iron	
Calcium carbonate ...	88.71	Calcium carbonate ...	16.84
Magnesium carbonate..	8.09	Magnesium carbonate..	2.60
	<hr/> 100.92	Water	12.54
Specific gravity ----	2.654		<hr/> 99.88
		Specific gravity ----	2.688

One band is a lime-silica oolite, the other, a silica-lime oolite. The microscopic section of this piece shows the two bands plainly. (see fig. 4). The lime-silica band is distinguished by spherules having a marked radiate structure. Crossing the dark dividing line of granules, we find the silica-lime band characterized by a lighter color, and by spherules having the concentric structure, interspersed with occasional radiate stragglers. While there are indications of a different mode of formation, it seems probable that the siliceous oolite is derived from the calcareous by the replacement of lime particles by silica.

FIGS. 5 and 6.—Micro-sections of Siliceous Oolite from Pennsylvania, magnified 10 diameters.

The following is an analysis of the siliceous oolite :

<i>Siliceous Oolite.</i>			
Silica	-----	95.83	
Oxide of aluminium	-----	} 2.93	
Oxide of iron	-----		
Lime	-----	1.93	
Magnesia	-----	trace	
		<hr/>	
		100.69	
Specific gravity	-----	2.63	
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<i>Single granule from Pennsylvania Siliceous Oolite.</i>		<i>Single granule from the Iowa River Oolite.</i>	
Silica	-----	Silica	-----
Iron	-----	Iron	-----
	<hr/>	Calcium carbonate	-----
	100.00		<hr/>
			99.98

These interesting specimens of siliceous oolite were sent us by Mr. George R. Wieland of State College, Center Co., Pa. Two miles west of this place there are three or four square miles of light sandy soil, mostly uncleared, hence called the "Barrens," where this oolite, associated with flint, occurs scattered about in the form of surface bowlders weighing as much as 400 pounds. The fact that these masses of siliceous oolite are stained with iron oxide, and that they occur in an isolated spot, may account for their having escaped more general notice hitherto. It is said to occur also about fifteen miles northwest of College Centre.

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