A STUDY OF THE NEW RICHMOND SANDSTONE FROM TWO LOCALITIES IN WISCONSIN

BY

C. E. NEEDHAM*

Northwestern University, Evanston

INTRODUCTION

The term *New Richmond* was first applied by Wooster[1] to sandstone beds at New Richmond, Wisconsin, without being very accurately defined. It has since come to mean the sandstones and thin interstratified dolomites constituting the middle formation of the Prairie du Chien, or Lower Magnesian group of Ordovician age, separating the Skakopee dolomite above from the Oneota dolomite below.

In connection with a detailed study of the New Richmond formation from well-cuttings on file at the offices of the Illinois State Geological Survey, the writer has carried on some study of the formation in Wisconsin. Two exposures are deemed worthy of discussion at this time, one of these at New Richmond in the northwestern part of the state, the other at Prairie du Chien in the southwestern part of the state.

EXPOSURE AT NEW RICHMOND, WISCONSIN

Section at New Richmond, Wisconsin, south bank of Willow Creek, at dam.

	Thickness Feet
Shakopee formation	
3. Dolomite, gray, in beds 2 to 8 inches thick; bedding irregular and wavy, shows algal structures; near the middle is a conglomerate of dolomite pebbles, some of which are edgewise; texture, fine to medium grained. The dolomite is sandy to a considerable degree; the lower part is somewhat cross-bedded	10
New Richmond formation	
2. Sandstone, white to pale yellow, friable, thin bedded and irregular; cross-bedded	1¼
Covered interval (a few inches)	
Oneota (?) formation	
1. Dolomite, gray, hard, fine grained, oölitic and slightly sandy..	1

* The writer wishes to express his thanks to Dr. A. J. Walcott of Northwestern University for his assistance rendered both in the field and laboratory.

[1] Wooster, L. C., Geol. of Lower St. Croix Dist., Geol. of Wis., Vol. IV, p. 106, 1873-79.

CHARACTER OF THE NEW RICHMOND

Texture

The New Richmond formation at this exposure is a fine grained sandstone with considerable quantities of both very fine and medium sand. Most of the grains are rounded to subrounded, but a few are subangular. Most of them show frosting and pitting, but little or no secondary enlargement. The texture is not uniform throughout the beds, but may change rapidly from layer to layer so that the proportion of medium grains is much increased. Dolomite is present in small quantities as tiny crystals between the sand grains, but it is seldom abundant enough to cement more than a very few sand grains together.

Petrography

Quartz grains constitute 99 per cent or more of the detrital material in this exposure. The remaining 1 per cent, or less, consists of mineral grains heavy enough to sink in bromoform (sp. gr. 2.8). Even though this heavy crop is very small it is interesting and instructive.

Garnet is the most abundant heavy mineral, making up about 45 per cent of the heavy crop. The grains are very fine, pink, and show considerable rounding. Some are smooth and polished, but others are pitted or rough.

Tourmaline is next to garnet in abundance, making up about 25 per cent of the heavy crop. It is found in very fine grains, all of which are well polished. Many of them are rounded, some are pea-shaped, and a few are elongated. The colors are brown and green; a few grains are blue.

Collophane, the amorphous form of apatite, is present to the extent of about 19 per cent. It occurs mostly as fine grains with a few of medium size, generally somewhat rounded and polished. The color is gray to an almost pale lavender tint. Under the microscope it is seen to be generally isotropic, but many grains show very feeble and non-uniform double refraction. Very tiny inclusions of double refractive substances are common. The centers of the grains are usually clouded whereas the edges are more nearly clear. The index of refraction lies between 1.6186 and 1.6196. Milner[2] points out that apatite carried into the sea as detrital material undergoes a degeneration. This may explain the condition of the apatite in this exposure at New Richmond.

Zircon, so abundant in the St. Peter and Dresbach sandstones, constitutes only about 9 per cent of the heavy minerals in the New Richmond. The grains are very fine, polished, nearly colorless, and rounded to subrounded; many of them are slightly elongated.

Ilmenite is not important as a heavy mineral in this exposure, although it may constitute as much as 1 or 2 per cent of the total heavy crop.

Galena is found as a few very small, fresh cubes. It is probably not detrital; it may have been introduced secondarily at the time of the mineralization resulting in the Upper Mississippi Valley lead and zinc ores.

The Exposure at Prairie du Chien, Wisconsin

The bluffs of the Mississippi River just east of the city of Prairie du Chien show excellent exposures of every formation from the Galena to near the base of the Oneota. The section for the Prairie du Chien group is as follows:

	Thickness feet
Shakopee formation:	
3. Dolomite, gray to light buff, fine grained, nearly free from sand; many small cavities filled with secondary calcite.....	**35±**
New Richmond formation:	
2. Sandstone, pale yellow, friable, slightly dolomitic; cross-bedded	**5**
Oneota formation:	
1. Dolomite, gray with some pinkish dolomite in lower part; much thin bedded and nodular chert; secondary calcite and quartz filling small cavities; a well defined algal zone is present in the upper half; occasional thin seams of green shale are found; the upper part of the formation is sandy.....	**200±**

Character of the New Richmond

Texture

At this exposure the New Richmond is a friable, medium grained sandstone with smaller quantities of fine and coarse sand. Most of the grains are rounded or subrounded, and many of them are frosted and pitted, the larger ones more so than the smaller. The grains show little or no secondary enlargement. Dolomite is present in greater or lesser quantity, generally in small, well defined crystals. In places the dolomite is sufficient to cement the sandstone rather firmly.

[2] Milner, H. B., Sedimentary Petrography, Second Edition, p. 439, New York and London, 1929.

Petrography

Quartz grains make up all but a small part of the New Richmond standstone. Many of them show tiny inclusions, undulatory extinction, and exhibit strain figures. This would seem to show that they were originally derived from igneous or metamorphic rocks. Many other grains, however, do not exhibit these features; they may have been derived originally from quartz veins, geodes, etc. Many of the grains show decided solution in the form of small, but often deep, embayments which are tightly packed with dolomite.

Feldspar grains are found in surprisingly large numbers in the sandstone. They may make up as much as 2 per cent of the total detritals. A few of the grains are slightly altered, but in nearly every case they are very fresh. They are subrounded and generally smaller than the quartz grains. Most of them are plagioclase, but a few are microcline.

Glauconite is abundant in a very thin, dolomitic sandstone band marking the contact of the New Richmond with the Oneota. This is particularly interesting in view of the fact that none of the Ordovician formations in the upper Mississippi Valley can be described as glauconitic. The glauconite grains are small, irregular, and spongy; they have every appearance of being autochthonous. The significance of this glauconite is pointed out below.

Among the heavy minerals garnet is by far the most abundant, making up about 90 per cent of the heavy crop. The grains are fine to medium, pink to red, and rounded to subrounded. As a rule the grains are not polished but instead show a peculiar roughened or pitted pattern on their surfaces, which may be a reflection of the dodecahedral cleavage.

Tourmaline is next to garnet in abundance, but it makes up only about 6 per cent of the heavy crop. The grains are larger than those from the exposure at New Richmond, but their characters are much the same.

Zircon is of very minor importance, making up 1 per cent or less of the crop. The grains are very small and well polished; most of them are slightly elongated.

Collophane is likewise virtually absent, usually constituting less than 1 per cent.

Galena is found as a few tiny cubes like those from the exposure at New Richmond.

Origin of the New Richmond Sandstone

The dolomite layers in the New Richmond formation, some of which are fossiliferous, according to Sardeson,[3] and the cross-bedded character of the sandstone show that the formation was laid down in shallow marine waters. No doubt some of the quartz grains were frosted by wind action before deposition in the sea. The great abundance of garnet and the well worn character of the tourmaline, zircon, and many of the quartz grains show that most of the sand has passed through more than one cycle of erosion. It is believed, then, that the New Richmond sandstone was derived largely from the Cambrian and pre-Cambrian sandstones of this region. But the abundance of amorphous apatite in the New Richmond exposure and the feldspar in the Prairie du Chien exposure are worthy of more than passing mention. It seems rather improbable that these two minerals could have survived a second cycle of erosion. Therefore, it is believed that a part of the sand was derived directly from the pre-Cambrian crystalline rocks to the east, north, or west. Furthermore, the freshness of the feldspar grains indicates that the climate, at least part of the time, favored mechanical weathering rather than chemical weathering.

Stratigraphic Relations

Most students have held that the three formations comprising the Prairie du Chien group are conformable one on the other. However, it has long been known that there is a distinct faunal break at the top of the Oneota, and Ulrich[4] feels that he has found evidence of an erosional contact at this horizon. Additional strong evidence of an unconformity between the New Richmond and the Oneota is afforded by the thin band of autochthonous glauconite found by the present writer separating these two formations. Goldman[5] especially has pointed out the significance of glauconite under these conditions. Consequently, the present writer is of the belief that the New Richmond formation is unconformable on the Oneota. As to the time value represented by this unconformity, the writer does not care to hazard an estimate.

Regarding the relation between the New Richmond and the Shakopee, there is no conclusive evidence that an unconformity exists between them. In fact, according to Sardeson,[6] some of the interbedded dolo-

[3] Sardeson, F. W., Fauna of the Magnesian Series, Bull. Minn. Acad. Sci., Vol. IV, pp. 92-101, 1896.

[4] Ulrich, E. O., Notes on new Names in Table of Formations and on physical Evidence of Breaks between Paleozioc Systems in Wisconsin, Trans. Wis. Acad. Sci., Vol. 21, p. 101, 1924.

[5] Goldman, M. I., Lithologic subsurface Correlation in the Bend Series of Northeast Texas. U. S. G. S. Prof. Paper No. 129, p. 3, 1921.

[6] Sardeson, F. W., op. cit.

mites of the New Richmond contain the same fossil forms found in the Shakopee. For the present, therefore, the two formations had best be considered as conformable.

Summary

1. The New Richmond formation of western Wisconsin is a white to yellowish, friable, medium grained, cross-bedded sandstone containing more or less dolomite.

2. The sand grains are mostly rounded to subrounded and frosted. Many of them show solution embayments filled with dolomite.

3. The most abundant heavy minerals are garnet, tourmaline, amorphous apatite, and zircon, in the order named.

4. Plagioclase and microcline are common in the exposure at Prairie du Chien.

5. The New Richmond is a marine formation deposited in very shallow waters. Some of the sand grains may have been wind blown before deposition in the sea.

6. Most of the sand was probably derived from sandstones of Cambrian and pre-Cambrian age.

7. Pre-Cambrian crystalline rocks, however, appear to have contributed directly to the sand, as evidenced by amorphous apatite and feldspar.

8. The freshness of the feldspars indicates climatic conditions such that mechanical weathering was favored over chemical weathering at least part of the time.

9. The New Richmond formation appears to be unconformable on the Oneota and conformable with the Shakopee.