The Geology of the New Richmond Sandstone,
Prairie du Chien Group,
Southeastern Minnesota

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Abstract:

This study examines the New Richmond Sandstone, a relatively unknown heterolithic assemblage of sandstone, carbonate, and shale that is commonly considered part of the Shakopee formation of the Prairie du Chien group. Stratigraphic columns constructed from seven outcrops of the New Richmond in southeastern Minnesota and northeastern Iowa show that it varies between 7 m and 20 m in thickness within the study area and consists of two facies: the Prairie Island and the Root Valley. Previous studies found that the New Richmond was deposited in part through eolian action. SEM studies of individual grains did not confirm this.

Keywords: New Richmond, sandstone, Shakopee, Prairie du Chien, Ordovician, stratigraphy, SEM data, Minnesota
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Introduction

The Prairie du Chien (PDC) Group, of Early Ordovician age, crops out in southern Minnesota, northeastern Iowa, and southern Wisconsin, and extends into parts of the subsurface of Michigan and Illinois, ranging from ~60 – 600m in thickness (Smith et al., 1996). It is composed of three main members: the Oneota Dolostone, the New Richmond Sandstone, and the Shakopee Dolostone (Figure 1). Extensive study has been completed on the dolostone members of the PDC (Johnson and Simo, 2002; Smith et al., 1996; Smith and Simo, 1997). There is comparably little information available on the New Richmond, and of the few studies available, their results are somewhat conflicting. This study adds to the pool of information and clarifies some points about the New Richmond, providing a broad overview of the member by using stratigraphy and scanning electron microscopy [SEM] data to determine details of deposition and composition.

Literature Review

In 1882 L. C. Wooster proposed that the New Richmond beds be considered an individual member of the what was at the time called the Lower Magnesian Group (Shea, 1960; Squillace, 1979; Ulrich, 1924). H.F. Bain, in 1906, changed the name of the Lower Magnesian Group to the Prairie du Chien Formation, later evolving into the Prairie du Chien Group (Needham, 1932; Shea, 1960; Squillace, 1979; Ulrich, 1924). For a more detailed history of the nomenclature of the New Richmond, see Ulrich (1924), Needham (1932), Shea (1960), or Squillace (1979).
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Figure 1: Generalized stratigraphic column of the Prairie du Chien and surrounding units. Modified from (Smith and Simo, 1997).
The New Richmond Member consists of a thin (maximum ~20 m) heterolithic assemblage of sandstone, carbonate, and shale, and is often considered part of the Shakopee Formation of the PDC Group (Davis, 1966; Johnson and Simo, 2002; Runkel, 2002; Squillace, 1979). Defining characteristics of the New Richmond include eolian cross-bedding and sandy stromatolites (Austin, 1974; Davis, 1968; Shea, 1960; Squillace, 1979). Where present, it occurs between the two dominantly dolomitic units of the PDC, the Oneota and upper Shakopee. The New Richmond is thickest in southeastern Minnesota, in the area of the Hollandale Embayment, but extends into parts of Iowa and Wisconsin (Squillace, 1979).

The New Richmond was deposited nearshore during several highstands, with abundant mudcracks and ripple-marks testifying to frequent exposures to subaerial conditions (Austin, 1970; Davis, 1966; Shea, 1960; Smith et al., 1996; Squillace, 1979).

Historically, two lithofacies have been found within the New Richmond Sandstone; the Prairie Island and the Root Valley Lithofacies (Squillace, 1979). However, complete sequences of the New Richmond may have only one lithofacies. When both lithofacies are present in an outcrop, the Prairie Island is always the lower lithofacies.

The Prairie Island Lithofacies consists primarily of quartz arenite that is interbedded with dolomite, shale, and arenaceous dolostone. The Root Valley Lithofacies is solely quartz arenite (Shea, 1960; Squillace, 1979). Both lithofacies contain cross-bedding and vugs. Fossils (trilobite and conodont) are rare within the sandstone, and the Root Valley Lithofacies is considered to be littoral and eolian in origin (Austin, 1970; Smith, 1991; Squillace, 1979).
The Prairie du Chien Group

The Oneota Dolostone was deposited unconformably on the Jordan Sandstone (Runkel, 1994) and is a nearly pure dolomite unit that is extensively quarried (Needham, 1932; Runkel, 2002). The Oneota and New Richmond are separated by an unconformity (Andrews, 1955; Johnson and Simo, 2002; Needham, 1931; Ostrum, 1964) representing an unknown length of time of surficial exposure, but the unconformity is correlated to an Early Paleozoic conodont extinction event (Smith, 1989).

The New Richmond Sandstone and Shakopee Dolostone are considered conformable, with the boundary between New Richmond and the Shakopee frequently marked by a green shale bed. The entire PDC Group is characterized by oolite, mudcracks, and ripple-marks, indicating a shallow, possibly supratidal, environment. In the Oneota and Shakopee Dolostones, the presence of moldic nodular anhydrite suggests a hypersaline environment (Smith and Simo, 1997).

The PDC provides an important conduit for local groundwater movement. The PDC was exposed during several lowstands of sea level, causing extensive karsting to develop throughout the group. The carbonate of the Oneota and Shakopee has variable water conductivity; however, where high amounts of karsting occur, such as the upper Oneota, or an extremely porous area, such as the New Richmond, the water conductivity is high (Runkel et al., 2003).

Surrounding Lithologic Units

Immediately below the PDC lies the Jordan Sandstone. This sandstone is Late Cambrian in age and was deposited as a series of progradational sequences (Runkel,
1994). The Jordan is a probable source for the New Richmond Sandstone, based on proximity within the stratigraphic sequence and the large garnet percentage found in heavy mineral studies in both the Jordan and New Richmond Members (Galarowicz, 1997; Pride, 1966; Shea, 1960; Squillace, 1979; Thiel, 1935).

The St. Peter Sandstone, a remarkably pure quartz arenite, was deposited unconformably above the Shakopee Dolostone. This unconformity represents a large time of subaerial exposure for most of the PDC, contributing to extensive karsting in the Shakopee (Smith, 1991).

Methods

Field

Stratigraphic columns were constructed based on outcrops of the New Richmond measured at seven sites along an approximate 250 kilometer northwest-southeast transect (Figure 2). Outcrop locations were chosen based on geologic maps and previous work (Davis, 1968; Runkel, 2002; Shea, 1960; Squillace, 1979).

Where possible, samples were gathered approximately every meter for analysis. Special attention was paid to the borders of the New Richmond with the Shakopee and Oneota, looking for shale boundaries and evidence of karsting.

SEM

Of the samples collected, three were selected for SEM analysis. The principal purpose for examining the samples under the SEM was to look for evidence of eolian markings, so only samples from the Root Valley Lithofacies were considered for analysis.
Figure 2: Map showing general study area and sample sites. Modified from (Squillace, 1979), (Pride, 1966).
Grains showing signs of eolian markings are typically frosted grains with a pitted, pocked texture (Margolis and Krinsley, 1971). All samples analyzed consisted of loose sand. One sample from Dorchester, IA (Location 1, ~13.0 m), one from Whitewater State Park, MN (Location 4, ~5.0 m), and one from Plainview, MN (Location 5, ~4.0 m), were chosen.

The samples were attached to carbon foundations, which were placed on aluminum plugs. These were then sputter coated with gold to prevent “charging,” or poor interactions between the non-metallic sample and the electron beam. The samples were examined at a frequency of 10kv. This low voltage was used as another preventative measure against charging. Photos were taken of grains representative of the larger sample as a whole. Particular emphasis was made to gather photos of grains with cements and eolian markings.

**Results**

*Stratigraphy*

From the outcrops examined, the New Richmond varies from 7 m to 19 m in thickness, with the formation thickest in northeast Iowa and thinning in all directions (Figure 3). Most outcrops were predominantly sandstone, with layers of shale, dolomite and arenaceous dolostone interbedded.

A cross-section from northeastern Iowa – St. Paul, MN, shows the distribution of the Prairie Island and Root Valley Lithofacies and the relation between the Oneota, Shakopee, and New Richmond (Figure 4).
Figure 3. Isopach map showing relative thicknesses of the New Richmond Member based on compiled field measurements from this study and Squillace, 1979. Modified from (Squillace, 1979)
Figure 4: Schematic cross section of the Prairie Island and Root Valley facies of the New Richmond Member of the Prairie du Chien Group. The numbers represent sample sites, and the bars correspond to the height and location of the outcrop within the New Richmond. The transect runs from northeast Iowa to southeastern Minnesota. The New Richmond grades into the Shakopee to the south and the north of this section. The base represents the unconformity with the Oneota. Vertical exaggeration: approximately 8,000. Data from (Squillace, 1979) and (Austin, 1991) were consulted for this figure.
Grain size throughout all outcrops was variable, but the sandstone was predominantly medium grained. No beds could be correlated between outcrops. Complete stratigraphic columns can be found in Appendix 1, with directions to their locations in Appendix 2.

**Lithofacies**

Four of the outcrops examined contained the entire New Richmond Member (Table 1). Both the Root Valley and Prairie Island Lithofacies were found within three outcrops: Lanesboro, Plainview, and Mazeppa. Dorchester, Eitzen, and Whitewater (locations 1, 2, and 4) contained only the Root Valley Lithofacies and Hastings was comprised of the Prairie Island Lithofacies (location 7).

Dorchester, IA (Location 1) consisted entirely of the Root Valley Lithofacies; mostly cross-bedded sand that was somewhat bioturbated in the lower half of the outcrop. Many structures in the upper part of the outcrop had been obliterated due to recent land slides and bird nesting (Figure 5).

Eitzen, MN (Location 2) is 24 km (15 miles) north-northeast of Dorchester, IA. This section was not complete; the New Richmond/Shakopee boundary was not present. The bottom two meters of this formation is covered by large (40 cm by 10 cm) calcite chunks and was heavily weathered, obscuring the Oneota/New Richmond contact. The remainder of the outcrop was Root Valley Lithofacies, with cross-beds and planar beds throughout. Ripple-marks were also found at this outcrop (Figure 6).

Lanesboro, MN, is approximately 60 km (40 miles) northwest of Eitzen. Samples were taken when accessible (up to 8 m above the Oneota/New Richmond contact). The
<table>
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<th>Location</th>
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<th>RV (m)</th>
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Table 1: Stratigraphic data from the seven measured outcrops.
Figure 5: Outcrop at Dorchester, IA. This area represents the thickest sequence of the New Richmond, at over 19 meters. Person is 1.6 m tall.
Figure 6: Ripple marks in float, found at Eitzen, MN, with 1.5 m bar for scale. While they are not in place, it was clear at the outcrop that this block fell from the bed 10 m above the Oneota-New Richmond contact.
Prairie Island Lithofacies comprised the bottom third of the outcrop; the 10 m above was the Root Valley Lithofacies. Stromatolitic layers were present within the Prairie Island Lithofacies, and a few sand stromatolites were possibly present within the Root Valley Lithofacies; however, verification of these sand stromatolites was not possible.

Whitewater State Park, MN, 40 km (25 miles) north of Lanesboro, consisted of 7 m of exposed Root Valley Lithofacies. The Oneota/New Richmond contact was not present at this outcrop. The entire outcrop consisted of large scale cross-beds (1 – 1.5 m high), some with smaller cross-sets within them. There was a pronounced karst layer 1 m below the New Richmond/Shakopee contact. The entire outcrop was white, friable sandstone.

At Plainview, MN, 20 km (12 miles) north of Whitewater State Park, the entire New Richmond section, 7 m, was present. The bottom two meters of outcrop were stromatolitic Prairie Island Lithofacies; the remainder of the outcrop was Root Valley Lithofacies. At the New Richmond/Shakopee border, a 20 cm layer of predominantly green shale, with white and red sand interbedded, was present.

In Mazeppa, MN, 40 km (25 miles) northwest of Plainview, a complete section of the New Richmond, also 7 m thick, was present. The Prairie Island Lithofacies extended from the base of the outcrop; above that, in the Root Valley Lithofacies, there were undulatory 0.5 m thick sand beds with no visible structures. The border between the Prairie Island and the Root Valley varied by up to a meter due to the wavy bedding.

A sand chimney dominated one area of the Mazeppa outcrop. It extended through the entire thickness of the exposed New Richmond and Shakopee units. The chimney
widened considerably at the border between the New Richmond and the Shakopee. The sand was white and friable, with vertical layers of green shale running throughout.

Hastings, MN, 65 km (40 miles) northwest of Mazeppa, was composed of solely the Prairie Island Lithofacies. The outcrop consisted of 8.2 m of arenaceous dolostone and dolomite. Most of the outcrop was poorly exposed, and no bedding structures were found within the section.

SEM

No eolian markings were found on the three samples selected for analysis. Secondary quartz cement, however, was found growing on several grains from each of the three samples examined (Figure 7). This cement is characterized by multiple sharp pyramids spread over the surface of the grain.

Discussion

Stratigraphy

The isopach map (Figure 3) and lithofacies cross section (Figure 4) indicate a basin environment with two predominant depositional areas (Locations 1 and 3). The Root Valley Lithofacies is dominant in the paleobasins, while the Prairie Island Lithofacies extends on either edge of the basins to grade into the Shakopee Dolostone both north and south of this embayment.
Figure 7: SEM photomicrograph of sand grains from the Root Valley Facies of Whitewater, MN (Location 3, ~5 m). The Whitewater location shows secondary quartz cement growth on the sand grain. Sand grain shown is representative of the entire sample.
Lithofacies

The presence of only one lithofacies in Dorchester, IA, is supported by a previous study completed by Squillace (1979), where he also found only one lithofacies present. However, Squillace (1979) found only ~13 m of the New Richmond at Dorchester. Nineteen meters of stratigraphic section were measured at Dorchester for this study, which, given the predicted thickness of the New Richmond in Northeastern Iowa, 19 m of the New Richmond Member seems a much more likely value. A reason the two measurements are so different can be attributed to the difference in measuring methods over an extended (300+ m horizontally) exposure.

Similarly, only the Root Valley Lithofacies was found in Eitzen, MN. Squillace found two lithofacies at this location, with the Prairie Island changing to the Root Valley approximately 3 m into the New Richmond Member. Unfortunately, since the stratigraphy at the Eitzen location for this study was obscured from the Oneota contact to ~3.5 m into the New Richmond Member by heavy erosional markings and secondary calcite mineralization, this division could not be verified. The Root Valley was present for the entire exposed outcrop in this area.

At Lanesboro, MN, there is a complete sequence of the New Richmond. The lithofacies division occurs approximately 5 m above the contact with the Oneota. These data corresponds to Squillace’s findings (1979). Past studies have found sand stromatolites in this area (Davis, 1968; Squillace, 1979); some possible sand stromatolites were noticed in this study, but their presence could not be verified in the field. Ripple-marks and mud cracks have also been found in the Lanesboro outcrop (Squillace, 1979), indicating deposition occurred in a near-shore environment.
At Whitewater State Park, MN, only the Root Valley Lithofacies is present within the 9 m of exposed outcrop. The contact with the Oneota is not present within this area, so the Prairie Island could occur below the exposed Root Valley. Squillace (1979) also found only the Root Valley Lithofacies present at Whitewater.

The roadcut at Plainview, MN, has changed significantly in the last 25 years. Squillace (1979) was unable to locate the Oneota at the outcrop, and made the division between the Prairie Island and Root Valley approximately 1 m into the then-exposed outcrop. Since that time, a drainage ditch has been added, exposing the top of the Oneota. This adds another meter to the exposure of the New Richmond; however, the boundary between the Prairie Island and Root Valley Lithofacies is still in the same horizon, two meters above the Oneota.

At Mazeppa, MN, the Prairie Island and Root Valley Lithofacies can be divided approximately two meters below the contact with the Shakopee (the Oneota is not exposed at this outcrop). Squillace (1979) made a similar assessment. There are prominent carbonate stromatolite beds in the lower part of the Prairie Island Lithofacies.

The outcrop at Mazeppa has a sand chimney from the lithofacies contact into the Shakopee, continuing upwards until the end of the exposure. This sand chimney contains vertical bands of green shale. This chimney possibly originally linked to the St. Peter sandstone. The sandstone would have either filled in previously existing karst in the PDC, or a postdepositiona sinkhole developed, allowing the St. Peter entrance into the PDC Group (Cowan, 2005; Runkel et al., 2003).

The Hastings, MN, outcrop consists solely of arenaceous dolostone and dolomite layers, which places it in the Prairie Island Lithofacies. This assessment is supported by
Squillace (1979); however, Shea (1960), upon examining the outcrop, determined that it was undifferentiated PDC. Since there is no clear quartz arenite layer in the area, this argument has merit; however, based on the work of Squillace (1979) and Shea (1960) at nearby outcrops, the arenaceous dolostone at Hastings should be considered part of the New Richmond. Throughout the literature, there is much debate about whether or not the New Richmond is present in localities north of Rochester, MN (Austin, 1970; Shea, 1960; Squillace, 1979), mainly due to an unclear definition of the characteristics of the New Richmond Sandstone. Since there is no consensus on the definition of the New Richmond, the distinction between New Richmond and Willow River beds of the Shakopee is still somewhat arbitrary.

**SEM**

The SEM results did not indicate that the New Richmond was deposited in an eolian environment; however, multiple past studies have found evidence within the outcrop suggesting an eolian deposition environment (Austin, 1974; Shea, 1960; Squillace, 1979). However, none of those studies incorporated SEM data into their conclusions.

Since only a small number of grains from one bed from each of the three sites was examined, the odds were slim that eolian grains would be found. Most likely, a wider variety of samples from different outcrops and different stratigraphic sections would produce some results indicating an eolian mode of deposition in areas of the New Richmond.
Conclusions

The New Richmond is a heterolithic sandstone, shale, and arenaceous dolostone formation within the Lower Ordovician Prairie du Chien Group. It consists of two lithofacies: the basal Prairie Island and the Root Valley. It outcrops in a narrow band along the banks of the Mississippi River in southeastern Minnesota, southwestern Wisconsin, and northeastern Iowa. From outcrop exposures, the New Richmond is concentrated in extreme southeastern Minnesota and northeastern Iowa, with the Root Valley being the dominant lithofacies in the center of its range, grading into the Prairie Island as the member narrows and grades into the Shakopee.

The New Richmond was deposited in a near-shore, coastal dune environment. It is hypothesized that the Root Valley was deposited at least in part from eolian action. No evidence was found for this from SEM studies of individual grains; however, the sample size for this was relatively small. A larger sample could possibly yield evidence of eolian deposition.

Acknowledgements

This project could not have been completed without the help of numerous people. All of the following were instrumental in getting this project off of the ground. Thanks to: Profs. Clint Cowan and Mike Smith, who acted as advisors to me for this project. An extra thank you to Mike, as he was able to acquire and smuggle two invaluable unpublished theses from the UW-Madison library that I otherwise would have had to do without. Cam Davidson aided me numerous times with the SEM; I could not have done this without his help. Tony Runkel and Bob Tipping of the Minnesota Geological Survey
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Works Cited


-, 1932, Contributions to the Subsurface Geology of Northern Illinois, Between the Outcrops of the St. Peter and Dresbach Formations, With Special Reference to the New Richmond Formation [Doctoral thesis]: Northwestern University, 150 p.


-, 2002, Contributions to the geology of Wabasha County, Minnesota: University of Minnesota.


Appendix 1: Stratigraphic columns of the New Richmond Member of the Prairie du Chien Group, with facies marked. Width of column denotes grain size, with the wider columns indicating larger grains.
Appendix 2

Outcrop locations

These outcrop locations were adapted from (Squillace, 1979), and proved invaluable in locating the actual New Richmond outcrops from among many different bluffs of southeastern Minnesota.

Location 1: Dorchester, IA

Roadcut located on A-19, approx. 0.6 km (0.4 miles) west of Dorchester, IA. (T99N, R6W, Allamakee County) 19 m of outcrop

Location 2: Eitzen, MN

Roadcut located on MN Highway 76, approx. 6.5 km (4 miles) northwest of Eitzen, MN. (SE 1/4, SE 1/4, Sec. 11, T101W, R6W, Houston County) 11 m of outcrop

Location 3: Lanesboro, MN

Roadcut located on County Road 8, approx. 0.4 km (0.25 miles) northwest of Lanesboro, MN. (W 1/2, Sec. 13, T103W, R10W, Fillmore County) 15 m of outcrop

Location 4: Whitewater State Park, MN

Roadcut located on the west side of MN Highway 74, near the southern entrance to Whitewater State Park, approx. 8 km (5 miles) north of St. Charles, MN. (NE 1/4, NE 1/4, SE 1/4, sec. 30, T107N, R10W, Winona County) 9 m of outcrop

Location 5: Plainview, MN

Roadcut located on the south side of County Road 8, approx 6.5 km (4 miles) east of Plainview, MN. (S 1/2, Sec. 7, T108N, R10W, Winona County) 7 m of outcrop
Location 6: Mazeppa, MN

Roadcut located on Wabasha County Road 1, located approx. 0.4 km (0.25 miles) west of Mazeppa, MN.
(SE 1/4, Sec. 1, T109N, R15W, Wabasha/Goodhue County Border)
7 m of outcrop

Location 7: Hastings, MN

Stream cut located approx. 0.6 km (0.4 miles) east of the US Highway 61 bridge over the Vermillion River. Outcrop is located in a rails-to-trails park, underneath a former rail bridge. Outcrop is hard to access.
(NW 1/4, NE 1/4, SE 1/4, Sec. 34, T115N, R17W, Dakota County)
8 m of outcrop