Glauconite from Red Wing

Mark, Frances, and Alex

Introduction to Geology

Fall 2005

Abstract:

The primary goal of our research was to distinguish important characteristics of glauconite taken from the Franconia formation in Red Wing, Minnesota. We conducted our studies on a sample removed from the field in Red Wing. After conducting research on previous studies on glauconite and analyzing data gathered from our own analysis, we were able to conclude that the glauconite in the Franconia formation follows similar structural patterns as other glauconite. We were also able to determine a quartz-to-glauconite ratio in our sample, as well as compare and contrast the individual grains. The presence of glauconite in our sample supports the theory that a Pre-Cambrian ocean once existed in this area as it forms only in marine environments.

Introduction:

Glauconite, a mineral formed from biotite mica and volcanic glass with a chemical formula $(K,Na)(Fe^{3+},Al,Mg)_2(Si,Al)_4O_{10}(OH)_2$, is formed in reducing marine environments along continental shelves (Unknown author, 11/10/2005). This greenish formation is loosely associated with quartz-rich sandstone such as the Franconia formation in Minnesota. Glauconite contains high concentrations of iron that contribute to its recognizable, dull green color. Other physical properties of this mineral include a hardness of two and one perfect cleavage plane (Unknown author, 11/8/2005). Because of the softness of glauconite, it is usually found in fine, well-rounded grains. Glauconite is an important mineral used in K-Ar dating. The glauconite in the Franconia formation in Minnesota has been dated at about 500 million years old (Edwards, et al., 1959). The Franconia formation, composed of quartz-based sandstone deposited by a Pre-Cambrian ocean, exists throughout much of southern Minnesota. It is accompanied by other layers of limestone, mudstone, and other sandstone sediments.

While most minerals form through volcanic activity, glauconite is created in reducing marine environments (Unknown author, 11/8/2005). Glauconite crystals take approximately 100,000 years to grow, and only do so in relatively still water. This slow crystal formation contributes to its instability. Therefore the presence of glauconite suggests a period of calm oceanic activity.

Through our research, we found the glauconite stratigraphy we sampled primarily consisted of glauconite and quartz grains. The quartz grains were larger and more angular than the glauconite grains. We also noticed that the finer we sieved our sample, a greater proportion of glauconite would result. All of our findings coincided with previously recorded glauconite research.

In order to determine if glauconite and quartz grains in the Franconia formation of southern Minnesota share the same source material, we characterized the grain size and shape, and we calculated the proportion of glauconite to quartz in our sample.

Methods:

The glauconite stratigraphic layer sampled came from Barn Bluff in Red Wing, MN. This layer was embedded in the Franconia sandstone formation.

The single sample was sieved through six different sized sieves.

Table 1. Sieve number and opening size used to sort glauconite sample by grain size.

Sieve Number	Opening Size (in.)
20	0.0331
30	0.0234
50	0.0117
100	0.0059
170	0.0035
230	0.0025

Each individually sieved section was then massed with a Fisher Scientific accu-4002D scale. Thin sections of the four finest sieved sizes-sieve 100, 170, 230, and >230- and two cut sections of sandstone were prepared using standard methods of thin-section preparation. After the samples cooled, they were polished to make them thin enough to allow light to pass through. These sections were then analyzed with an Olympus BX51 microscope using a 10x and a 40x lens, and Nikon ACT-1 computer software. Photographs were taken various fields of view of each slide using the microscope.

The proportion of glauconite to quartz was determined by counting individual grains, light versus dark grains, within a field of view using a 10x lens. For each slide, counts were conducted in five different fields of view and averaged to find the most accurate result. We also used the microscope to determine the sizes and shapes of the grains.

Results:

The sample was collected directly from a two and a half foot stratigraphic layer of glauconite embedded in an outcrop of the Franconia formation sandstone. Approximately 15 feet below the sample stratigraphic layer, the Franconia formation surrounding the glauconite was a sandy-tan color, but the glauconite layer was a dull green color.

At the site of the fault, we could see the contact between the Franconia with glauconite and the surrounding dolostone. The fault itself had pulverized the dolostone and Franconia sandstone for about two and a half feet on either side. In these pulverized areas the sandstone and glauconite layers were mixed with some even intruding into the dolostone. Other sedimentary layers, Jordan sandstone, St. Lawrence dolostone, and Prairie du Chien dolostone, surrounded the Franconia formation.

The glauconite sample contained grains of all sieved sizes from 0.0331 in. to 0.0025 in. The majority of the sample, by mass, consisted of 0.0059 in. sized grains.

Table 2. The mass of sieved sections in grams section slide

Sieve Number	Mass (g)
20	292
30	84.0
50	157
100	501
170	182
230	42.5

The proportion of Glauconite, or green grains, increased as grain size decreased. Thus the proportion of quartz greatly decreased after 0.0059 in. sieve (Table 3, Figure 1). Glauconite and quartz grains varied in shape. Glauconite grains were well rounded while quartz grains appeared angular.

Table 3. Average percent of quartz and glauconite grains in a sieved

Sieve Number	% Quartz	% Glauconite
100	84	16
170	76	24
230	66	44
>230	N/A	99.9

Discussion & Conclusion:

The proportions of grains and the weights show that the quartz grains were generally larger than glauconite. This larger size, the greater angularity of the quartz grains, and its hardness level of seven suggest that it is not as susceptible to mechanical weathering. In comparison, the glauconite grains are very rounded, possibly resulting from its much lower hardness level of two and unstable crystal formation. While both minerals have experienced enough weathering to reduce them to minuscule sand grains, the quartz has resisted the tendency to become rounded. It is entirely possible that the quartz may have been subjected to less weathering; however, the grains must have traveled in a marine environment before settling to form sandstone. The wave action on the quartz should have provided enough weathering to substantially break down the mineral, thus making the grains well rounded.

Another explanation for the angularity of the quartz is the fault. Faults erode rocks quickly and violently into a fine powder. The fault could have affected the weathering and mixing of our sample, although both the quartz and glauconite should have been equally subjected to this eroding. The grains of quartz may have been rounded initially by the wave action and the fault could be responsible for crushing the grains and destroying the roundness. The glauconite on the other hand was probably formed at or very near the quartz deposit site in a calm marine environment, and so has experienced little to no weathering due to wave action. All weathering of the glauconite could be due to faulting. Because glauconite is so soft, it may form more rounded grains when crushed by the fault. This would explain why the fault failed to affect both minerals equally.

Based on past research, we suggest that our sample follows regular patterns associated with glauconite formation. The quartz probably came from many different source materials, while the glauconite formed relatively close to its current location.

Further study of the glauconite in the Franconia formation sandstone might focus on the crystalline structure of the minerals. The makeup of the minerals could provide further insight into the weathering of the glauconite and quartz grains.

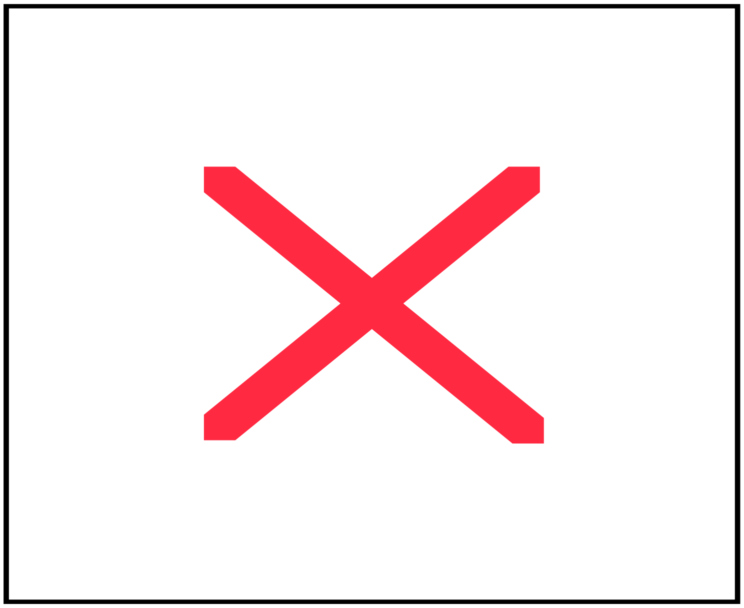

Figure 1. For each sieved section slide, the proportion of glauconite to quartz grains was calculated from the average number of dark and light grains in five fields of views in the Olympus BX51 microscope.

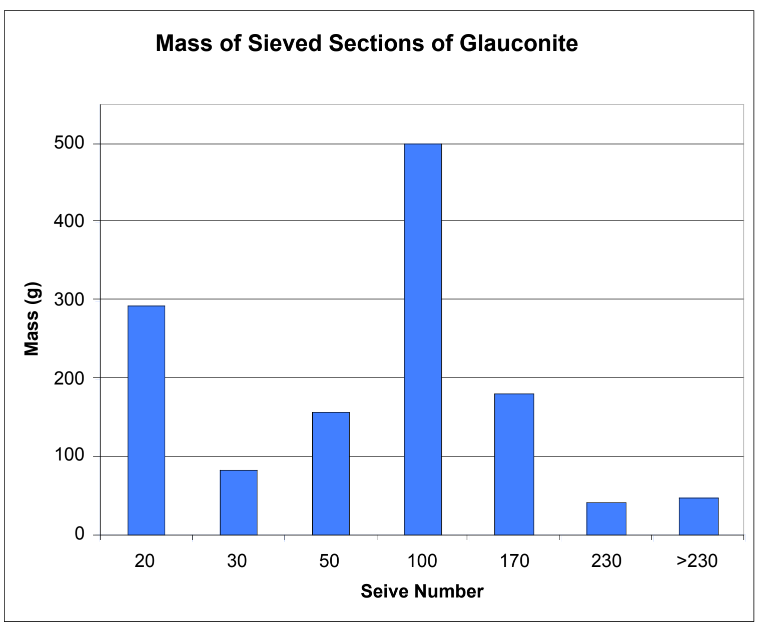

Figure 2. The mass of sieved sections of glauconite stratigraphy as collected, including glauconite and sandstone grains.

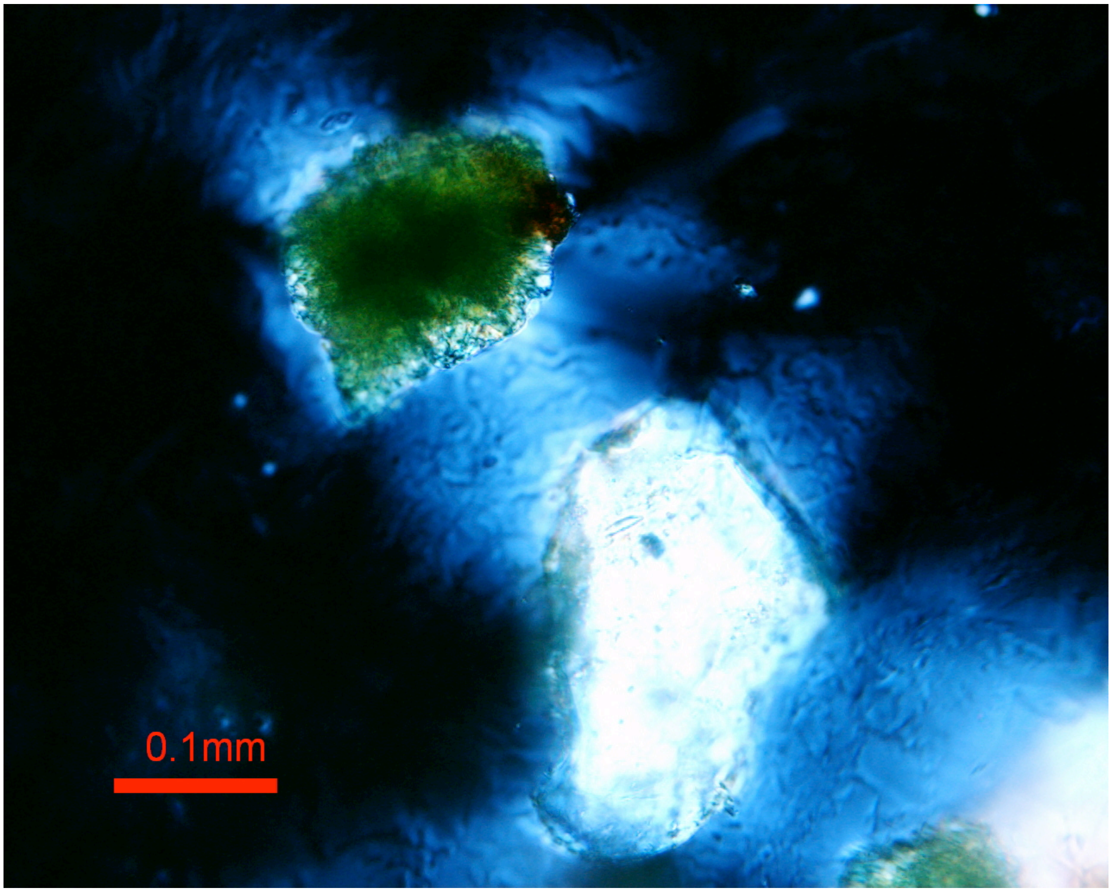

Figure 3. Rounded glauconite (green) and angular quartz grains (clear) from sieved section number 230, with opening 0.0025 in. was imaged with 40x lens in an Olympus BX51 microscope.

References

Amorosi, A., 2003, Glaucony and Verdine: Encyclopedia of Sediments and Sedimentary Rocks, p. 331-333

Ehlmann, A.J., 1978, Glauconite: Encyclopedia of Earth Sciences Series, v. 6, p. 364-366

Edwards, G., Goldich, S.S., Baadsgaard, H., and Weaver, C.E., 1959, Investigations in radioactivity-dating of sediments [Minnesota and Montana]: AAPG Bulletin, v. 43, p. 645-662

http://rruff.geo.arizona.edu/doclib/hom/Glauconite, 2001, Glauconite

http://en.wikipedia.org/wiki/Glauconite, 2005, Glauconite

Properties of Glauconite in the Franconia Formation in Red Wing, Minnesota

Research and Analysis by:

Mark Merrill

Alexandra O'Neill

Frances Reid

November 16, 2005