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Petrology of St. Peter Sandstone

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Geology 110

Collected from Cannon River Wilderness Park (MN)

Abstract:

Using a petrographic microscope to analyze St. Peter Sandstone, we attempted to determine the source and transporting agent of the formation at Cannon River Wilderness Park. We found that the grains were well rounded and mainly distributed between sieve meshes 50 and 100, indicating medium sorting. Smaller grains were more angular, whereas the larger grains have a more spherical quality. This could be an indication that the grains are coming from different sources, and are likely transported by a combination of eolian and fluvial agents. Because the sample of St. Peter that we examined is almost completely quartz, we are almost certain that the depositional environment was a beach.

Introduction:

McCormick and Hammond (2004), in their analysis of St. Peter Sandstone in Nebraska, South Eastern Minnesota, and Northwest Iowa found the sandstone to be clean and medium to well-sorted. They found medium grains of pure, mature quartz. Mazzulo and Ehrlich (1983) also conducted a study of St. Peter Sandstone in sourtheastern Minnesota found both smooth, well rounded grains and irregular, angular grains. McCormick and Hammond interpreted from the silt, clay and fossils present that the sandstone was deposited in marine environment. However, they also found some evidence in the bedding that the sandstone was deposited through eolian processes, and they concluded that a combination of wind and water were involved in the transport and deposition of the sandstone. The sandstone was very likely deposited near shore. In contrast, Mazzulo and Ehrlich (1983) found curved grooves and scratches on the grains, and concluded that the well rounded grains were transported with eolian processes and deposited on a beach. They said that irregular grain sizes are accounted for by fluvial transport.

In this project, by examining the various features of our sample of the St. Peter Sandstone, we are attempting to establish which agent transported the sand to its current location as well as make a hypothesis about the depositional environment of the grains. We will inspect the degree of sorting, roundness, and the sizes of the grains to determine if they were carried by wind or water, or quite possibly a combination of the two. The degree of roundness would be an indication of a high or low energy environment.

To carry out our methods of observation of the St. Peter Sandstone, we used seven different sieve sizes for separating the grains and a scale to measure how much of each grain size was represented within the kilogram of sand. A petrographic microscope was used for examination of the grains, and we also took pictures of the different grain sizes with a digital camera through the ACT-Nikon program. In our results section, we will report our findings of the grain sizes determined by the sieves and the microscope and talk about the rounding and sphericity we examined.

Methods:

Our portion of the St. Peter Sandstone was collected from the Cannon River Wilderness Park in Rice County. The first step was measuring out approximately one kilogram in order to later determine the grain size distribution. To determine the degree of sorting, we sieved the grains through several different sizes and found the grain size distribution. The sieve numbers that we used were 35, 40, 50, 60, 70, 80 and 100. After sieving the sand, we measured the amount that was left from each section. We then proceeded to make thin sections using the standard procedure.

Results:

Size of Grains

After dividing our sample into groups according to sieve size, we found that the average grain radii (by group) ranges from 74 microns to 312 microns. The average grain radius among all sub-groups was 161 microns, and the standard deviation is 85.35. See appendix A.

Distribution of Grains

When we sieved our sample of approximately 1 kg of St. Peter's sandstone, very few grains did not pass through the 35 sieve (1.6 g), and only 83.9 g passed through the 100 sieve (see appendix B). The largest proportion of sand sat atop the 50 sieve (307.6 g), accounting for 32.7% of the composite weight of our sample.

Roundness and Sphericity

We observe various degrees of rounding and sphericity in our samples. The course grains (those that would not pass through the 35 sieve), were fairly well-rounded and spherical. The surfaces of the sand grains appear smooth. The finer grains in our samples appear to get progressively more angular and less spherical, and we observe more scratches on the surface.

Discussion:

The St. Peter Sandstone's grains are very well rounded, indicating that they have undergone significant weathering through processes involving wind or water. It is difficult to determine which of these agents has caused the rounding, but glaciers can be ruled out as an agent due to the relative uniformity of grain size. According to the Wentworth Scale, our grains rage from mostly very fine to a few medium sized grains. This type of range is an indication of medium sorting, which reinforces that the agent of transportation must have been wind or water.

The thin sections also showed us that the sand is composed almost entirely of quartz, the most durable of minerals. This agrees with Giles (1930) findings that the St. Peter of Arkansas was 99 percent silica. Because other minerals are almost completely absent, the grains must have been present in a high energy environment, such as a beach environment where tides are regularly washing up and weathering the sand.

Like Albert Giles in "St. Peter and Older Ordovician Sandstones of Northern Arkansas," we found that here were hardly any grains staying in sieves larger than 35, and less as it got to size 100. Giles also found the smaller grains to actually be fragments and flakes derived from attrition of the larger grains. While we did not really look into that, we did notice that the very smallest groups of grains were not as well rounded as the larger ones, and this fragmentation could possibly account for that. Another possibility is that the grains could be coming from different sources.

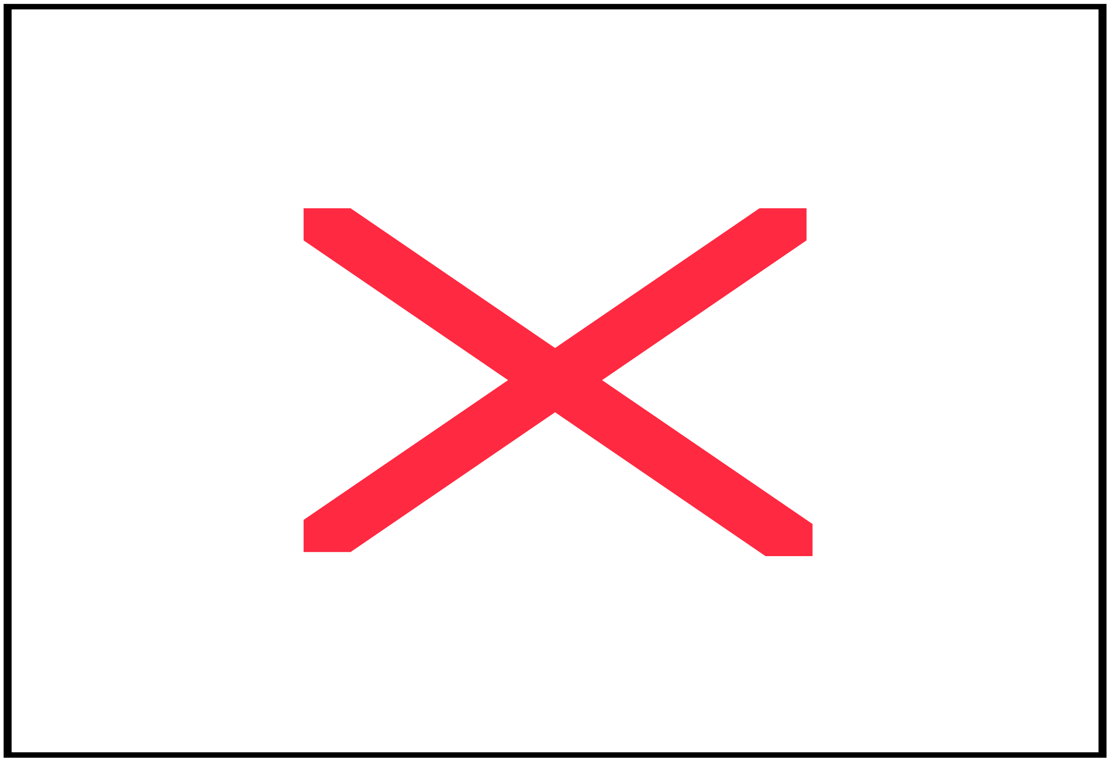
Errors include loss of sand during sieving – this probably affected all grain sizes but may have been skewed to one side since many of the lighter particles easily became airborne and are lost. Also, the St. Peter was not well cemented and could mostly be broken up using fingers. However, not all of it was broken up using our fingers, so during that process we may have inadvertently fractured some of the larger grains, resulting in smaller, angular pieces.

Had we more time, it would be nice to investigate the actual percentage of non-quartz grains and investigate what they were. Our sample of St. Peter sandstone was quite pure, but there were a few other minerals present in small amounts. Also, we noticed that there seemed to be more a slightly higher percentage of non-quartz grains in certain sieve sizes. Further investigation might give us clues as to why that is.

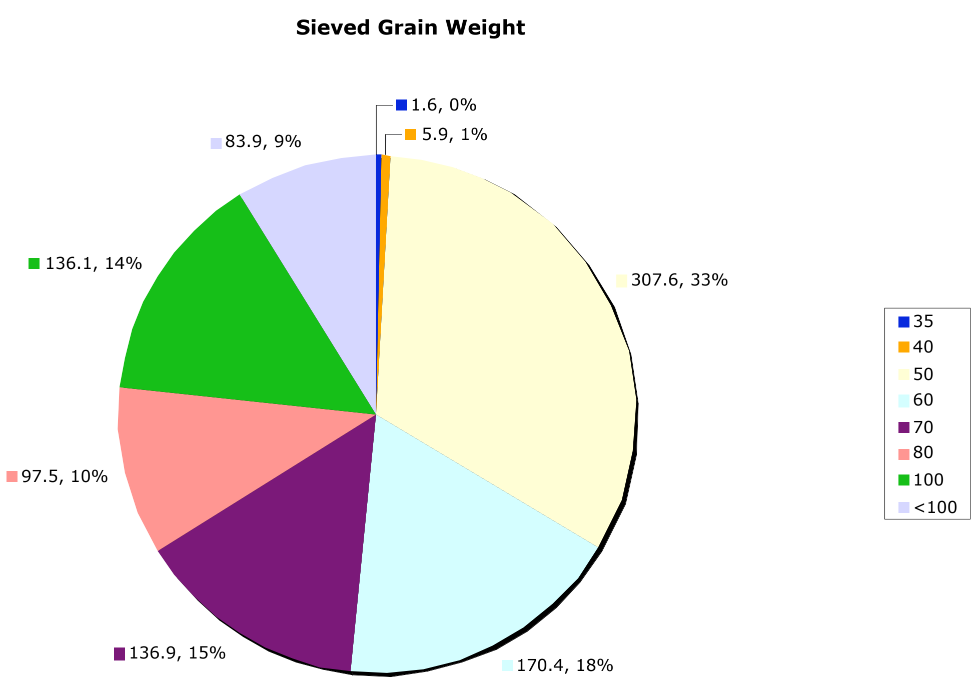
We could also examine the porosity and permeability of the St. Peter Sandstone, and perhaps see if there was any cementing material. In addition, we could take larger samples, compare samples from different areas in the Canon River Wilderness Park, or even compare samples collected in other sites in Minnesota or neighboring states. That would require quite a bit more traveling than this initial investigation, and would require more time than we have.

Since we found differences between the larger grains, which were well rounded, and the smaller grains, which were more angular and seemed to have a higher proportion of non-quartz minerals, it is possible that our sample had two separate populations, from two depositional processes. A simple chemical analysis of the grains to see if there was a significant different difference between the two could help determine whether we actually had two separate populations.

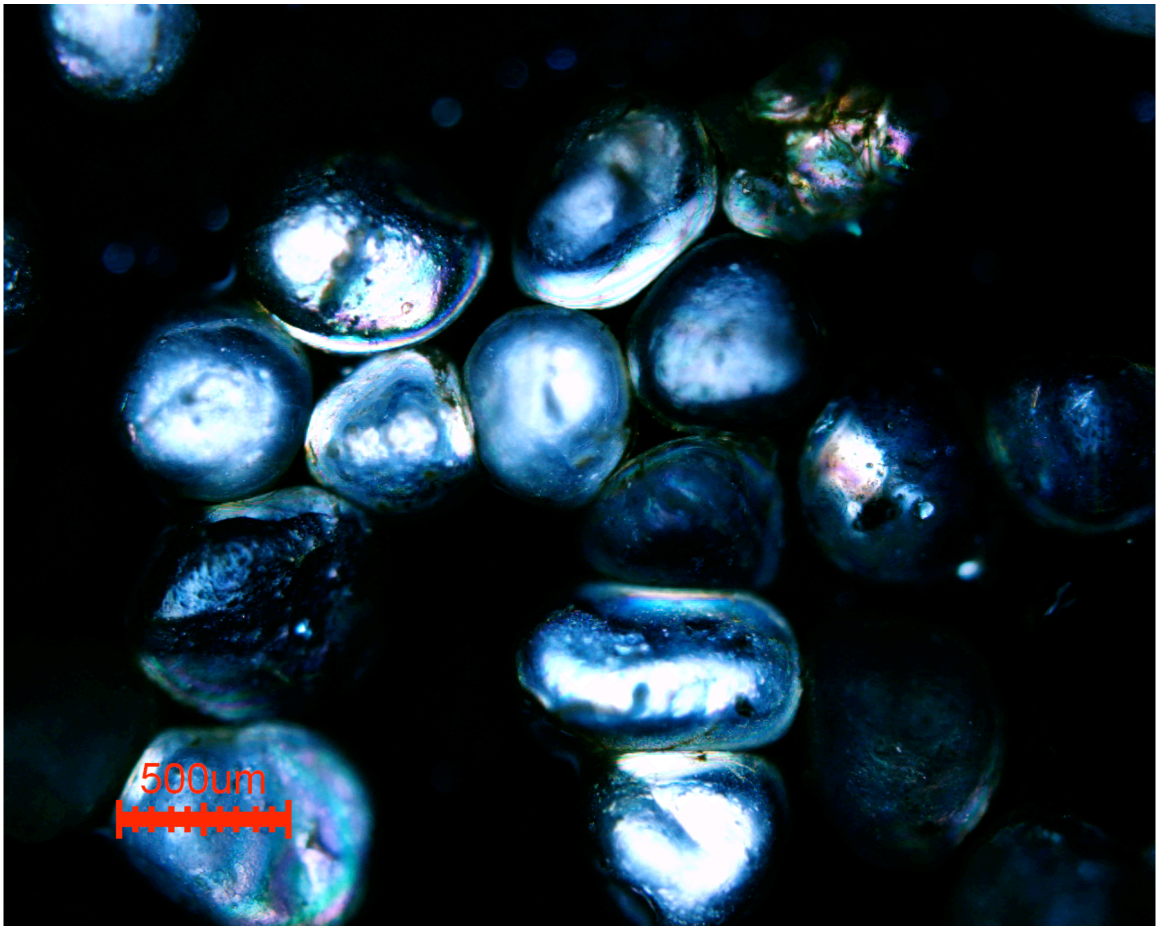
Appendix A



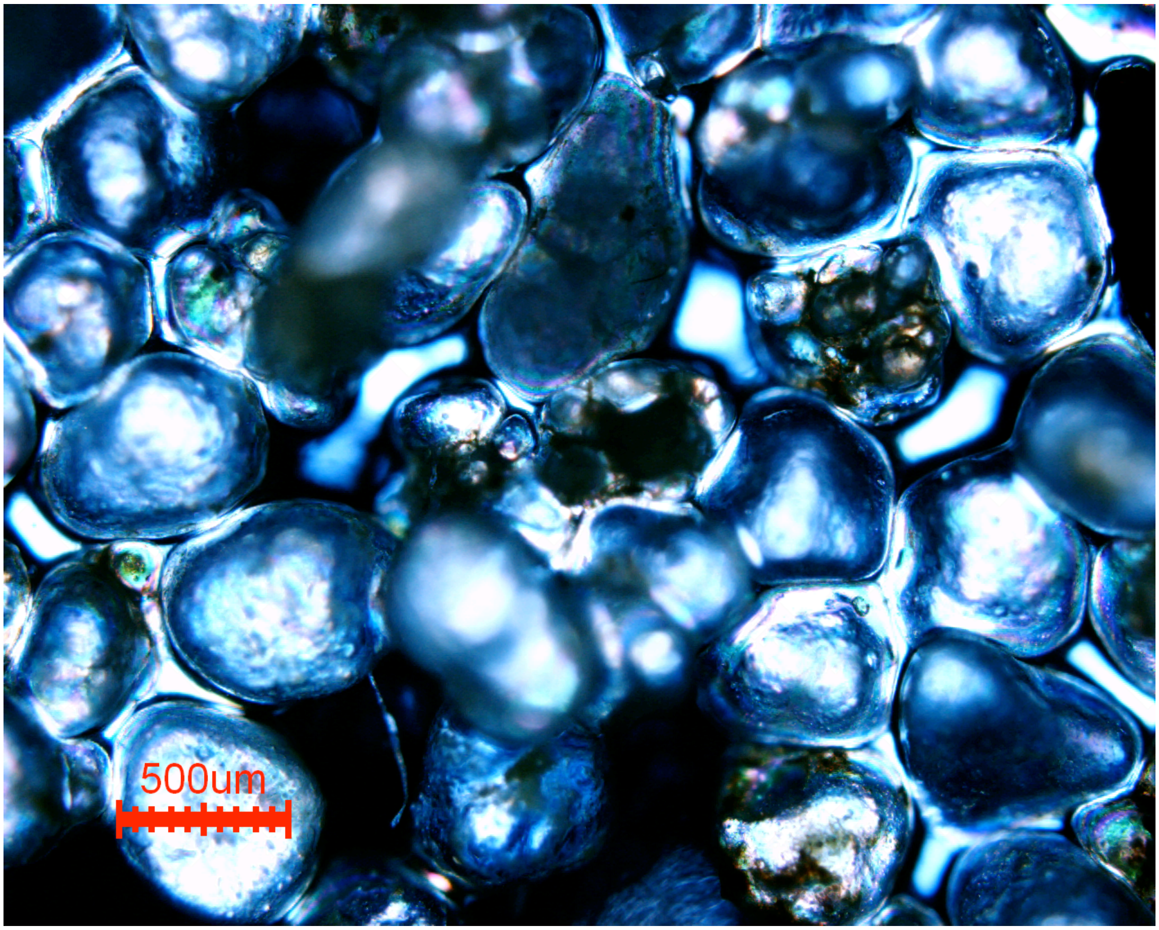
Appendix B


Sieved Grain Weight
1.6, 0%
5.9, 1%
83.9, 9%
307.6, 33%
136.1, 14%
97.5, 10%
136.9, 15%
170.4, 18%
35
40
50
60
70
80
100
<100

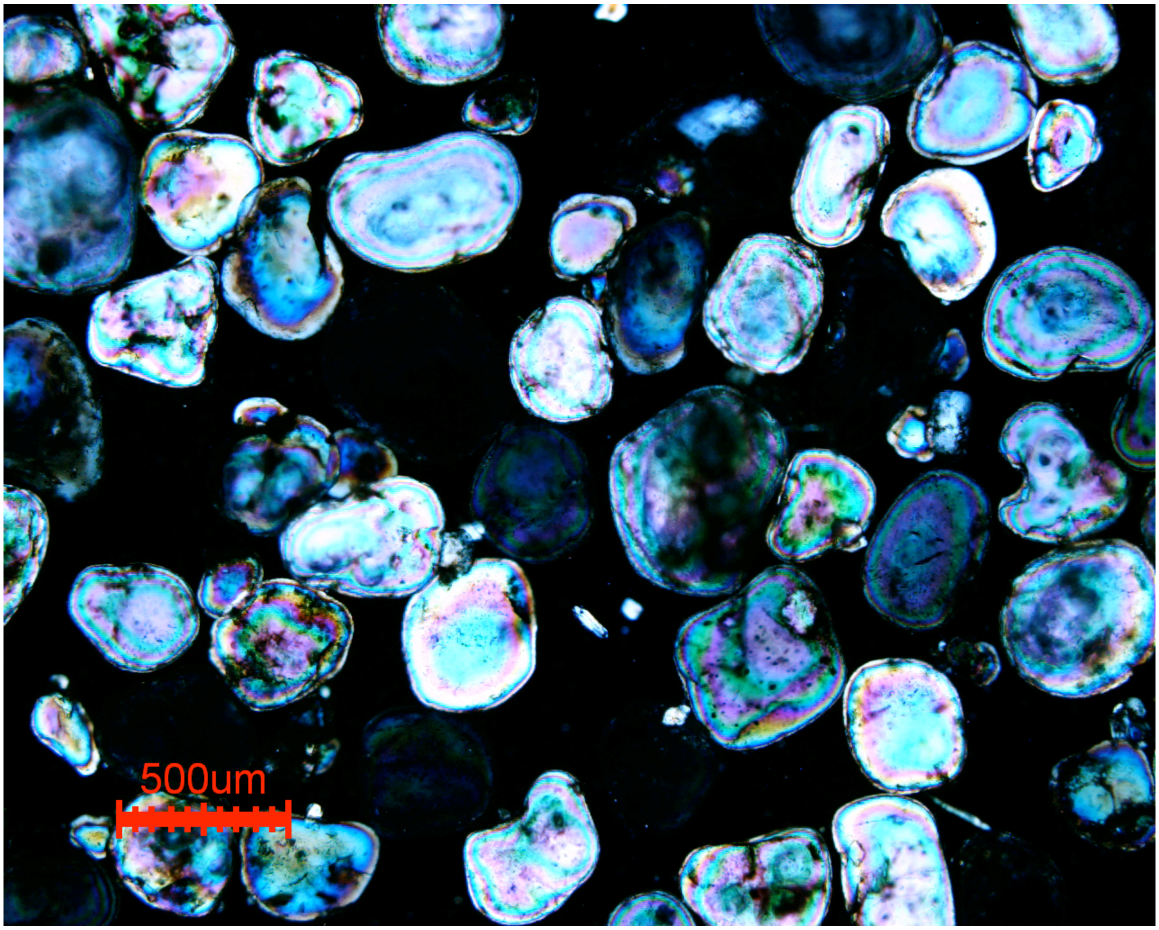
Mesh 35



Mesh 40



Mesh 50



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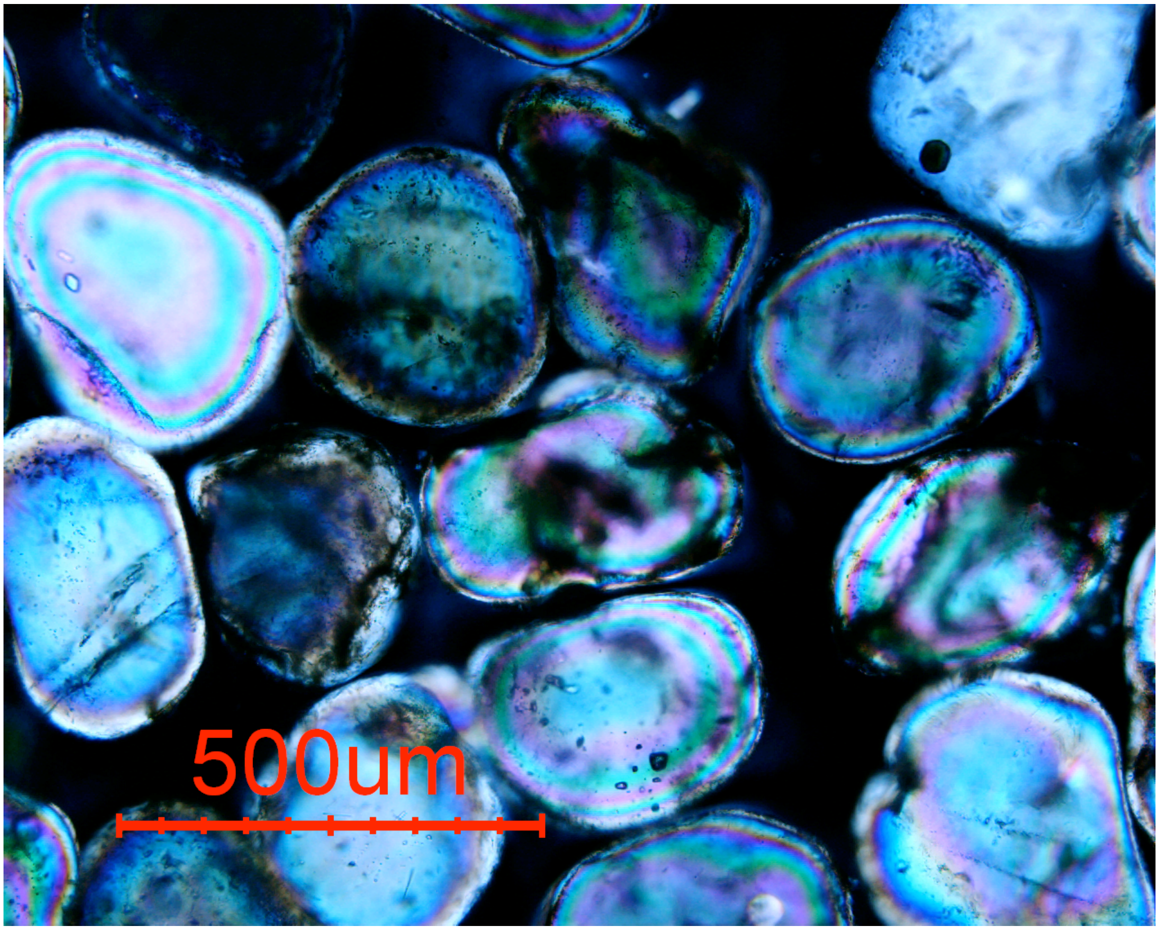
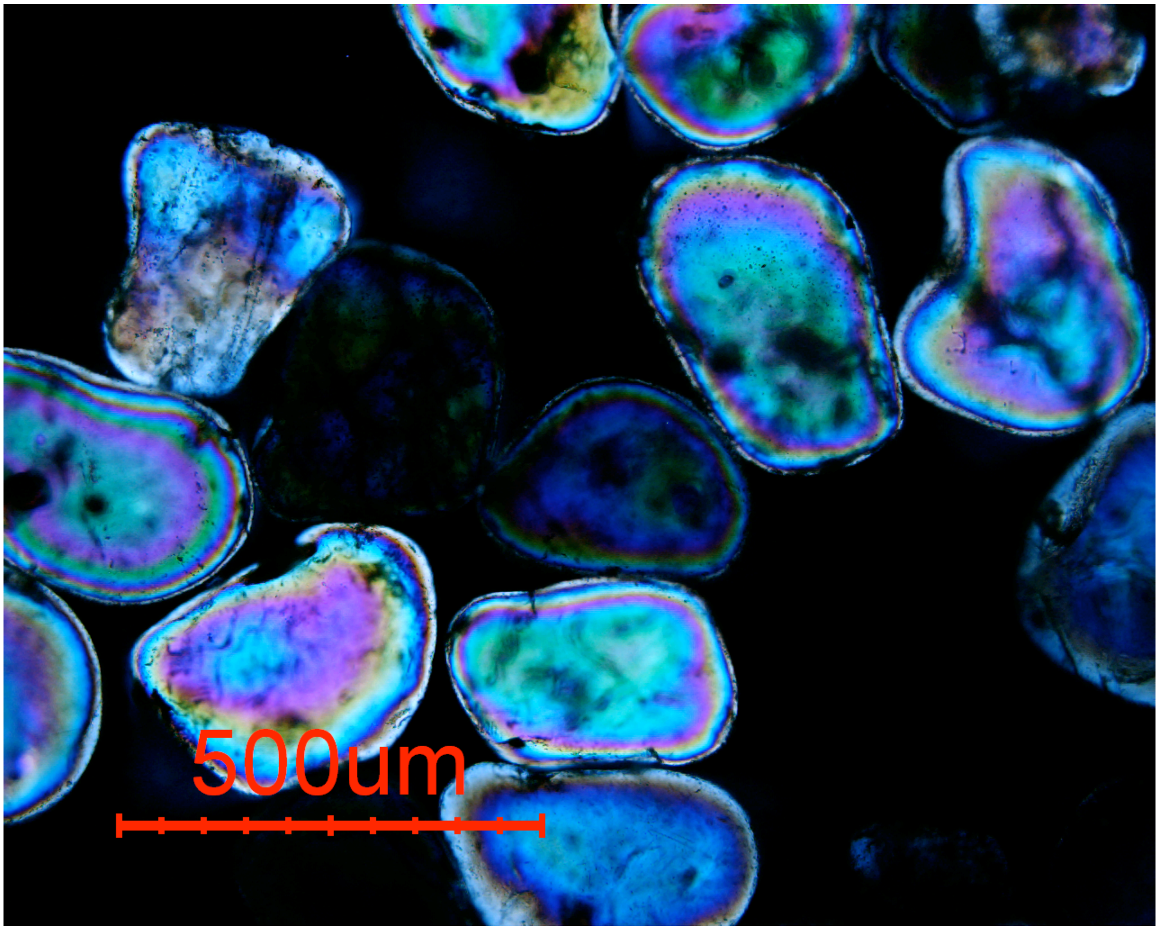
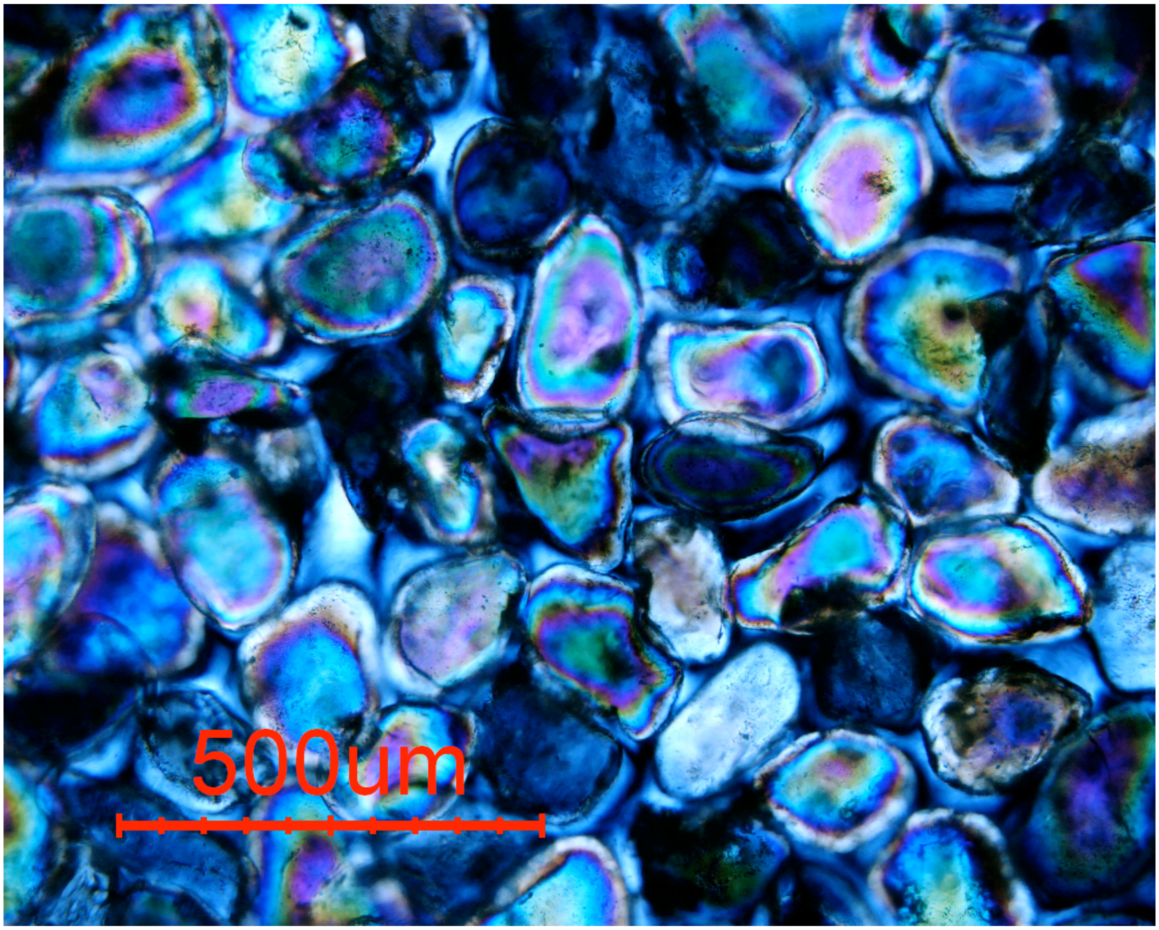


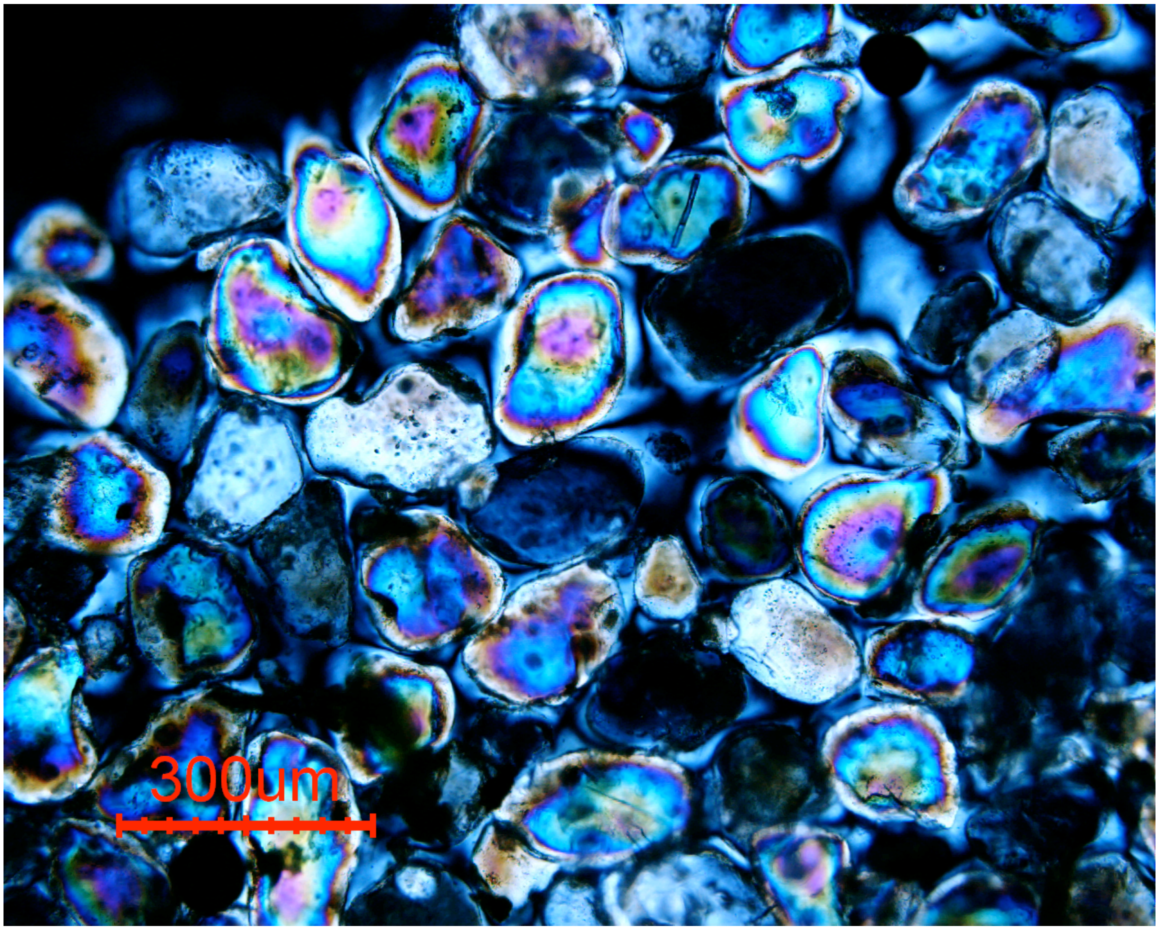
Mesh 70



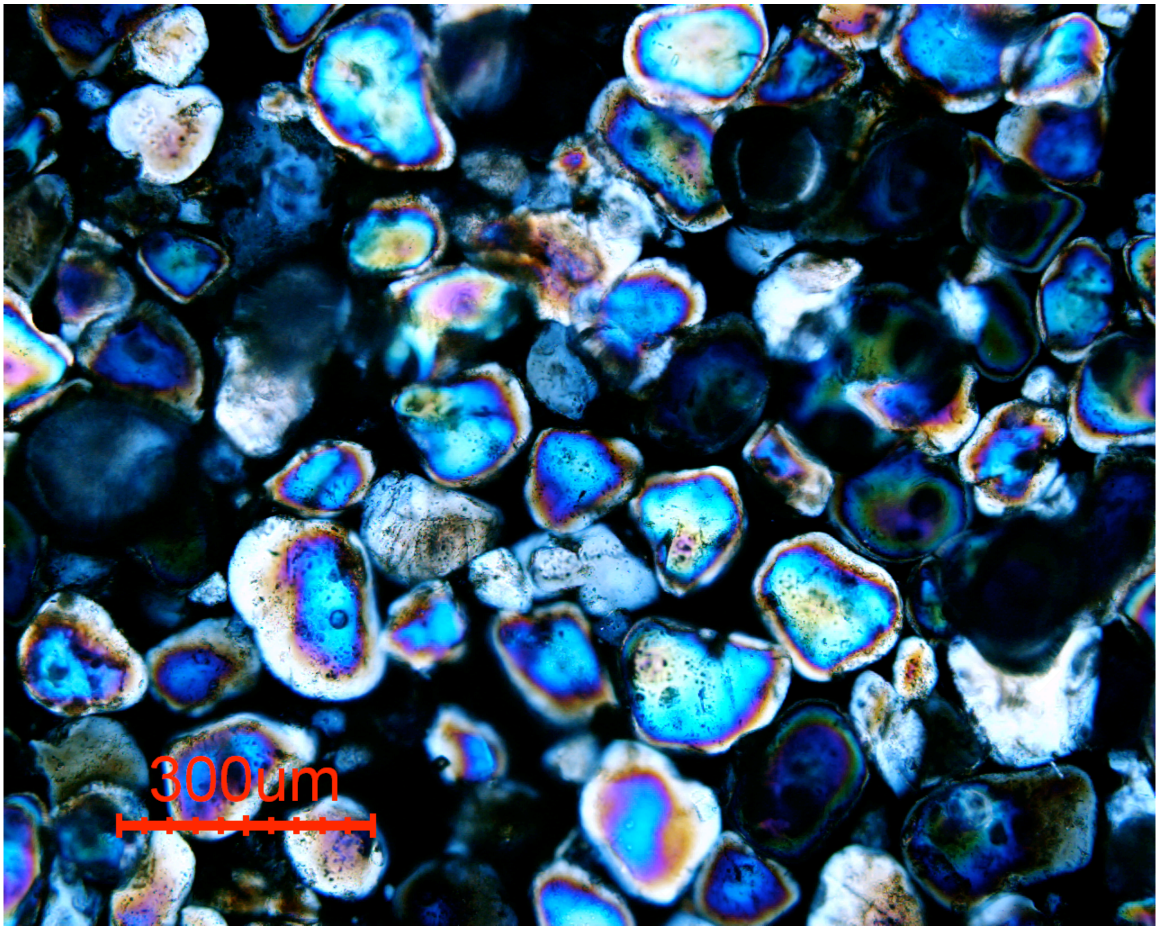
Mesh 80



Mesh 100



Less than 100



Bibliography

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Mazzullo, James M, and Ehrlich, Robert. "Grain Shape Variation in the St. Peter Sandstone: A Record of Eolian and Fluvial Sedimentation of an Early Paleozoic Cratonic Sheet Sand". *Journal of Sedimentary Research* 53 (1983): 105-119.

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