Marietta College

Department of Petroleum Engineering and Geology

From: Dr. David L. Jeffery
Professor of Geology, Marietta College

To: Mayor Joe Matthews
Start Westward Monument Committee
C/O Jean Yost, Chair

Re: Start Westward Monument deterioration

Dear Mayor Matthews and Start Westward Monument Committee,

As I have discussed with Mr. Jean Yost and Mr. Tony Durm, I have conducted several investigations into the local sandstone layers from which the Start Westward Monument was quarried. We have made numerous observations about the history and composition of the sandstone and I currently have a manuscript that I and a co-author will be submitting for publication. In short, the problem with the deterioration of the monument lies with the clays within the matrix of the sandstone.

These clays formed after deposition, during the hydrothermal conversion of potassium feldspar and muscovite to illite, a clay that is very good at absorbing water. Upon exposure to the humidity in the atmosphere, the illite, along with other clays present such as kaolinite, chlorite, and vermiculite absorb water around the exposed surfaces of the rock. Thus, over numerous years, along with rain and freeze thaw, the surface that has been absorbing water exfoliates, as is seen to be happening to the monument. In order to preserve the monument from further such deterioration the monument should be in a climate controlled environment.

That manuscript I am currently writing primarily concerns the conversion of potassium rich feldspars and muscovites in the original rock to clay minerals during deep burial during the later stages of the Alleghenian Orogeny, which was when the Appalachian Mountains formed. Initially, the local rocks were deposited as arkosic arenites, meaning they contained a high proportion of potassium feldspar, likely greater that 25%, and very little clay. During burial and the latest stages of the orogeny, warm, basinal waters containing high concentrations of sodium from thick salt layers in the center of the basin were pushed through the sandstones. The potassium feldspars and muscovites in the rock were converted to clays such as Illite and kaolinite.

The characteristics that are indicative of this transformation can be observed in thin sections under a microscope. In these thin sections, muscovites can be seen in the midst of their conversion. Those muscovites are quite literally, “caught in the act” of their transformation, and most of the other clays reside in pockets that are not disseminated through the rock, but are the same size and shape of the former potassium feldspar grains.

Some of these former potassium feldspar grains are rarely preserved as tiny remnants surrounded by kaolinite and illite. The clue to how this happened lies in the fact that another mineral, plagioclase feldspar, which is usually more susceptible to deterioration by diagenesis, is preserved.

Plagioclase preservation while potassium feldspars were destroyed is the main evidence that the conversion to clay happened by means of hot fluids in the deep subsurface and not from either depositional processes or surface waters at exposure. These fluids must have been 125-140 degrees Celsius and included the presence of high amounts of sodium in order for this to happen.

The clays in these rocks, thus, are the product of transformation during burial and are not sedimentary clay matrix disseminated through the rock. Up until the time they were quarried, their impermeability, resulting from the pore spaces being clogged by these diagenetic clays, meant that the portions of the rock far from the outcrop had never been exposed to large amounts of water. Upon exposure to the atmosphere and humidity, these clays absorb water and the rock surface deteriorates through exfoliation. If you have any further questions, please feel free to contact me.

Sincerely,

Esignature DJ

Dr. David L. Jeffery
Professor of Geology
Department of Petroleum Engineering and Geology
Marietta College
Marietta, OH 45750
(740) 376-4844, jefferyd@marietta.edu