REINTERPRETATION OF MT NEBO POINTE SAND INJECTITE COMPLEX, PITTSBURGH, PA

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ABSTRACT

Continued study of the Mt Nebo Pointe highwall suggests the spectacular sand-filled cracks were not formed by injection as first hypothesized, but by chemically active fluids that flowed along joints and fractures, resulting in blocky vertical weathering along Liesegang bands.

Petrographic analysis of oriented samples showed the inter-crack sandstone and the host rock exhibit the same mineralogy, subhorizontal grain trends and grain packing. Close examination of the highwall revealed that some cracks contain horizontal muscovite-rich weathering planes concordant with bounding surfaces. Conversely, a sand injectite hypothesis would predict the material to be of different composition with clear dike-parallel grain trends, tight packing and truncation of host sedimentary structures. Only one sample showed any vertical trends, appearing to grade laterally from coarse to fine sand.

However, the mineralogy does suggest pervasive oxidative diagenesis related to fluid flow. Chlorite grains and iron oxide cement account for 15% and 3% of the host rock respectively, while the inter-crack sandstone contains up to 25% chlorite, ubiquitous iron oxide cement and increased secondary porosity. Muscovite and biotite are important accessories in all samples, and kaolinite is a minor accessory. Throughout the highwall, zones within and immediate to fractures are dominated by iron-oxide cement and Liesegang bands. A sharp “bathtub ring,” seen approximately six meters from the base, may indicate the maximum saturation level.

The distribution of crack morphologies does not appear to be associated with the highwall’s excavation. Cracks in the flanks tend to fan upwards while those nearer the center are linear and subvertical, even where overburden is minimal. It seems more likely this is linked to the joints’ proximity to the surface during either their formation or oxidation.

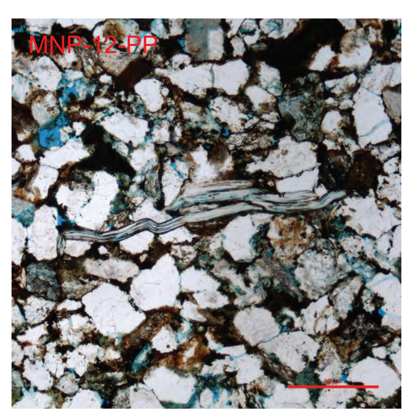
In light of these results, the term “dike” previously and tentatively used to describe these features is now considered an inaccurate genetic description.

METHODS

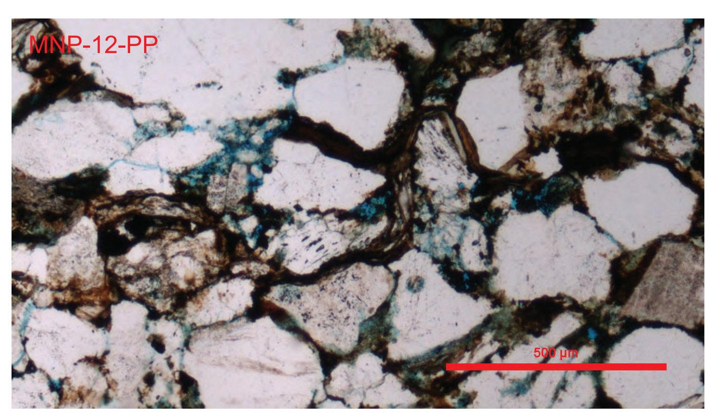
Petrography of oriented samples was a key component of this work. Thin sections were prepared by Calgary Rock and Materials Services Inc. and analyzed using a Nikon Eclipse 50i POL microscope. All thin sections and micrographs are vertically oriented. The trend of each sample was determined by systematically measuring the orientations of inequant grains, particularly micas. Rose diagrams were plotted with R. More detailed observations of joint morphologies and distribution were conducted in the field and with the high resolution panoramic image shown at the bottom of this poster.

IMPORTANT NEW OBSERVATIONS

Some sedimentary structures persist horizontally through joints and Liesegang bands bracket the vertical planes of weathering (see right). Many micas are contorted around and pinched between other grains (see below). Joints show a weak preferred tendency which is different than the host rock (see rose diagrams at right).

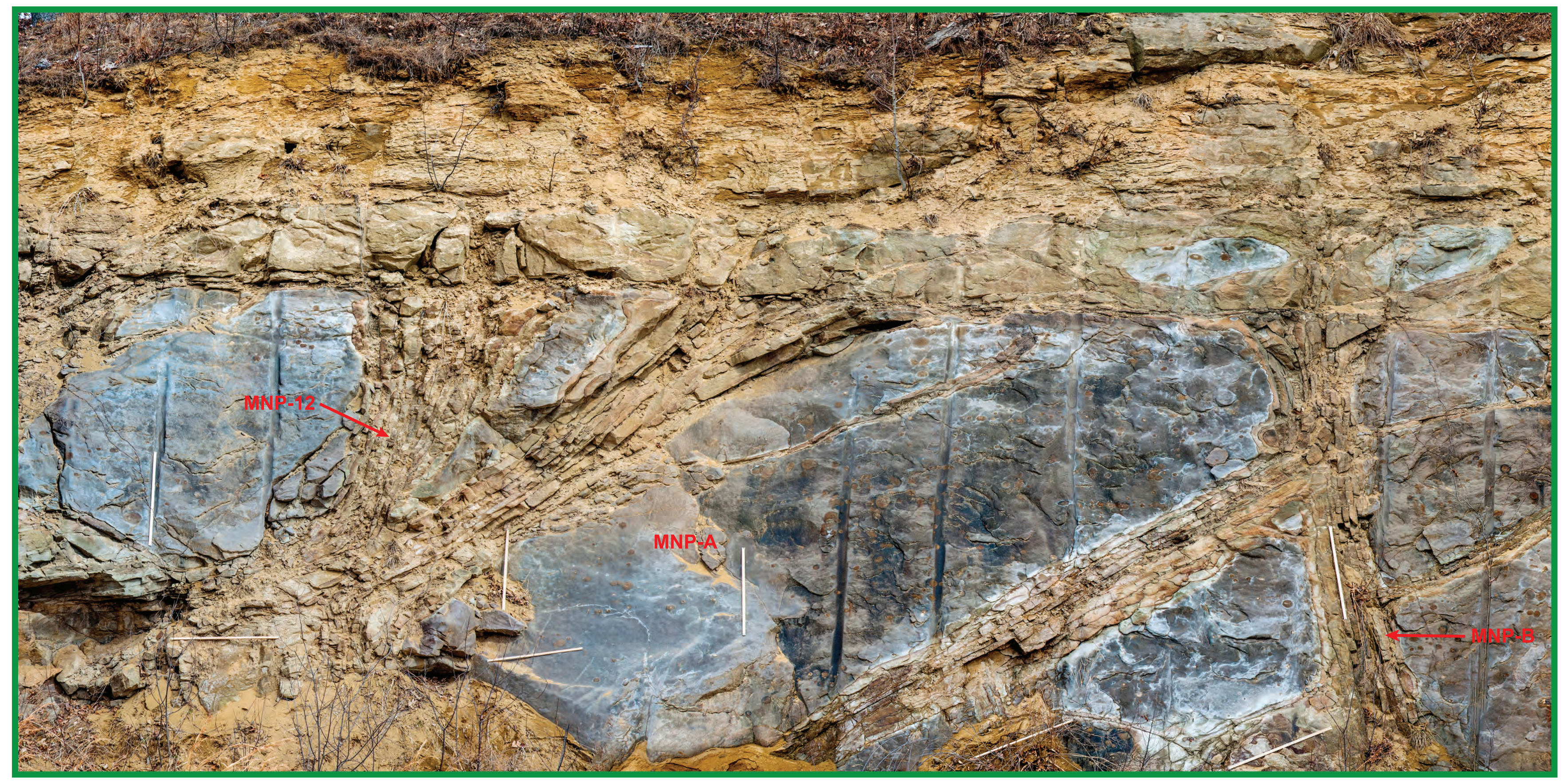


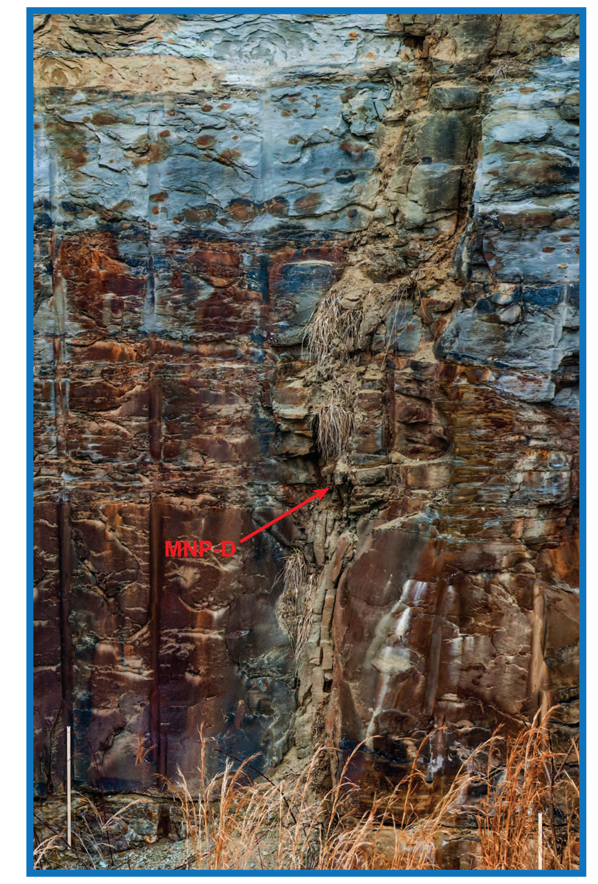
A kinked muscovite grain in MNP-12. Scale bar is 500 microns.



A contorted biotite grain in MNP-12.

This joint exhibits subhorizontal fracture concordant with host rock cross-bedding. Meter stick for scale.

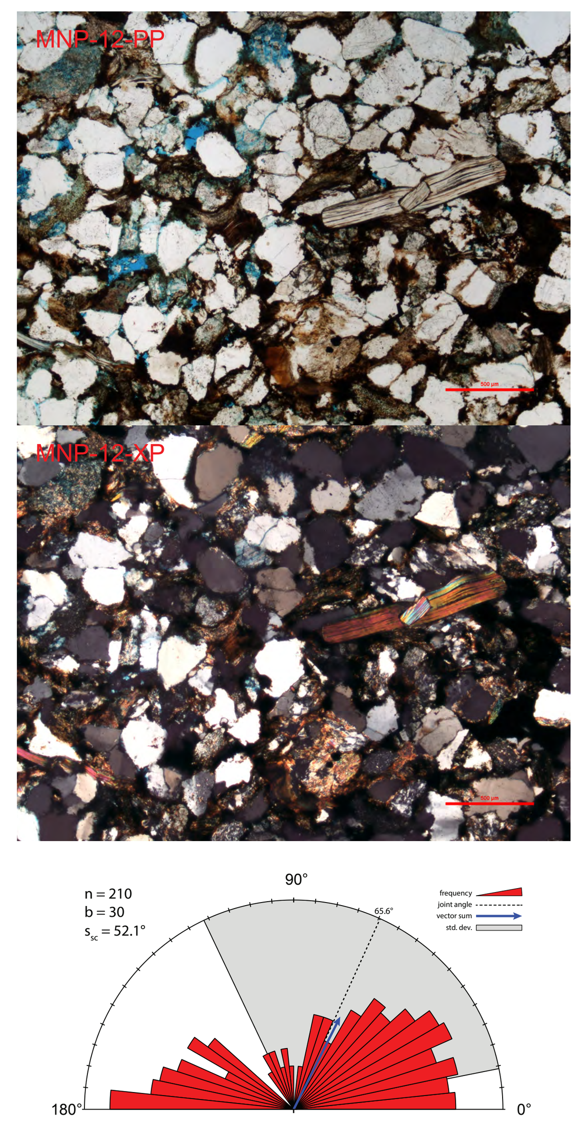




(above)
Only a hand sample was collected for this location. It was selected because there appeared to be a truncated coal seam near the base (indicated by the arrow). However, it seems to be very similar in composition to MNP-B, and the grains are horizontally oriented. Meter sticks for scale.

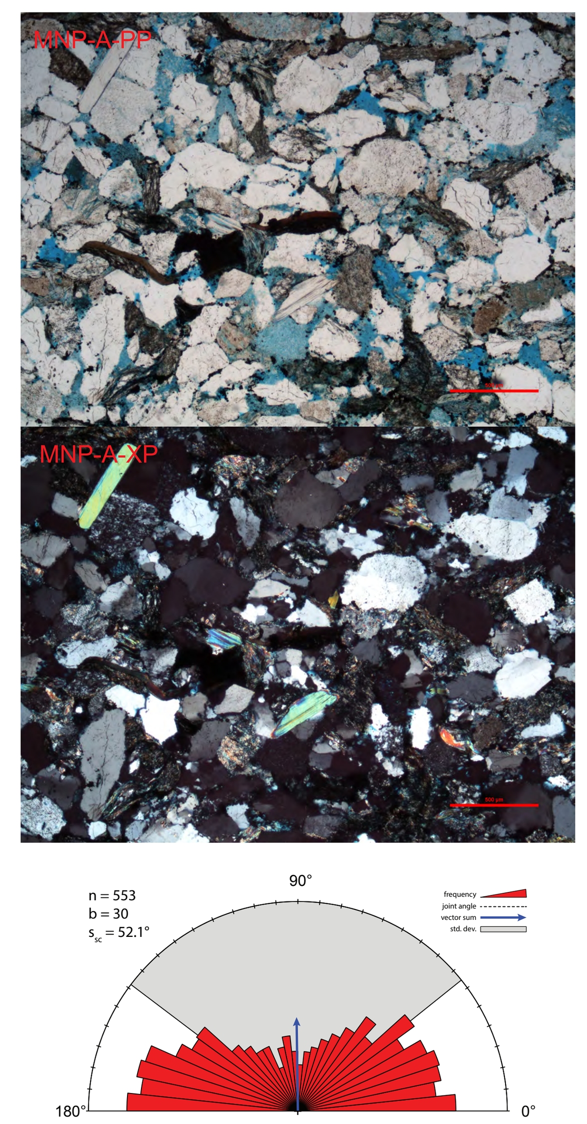
(lower left) An oxidation spot with hematite pebble nucleus. These halos are common throughout the massive sandstone.

(lower right) Conglomerate lenses of hematite pebbles on the lower eastern wall often occur below coal seams. These zones are intensely colored. Meter stick for scale.



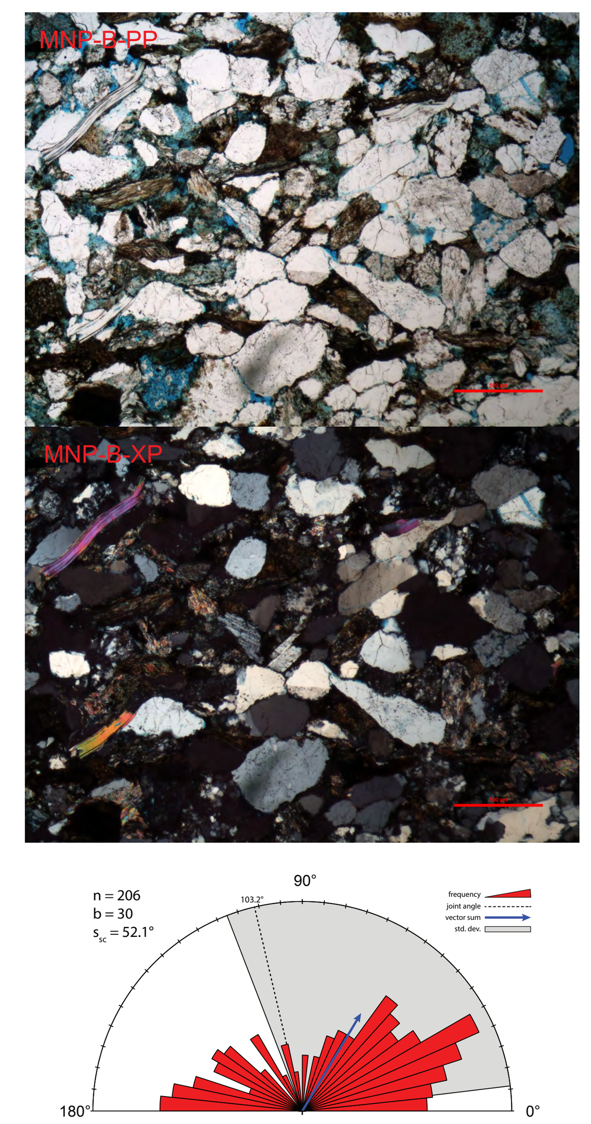
MNP-12

Immature micaceous sandstone. Moderately-poor sorting. About half fine/medium subangular quartz Micas are tabular to platy, reaching lengths up to 1 mm. Biotite accounts for about 18%, which is higher than in other samples. Muscovite is the second most abundant mica at 9%, followed by chlorite at only 5%. Much of the biotite is moderately to highly weathered. Micas are very frequently seen contorted, pinched between and wound around other grains. Exhibits peculiar lateral grading from medium sand on the left to fine/-medium sand on the right, which is bounded by a Liesegang band. Iron oxide cement accounts for only about 4%, but more may be present in the grooves of mica grains. Kaolinite and plagioclase are minor accessories.



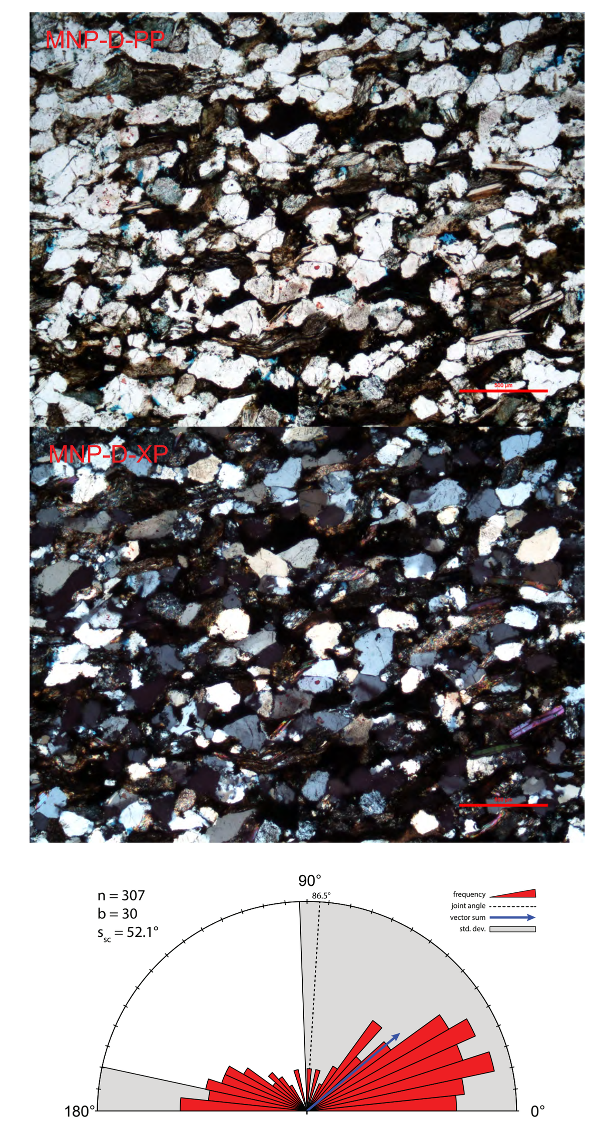
MNP-A: massive sandstone

Immature micaceous sandstone. Moderately poor sorting. About half fine/medium subangular quartz: Most exhibit undulatory extinction, many contain abundant fluid inclusions, and some are aggregate grains. Abundant platy chlorite, often pinched between grains and/or in direct contact with muscovite, which is the secondary mica. Biotite, along with angular/subangular plagioclase, chert and K-feldspar, is an accessory. There may be minor kaolinite as well. Iron oxide cement is seen as frequent nucleations around grain boundaries. The remaining volume, about 15%, is pore space, a large fraction of which is secondary. The inequant grain trend appears to be bimodal. Hand sample is gray, massive and structureless.



MNP-B

Immature micaceous sandstone with abundant hematite cement. Moderately poor sorting. Mineralogically identical to MNP-A, except that a significant portion of the pore space is filled with iron oxides. About 45% angular/subangular quartz and quartz aggregates, 20% chlorite, 10% hematite grains and iron oxide cement, 3% muscovite, accessory biotite, plagioclase K-feldspar, and about 12% porosity. Inequant grains show a weak polymodal trend, which is less evenly distributed than MNP-A. Hand sample is reddish in color, but texturally comparable to the massive sandstone host. Joint exhibits vertical blocky structure of near constant width, and joint-parallel Liesegang bands are abundant.



MNP-D

Immature micaceous sandstone with ubiquitous hematite cement. Moderately poor sorting. Texture is slightly finer and better sorted than MNP-A or B, and contains a higher fraction of quartz. Chlorite is a dominant mineral, but there are also notable grains of muscovite and biotite. Very little porosity, and about half is secondary, possibly from dissolved K-feldspar. Inequant grains show a weak polymodal trend, which could correspond with the low angle cross-beds. The joint exhibits similar vertical structure to MNP-B, but also fractures subhorizontally. The top and bottom of the hand sample are planar, and the bottom has a high concentration of flat-lying muscovite: this could represent a bounding surface concordant with the host rock.

DISCUSSION

These features have presented an intriguing puzzle. At first appearance, they certainly resemble injectites, in that they are sand-filled cracks possessing clear vertical features and with apparently different character than their host rock. In places, they also appear to truncate sedimentary structures, but in the westernmost part of the wall, the massive host rock contains no traceable sed structures to confirm this. Where the host rock is cross-bedded, the foresets are so fine that they are nearly impossible to establish whether they persist through the feature. Objects initially taken to be oriented clasts turned out not to be clasts at all, but undisplaced host rock that has undergone oxidation to a lesser degree, and is therefore, a grayer hue. Liesegang banding is pervasive on either side of virtually every crack in the wall, indicating joint-parallel fluid migration. Oxidation spots around hematite clasts are abundant in the massive sandstone. The thin sections clearly show that both the host rock and selected joint material show weak polymodal horizontal grain preference rather than the strong preference associated with true injectites. There also does not seem to be significant reduction of porosity within joints, except where hematite has precipitated. MNP-12 is significant because it contains the only trends which may be consistent with an injectite hypothesis. The lateral grading within MNP-12 is anomalous, yet not dismissable. Many micas, especially in MNP-12, have been contorted around other grains. Pressurized fluid migration could conceivably rotate the grains a little without entirely mobilizing them. It has been suggested that these joints are the consequence of unloading during excavation, but no correlation could be found between joint morphology and either overburden or proximity to the surface. Also, to the best of our knowledge, no similar features have been reported in Casselman Fm. anywhere in the Pittsburgh area, a city where wall excavations are common.

CONCLUSIONS

Our observations suggest these features are preexisting joints intensely weathered by oxidation during pressurized fluid migration. In contrast with true injectites, these joints are compositionally and texturally identical to the host rock, and do not contain strong orientation preferences or abnormally tight packing. They do exhibit weak grain trends rather than random orientation, also consistent with pressurized fluid migration. The blocky vertical weathering corresponds to zones between extensive joint-parallel Liesegang bands, and the joint morphology distribution shows no correlation to overburden, indicating they are not related to excavation unloading.

ACKNOWLEDGMENTS

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Mt Nebo Pointe highwall

composite of 485 images