Predicting the presence of headwater wetland depressions, Valley and Ridge Physiographic Province, central Pennsylvania

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Abstract

This project involves the development of a conceptual model of the formation of wetland depressions in headwater saddles on shale. The model considers paleoenvironmental landscape changes that probably occurred during the Pleistocene Epoch, and may provide a tool for predicting the location of these important features in otherwise obscure landscape positions. The project includes an assessment of the presence or absence of wetland depressions in headwater saddles on shale to determine the effectiveness of using field observations as a predictive tool.

Wetland depressions are elliptical shaped basins that are typically isolated -- they have no surface water connections to any other bodies of water. They are often filled only in the spring and early summer, thus may be called vernal pools. These types of pools are important breeding habitats for a broad range of flora and fauna. In our experience, the wetlands described here are distinct and unique features of the central Pennsylvania landscape that most often have not been recognized in the National Wetland Inventory. This lack of recognition presents a challenge to land managers and any effort to conserve these important wetland habitats. Their headwater position emphasizes the need to protect them to maintain water quality at downstream locations.

The focus of field efforts during this REU field season is on two sites previously known to the research team: Chestnut Springs in the Rothrock State Forest (SF) and Mohn Mills in Bald Eagle SF (Figure 1). At each site at least two soil pits were dug on the flanks of the wetland, described using standard field soil descriptive methods, and sampled in 10-centimeter increments for geochemical analyses (Figure 2). Cores were augured into wetland sediments and described and sampled in the field. Ground-penetrating radar surveys were performed to elucidate the internal stratigraphy of the soils and sediments and to determine a depth to bedrock (Figure 3). Samples were returned to Penn State laboratories where they were air dried, and then prepared by standard methods for major oxide and trace element geochemical analyses (Figure 2).

A similar stratigraphy was observed in all of the soil pits (Figure 2): a boulder/cobble layer exists at depth, overlain by fine-grained material (sand and clay) that encompasses the majority of the soil column. Boulders and cobbles are also visible at the soil surface and are associated with widespread talus deposits visible throughout the central Appalachian Mountains. Where water was encountered, it occurred within the deep boulder zone. In the vernal pool cores, the uppermost lithology consisted of fine organic material overlying clay. A layer of rock was encountered in the vernal pool core at Chestnut Spring.

A swath of the central Pennsylvania Valley and Ridge province known to contain wetland depressions in headwater saddles on shale was evaluated using LiDAR imagery and topographic maps, and our ongoing assessment indicates that 100% of them contain wetland depressions (Figure 4).

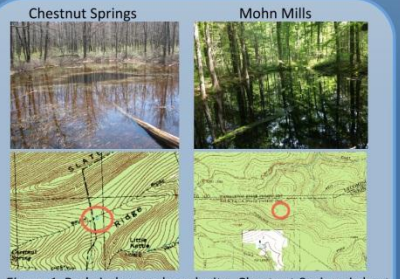

Figure 1. Red circles mark each site. Chestnut Springs is best representative of the topographic model focused on here. The many depressions at Mohn Mills exist in a headwater position but on a drainage flank rather than in a saddle.

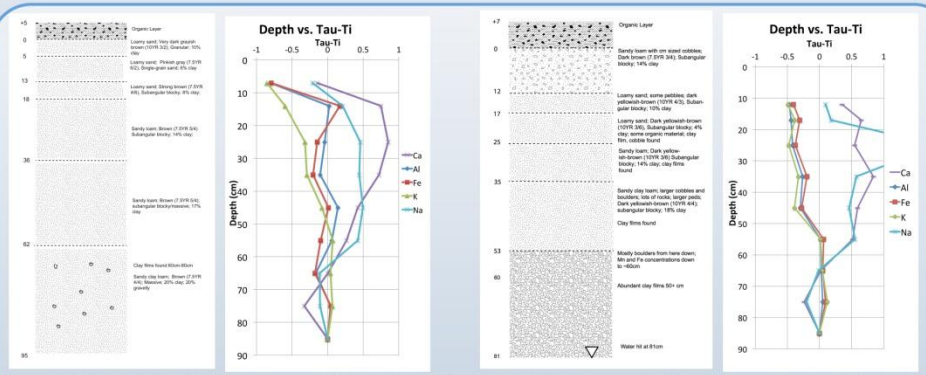

Figure 2. Soil logs and Tau plots derived from soil pit descriptions and geochemical data from samples taken at Chestnut Springs (left) and Mohn Mills (right). At Mohn Mils, Fe, K, and Al show progressive relative enrichment from the soil surface to 55 cm – the modern weathering front. At Chestnut Springs, those same elements display a more complex distribution suggestive of the presence of paleoweathering signatures or paleosols. Enrichment of Ca and Na in both profiles is interpreted as indicating the presence of plagioclase feldspar, probably derived from the fluvially-deposited Bald Eagle and Juniata Fm parent material.

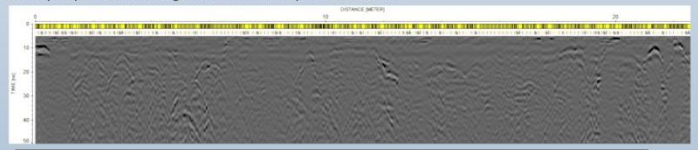

Figure 3 (left). Ground penetrating radar survey from Chestnut Springs. Note the prominent transition from a zone of hyperbolas to overlying layered structure at ~14 ns. The hyperbolas denote the boulder zone encountered at ~1 m in all dug pits, whereas the layered structure marks the sandy loam parent material of the soil. Occasional hyperbolas at the top of the profile are associated with scattered boulders encountered at the soil surface.

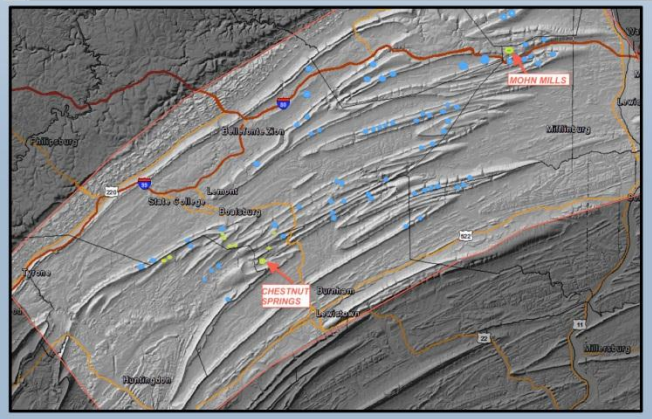

Figure 4 (left). LiDAR base map showing the location of visited and potential study sites within the central Pennsylvania study area (lightly shaded region). Red arrows denote Chestnut Springs and Mohn Mills study sites. Blue dots indicate potential study sites based on topographic location and green dots indicate verified vernal pool locations.

Conceptual Model

The similar stratigraphy of a boulder zone overlain by sand and clay with occasional boulders at the surface is interpreted to record the Illinoisan Glacial (deepest boulders), Sangamon Interglacial (sand and clay), and Wisconsinan or Last Glacial Maximum (uppermost boulder talus).

The depressions exist in headwater locations in the otherwise rugged rocky landscape that has no other depressions. They are typically surrounded by the surface boulder talus – but that does not exist in the pools. This observation suggests that something existed in the depressions at the time of talus deposition that blocked deposition of the uppermost boulders. The past presence of pingos has been interpreted in the central PA landscape (Marsh, 1987). Pingo ice could have blocked talus deposition, later melting leaving a depression that was infilled by windblow silt and clay.

Future Work

1. Analyze remaining samples from other soil pits and wetland cores
2. Run GPR crossing lines at Chestnut Springs during dry or frozen season
3. Run full GPR survey with crossing lines at Mohn Mills
4. Process and interpret all survey data
5. Review topographic survey of quadrangle maps
6. Field check all sites from topographic map survey
7. Expand survey area along the mapped glacial front and identify additional sites for focused study

References

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Acknowledgements

- NSF Grant "Collaborative Research: REU/RET Site - Introducing Critical Zone Observatory science to students and teachers
- Thanks to John Schneider for field work assistance.
- Thanks to Ashlee Dere for guidance on field soil descriptions.
- Thanks to Henry Gong for running geochemical analysis on the samples.