

Geochemical analysis of the iron-enriched soil of Meherrin, Virginia

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The red soil of Meherrin is an attractive part of the Southern Piedmont region of Virginia, largely due to its fertility. It consists mainly of ultisols of the Georgeville series with comparatively higher amounts of clay (up to 27%). Three sites in Meherrin have been assessed concerning their soil characteristics, including texture and elemental composition, to understand the cause of the color and the special properties of the soil. Samples were collected at 6-inch depth intervals using a core sampler to cover the entire soil profile.

Although Olympus X-ray diffraction (XRD) is the focus of this experiment, other techniques were also used, including:

- X-ray fluorescence (XRF) spectrophotometer to understand the role of the elemental composition in controlling the soil color and properties.
- Scanning electron microscope (SEM) equipped with an energy dispersive spectrum (EDS).

After thoroughly washing and drying the greater than 63 μm samples, the magnetic particles were manually separated with a strong hand magnet, and the elemental composition was determined by XRF. XRD analysis of the separated magnetic particles was conducted by an Olympus transmittance TERRA[®] XRD instrument with a cobalt anode.

The Fe_2O_3 content in the bulk samples is relatively high—it varies between 30% and 10%. Only in the samples from location MA does the concentration of Fe_2O_3 increase with depth, though the highest concentration Fe_2O_3 is observed in the shallowest samples. In all three sample locations, the distribution of alkali metals does not show any discernible trend.

The result of the elemental analysis of the separated magnetic fraction shows comparatively elevated concentrations of Co_3O_4 (~4740 ppm), NiO (~1060), and Cr_2O_3 (~ 1060 ppm). SEM analysis of the separated magnetic particles revealed the presence of well-preserved euhedral crystals of magnetite, hematite, and probably wustite (cubic FeO) along with magnetic spherules and relic grains with apparent widmanstätten patterns. The widmanstätten patterns may indicate an extraterrestrial or volcanic source of the iron-enriched mineral phases that are accountable for the special characteristics of Meherrin's soil.