DELINEATION OF THE BOUNDARIES OF A BURIED PRE-GLACIAL VALLEY WITH LANDSAT-1 DATA A-7

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ABSTRACT

The continuity of a narrow meandering strip of Udoll (prairie) soils running east and west for approximately 40 miles across north central Indiana in an area predominantly of Udalfs (timber soils) is apparent in LANDSAT-1 (ERTS-1) data. The dark Udoll soils occur in predominantly flat topography contrasting sharply in satellite imagery from surrounding light colored Udalf soils in the characteristically rolling, undeveloped landscape of the late Wisconsin till plains.

The data for the LANDSAT-1 imagery over central Indiana for June 9, 1973 were processed through a clustering procedure and classified with resulting increased definition of the boundaries among soils grouped according to nine categories and vegetation to two categories of reflectance.

This dark stretch of prairie soil is believed to have formed in the heavy textured, poorly drained glacial debris which filled a major pre-glacial tributary of the Teays River system. This valley was apparently reoccupied and partly reexcavated by surface drainage during interglacial times following retreat of the Kansan and Illinoian age ice invasions. Final filling of the valley occurred during retreat of the East White sublobe of the Wisconsin stage ice.

Interestingly enough, the origin and the continuity of this meandering stretch of prairie was not recognized by soil scientists who over a 60 year period, mapped the three counties which encompass it. Furthermore, geologists who had been searching for the exact location of this buried valley had been unsuccessful until the LANDSAT data provided an adequate synoptic view.

Ready identification and location of the valley has significance to soil survey and land classification people as a guide to soil classification and land use and to geologists as a guide to location of a potentially economically significant aquifer.

INTRODUCTION

LANDSAT-1 data for west central Indiana revealed an anomalous reach of dark land meandering in an east-west direction through an area of lighter colored soils. Field studies of the soils and geology of the region reveal the dark area to consist predominantly of prairie soils in contrast to surrounding timber soils. Also the dark strip is found to delineate a long sought buried tributary of the Teays preglacial river system.

The results of the study suggest a technique for using LANDSAT data to locate other buried valleys which may be important sources of ground water and mineral deposits.

TECHNIQUES

Multispectral scanner data acquired during a LANDSAT-1 overpass on June 9, 1973 was classified with the standard LARSYS classification procedure into eleven spectral classes: five classes of very dark-colored soils, two of soils of intermediate tone, two of light-colored soils, and two of green vegetation. Corn and soybeans, which covered most of the cultivated land in this area in the 1973 growing season, by June 9 had not produced enough canopy to interfere noticeably with the reflected radiance from bare soil. A plot of relative reflectance was made along a north-south transect south of Frankfort, Indiana and perpendicular to the east-west reach of dark-colored soil.

DISCUSSION

The continuity of a long, narrow, meandering strip of prairie soils traversing approximately 65 km in an east-west direction across north-central Indiana was first noted on LANDSAT-1 imagery. This particular reach of dark-colored soils, although mentioned as a local phenomenon in three individual county soil survey reports, was not previously

recognized as a continuous feature. Early residents also apparently were unaware of the true extent of this long, ribbon-like stretch of dark-colored land, because they gave it local names at different places, such as Round Prairie, Clinton Prairie, Twelve Mile Prairie, and Vinton Prairie.

In Figure 1 the stretch of dark-colored soil is seen meandering through and bounded by the lighter colored soils which are predominant in this region. The plot of reflectance across the dark soil area shows measureably lower reflectance of the dark area (Figure 2).

The dark-colored soils are of the Aquoll and Udoll suborders. These soils have developed under grassland vegetation. The Aquolls represent more poorly drained soils than the Udolls. The lighter colored, surrounding land consists primarily of Udalfs, soils developed under northern hardwood forests. Pioneers found the light-colored soils dominant on the undulating till plain terrain, which was heavily forested with such deciduous trees as walnut, poplar, hickory, beech and oak. Before artificial drainage and cultivation, the linear, meandering stretch of flat, dark-colored land was mostly poorly drained and vegetated with grasses, commonly "marsh grasses".

The darkness of Udoll and Aquoll soils, in contrast to the lighter colored Udalfs, results from a balance between additions of organic matter to their surface layer and the rate of decomposition. The equilibrium level for organic matter content and consequently darkness of color typically is greater in the surface layers of grassland soils than in timbered soils.

Specially trained crews of soil scientists have on two occasions mapped the area in detail without recognizing that the dark-colored soils belong to a single linear, long, meandering strip of terrain (Hurst and Grimes, 1914, Tharp et al, 1914, Ulrich et al, 1959). Had this fact been discerned at the beginning of soil survey work in this area, the survey would have been expedited more quickly and effectively and costs reduced. Geological field studies, using conventional surface mapping and subsurface analysis of water well records, had suggested as early as 1915 that a buried preglacial valley might traverse the area. However, the synoptic view provided by LANDSAT-1 imagery shows the true extent and character of the dark-colored soil, permits a more accurate definition of the probable course and boundaries of the ancient stream, and reveals regional relationships which previously could only be surmised from extant data.

The area is located just a few miles east of the classic eastern boundary of the Prairie Peninsula or Prairie Point which extends from the west into lands predominantly covered by hardwood forests at the time of settlement. (Trewartha, 1968, Brochert, 1950). The anomalous extension of grasslands into an area where the macroclimate favors hardwood forests results from the flat topography and fine-textured surface material filling the old valley. These naturally poorly drained soils favor grasses rather than trees.

This buried valley, recently named the Clarks Hill Valley (Maarouf and Melhorn, 1974) on the basis of subsurface geological analysis, is evidently a major preglacial tributary of the Teays River system. This valley was apparently reoccupied and at least partly reexcavated by surface drainage during interglacial times following retreat of the Kansan and Illinoian age ice invasions. Final filling of the valley occurred during retreat of the East White sublobe of the Wisconsinan stage ice. This recession also produced a rather flat till plain surmounted by a few crevasse-fill deposits or kames. The old valley may have remained slightly lower topographically even during retreat of the Wisconsinan ice, and for a time may have provided ice border drainage to the newly-formed Wabash River below Lafayette. With gradual cessation of meltwater flow, the linear depression became a series of ponds or sloughs which infilled with lacustrine silts and clays or colluvial deposits. This eventually raised the old valley floor level nearly to that of the adjacent terrain. The Udoll and Aquoll soils seen on the LANDSAT-1 imagery developed on these infill materials.

These differences in soils and terrain of the valley compared with the surrounding lands has a noticeable effect today on farming practices and economic conditions. Figure 3 shows a farmstead in the valley fill area with typically new and abundant grain storage equipment, whereas Figure 4 shows a typically modest farmstead in the rolling terrain and lighter colored soils of the till plain which surrounds the valley.

CONCLUSIONS

The results of this study suggest that elsewhere in the glaciated plains region of central North America, machine classification of spectral response from soils and vegetation may have value in defining and tracing similar buried valleys whose position is poorly known or whose presence is only suspected. The valleys are locally important sources of groundwater and industrial mineral deposits.

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Figure 1. Dark-colored Udoll and Aquoll soils delineate the surface of a buried preglacial valley in Indiana.

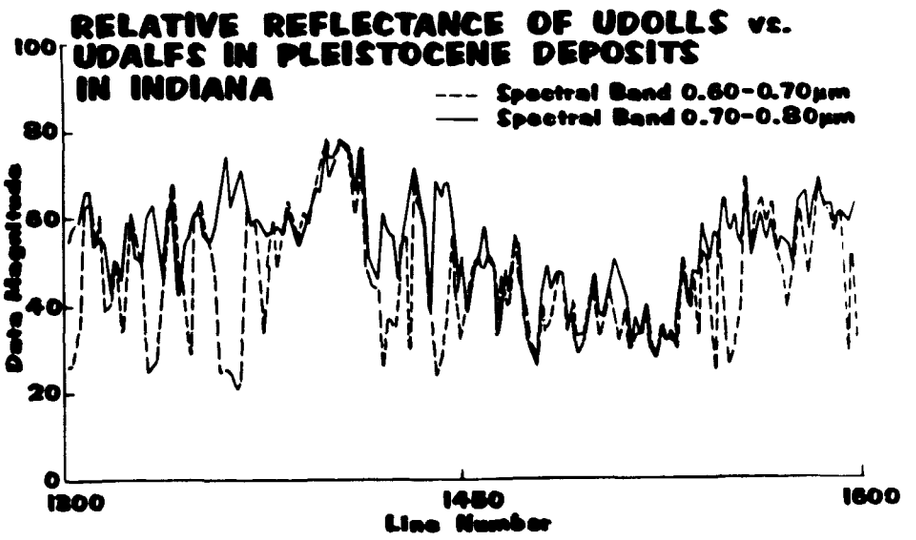

Figure 2. Relative Reflectance along north-south transect across buried Clarks Hill Valley. Reflectance is lower across the darker soil.

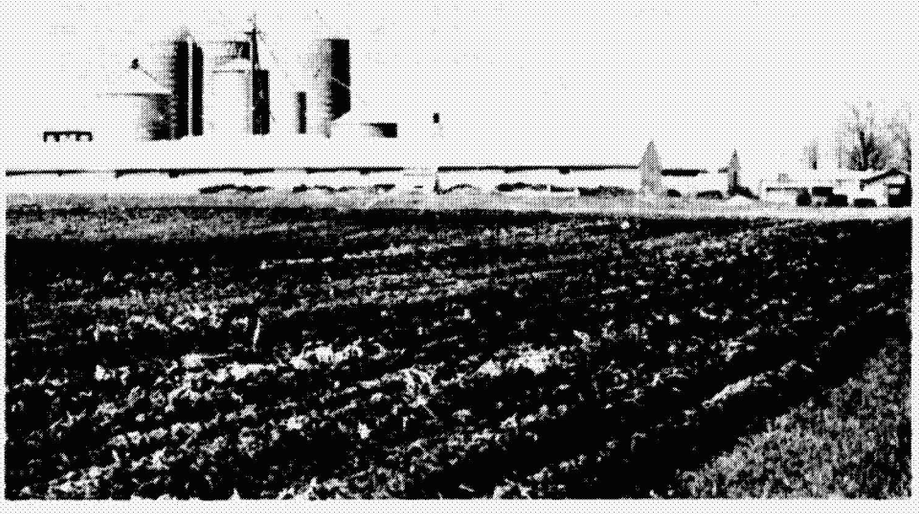

Figure 3. Homestead on Aquoll soils on surface of buried Clarks Hill Valley reflects high soil productivity.

Figure 4. Homestead on Udalf Soils reflects lower productivity than found on Udoll and Aquoll soils of the adjacent Clarks Hill Valley.