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RECONNAISSANCE CLAY MINERAL MAPPING IN SOUTHWESTERN ONTARIO BY MICROCOMPUTER PROCESSING OF RADIOMETER REFLECTANCE DATA

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SUMMARY

Knowledge of the mineralogical composition of soil and overburden cover is important in a number of disciplines including; agricultural science, studies of toxic waste disposal, and exploration for industrial minerals. Overburden (and rock) mineralogy may be determined by a number of laboratory methods including petrographic, geochemical, differential thermal analysis and x-ray diffraction techniques. Whilst these techniques are effective they are slow and costly and therefore not generally applicable to reconnaissance or regional surveys.

Recently, portable instrumentation has been developed (CLAYPAK) which facilitates rapid, semi-quantitative analysis of the kaolinite, biotite, smectite, illite, mixed layer smectite/illite clay minerals and chlorite modal content of soils and rocks. CLAYPAK utilizes the Barringer Hand Held Ratioing Radiometer (HHRR) and an active light source to measure sample reflectance at 1.86, 1.9, (optionally 2.2), 2.65, 2.68, 2.71, 2.73, 2.75 and 2.77 micrometers. These reflectance data are input to a spectral deconvolution algorithm which executes on a modified Epson HX-20 microcomputer which is interfaced with the HHRR, to give estimated modal percent mineral composition.

The deconvolution algorithm is relatively simple consisting of a least squares fit of three spectral components: 1) the sample spectrum; 2) the spectrum; 3) the theoretical spectra of various clay mineral mixtures. The estimated, least squares mineral content is then modified using a series of empirical selection rules to reduce the effect of known interferences. Previous work has shown this technique compared favourably with semi-quantitative x-ray diffraction results on a test suite of samples.

Clearly, the CLAYPAK instrumentation offers a number of advantages over laboratory based techniques for regional and reconnaissance surveys of soil and rock clay mineralogy. The objective of this study was to obtain such mineralogical data for overburden samples from the Windsor-Essex area of Southwestern Ontario, Canada and to compare the mineralogic data with known Quarternary geology, and regional LASWETRACE™ geochemical data.

The study was carried out in an area of approximately 200 square kilometers bounded by a line intersecting Amherstburg to the north, Colchester to the east and the shore of Lake Erie to the south and west. Surface overburden samples were obtained at a density of approximately 1.3 samples per square kilometer. Quarternary deposits in the area consist of Pleistocene and recent non-stratified drift (i.e., till) and stratified drift (i.e., sand and gravel of glaciofluvial origin, loam of fluvial origin and gravel, sand, silt and clay of glaciolacustrine or lacustrine origin). Recent deposits consists primarily of reworded pleistocene deposits as alluvium and shoreline sand and gravel deposits.

The oldest and most widespread Quarternary deposits fround in the area are tills formed during the Winsconsinan. Three types of till have been defined; a sany silt till; a clayey silt till; and a sandy loam till. The first type is most common in the study area. Areas of glaciofluvial gravelly sand, medium sand and clay rich glaciolacustrine sediments occur as a thin discontinuous cover of southeast-northwest trending lenses and bands overlying the sandy silt till.

The distribution of clay minerals and geochemical data in the study area are presented as contoured plots. Certain patterns are revealed by the two data sets and are correlated and these are interpreted with respect to the distribution of overburden types. This study demonstrates the feasibility rapidly mapping clay mineralogy by computer processing of remotely sensed reflectance data, at a fraction of the cost of previously available techniques. Potential applications of the procedure to agriculture, toxic waste disposal site selection and exploration for industrial minerals are discussed.