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OCCURRENCE OF DETRITAL MINERAL MATTER IN OKEFENOKEE PEATS

by

Michael J. Andrejko and Robert Raymond, Jr.

Peat, the precursor of coal, is predominantly composed of partially decomposed plant debris along with varying amounts of inorganic material. This inorganic matter (often referred to as "ash") consists of a mixture of distinct mineral species and ionically-bound or complexed inorganic compounds. The composition of this inorganic fraction is controlled by a variety of botanical and depositional environments and processes. The peats used in this study are from the Okefenokee Swamp, a low-sulfur, exclusively fresh water analog of an ancient coal-forming environment. Unlike other peat deposits, the inorganic fraction of Okefenokee peats is primarily composed of silica, most of which consists of biologically-derived, authigenic particles[1]. However the peats do contain non-biogenic mineral particles of both a silica and non-silica composition. The purpose of this project was to determine grain textures and elemental compositions of the non-biogenic particles through use of scanning electron microscopy (SEM) and energy dispersive x-ray (EDX) analysis. Analytical results indicate that many of these mineral particles are detrital in origin.

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Methods of Analysis

Peat samples were collected using a piston coring device developed by Cohen and Spackman[2]. The cores (7.5 centimeters in diameter) were taken in sections 120 centimeters in length from two major peat-forming environments. These consisted of a marsh habitat located in Grand Prairie and a swamp-forest environment located near Minnie's Lake. At each site, the cores were sealed within aluminum coring tubes to await transportation to the laboratory.

At the laboratory, the cores were cut open and separated into halves. After initial descriptions of macroscopic features were completed, the material inside the cores was sampled at intervals of 7.5 centimeters. One half of each sample was used for ash and mineralogical determination. Samples were placed in glazed porcelain crucibles (which were pre-fired and pre-weighed) and oven dried at 105°C for 16 hours. After moisture content was determined, the crucibles were placed in a temperature-regulated muffle furnace and ashed at 550°C for 16 hours to determine total ash content. The ashed material was digested in dilute HCl and filtered through ashless filter paper. Each filter paper was placed into the corresponding original crucible and ashed again at 550°C for 1 hour. The resultant residue was retained for analysis. The basal mineral sediments were also ashed and acidified prior to being processed for grain size analysis. The sand and silt size fractions were examined separately.

Each ash residue from the above process was split into equal sub-samples. One sub-sample was dispersed on an aluminum stub, sputtered-coated with gold palladium and examined with an ISI Model DS-130 scanning electron microscope. Qualitative elemental composition of the mineral particles within the inorganic residue was determined by use of a Kevex energy-dispersive x-ray analysis unit attached to the SEM.

Results

Identification of mineral forms in the residue was based on observed elemental ratios and grain morphologies. Tentative identifications were then compared to mineral suites known to occur within the surface sediments of the Georgia Coastal Plain[3].

Figure 1a illustrates a residue from the marsh peat sampled in Grand Prairie. The majority of the background particles are biogenically derived siliceous sponge spicules. The large grain exhibiting frosted texture is composed exclusively of silicon oxide (Figure 1b) probably in the form of quartz or chert. Occasionally other silicates were present within peat samples, an example of which is shown in Figure 2a. Crystal structure and elemental ratios (Figure 2b), suggest that this grain is an amphibole. However non-silica mineral grains formed an extremely small proportion of the non-biogenic mineral matter within the peat.

Within the mineral sediments at the base of the Minnie's Lake core, non-silica mineral matter constituted a relatively higher proportion than within the overlying peat. Observations indicated a greater abundance of these non-silica particles in the silt size fraction than within sand-sized material. Most of the basal materials exhibited weathered surface textures. Examples of weathered, non-silica particles from the basal mineral sediments can be seen in Figures 3 to 6. Figures 3a and b show a sub-rounded titanium oxide mineral, possibly rutile or leucoxene (a weathering product of ilmenite). Examples of silicate particles included an aluminum silicate (Figures 4a,b) possibly kyanite or sillimanite, and potassium aluminum silicates, possibly illite (clay mica) (Figures 5a,b), and K-feldspar (Figures 6a,b).

Discussion and Conclusions

There has long been a controversy regarding the origin of mineral matter in coals. Some researchers, such as Cecil[4], have advocated an authigenic origin for most minerals. Others, such as Finkleman[5], felt that although some minerals might have been authigenic in nature, there was strong evidence for substantial detrital input into the original coal-forming environment. He also felt that some minerals which might be considered by some as authigenic, were actually diagentic alterations of detrital material. Such views however are somewhat premature without detailed examination of the original minerals that occur within a modern coal-forming environment. In peat deposits where there are considerable influxes of fluvial or marine mineral-rich sediments, it is rather easy to readily identify various mineral components by x-ray diffraction (XRD). However, in environments such as the Okefenokee where the occurrence of non-silica minerals is rare, these minerals have been somewhat ignored due to their small sample populations. However by separating out (and thus concentrating) the inorganic residues from the peat, one can use SEM and EDX analysis to determine genesis of particles. Some of the mineral particles (e.g. Figures 1a, 3a, and 4a) exhibited weathered textures possibly due to transportion. In addition, the elemental composition in conjunction with the crystal forms of some of the grains (e.g. Figures 2 and 3) are not compatible with an authigenic origin. .

An advantage to EDX analysis in conjunction with SEM is that it permits non-destructive and simultaneous mineral determinations to be made while engaged in other SEM work. Such collaborative work has included identification and description of siliceous biogenic structures (e.g. diatoms, phytoliths and sponge spicules)[1]. The end result is that a more effective procedure, than for example XRD, is available for determining the mineralogy and geochemistry of minute individual particles in peat. In addition, SEM with EDX analysis allows for better documentation of the possible diagenetic alterations of residual minerals during peatification. This permits greater insight in the development and conceptualization of more realistic depositional and geochemical models regarding the origin of mineral matter in coal. We wish to note that subsequent refinements have demonstrated the versatility of the technique in that it can also be used for in-situ studies of the mineral particles within thin-sections of peat[6].

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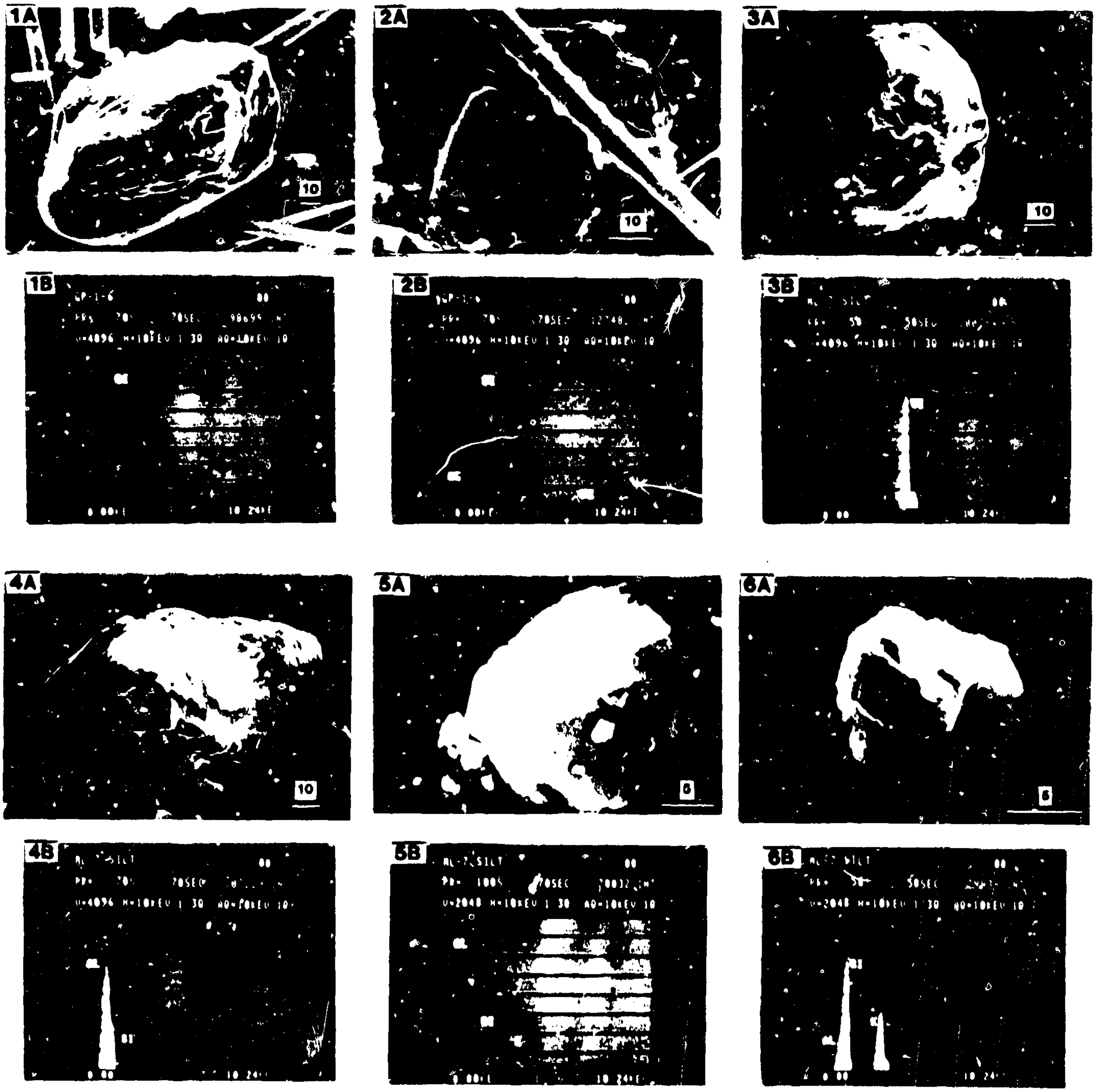
Figure Captions

FIGURES 1 - 6: SEM photomicrographs and respective energy dispersive spectra for detrital minerals from the Okefenokee Swamp. Particles in Figures 1 and 2 are from a marsh peat from Grand Prairie. Particles in Figures 3 - 6 are from mineral sediments at the base of the Minnie's Lake core. Presumed mineralogies of the particles shown in the figures are: (1) quartz; (2) amphibole; (3) rutile or leucoxene; (4) kyanite or sillimanite; (5) illite (clay mica), and (6) feldspar.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