TITLE: ELECTROSTATIC SURFACE STRUCTURES OF COAL AND MINERAL PARTICLES **DATE:** May 8, 1994

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I. ABSTRACT

OBJECTIVE: The aim of our studies is development of a comprehensive physical and chemical model for electrostatic charging of coal carbons and mineral particles. Properties of the fundamental constituents of coal are analyzed in relation to bulk coal powders processed with a laboratory scale electrostatic separator. Characterization techniques include: quantitative sulfur analyses, single particle charge and mass measurements, petrographic analyses, ultraviolet photoelectron spectroscopy, and effects of chemical conditioning agents and oxidation on beneficiation. Electrostatic beneficiation may become commercially viable when the factors which influence charging properties of each maceral and mineral type is understood.

WORK DONE AND CONCLUSIONS:

A fluorescence petrographic microscope was equipped with a cube and polarizers for white light observation of coal particles and bulk coal specimens. This allows for improved ability to differentiate maceral and mineral types. In one study, charged copy machine toner powders are deposited onto charged or uncharged polished coal specimens. The powder deposits onto different types of macerals and minerals on the coal surface depending on experimental conditions. For example, when both the coal sample and powder are charged, powder deposits primarily on interfaces between macerals and minerals. Fringe field effects thus dominate. Conversely if the coal is not charged, then the charged toner powder adheres preferentially on inertinite macerals. Deposition of charged toner on inertinite is likely due to image charging of the inertinite by the toner since inertinite is the most electrically conductive maceral.

Based on experiment and theory, the main points of our current chemical model for charging are as follows: Inertinite macerals are readily charged positive by induction. Among coal carbons, liptinite macerals adopt the highest charge due to metastable fluorescent electronic states. The lesser positive or

even negative charge observed for oxidized coal carbons is attributed to proton transfer from carboxylic functions and electron acceptor behavior of surface oxygen species. Pyrites adopt a negative charge by electron transfer to disulfide ions of the crystal surface. Oxidized pyrites adopt a lesser negative charge due to proton transfer from atmospheric moisture onto weakly acidic oxide species on pyrite surfaces.

It is accepted that oxidized coal surfaces are detrimental to the efficiency of electrostatic beneficiation. Current studies include use of SO_2 gas as a conditioning agent to enhance oxidized coal and mineral powder charge properties. The theory is that SO_2 as a reducing agent, reacts with oxidized particle surfaces. The resulting surface modified by redox disproportionation of SO_2 and oxidized surface species may exhibit improved properties for beneficiation.

Ultraviolet Photoelectron Spectroscopy (UPS) will provide electron work function data for individual macerals and minerals. Work function data will then be related to triboelectric charging data. An older non-functional spectrofluorometer, Turner 430, is being converted for use as a UPS instrument. The Xenon arc lamp has been replaced and the eliptical collection mirror and plane folding mirror have been repolished and recoated. A free air photoelectron emission detection system similar to one reported by Kirhata and Uda (Rev. Sci. Inst. 52(1), 1981) is being studied for development here.

Experimental Studies of the charge distribution of triboelectrically charged particles as a function of size will be made. An instrument is being developed for this purpose. A video camera is used to capture images of airborne particles as they flow through a region subjected to an alternating electric field. The image is analyzed to obtain the amplitude and phase of the particle motion in the AC field and the settling velocity of the particle. This information is used to calculate charge and aerodynamic diameter for each particle in the video frame. Ten frames per second can be analyzed with up to 15 particles per frame. The prototype instrument is nearing completion.

Another method of measuring particle size and charge is to look at the response of particles to an oscillating electric field around a toroidal electrode. Computer algorithms have been written for calculating the electric field in three dimensions around an isolated toroid. Particle motion has been computed with inclusion of viscous and gravitational forces for a variety of particle diameters and charges.