TITLE: COMPREHENSIVE INVESTIGATION OF THE LIBERATION CHARACTERISTICS OF PYRITE AND OTHER MINERAL MATTER FROM COAL

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ABSTRACT

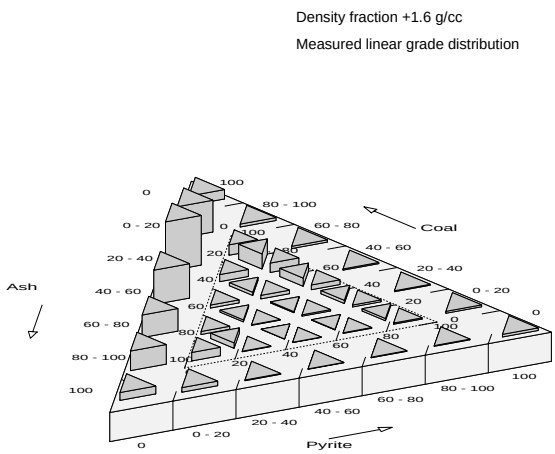
OBJECTIVE: The objective of this project is the development of methods for the measurement, prediction and modeling of the liberation characteristics of mineral matter and pyrite from coal, and to implement these findings in viable computer-simulation systems for coal cleaning plants. The central thrust of the project will be based on using the Andrews-Mika diagram as a convenient and experimentally verifiable model for the liberation characteristics of the constituents of coal during comminution. In order to establish the Andrews-Mika diagram, it is necessary to develop efficient techniques for density fractionation and for the measurement of the liberation spectrum in products obtained from the comminution of narrow composition fractions of coal. Dense-liquid techniques are used to produce fractionated samples, and image-analysis techniques, using linear-intercept analysis, are used to measure the liberation spectrum. The prediction of the liberation of mineral matter and pyrite from coal after comminution is based on a linear stochastic model for the description of the mineralogical texture and the random fracture pattern associated with the comminution process. Stereological correction of the distribution of linear grades is required for both the measurement and prediction of the true distribution of volumetric grades in the particle population.

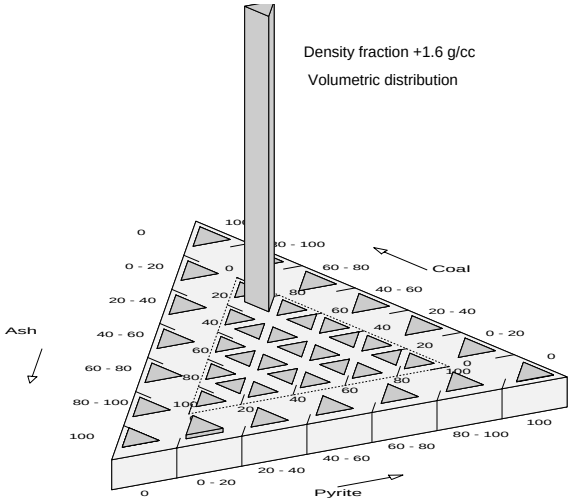
WORK DONE AND CONCLUSIONS: An approximate Andrews-Mika diagram for the comminution of Pittsburgh #8 coal at a parent size of 710-1000 microns and a parent density in the range 1.29-1.31 g/cc has been constructed. The procedure was based entirely on dense-liquid fractionation. The parent particles were comminuted in an ultrasonic grinding mill and the progeny larger than 38 microns was fractionated at 1.25, 1.27, 1.29, 1.31, 1.33, 1.35, 1.37, 1.39, 1.45, 1.50 and 1.60 g/cc. Each of these fractions was screened at 500, 355, 251, 180 and 106 microns so that the complete disposition of the progeny particle populations could be established in the particle, size particle density space. This yielded an equivalent 2-component Andrews-Mika diagram for this parent population. The diagram is consistent in its general characteristics with equivalent Andrews-

Mika diagrams determined for sulfide ores but shows characteristically slow liberation as the particle size decreases. This is to be expected because of the fine-grained texture of the ash minerals and pyrite in the coal.

The essential nature of this project requires a technique for the measurement of three component mineral liberation distributions and the only viable technique for this is image analysis. In order to use image analysis, it is necessary to be able to make images of mounted and sectioned particles as well as unbroken coal, which clearly distinguishes each of the three phases that are important and which enables the individual particles to be distinguished from the mounting medium. Successful techniques have been developed to produce these images by scanning electron microscopy using back-scattered electron detection. Using this technique and appropriate image processing and image analysis algorithms, the linear-intercept distributions three phases in the unbroken coal samples have been established for Pittsburgh #8. In addition, the Markov matrix of phase-to-phase transition probabilities for a linear probe that penetrates the coal has been determined. These data form the input to the linear stochastic model for the prediction of liberation after comminution. Images have been collected from the progeny material from the Andrews-Mika experiment and from six individual size fractions of the Pittsburgh #8 coal sample. The linear-grade distributions have been determined for these samples.

A stereological correction procedure has been developed for three-component systems using an inversion kernel that was determined by generating computer simulated particles at 43 different particle compositions. This kernel has been demonstrated to be effective for stereological correction using the inversion procedure based on entropy regularization. An example of the stereological correction is shown in the figures. These show the measured distribution of linear grades and the corresponding volumetric distribution in the +1.6 g/cc fraction.





Publications, presentations and reports

1 King R P and Schneider CL Comparison of Stereological Correction Procedures for Liberation Measurements. Accepted for publication in Trans. Instn. Mining and Metallurgy. 1997

2 King R P Practical Optimization Strategies for Coal Washing Plants. Presented at 1997 Annual Meeting SME Denver Feb 1997 Preprint 97-70

3 King R P and Schneider C L Strereological Correction of Linear Grade Distributions for Mineral Liberation. Submitted to Powder Tecnology 1997