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Quantitative Inorganic Profiling of Coal Seams Using Core-Scanning and Hand-held X-ray Fluorescence Techniques

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Detailed quantitative profiles have been produced to show the abundance and distribution of inorganic elements in exploration cores of coal seams using an Itrax core scanner (Cox Analytical, Sweden). Such an approach allows non-destructive evaluation of the ash yield, ash chemistry and sulphur profile in a coal seam, identifying horizons at which particular inorganic components may be concentrated, evaluating relationships between different elements in the coal, and guiding sampling for conventional analysis programs [1]. In conjunction with X-radiography, carried out as part of the scanning process, the results may also assist in understanding the mode of occurrence, formation and distribution of the different minerals within the seam, and in the design of facilities for optimum beneficiation of the mined coal products.

Calibration curves were prepared for key major elements (Al, Si, P, S, K, Ca, Ti and Fe) based on pressed pellets of independently-analysed reference coals [2]. The calibrated XRF data were used to produce a set of quantitative element and element-oxide profiles, which were plotted alongside the relevant X-radiographic and optical images to provide an integrated basis for assessing the variations in inorganic element characteristics through the core. The results were also compared to conventionally-determined chemical and mineralogical data for representative cores, to confirm the validity of the quantifications developed.

Although Na and Mg were below detection limits and could not be measured, the sum of the other major elements, expressed as oxides, was found to be approximately the same as the ash yield of the coal. The sum of the oxides is also inversely related to the level of Compton backscatter from the coal measured by the core scanner, allowing correlation with the same parameter used in down-hole geophysical (density) logging as an indicator of coal quality and ash yield. Factors such as interval spacing (spatial resolution) and measurement time (analytical precision) were evaluated as part of the program, to identify optimum, cost-effective combinations of scanning parameters for different industry and research applications.

The capacity of hand-held portable XRF analysers to provide similar data on coal cores has also been investigated, including separate calibration tests and comparative studies against the laboratory core-scanning system. Measurement of inorganic element concentrations at points 10 mm apart on a coal seam core, for example, was found to provide a similar profile for most elements to that obtained at a similar spacing by the laboratory scanner. Data from such hand-held instruments may be used to evaluate the quality of potential working sections at the mine or drill site, to correlate seams and seam sub-sections in deposit evaluation, and to identify intervals more effectively for conventional sampling and analysis programs.

A series of pressed pellets, prepared from measured blends of low-ash coal with different mineral components, is currently being developed as calibration standards to facilitate the use

of hand-held XRF analysers on coal seams. Other factors that may affect results from hand-held XRF units when used on coal are also being evaluated.

References:

[1] Kelloway, S et al. (2014) International Journal of Coal Geology 128-129: 55-67
[2] Kelloway, S et al. (2014) Powder Diffraction 29 (S1): S28-S34