Profiling of P and S in Mozambique coal using an XRF core scanner

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Elements such as phosphorus (P) and sulphur (S) are deleterious in coal utilization. These elements are mostly associated with minerals, such as apatite [$Ca_5(PO_4)_3(OH, F, Cl)$] and pyrite (FeS_2); S may also be present in the coal's organic structure. To assess the potential for their removal, it is important to understand the relationship between the organic and mineral components, and the distribution of minerals and inorganic elements within the mined coal seam.

Automated core scanners, such as the Itrax XRF core scanner, allow acquisition of a detailed profile for most inorganic elements (major and trace) without the necessity of subsampling or destroying the core, thus maintaning its integrity, and for quickly identifying problematic areal associations. In this project 33 m of core from the Chipanga Seam, Karoo Coal Measures, Moatize Sub-basin (Mozambique) of Early Permian age, were scanned using facilities at the University of New South Wales. A Cr anode (1.8 kW) was used as the X-ray source, rather than Mo, partly because it has higher sensitivity for measuring P and S. The XRF measurement was conducted at 30kV and 30 mA, with a step size of 500 μm and an exposure time of 30s per step.

The chemical profiles obtained for Ca and P showed three different zonations within the seam. SEM/EDS analysis of polished sections identified apatite, occurring with clays in the cell lumens of inertinite macerals in the lower part of the seam and inside fractures with quartz in the the uppermost part of the seam. In the first case, the apatite was probably formed syngenetically in the early stages of peat formation; in the second it was of epigenetic origin, with the P coming either from magmatic fluids or remobilization from the lower part of the seam. Profiles for Fe and S show the distribution of pyrite, which occurs especially in carbonaceous mudstones. S is also present continuously throughout the core, representing an organic sulfur component. SEM/EDS analysis indicates higher S in the vitrinite layers. Marine influence, which is usually associated with pyrite formation, has not been identified in the Moatize coal deposits.