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Potential Land Contamination Associated with Solid Chemicals Mobilized by Spontaneous Combustion of Coal

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Coal has been a global energy source for a long time and has played a vital role in the growth and stability of world economy. Sixty countries across the globe mine about 5,000 million ton of coal annually. South Africa is the fourth largest coal producer in the world, with an annual production of about 300 million tons. Given the size of South Africa's coal mining industry, it is no surprise that its environmental impacts are considerable. Coal mining unfortunately tends to make a notable impact on the environment, the impacts varying in severity depending on whether the mine is working or abandoned, the mining methods used, and the geological conditions. Opencast and underground coal mining has promoted the proliferation of coal fires, some burning for decades. Overburden rocks and dumps, often contaminated with waste coal present the risk of ignition. Once ignited, the dumps are very difficult to put out, and some dumps left by previous generations continue to smolder. This paper presents the potential risk of land contamination associated with the solid by-products mobilized during spontaneous combustion of coal in South Africa's coalfields. We described and documented the coal-fire gas minerals (CFGM) that form as a reaction product of gas produced by burning coal seam and waste dumps. Chemical compounds associated with burning coal fires are identified, along with the trace-elements released from coal and associated sediment during ignition. The coal fire gas-minerals (CFGM) identified included sulfur compounds and salammoniac. X-ray diffraction (XRD) studies of CFGM by-products confirmed the presence of mascagnite [$(NH_4)_2SO_4$], illite {$(Al, Si)_4O_{10}[(OH)_2 \cdot H_2O]$} letovicite [$(NH_4)_3H(SO_4)_2$], phlogopite [$KMg_3(AlSi_3)O_{10}(F, OH)_2$], titanium dioxide ($TiO_2$), barite ($BaSO_4$), iron sulfate ($FeSO_4$), gypsum ($CaSO_4 \cdot 2H_2O$) and silicate. The minerals are interpreted to have formed by condensation or sublimation; several may be alteration products. Other heavy elements found in the CFGM's are mercury, arsenic, lead, zinc, and copper. Arsenic and mercury were the major elements of potential environmental significance found accumulating around coal fire vents. One of the impacts from burning seams and dumps is the release of sulfur oxides. The sulfur compounds are concentrated in the wastes, and so contribute far more than the equivalent amount of clean coal. Another risk from the surface dumps is the slow oxidation of the sulfur compounds and the leaching of the resultant acid by rainwater percolating through the dump. The resultant impact is salination of the stream by dissolved sulfates, and, in a water-poor country like South Africa, this is to be avoided as far as possible. Gas exhaled from numerous vents and solid combustion by-products associated with the gas have the potential to serve as vectors for the transmission of toxins to humans by atmospheric pollution, food grown in soils that contain these solids, or even by wind-blown dust particles that are inhaled. The nature of the risks to human health and the environment of most of the CFGM by-products of spontaneous combustion in these coalfields are unknown and merit investigation.