

Low rank coal aquifers and kidney disease: evidence from Portugal, the Balkans, and the USA

^aFinkelman R.B, ^bFlores D, ^cOrem W, ^dTatu C

Coal-derived organic compounds have been found in aquifers associated with low-rank coals (lignites and subbituminous coal) in the Balkans, in Portugal, and in the USA. Laboratory leaching experiments have demonstrated that low rank coal releases large amounts of dissolved organic substances when leached with water. Similar types of organic compounds are detected in ground water flowing through aquifers with stratigraphically-associated lignites. Where people are drinking this water there appears to be an increased incidence of kidney diseases including renal pelvic cancer and a tubulointerstitial kidney disease known as Balkan Endemic Nephropathy (BEN). BEN is confined to a number of clusters of rural villages in Romania, Serbia, Bosnia, Croatia, and Bulgaria, and the geographic relationship between the occurrence of BEN and Pliocene lignite deposits is robust. All BEN villages use untreated water from shallow wells or springs as the primary water supply. A high percentage of the people living in the endemic regions suffers from end stage renal failure and requires dialysis treatment. In east Texas in the USA, the number of dialysis beds per unit population is two to three times higher in regions where people are drawing water from the lignite-bearing

aquifers than in adjacent regions where people are drawing surface water and water from aquifers not associated with lignite deposits. Significantly, there is no difference between the regions in the incidence of diabetes, the main cause of kidney failure. Similarly, in semi-arid Wyoming, and the Dakotas in the USA residents of rural areas use subbituminous coal as a primary aquifer for drinking water supplies. This water contains coal-derived organic substances that may be nephrotoxic. It is noteworthy that Wyoming and the Dakotas have among the highest rates of renal pelvic cancer in the USA. Toxicological studies using human kidney cell lines exposed to organic matter isolated from ground water in coal aquifers from BEN areas and elsewhere have demonstrated toxic effects on the cells. While not conclusive, these relationships indicate that organic compounds in the waters may be an important contributing factor for regional kidney disease. In Portugal, Carbon-13 nuclear magnetic resonance spectra of the Pliocene Rio Maior lignites are very similar to the spectra from lignites in the endemic areas of the Balkans. Hence, the toxic organic compounds leached from the Portuguese lignites could contaminate the aquifers in the region and lead to kidney disease.

^a University of Texas at Dallas, Richardson, TX 75080, USA (bobf@utdallas.edu)

^b Departamento e Centro de Geologia, Faculdade de Ciências, Universidade do Porto, Rua do Campo Alegre, 687, 4169-007 Porto, Portugal

^c U.S. Geological Survey, 956 National Center, Reston, Virginia 20192, USA

^d University of Medicine and Pharmacy Timisoara, Timisoara, Romania RO-300708