

# ARSENIC IN COAL AND STREAM SEDIMENTS FROM THE APPALACHIAN BASIN, KENTUCKY

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Arsenic (As) enrichment in coal and stream sediments have been documented in the Warrior Basin, northwestern Alabama (see Goldhaber and others, this workshop) and is attributed to interaction of Warrior rocks and coal with metamorphic fluids generated during the Allegheny orogeny. Similarly derived fluids are expected to affect the rocks and coal in the Appalachian Basin to the north as well (fig 1).

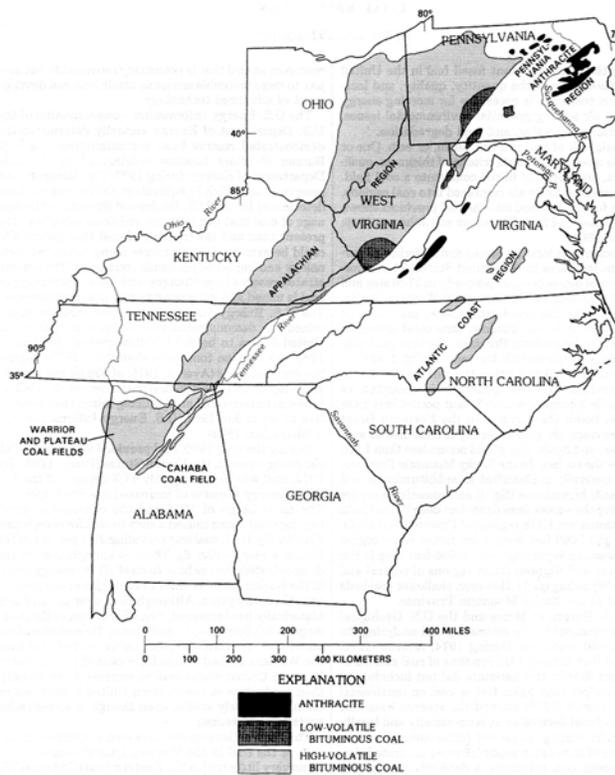


Figure 1. Map of the Appalachian Coal Region in Eastern USA. Study area is that portion of the region in Kentucky (modified from Britton and others, 1989)

Over one half the arsenic concentrations in 780 eastern Kentucky coals exceed the As mean<sup>3</sup> concentration for US coals (7.6 ppm; Bragg and others, 1997). Concentrations of arsenic in these Kentucky coals are as high as 680 ppm (whole-rock basis). Kentucky coals enriched in As tend to cluster along lines parallel to mapped cross strike discontinuities (CSD) thought to represent major basement structures (Coleman and

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<sup>3</sup> Arsenic data are lognormally distributed, therefore, means reported herein are geometric means.

others, 1988). These CSD's strike perpendicular to the overall trend of Appalachian folds and faults, and would have focused fluid generated during orogenic processes into the Kentucky Appalachian Basin.

This study evaluates whether the As in eastern Kentucky coals is being dispersed, and, if so, its effect on near-by stream environments. We reanalyzed 1200 NURE<sup>4</sup> stream sediment samples from the Kentucky Appalachian Basin for a suite of elements including As. Our working hypothesis predicts that stream-sediment chemistry reflects the lithology within the drainage basin with overprints from human activities that accelerate introduction of As-enriched material into the stream.

Our data for the NURE stream sediments in the Kentucky Appalachian Basin show that most stream sediments from the basin are not enriched in As (the mean As concentration for these NURE stream sediments is 3.8 ppm). Only seven percent of the samples have As concentrations that exceed 10 ppm, the average abundance of As in shale (Wedepohl, 1974); shale is the major lithology interbedded with the coal in the Central Appalachian Basin. Some distribution trends of the high As concentrations are observed (fig. 2). The most striking is the high concentration of As in samples along the western edge of the basin that correlate with exposure of Upper Devonian black shale. This Devonian black shale is often enriched in metals including As (for examples see Table 1). In addition, As enrichment along this margin is further enhanced in some streams impacted by coal mining and agriculture (Porter and others; 1995).

Element	Devonian black shale (ppm) <sup>5</sup>	Average shale (ppm) <sup>6</sup>
As	60	10
Mo	50	2
Ni	120	80
U	35	3.5
V	300	130

Some of the NURE stream sediments with high As concentrations are from the eastern Kentucky coal region where Pennsylvanian shale interbedded with coal is the dominant lithology (fig. 2). The source of enrichment in these stream sediments likely is related to human activity, including coal mining. Elevated amounts of ferric iron precipitate in streams affected by coal mining have been reported (Porter and others, 1995) and As released to the environment is quickly adsorbed onto the precipitates (Cullen and Reimer, 1989).

Our stream data indicate that As-enriched stream sediments are found along the basin margin where Devonian black shale crops out and in isolated stream reaches within the coal basin proper. Several of these As-enriched sites will be the focus of follow-up studies to investigate As dispersion in the Kentucky Appalachian Basin. Investigations will focus on As residence in the stream sediment and at its source (coal and Devonian black shale), mobility within the drainage basin, and effect on the local ecosystems.

<sup>4</sup> NURE (National Uranium Resource Evaluation) stream sediments in Kentucky were collected during 1978 to 1980, processed, and archived at the U.S. Geological Survey in Denver, CO.

<sup>5</sup> Average concentration in 14 core samples, Monroe County Kentucky (Leventhal and Kepferle, 1982).

<sup>6</sup> Wedepohl, 1974.

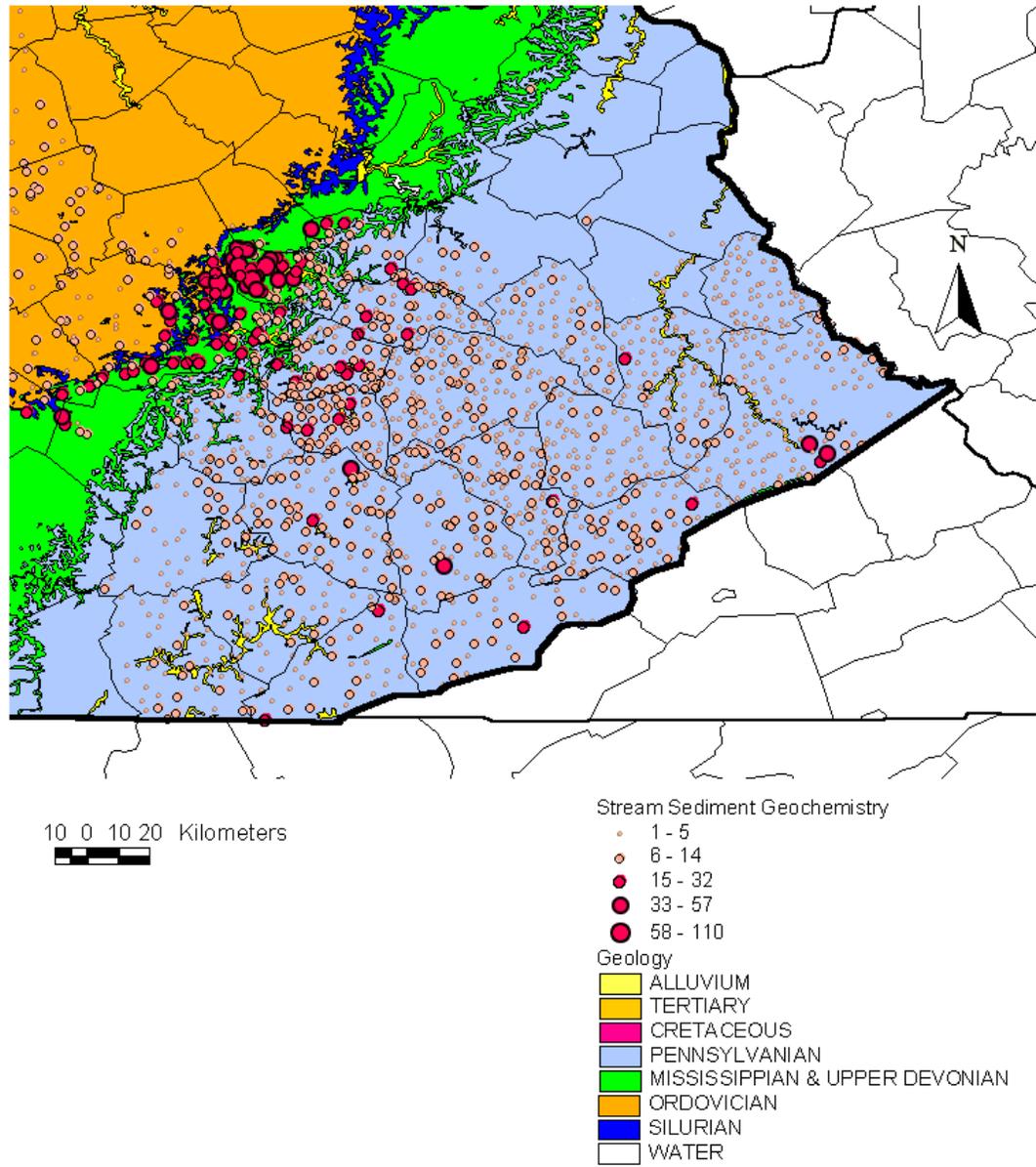


Figure 2. Map showing the generalized geology of the Kentucky Appalachian Basin, and arsenic concentrations (ppm) in NURE stream sediments.

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