ARSENIC IN TWELVE COAL BEDS/ZONES IN THE NORTHERN AND CENTRAL APPALACHIAN BASIN COAL REGIONS

L. J. Bragg[1], S. G. Neuzil[1], L. F. Ruppert[1], and S. J. Tewalt[1]

[1]U.S. Geological Survey, MS 956 National Center, Reston, VA 20192

Arsenic is listed as a potential HAP (hazardous air pollutant) in the 1990 Clean Air Act Amendments (U.S. Statutes at Large, 1990). Therefore, arsenic was one of the trace-elements characterized in the top-producing coal beds and coal zones that were studied in the recently completed Northern and Central Appalachian Basin coal regions assessment (USGS Professional Paper 1625C, in press). Six coal beds/zones were digitally assessed for coal resources and coal quality while the other six coal zones were summarized from existing data (resources and quality). The stratigraphic sequence of the twelve coal beds/zones discussed in this abstract is shown in figure 1. Arsenic concentrations in these coal beds/zones are examined both stratigraphically and geographically for trends.

SYSTEM	SERIES	GROUP	ASSESSED & UNASSESSED COAL BED/ZONE IN THE NORTHERN AND CENTRAL APPALACHIAN BASIN COAL REGIONS
PENNSYLVANIAN	UPPER	Monongahela Group	Pittsburgh
		Conemaugh Group	
	MIDDLE	Allegheny Group	Upper Freeport Lower Kittanning
		Pottsville Group	No. 5 Block Stockton/Coalburg Winifrede/Hazard Fire Clay Williamson/Amburgy Campbell Creek/Upper Elkhorn No. 3 Upper Elkhorn Nos. 1&2/Powellton Pond Creek
	LOWER		Pocahontas No. 3

Figure 1. Stratigraphic column showing stratigraphic distribution of the twelve coal beds discussed in the Northern and Central Appalachian Basin coal region.

Mean, range, and standard deviation for arsenic concentrations in in-ground complete channel and core samples of the twelve coal beds/zones are listed in table 1. The two sets of data are reported for different moisture bases, but because these coals are bituminous, their moisture content difference is small (probably less than 5%, which is probably within the experimental errors of the analysis and well within the standard deviation of the sample).

Table 1. Mean, range, and standard deviation for arsenic concentrations in samples of twelve coal beds/zones included in the assessment of the Northern and Central Appalachian Basin coal regions. The arsenic values for the six digitally assessed beds (*) were calculated to an as-received moisture basis, whereas the arsenic values for the six additional beds were obtained from the COALQUAL database (Bragg and others, 1998) and are on a remnant moisture basis.

[Ppm = parts per million; No. = number; N= Northern; C= Central]

Coal Bed/Zone	Coal Region	Mean ppm	Minimum	Maximum	Standard deviation	No. of samples
Pittsburgh*	N	12	0.33	61	13	140
Upper Freeport*	N	34	0.72	130	25	250
Lower Kittanning*	N	19	0.13	130	20	190
No. 5 Block	C	11	0.75	70	14	88
Stockton & Coalburg	C	11	0.40	79	14	193
Winifrede/Hazard	C	8.7	0.40	58	11	81
Fire Clay*	C	11	0.70	53	13	39
Williamson/Amburgy	C	28	0.61	120	30	37
Campbell Creek/Upper Elkhorn No. 3	C	14	0.85	85	19	136
Upper Elkhorn Nos. 1 and 2/Powellton	C	27	0.8	280	47	104
Pond Creek*	C	9.9	0.075	74	14	88
Pocahontas No. 3*	C	7.1	0.30	35	8.1	33

In Figure 2, arsenic values for the six digitally assessed coal beds/zones are shown as point data (Map A) and as county means (Map B). All the arsenic values (n=1358) for the 12 coal beds/zones were classified into 5 data categories, or quintiles, each representing 20 percent of the point data values. Additional data located only to county accuracy (n=1379) were included to generate the county means. Mean arsenic values for each county were calculated for each of the coal beds/zones and all county means (for all coal beds/zones) were grouped for classification into 5 data categories, or quintiles, each representing 20 percent of the county mean data values. Because the quintile intervals are based on different sets of data [point data versus county means], the ranges of arsenic concentrations will be different for both data sets. For the six digitally assessed coal beds, the county means are shown within the digital outcrop in Figure 2, Maps B.

The mean arsenic concentration for the1358 samples from these twelve coal bed/zones is 17 (±28) ppm (table 2). For the 3 beds from the Northern Appalachian Basin coal region (the Pittsburgh, the Upper Freeport, and the Lower Kittanning coal beds), the mean arsenic concentration is 22 (± 22) ppm with a range of 0.18 to 130 ppm. The nine remaining beds/zones are located in the Central Appalachian Basin coal region and have a mean arsenic concentration of 14 (± 24) ppm with a range of 0.075 to 280 ppm arsenic. Mean concentration of arsenic in each of the twelve coal beds/zones is below the mean arsenic concentration (35 ppm) in the Appalachian Basin (Finkelman and others, 1994). This mean concentration includes samples

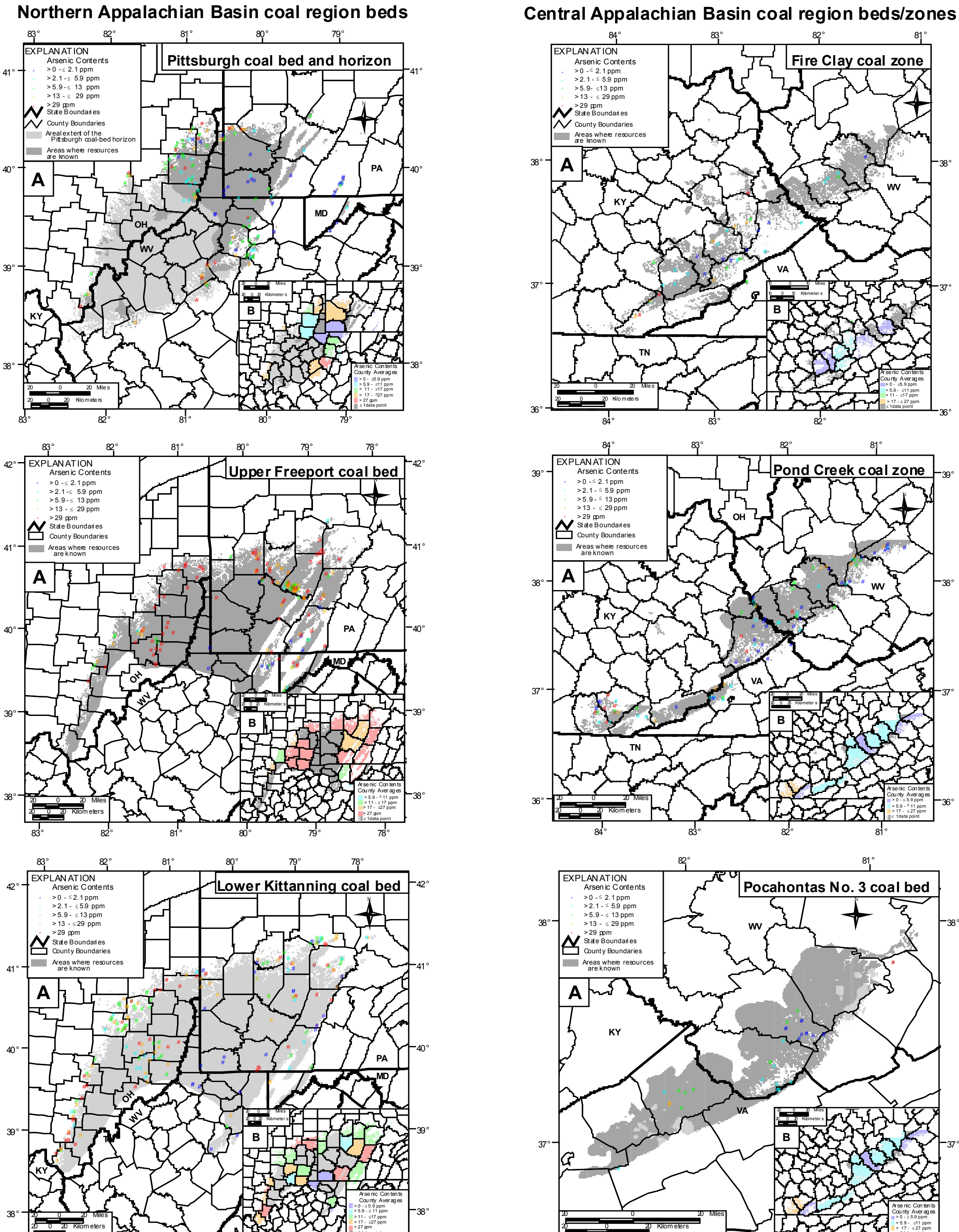

Figure 2. Maps showing arsenic concentration [parts-per-million (ppm)], as-received whole-coal basis] for the six digitally assessed coal beds. Map A shows arsenic content for geochemical records that are located by latitude and longitude. Map B shows county means for arsenic concentrations calculated for each of the coal beds/zones. The values are classified into five categories, each representing 20 percent of the data values for each data set.

from many more coal beds and zones throughout the Northern, Central and Southern Appalachian Basin coal regions and does not exclude any high outlier values. Three of the coal beds/zones have mean arsenic concentrations that are greater than the mean for U.S. coal 24 (± 5.5) ppm (Finkelman, 1993). These are the Upper Freeport (34 ± 25 ppm) coal bed, the Williamson/Amburgy (28 ± 30 ppm) and Upper Elkhorn Nos. 1 and 2/Powellton coal zones (27 ± 47 ppm). However, because arsenic is primarily associated with pyrite in coal, and because most of the Northern and Central Appalachian Basin coal is washed or cleaned prior to combustion, it is likely that atmospheric arsenic emissions from the combustion of the Northern and Central Appalachian Basin coal will be considerably less than would be predicted from the 17 (±23) ppm mean in-ground arsenic concentration for these 12 coal bed/zones (table 2). In addition, much of the coal currently being mined in the Appalachian Basin coal regions is lower in arsenic content than the average bed/zone for the Appalachian Basin. The available data do not appear to indicate any significant stratigraphic or regional trends.

Table 2. Arsenic concentration (parts per million (ppm)) means, ranges, and standard deviations for twelve top-producing coal beds/zones in the Northern and Central Appalachian Basin coal regions based on 1358 samples on an as-received or remnant moisture, whole-coal basis.

[Ppm = parts per million; No. = number]

Region	Mean ppm	Minimum	Maximum	Standard deviation	No. of samples
Northern & Central Appalachian	17	0.075	280	23	1358
Northern Appalachian	22	0.18	130	22	548
Central Appalachian	14	0.075	280	24	810

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