Chapter PQ

COAL QUALITY AND GEOCHEMISTRY, POWDER RIVER BASIN, WYOMING AND MONTANA

By G.D. Stricker and M.S. Ellis

in U.S. Geological Survey Professional Paper 1625-A

1999 Resource assessment of selected Tertiary coal beds and zones in the Northern RockyMountains and Great Plains region, U.S. Geological Survey Professional Paper 1625-A

Contents

Coal Quality and Geochemistry, Powder River Basin, Wyoming and Montana PQ-1
References Cited PQ-4

Figures

PQ-1. Index map showing the Powder River Basin.
PQ-2. Index map showing coal quality data distribution in the Wyodak-Anderson coal zone in the Powder River Basin.
PQ-3. Ash yield in the Wyodak-Anderson coal zone in the Powder River Basin.
PQ-4. Total sulfur content in the Wyodak-Anderson coal zone in the Powder River Basin.
PQ-5. Moist, mineral-matter-free Btu/lb in the Wyodak-Anderson coal zone in the Powder River Basin.
PQ-6. Pounds of sulfur dioxide per million Btu ($lbSO_2$) in the Wyodak-Anderson coal zone in the Powder River Basin.
PQ-7. Antimony concentration in the Wyodak-Anderson coal zone in the Powder River Basin.
PQ-8. Arsenic concentration in the Wyodak-Anderson coal zone in the Powder River Basin.
PQ-9. Beryllium concentration in the Wyodak-Anderson coal zone in the Powder River Basin.
PQ-10. Cadmium concentration in the Wyodak-Anderson coal zone in the Powder River Basin.

Figures-*continued*

PQ-11. Chromium concentration in the Wyodak-Anderson coal zone in the Powder River Basin.

PQ-12. Cobalt concentration in the Wyodak-Anderson coal zone in the Powder River Basin.

PQ-13. Lead concentration in the Wyodak-Anderson coal zone in the Powder River Basin.

PQ-14. Manganese concentration in the Wyodak-Anderson coal zone in the Powder River Basin.

PQ-15. Mercury concentration in the Wyodak-Anderson coal zone in the, Powder River Basin.

PQ-16. Nickel concentration in the Wyodak-Anderson coal zone in the Powder River Basin.

PQ-17. Selenium concentration in the Wyodak-Anderson coal zone in the Powder River Basin.

PQ-18. Uranium concentration in the Wyodak-Anderson coal zone in the Powder River Basin.

Table

PQ-1. Summary data for coal in the Wyodak-Anderson coal zone in the Powder River Basin

COAL QUALITY AND GEOCHEMISTRY, POWDER RIVER BASIN, WYOMING AND MONTANA

Actively mined coal from the Wyodak-Anderson coal zone in the Powder River Basin in Wyoming and Montana (fig. PQ-1) is considered to be "clean coal." For the location and description of this coal zone, see Chapter PF-Framework Geology of Fort Union coal in the Powder River Basin. This coal zone contains a low-contaminant, subbituminous coal resource that has the following arithmetic mean values (on an as-received basis) for coal that is not presently being mined or under lease to be mined in the future: **moisture**–27.66 percent, **ash**–6.44 percent, **total sulfur**–0.48 percent, **calorific value**–8,220 Btu/lb, **lb SO_2 per million Btu**–1.24, and **moist, mineral-matter-free Btu**–8,820. Arithmetic mean concentration (in parts per million and on whole-coal and remnant-moisture basis) of elements of environmental concern for coal in the Wyodak-Anderson coal zone (and stratigraphically equivalent beds in Montana and Wyoming) are: **antimony**–0.50, **arsenic**–2.6, **beryllium**–0.54, **cadmium**–0.21, **chromium**–6.1, **cobalt**–1.9, **lead**–3.0, **manganese**–26, **mercury**-–0.13, **nickel**–4.6, **selenium**–1.1, and **uranium**–1.3. Table PQ-1 is a summary of coal quality of the Wyodak-Anderson coal zone in Wyoming and Montana. Coal from the Wyodak-Anderson coal zone is produced from 23 mines in the Powder River Basin. This coal is utilized for electric power generation at power plants in 26 states. The Wyodak-Anderson coal is sometimes blended with higher sulfur coal to produce a compliant fuel.
Both proprietary and public data are used in the summary data tables, but is not shown on location maps or on other graphic displays. A common problem in statistical summaries of trace-element data arises when element values are below the limits of detection. This results in a censored distribution. To compute

unbiased estimates of censored data for the elements in this table, we adopted the protocol of reducing all "less than" values by 50 percent to generate a real value for these data. Summary statistics of range (minimum, with an "L" indicating "less than", and maximum values) and arithmetic means were generated using the modified data. Moisture values are reported on an as-received basis (American Society for Testing and Materials, 1994b, designation D3180-89). Because no equilibrium moisture values are available for this report, apparent ranks can not reliably be determined.

Between 1974 and 1994, the U.S. Geological Survey analyzed samples of coal for major-, minor-, and trace-element contents. Prior to performing the analyses, most of the coal samples were dried at room temperature and humidity for as much as 80 hours. Some samples, however, may have only been dried enough to allow grinding (to less than 100 mesh). Moisture content in the samples is unknown, although moisture contents were probably similar to that which would remain after air-dry loss determination (American Society for Testing and Materials, 1994c, D3302-91). Since the actual moisture content of the samples analyzed between 1974 and 1994 is unknown and can not be determined, the major-, minor-, and trace-element contents are reported on a remnant moisture basis. Also, the elemental analysis of the samples cannot be converted to any other moisture basis. In addition, these analyses can only provide an approximation of load factors (such as, pounds of mercury per trillion Btu).

For the following graphical displays, figures PQ-2 through PQ-17, show public data locations and values for variables listed in table PQ-1, except for calorific value and moisture, for the Wyodak-Anderson coal zone. The locations of public data points used in this summary are shown on figure PQ-2. When more than one

analysis was available per location, the analytical values were weight averaged on coal sample thickness. For ash and total sulfur (figs. PQ-3 and PQ-4), the values are color coded low, medium, and high, following guidelines established in U.S. Geological Survey Circular 891 (Wood and others, 1983). For moist, mineral-matter-free Btu, which is used in conjunction with other factors to determine apparent rank (fig. PQ-5), we utilized the apparent rank designations established by American Society for Testing and Materials, (1994a), designation D388-92a. For pounds of SO_2 per million Btu (lb SO_2) (fig. PQ-6), values are color coded to the U.S. Environmental Protection Agency's Phase I, Phase II, and non-compliant limits for sulfur emission from coal-fired power plants (U.S. Environmental Protection Agency, 1996).

No guidelines have been established for the elements of environmental concern (also referred to as "hazardous air pollutants" or "HAPs"). Analytical values for these elements (figs. PQ-7 through PQ-18) are color keyed based on the following parameters: (1) each element of environmental concern was ranked from the lowest to highest value for all data in the Northern Rocky Mountains and Great Plains region and (2) quartiles were established for each element such that low represents those values that are less than the .25 quartile (also known as the lower quartile or the 25th percentile), medium represents those values that are within the .25 to .75 quartiles (two quartiles representing 50 percent of the values or between the 25th to 75th percentile), and high represents those values that are in the upper .25 quartile (or greater than the 75th percentile).

REFERENCES CITED

American Society for Testing and Materials, 1994a, Annual book of ASTM Standards, Section 5, Petroleum products, lubricants and fossil fuels, vol. 05.05 Gaseous fuels; coal and coke; section D388-92a; Standard Classification of Coal by Rank: American Society for Testing and Materials, Philadelphia, Pennsylvania, p. 168-171.

_____1994b, Annual book of ASTM Standards, Section 5, Petroleum products, lubricants and fossil fuels, vol. 05.05 Gaseous fuels; coal and coke; section D3180-89; Standard Practice for Calculating Coal and Coke Analysis from As-Determined to Different Bases: American Society for Testing and Materials, Philadelphia, Pennsylvania, p. 318-320.

_____1994c, Annual book of ASTM Standards, Section 5, Petroleum products, lubricants and fossil fuels, vol. 05.05 Gaseous fuels; coal and coke; section D3302-91; Standard Test Method for Total Moisture in Coal: American Society for Testing and Materials, Philadelphia, Pennsylvania, p. 330-336.

Bragg, L.J., Oman, J.K., Tewalt, S.J., Oman, C.L., Rega, N.H., Washington, P.M., and Finkleman, R.B, 1994, U.S. Geological Survey Coal Quality (Coalqual) Database: Version 1.3: U.S. Geological Survey Open-File Report 94-205, CD-ROM.

U.S. Environmental Protection Agency, 1996, Standards of Performance for New Stationary Sources, 40CFR, Part 60.43, Standards for Sulfur Dioxide: Environmental Protection Agency, 27 p.

Wood, G.H., Jr., Kehn, T.M., Carter, M.D., and Culbertson, W.C., 1983, Coal resource classification system of the U.S. Geological Survey: U.S. Geological Survey Circular 891, 65 p.

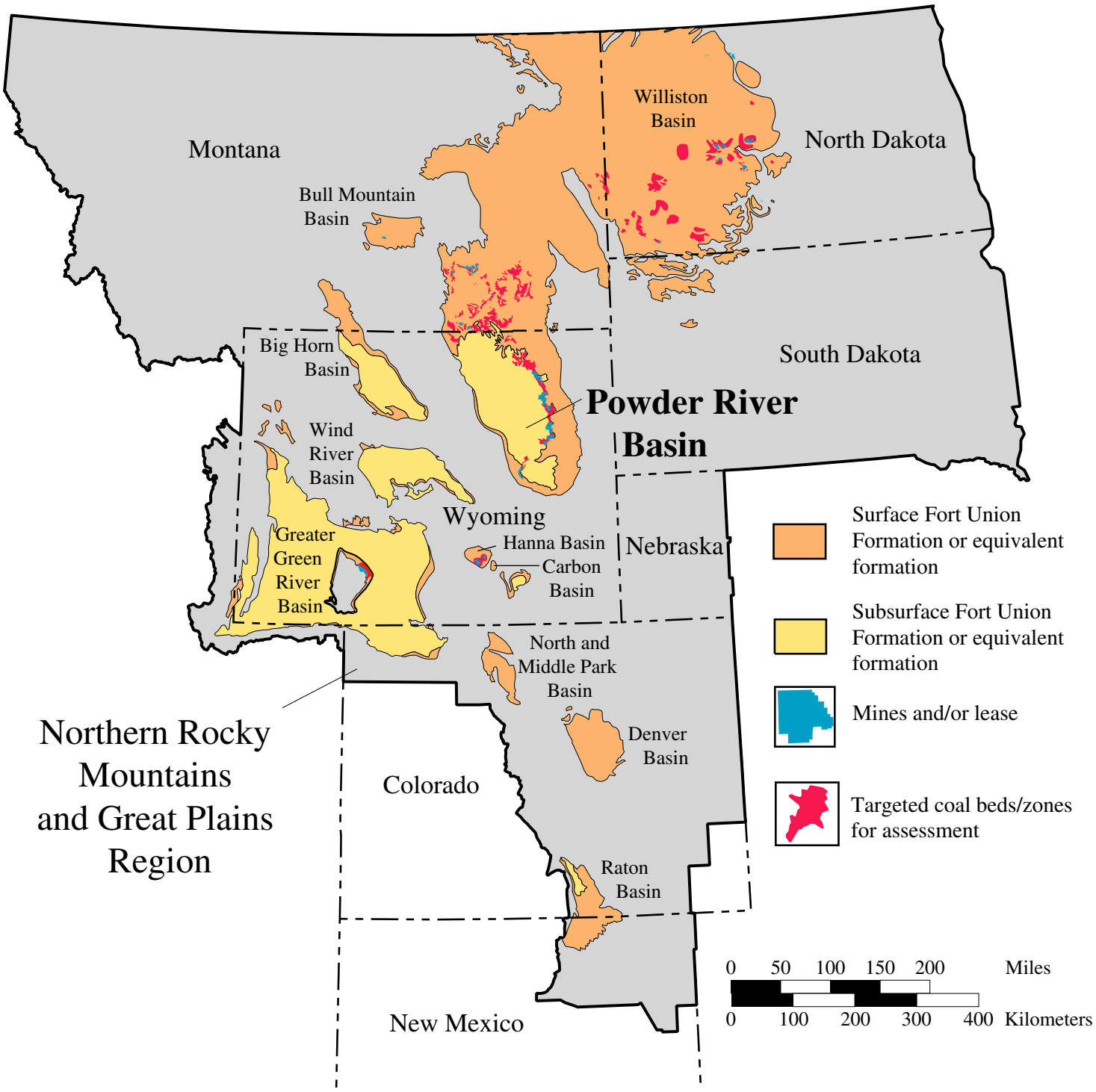

Figure PQ-1. Index map showing Powder River Basin, Wyoming and Montana

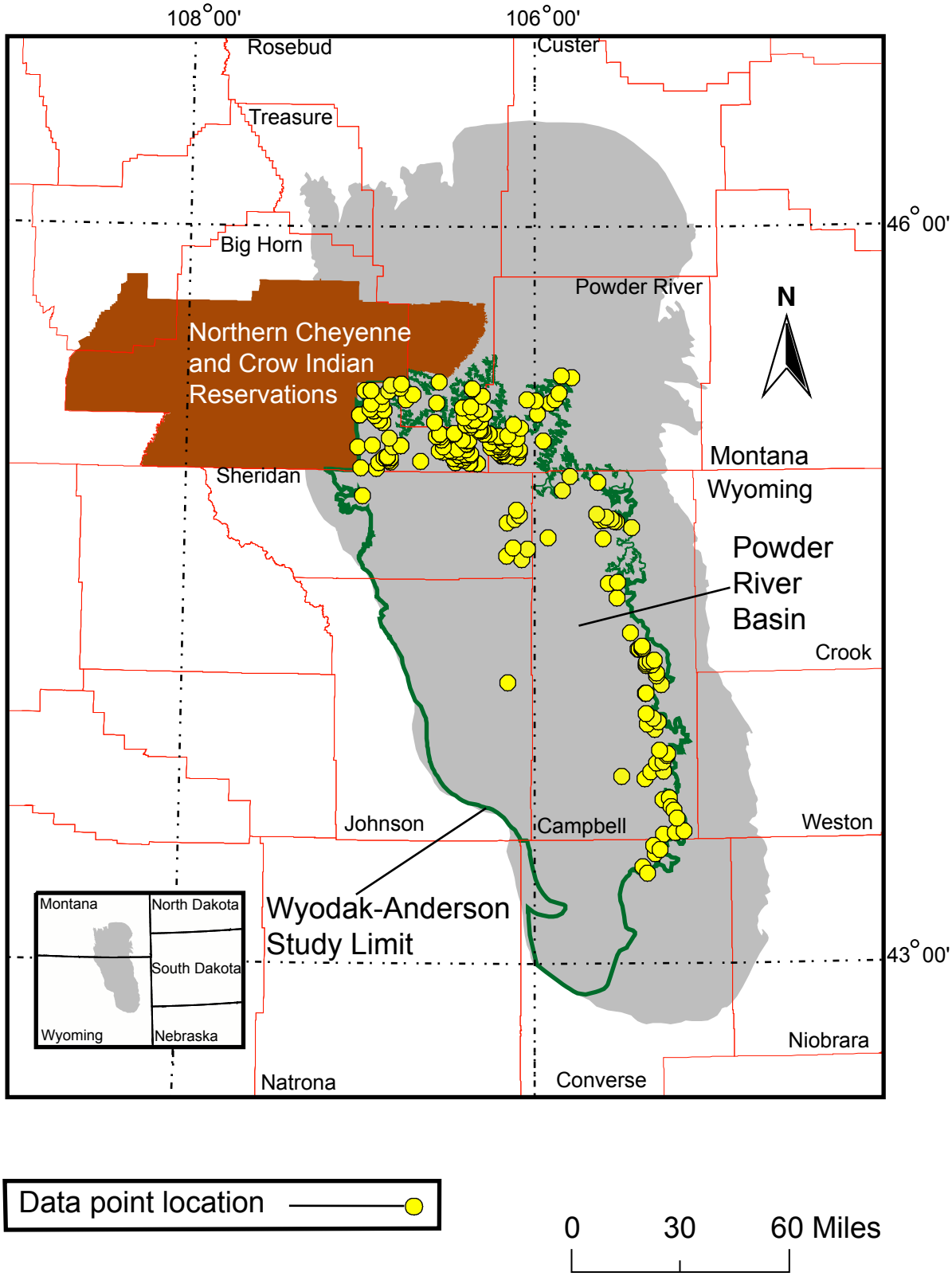

Figure PQ-2. Index map showing coal quality data distribution in the Wyodak-Anderson coal zone, Powder River Basin, Wyoming and Montana.

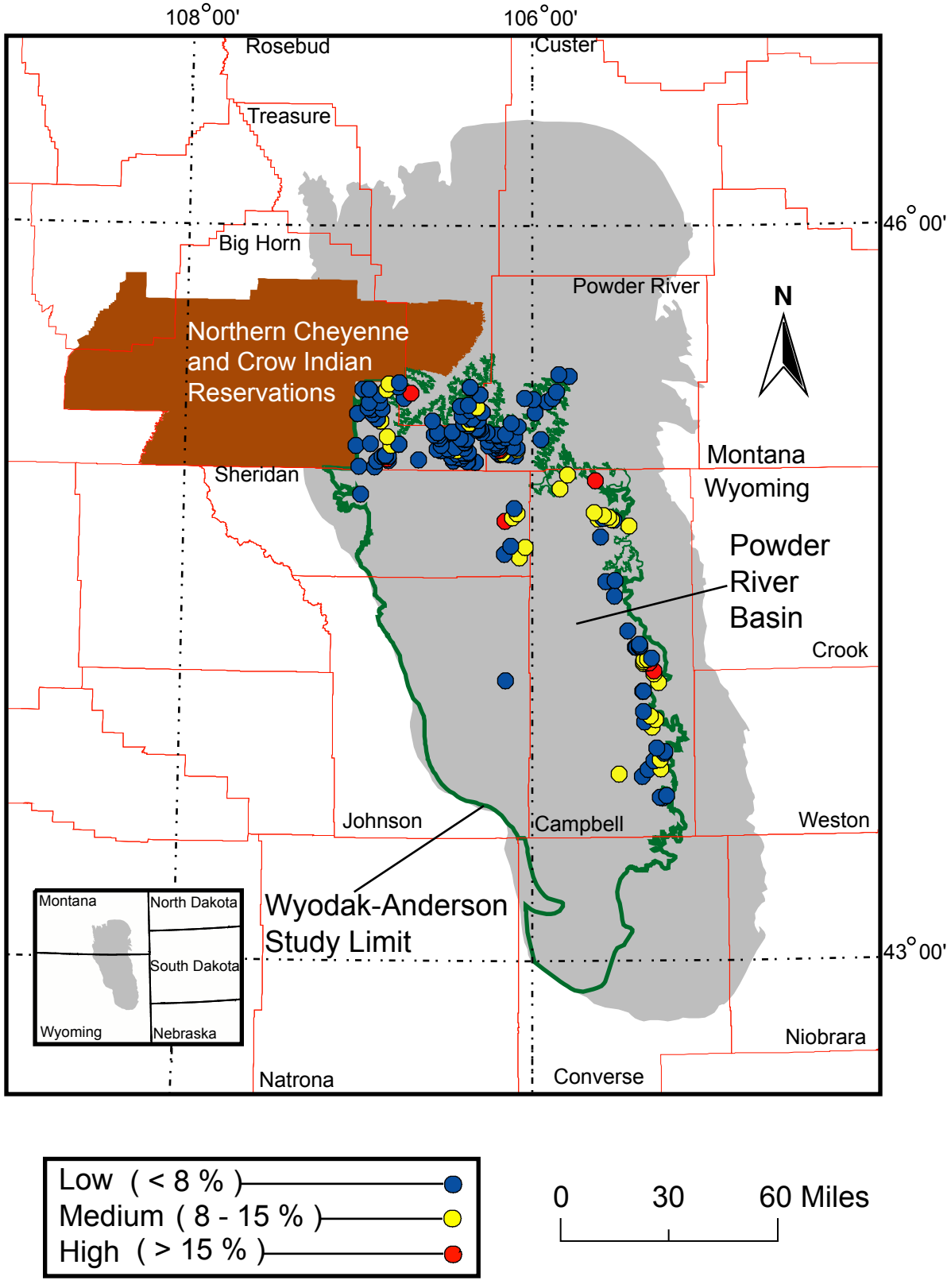

Figure PQ-3 Ash yield in the Wyodak-Anderson coal zone, Powder River Basin, Wyoming and Montana.

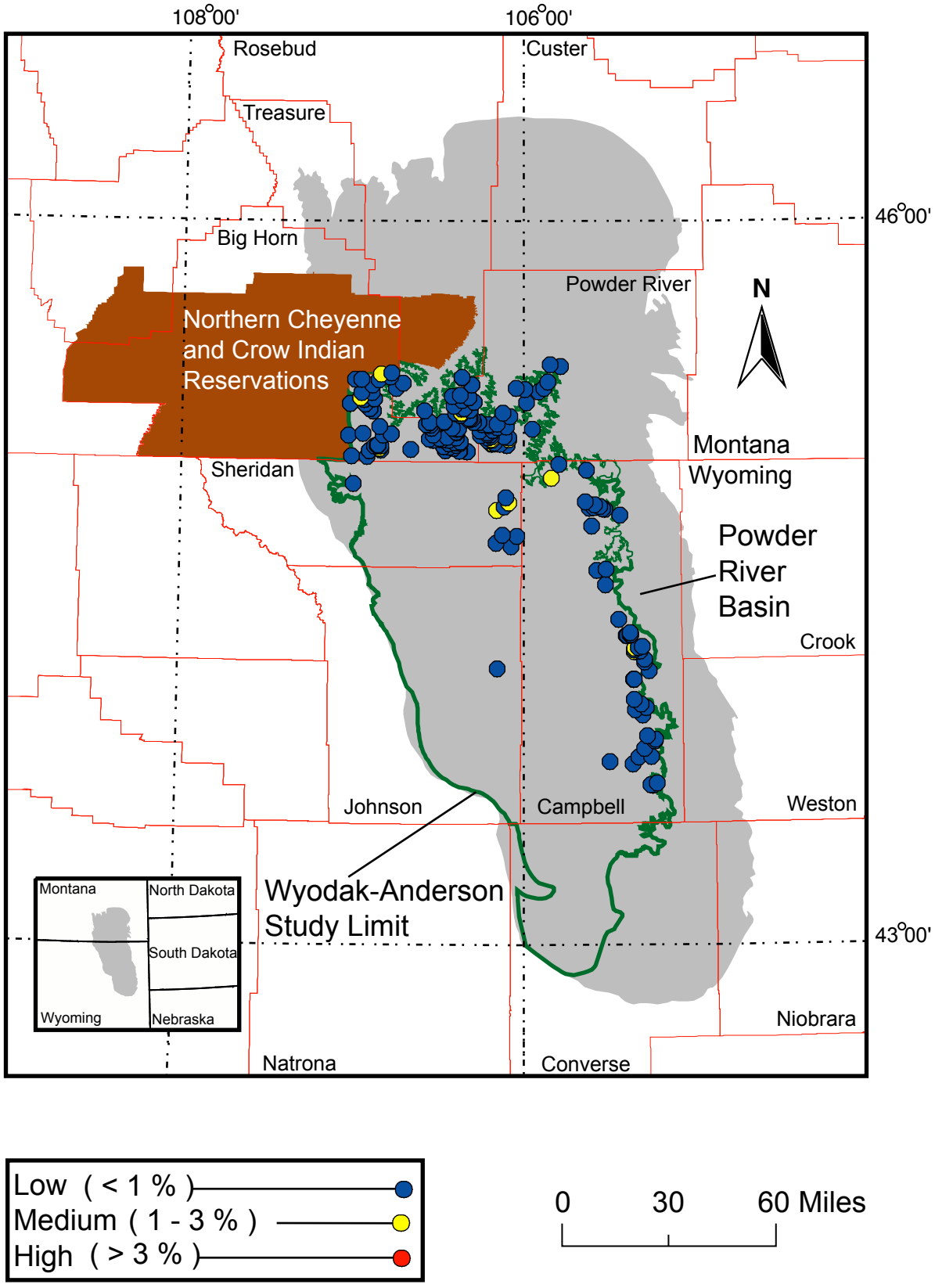

Figure PQ-4. Sulfur content in the Wyodak-Anderson coal zone, Powder River Basin, Wyoming and Montana.

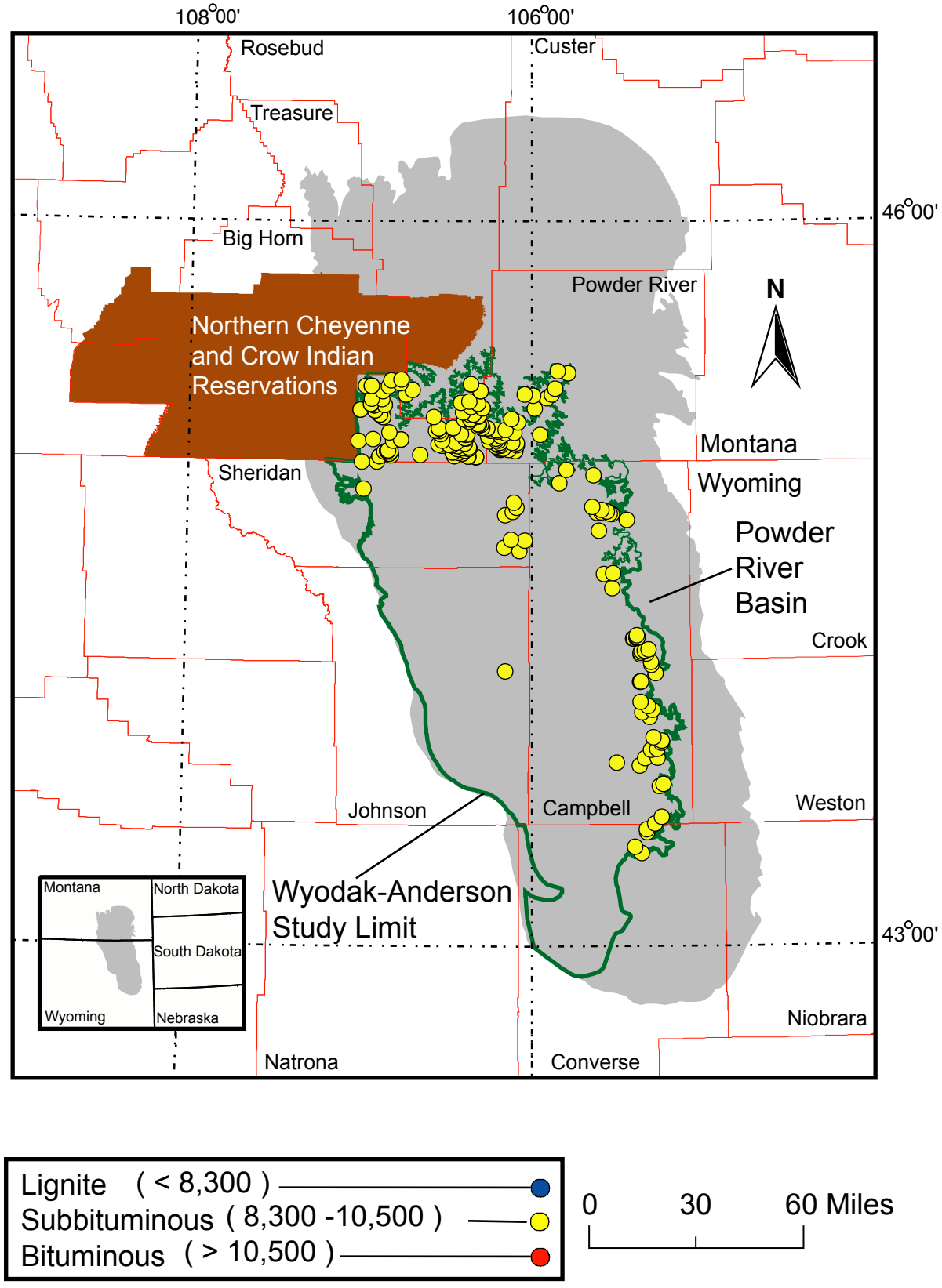

Figure PQ-5. Moist, mineral-matter-free Btu in the Wyodak-Anderson coal zone, Powder River Basin, Wyoming and Montana.

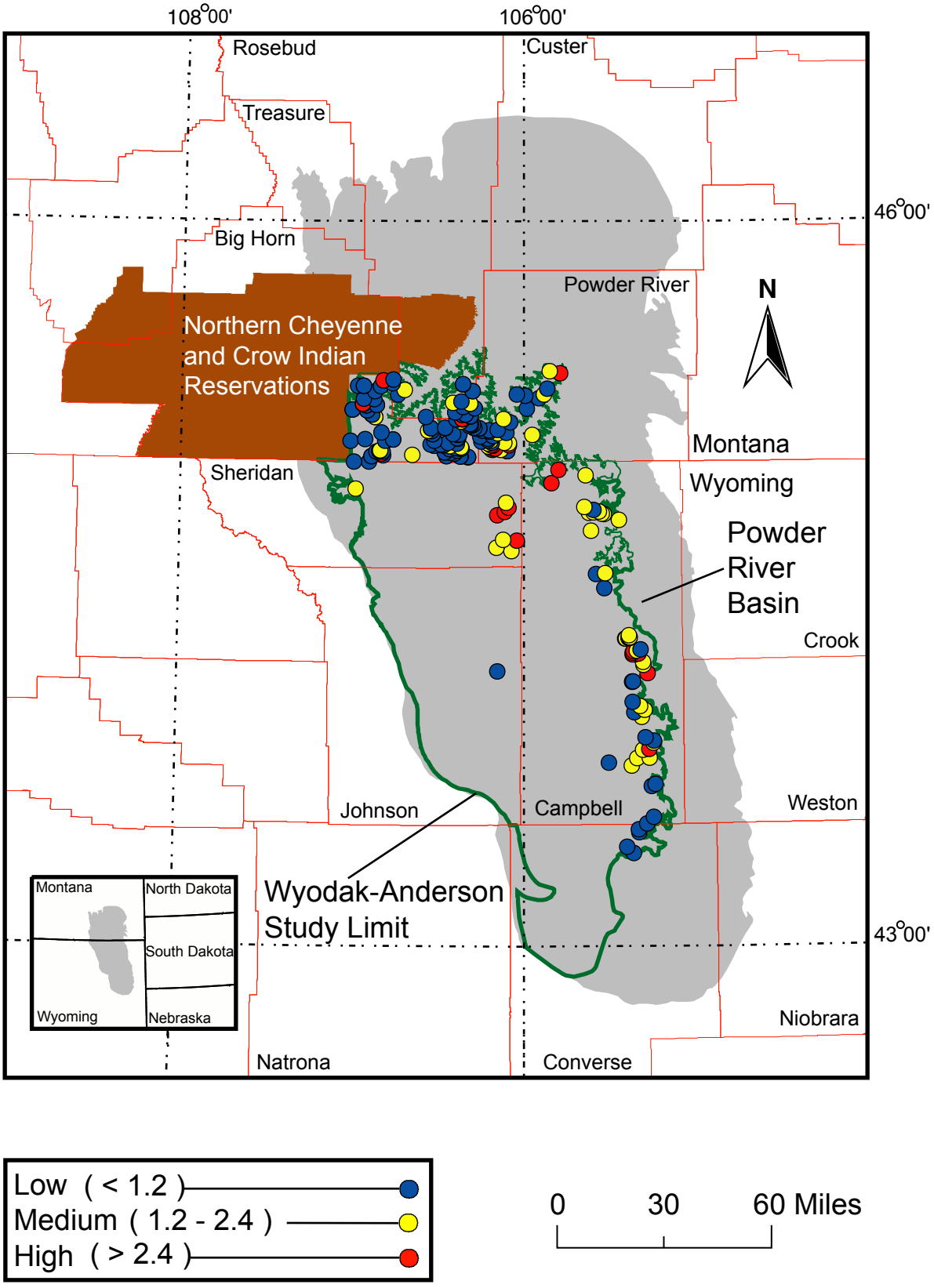

Figure PQ-6. Pounds of sulfur dioxide per million Btu in the Wyodak-Anderson coal zone, Powder River Basin, Wyoming and Montana.

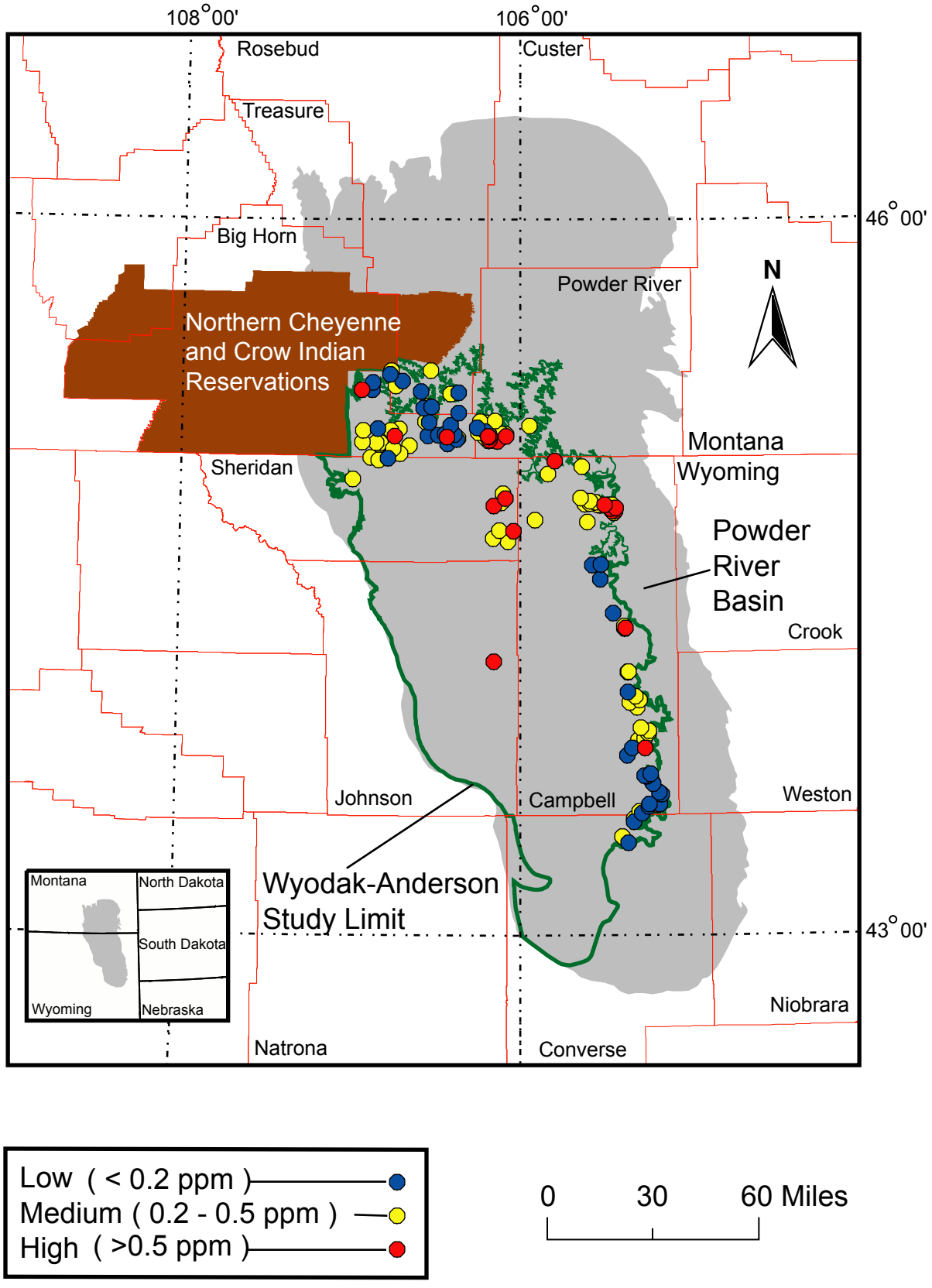

Figure PQ-7. Antimony concentration in the Wyodak-Anderson coal zone, Powder River Basin, Wyoming and Montana.

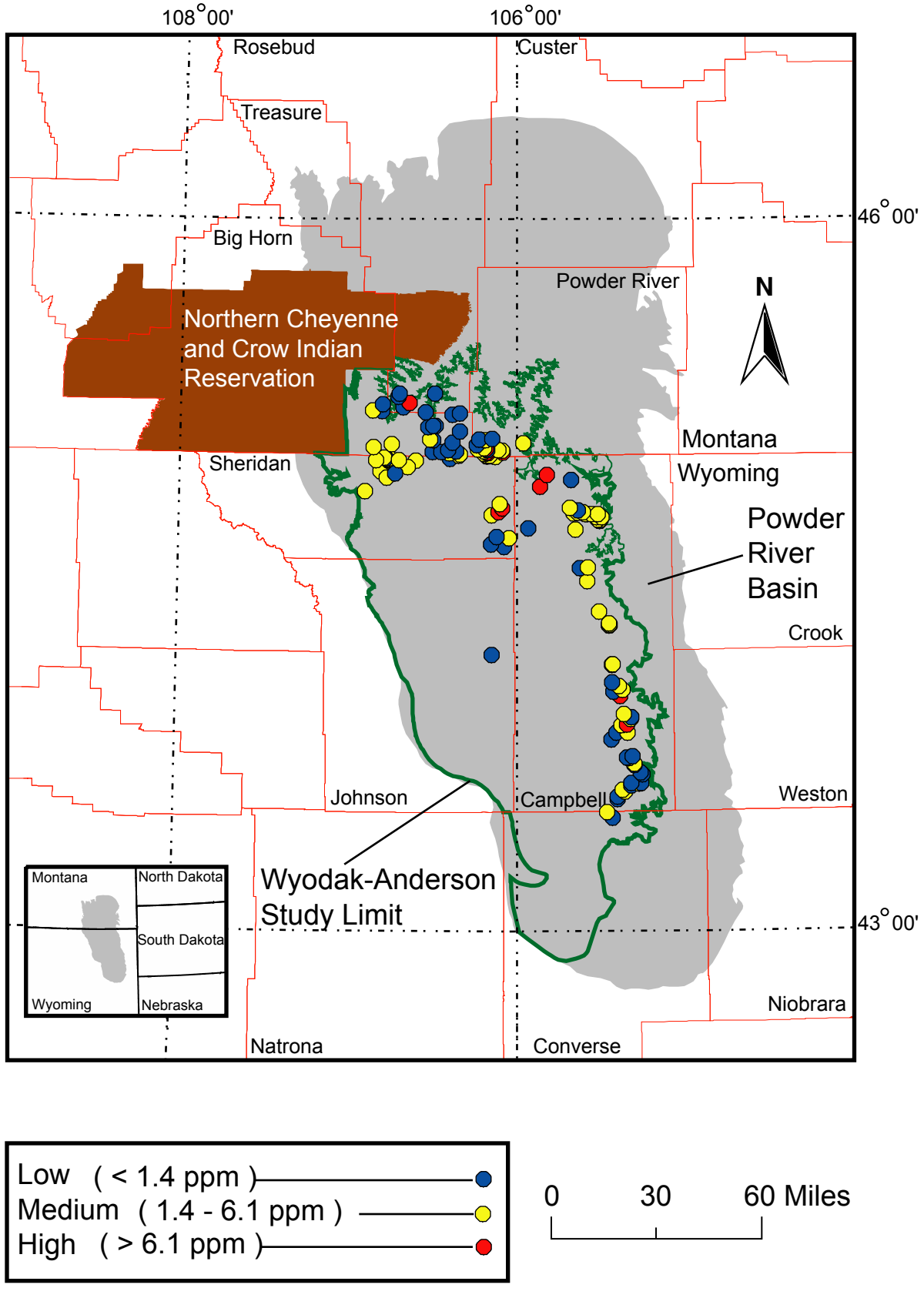

Figure PQ-8. Arsenic concentration in the Wyodak-Anderson coal zone, Powder River Basin, Wyoming and Montana.

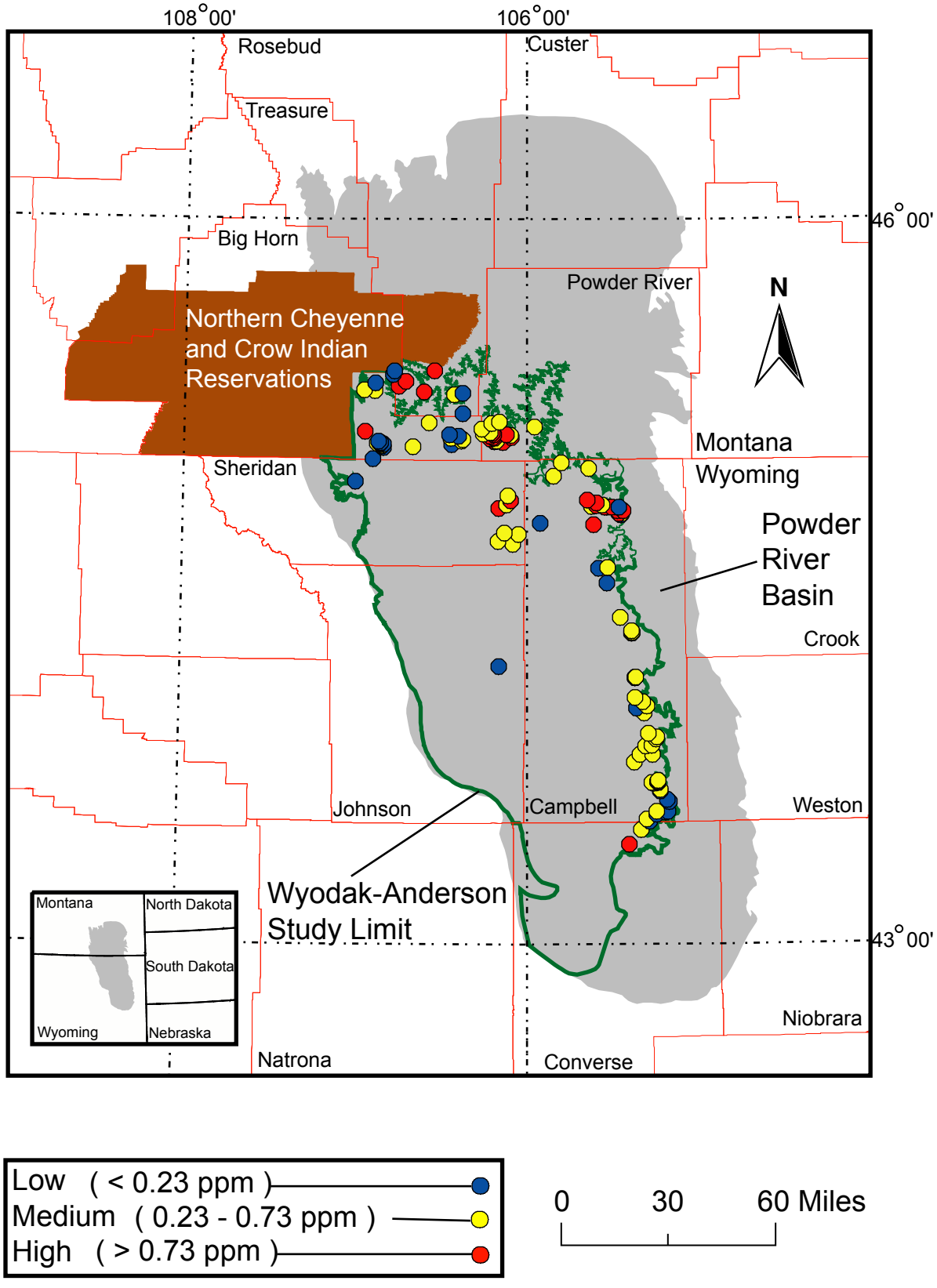

Figure PQ-9. Beryllium concentration in the Wyodak-Anderson coal zone, Powder River Basin, Wyoming and Montana.

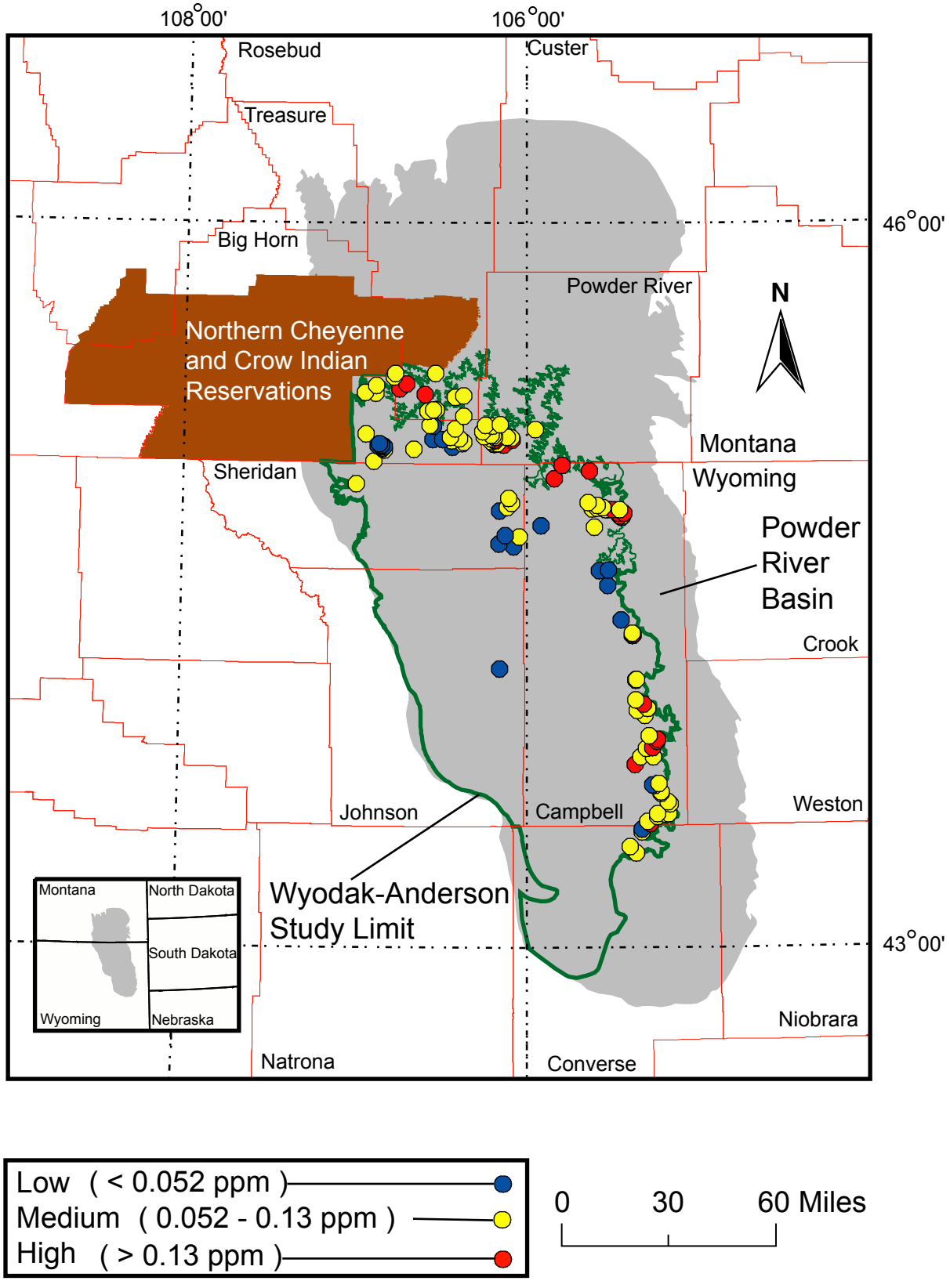

Figure PQ-10. Cadmium concentration in the Wyodak-Anderson coal zone, Powder River Basin, Wyoming and Montana.

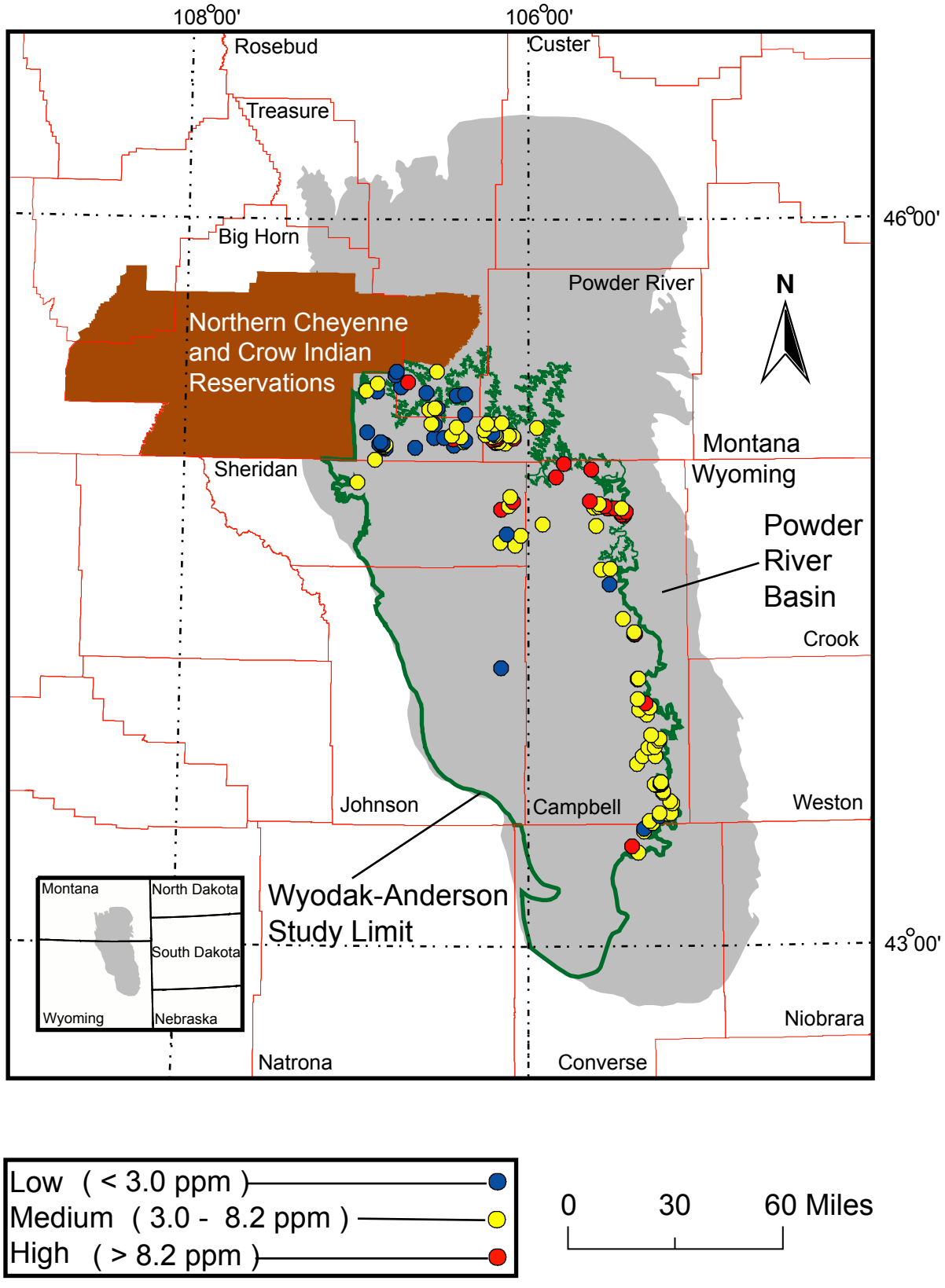

Figure PQ-11. Chromium concentration in the Wyodak-Anderson coal zone, Powder River Basin, Wyoming and Montana.

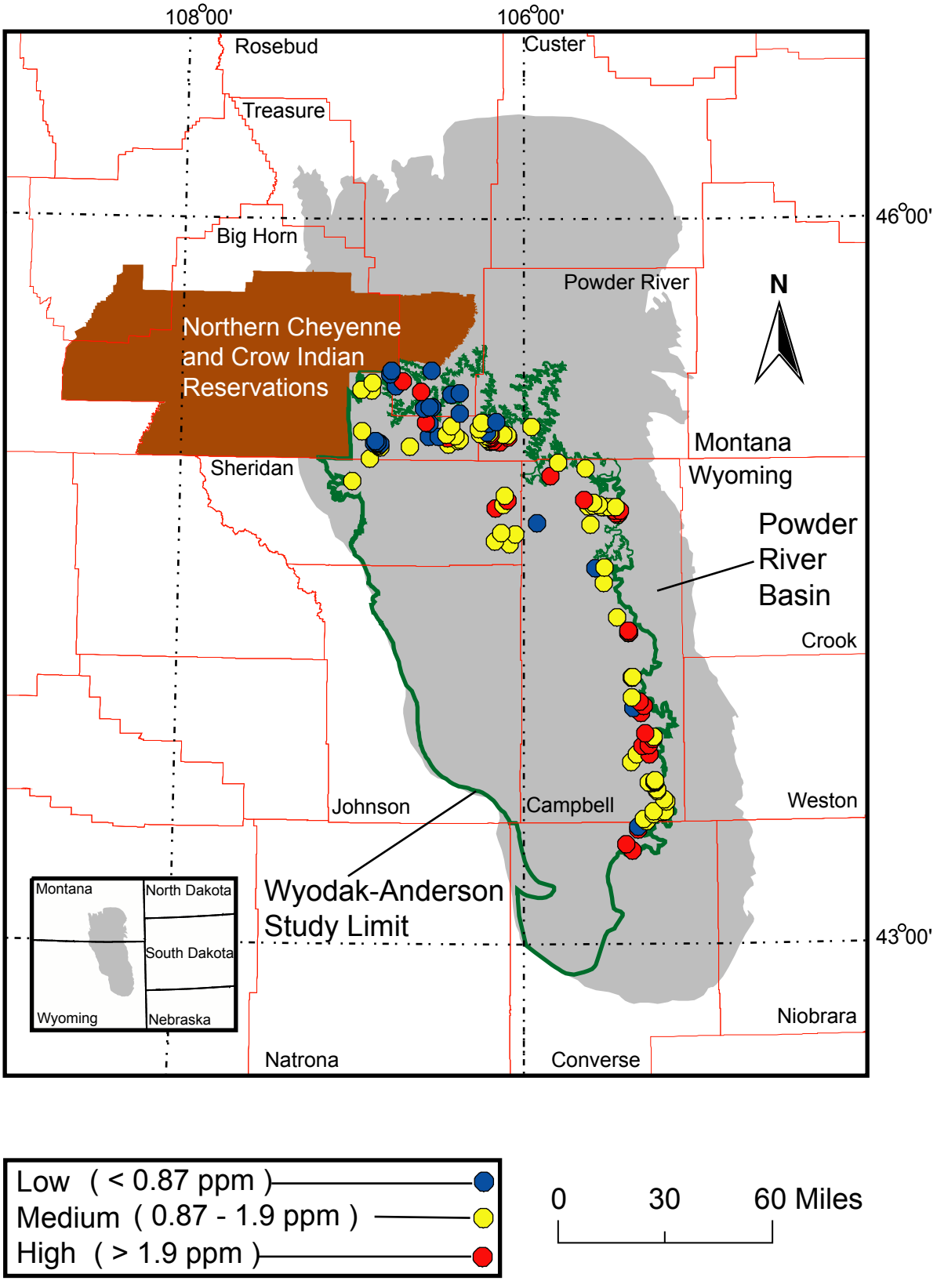

Figure PQ-12. Cobalt concentration in the Wyodak-Anderson coal zone, Powder River Basin, Wyoming and Montana.

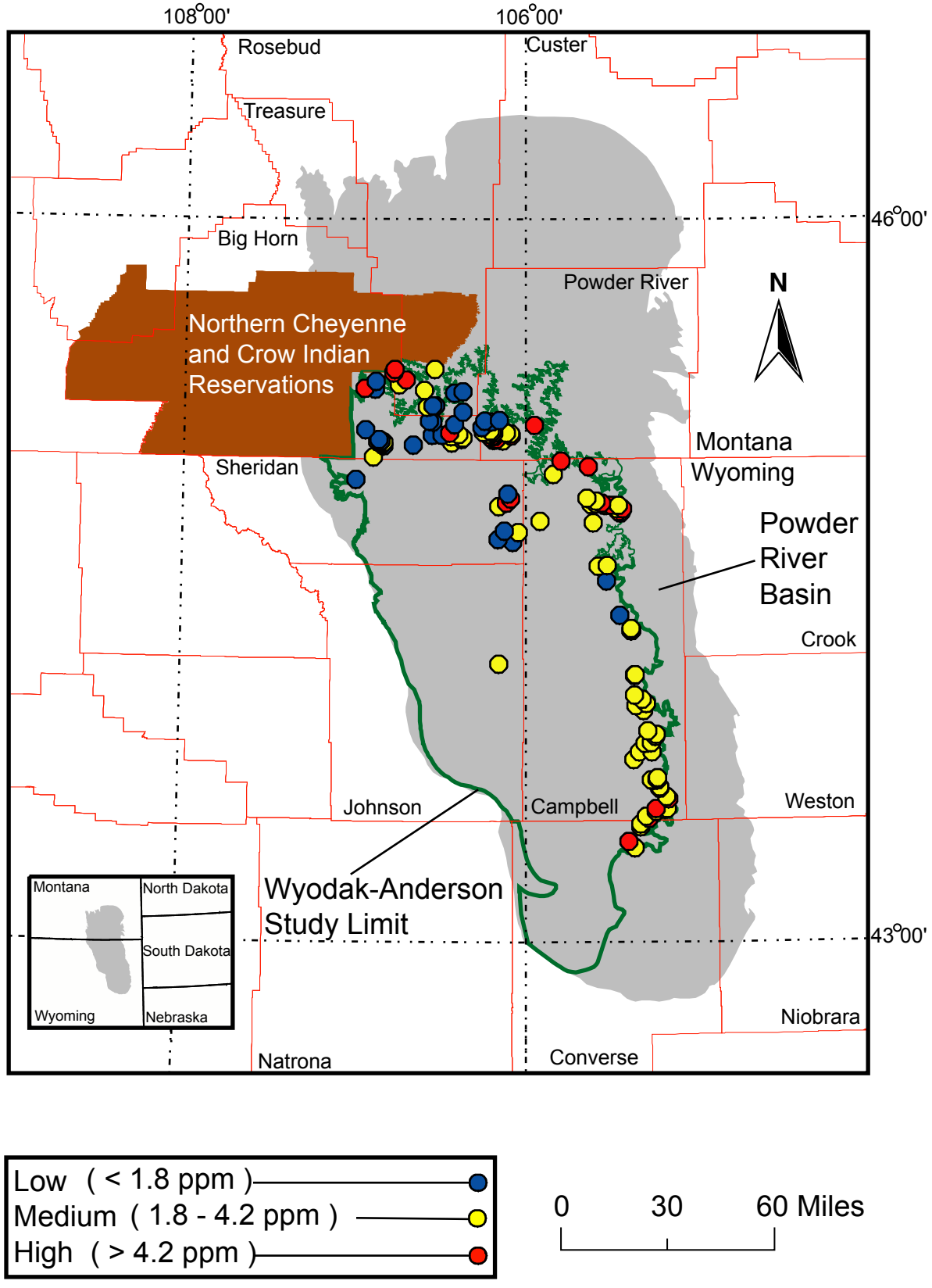

Figure PQ-13. Lead concentration in the Wyodak-Anderson coal zone, Powder River Basin, Wyoming and Montana.

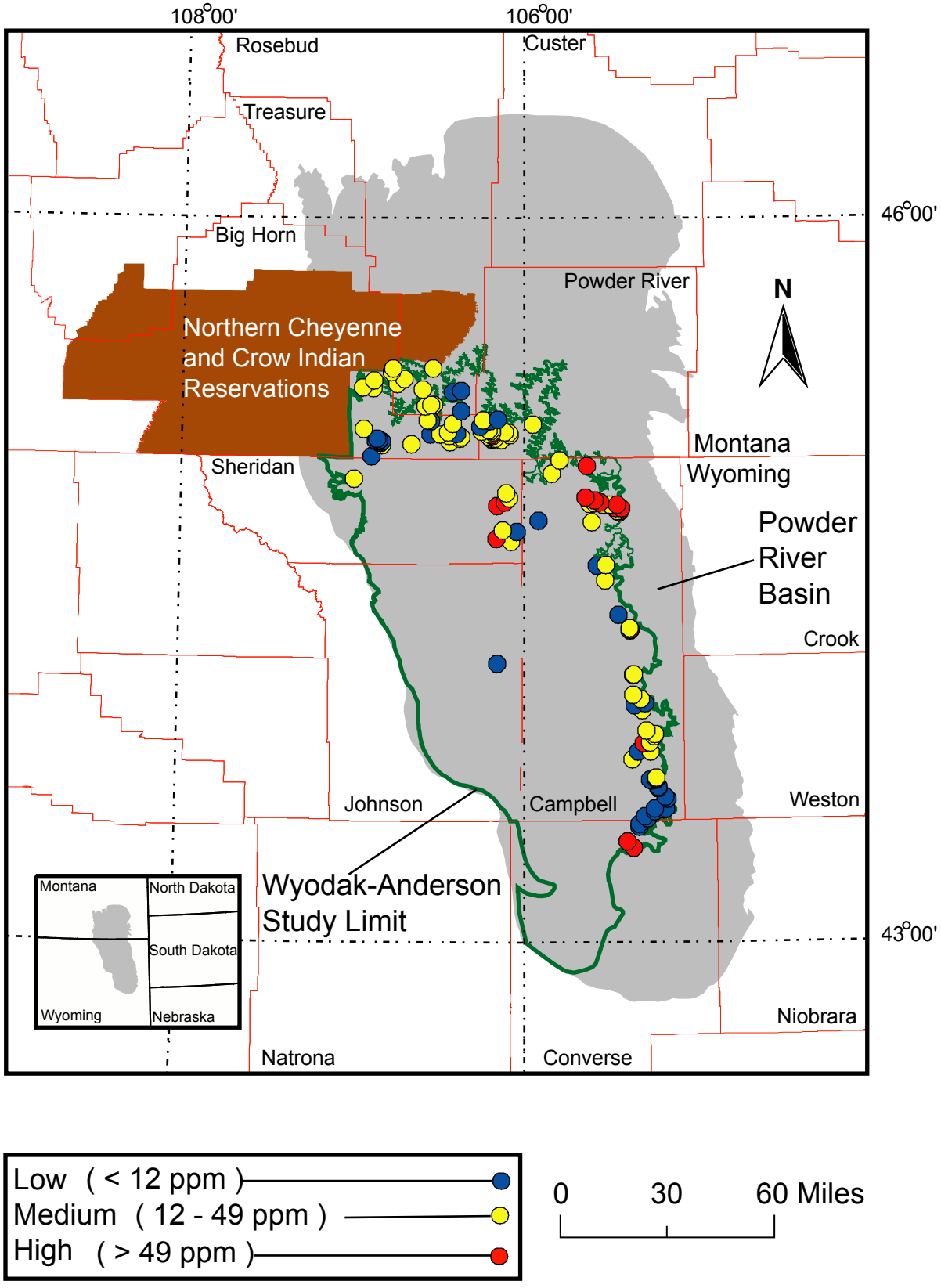

Figure PQ-14. Manganese concentration in the Wyodak-Anderson coal zone, Powder River Basin, Wyoming and Montana.

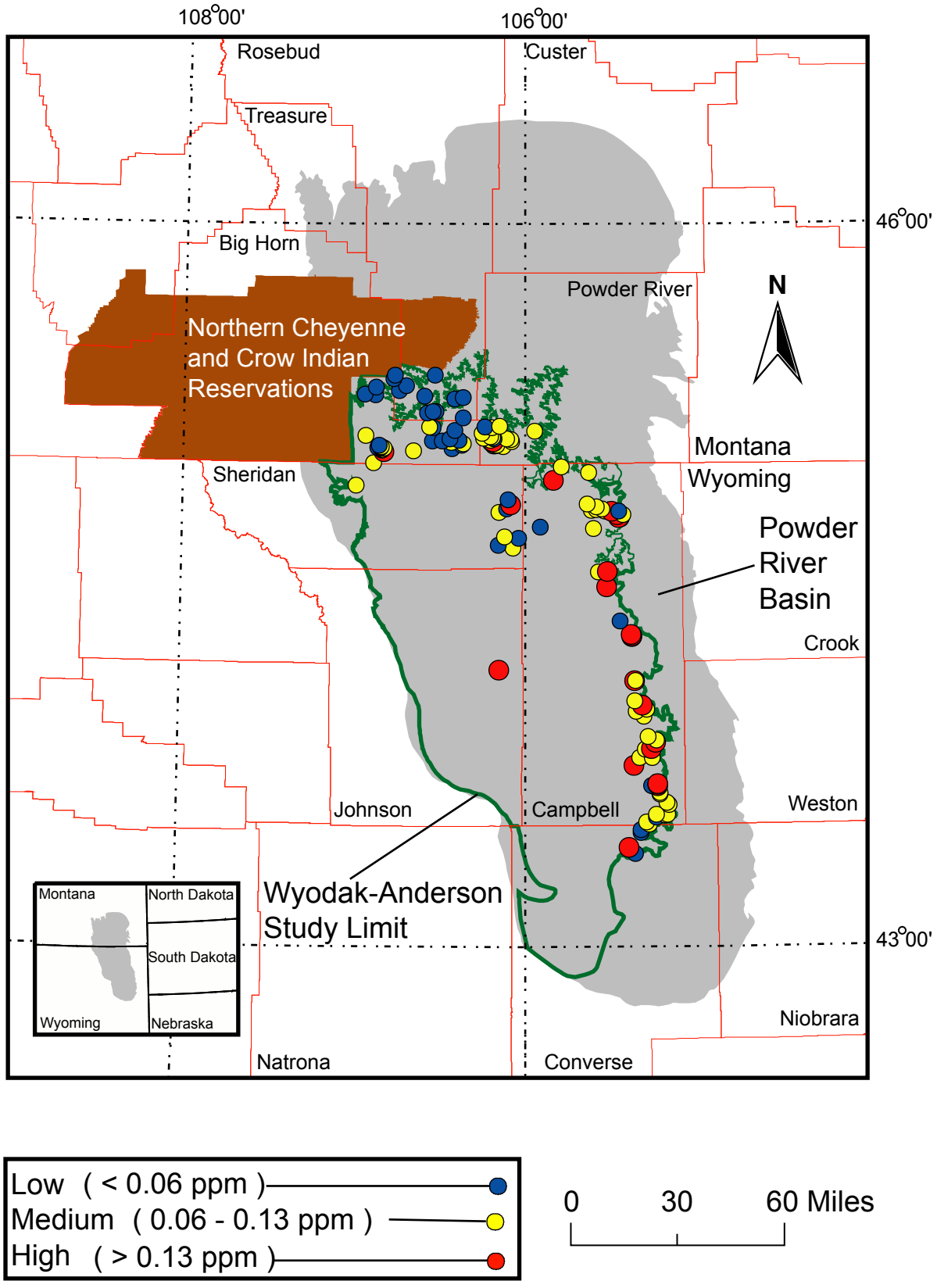

Figure PQ-15. Mercury concentration in the Wyodak-Anderson coal zone, Powder River Basin, Wyoming and Montana.

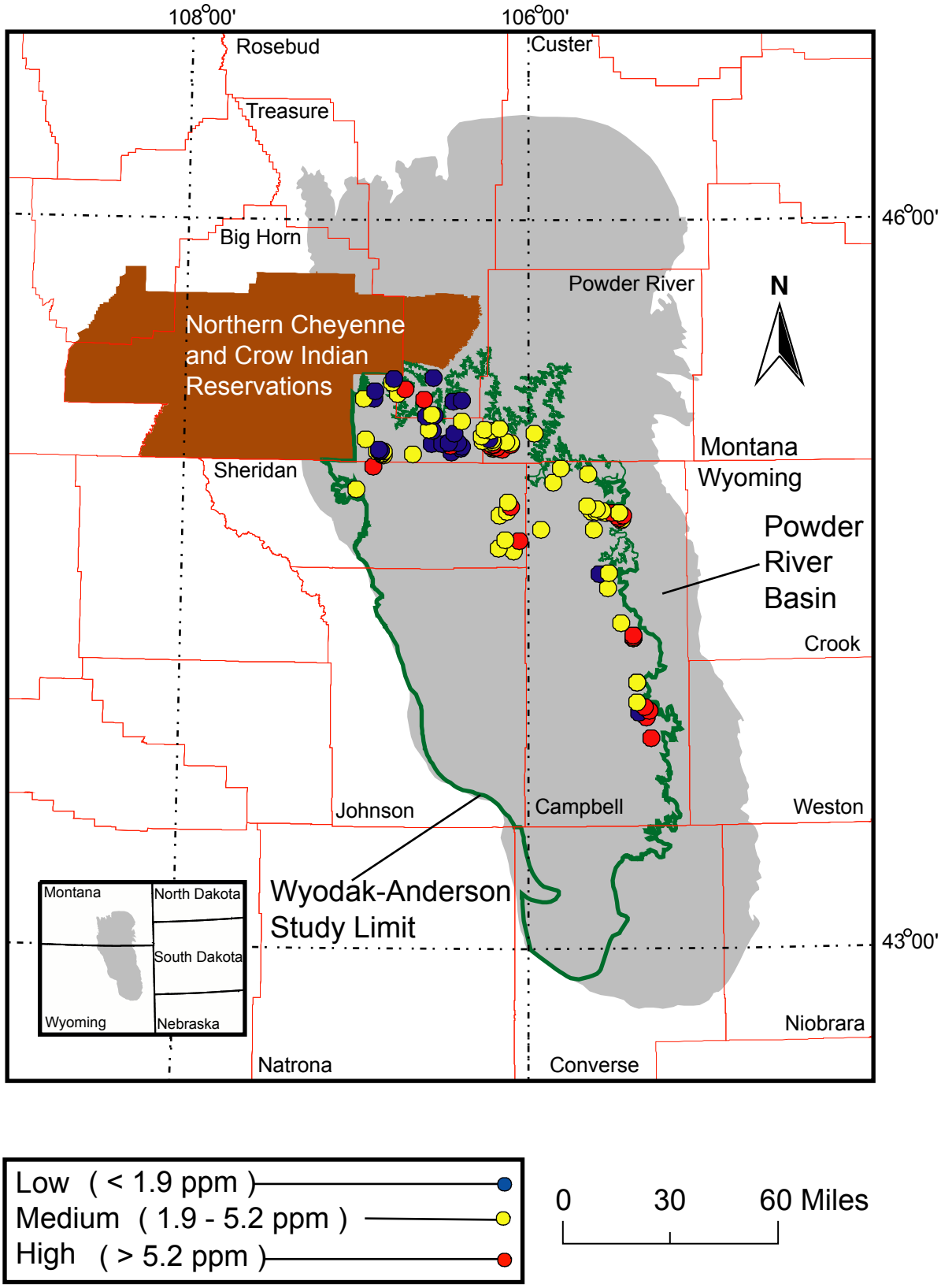

Figure PQ-16. Nickel concentration in the Wyodak-Anderson coal zone, Powder River Basin, Wyoming and Montana.

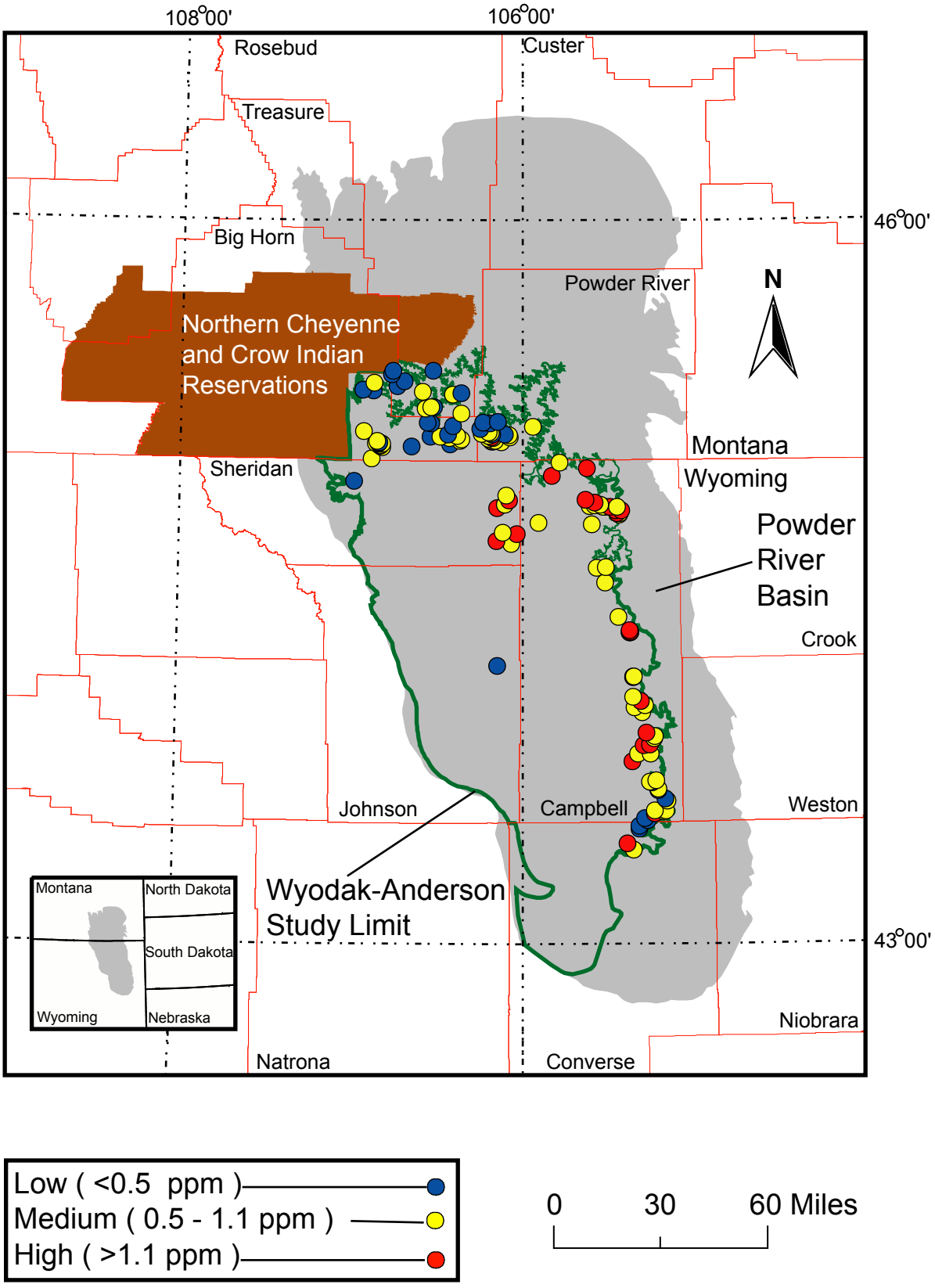

Figure PQ-17. Selenium concentration in the Wyodak-Anderson coal zone, Powder River Basin, Wyoming and Montana.

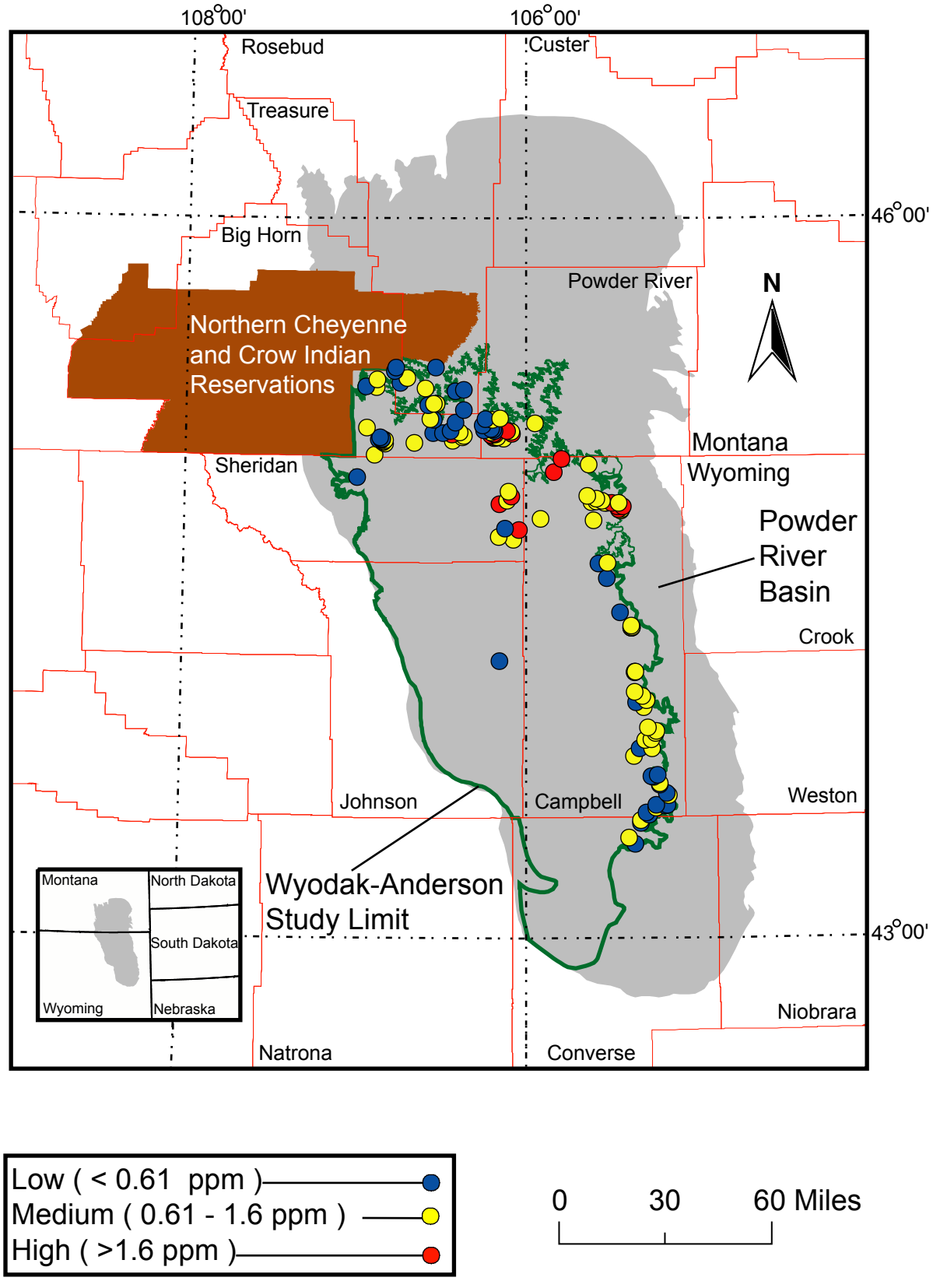

Figure PQ-18. Uranium concentration in the Wyodak-Anderson coal zone, Powder River Basin, Wyoming and Montana.

Table PQ-1. Summary data for coal in the Wyodak-Anderson coal zone in the Powder River Basin, Wyoming and Montana. Calculated from the unpublished U.S. Geological Survey coal quality database (USCHEM), February, 1992; Bragg and others (1994); and proprietary source(s)

Variable	Number of samples	Range		Mean
		Minimum	Maximum	
Moisture [1]	300	14.50	42.30	27.66
Ash [1]	279	2.86	25.06	6.44
Total sulfur [1]	279	0.06	2.40	0.48
Calorific value [2]	277	3,740	9,950	8,220
lb SO_2 [3]	277	0.14	7.88	1.24
MMMFBtu [4]	277	4,580	10,560	8,820
Antimony [5]	144	0.01L	17	0.49
Arsenic [5]	158	0.20L	19	2.6
Beryllium [5]	151	0.078L	3.3	0.54
Cadmium [5]	151	0.007L	3.0	0.21
Chromium [5]	161	0.59L	50	6.1
Cobalt [5]	160	0.38L	27	1.9
Lead [5]	162	0.50L	17	3.0
Manganese [5]	161	0.18	210	26
Mercury [5]	162	0.006L	27	0.13
Nickel [5]	161	0.71L	35	4.6
Selenium [5]	151	0.08L	16	1.1
Uranium [5]	157	0.11L	12	1.3

[1] Values are in percent and on an as-received basis.
[2] Value is in British thermal units (Btu).
[3] Value is in pounds per million Btu and on an as-received basis.
[4] Value is in British thermal units on a moist, mineral-matter-free basis.
[5] Values are in parts per million (ppm) on a whole-coal and remnant moisture basis; “L” denotes less than value shown.