U. S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

A RECONNAISSANCE STUDY OF RADON LEVELS IN SOILS DEVELOPED ON THE UPPER CRETACEOUS PIERRE SHALE JUST ABOVE THE SHARON SPRINGS MEMBER IN THE MISSOURI RIVER VALLEY IN SOUTHEASTERN SOUTH DAKOTA AND NORTHEASTERN NEBRASKA

By

Kendell A. Dickinson[1]

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A Reconnaissance study of radon levels in soils developed on the Upper Cretaceous Pierre Shale just above the Sharon Sprongs Member in the Missouri River Valley in southeastern South Dakota and northeastern Nebraska

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INTRODUCTION

Relatively high levels of radon were found in soil-gas samples in southeastern South Dakota and northeastern Nebraska. The samples were collected from soils developed on Upper Cretaceous Pierre Shale stratigraphically just above the upper contact of the basal Sharon Springs Member. The Pierre Shale is a dark gray to black shale that covers much of the High Plains and extends from southern Colorado to central North Dakota. The Sharon Springs Member is a uraniferous organic member of the Pierre (Gautier and others, 1984). Landis (1959) reports that in general the Sharon Springs contains about 10 ppm uranium, but some beds contain as much as 60 ppm. The Sharon Springs, which is less than 50 feet thick in the study area, is mostly dense hard noncalcareous dark gray to black shale with conchoidal fracture. It is interbedded with bentonite and is more resistant to erosion than the overlying part of the Pierre Shale (Tourtelot, 1956). The Sharon Springs is overlain by crumbly black shale of the middle part of the Pierre Shale that weathers to gumbo and underlain in the study area by the limestone and calcareous shale of the Cretaceous Niobrara Formation.

Methods

Soil-gas samples were collected at six localities during August, 1988 (table 1). Samples were collected at several stratigraphic levels at each locality representing different distances above the top of the Sharon Springs Member. The sample positions were determined by measuring upward from the top of the Sharon Springs with a Jacob's staff over soils developed on the middle part of the Pierre Shale. (fig. 1)

Soil-gas samples were collected by drawing gas with a syringe from a hollow 75cm probe driven vertically into the soil with a slide hammer (Reimer, 1991). Twenty cubic centimeters of the gas were held in the syringe for a 5-minute period to permit thoron decay. A background count was made simultaneously from the evacuated counting chamber. The sample then was counted for 5 minutes in an EDA Instruments Inc. RDA-200 radon detector. The background count was subtracted from the soil-gas count before converting to picocuries per liter (pCi/L). The conversion factor for a 20cc sample is 5. The data are presented in table 1.

Soil gas was sampled and tested for radon at six localities near or on the shores of the Missouri River in southeastern South Dakota and northeastern Nebraska (fig. 2). The localities were located (1) about 3 miles north of Chamberlain, on highway 47 in Brule County, South Dakota; (2) on the west shore of the Missouri River directly

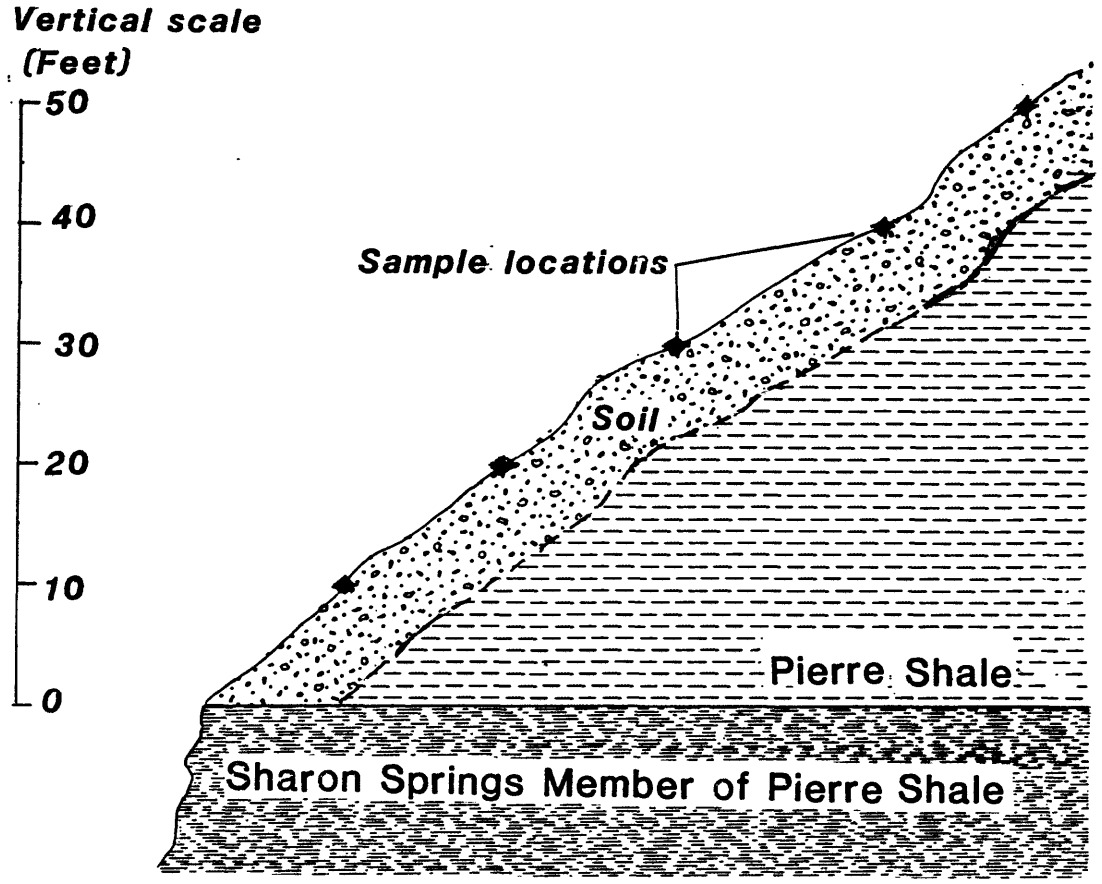

FIGURE 1. Schematic diagram showing sample positions at a sample locality

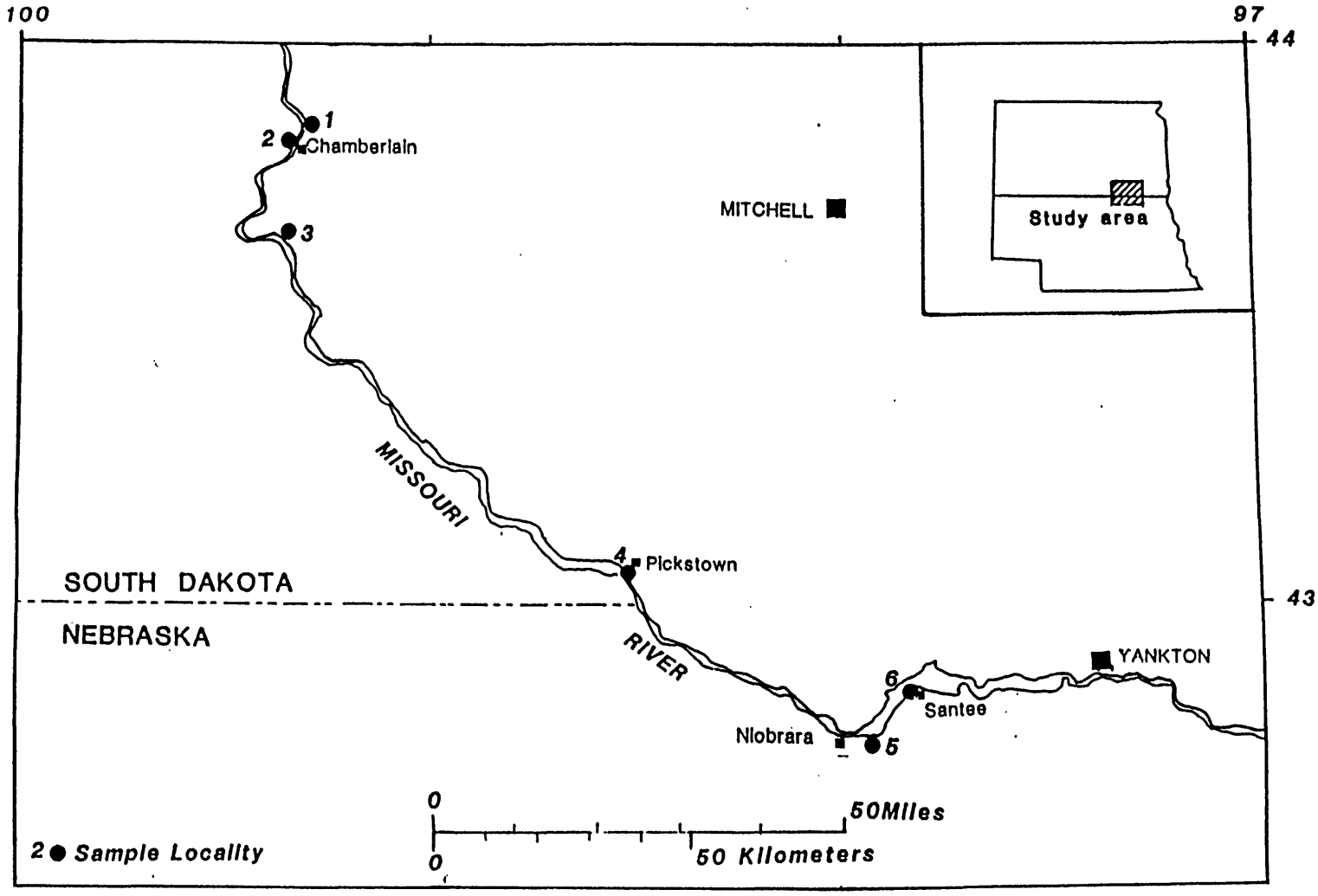

FIGURE 2. Map showing sample localities

across from Chamberlain, in Lyman County, South Dakota; (3) about 12 miles southwest of Chamberlain, in Grandview County, South Dakota, at the Boyer State Public Hunting area on the shore of Lake Francis Case; (4) on the banks of the north spillway at Fort Randall Dam, near Pickstown in Mix County, South Dakota; (5) At Maiden's Leap in the Santee Indian Reservation about three miles east of Niobrara on highway 12 in Knox county, Nebraska; and (6) About 1/2 mile west of the housing development in the village of Santee, also in Knox County, Nebraska.

Table 1. radon in soil gas above the Sharon Springs Member of the Pierre Shale

Sample No.	Background (Counts)	Measurement (Counts)	Soil-gas Radon (pCi/L)	Distance above SSM* (ft.)
		Locality 1		
		Two miles north of Chamberlain, South Dakota		
25-2	20	72	260	10
25-3	12	74	310	25
25-4	27	159	660	40
25-5	28	538	2550	50
25-6	47	218	855	60
25-7	52	231	895	60
		Locality 2		
		West side of bridge, Chamberlain, South Dakota		
25-8	4	142	690	10
25-9	13	137	620	10
25-10	22	261	1195	20
25-11	37	136	495	30
25-12	21	40	95	40
25-13	27	61	170	35
25-14	23	253	1150	20
		Locality 3		
		Boyer Lake Access, South Dakota		
26-1	12	144	660	10
26-2	25	190	825	30
26-3	23	94	355	50
26-4	20	272	1260	10
26-5	22	224	1010	10
		Locality 4		
		Fort Randall Dam, Northeast Spillway, South Dakota		
27-1	8	303	1475	15
27-2	30	172	710	10
27-3	47	241	1030	20

Table 1. Continued:

Sample No.	Background (Counts)	Measurement (Counts)	Soil-gas Radon (pCi/L)	Distance above SSM* (ft.)
		Locality 5		
		Maiden's Leap east of Niobrara, Nebraska		
27-7	11	440	2145	10
27-8	58	274	1080	15
27-9	47	365	1590	5
		Locality 6		
		One-half mile southwest of Santee, Nebraska		
27-4	3	278	1375	20
27-5	15	250	1175	25
27-6	26	232	1030	15

* Stratigraphic distance measured above the upper Sharon Springs Member (SSM) with a Jacob's staff.

RESULTS

Radon concentrations ranged from 95 to 2550 pCi/L in soil-gas measurements that were taken from 5 to 60 feet above the top of the Sharon Springs Member. All the localities had at least one measurement in excess of 1000 pCi/L (moderate radon level) and two localities had measurements in excess of 2000 pCi/L (high radon level) (table 1; Gundersen and others, 1987). These values are high enough to cause concern as a source for indoor radon in dwellings (Schumann and others, 1991). Houses built on the Sharon Springs Member in the village of Santee, Nebraska exhibit high indoor radon values (Personal communication, J. Otton, 1992). These homes are within about one mile of sample locality number six in this report.

The relation between the soil-gas radon concentrations and the stratigraphic distance above the Sharon Springs Member is shown in figure 3. The amount of radon in the gas is generally inversely proportional to the distance above the top of the Sharon Springs. The correlation coefficient calculated from the data in table 1 is only -.12, which is not significant for 27 sample pairs. Sample 25-5 is, however, an outlier that greatly effects the calculated correlation coefficient. If sample 25-5 is left out of the calculation, the correlation coefficient between the remaining 26 sample pairs is -.38, which would be significant at the 90% confidence level. The data presented here are insufficient to make this conclusion reliable. They do, however, suggest the relationship. Sample 25-5 may have been measured over a fracture or some other opening that allowed the soil gas to rise rapidly through the rock beneath the soil.

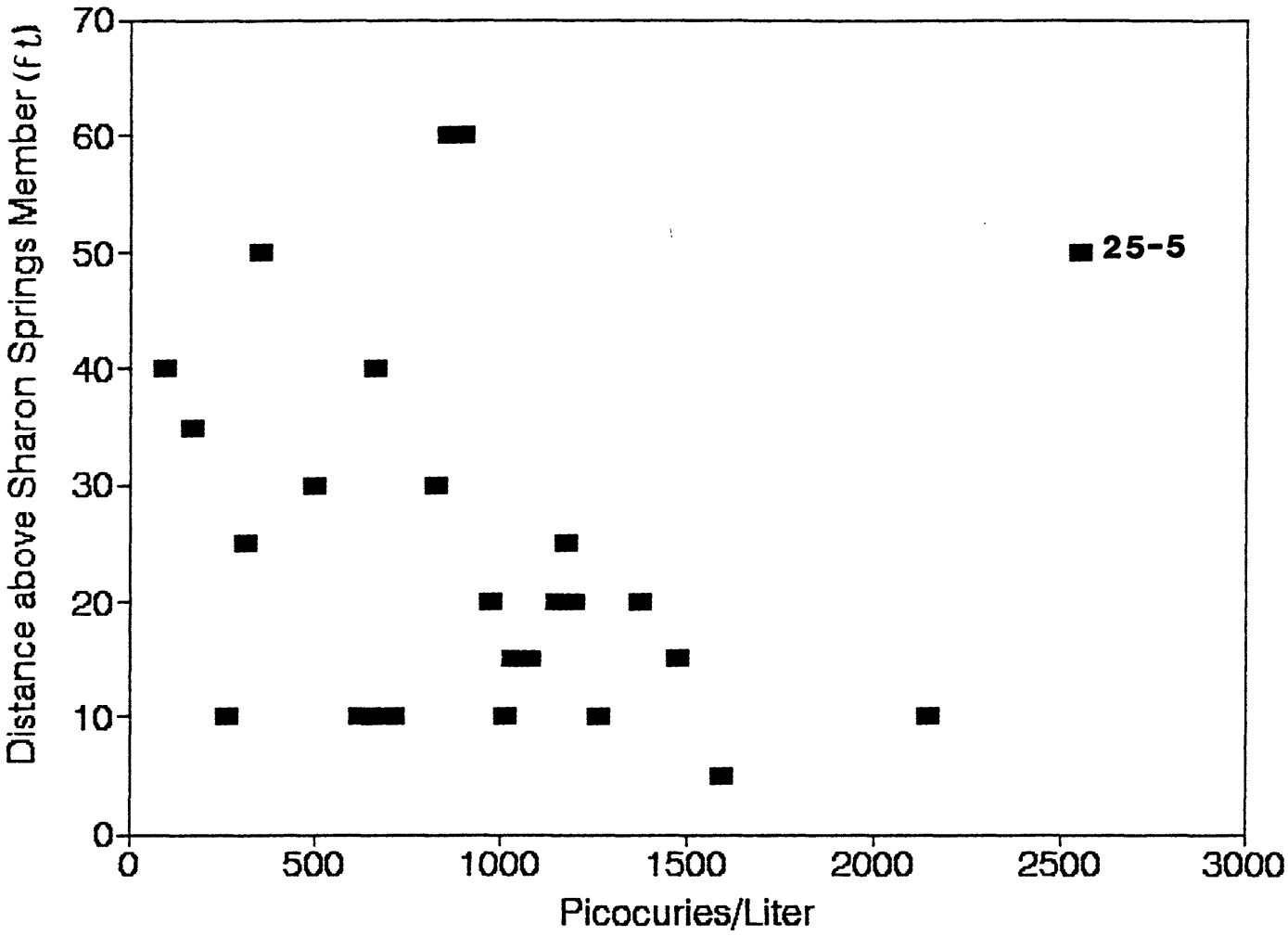

FIGURE 3. Scatterplot showing relation between radon concentrations in soil gas and stratigraphic distance above the Sharon Springs Member.

More soil-gas samples should be taken not only near the Sharon Springs but farther away so that baseline values for radon could be established for the middle and upper parts of the Pierre Shale as well.

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