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Iodine and Algae in Sedimentary Rocks Associated with Iodine-Rich Brines

ABSTRACT

Neutron activation analyses of iodine and uranium in Paleozoic sedimentary rocks from the northern Oklahoma platform of the Anadarko basin show 0.9 to 12.3 ppm I and 0.07 to 8.7 ppm U. The samples were taken from strata in Kingfisher County, Oklahoma, where anomalously high concentrations of iodine were found in associated subsurface brines. Micropaleontological examinations reveal algal strands in the more iodine-rich rocks.

INTRODUCTION

Subsurface brines associated with Paleozoic sedimentary beds in the northern Oklahoma platform of the Anadarko basin contain anomalously high concentrations of iodide (Collins, 1969). To investigate a possible correlation between the iodide in brine and the associated rock strata, samples of the rocks were analyzed by neutron activation analysis and thin sections were examined to see if some ancient biota could be the source of the iodine (Gulyayeva and Itkina, 1962; Cosgrove, 1970).

EXPERIMENTAL PROCEDURE

Portions of untreated dry Paleozoic rock samples from oil wells in the areas of interest were pulverized, and other portions of the same samples were prepared as thin sections for micropaleontological examination. The pulverized portions were analyzed by neutron activation analysis to determine iodine and uranium content using the procedures given by Becker and others (1968) and Bennett and Manuel (1968).

DISCUSSION OF RESULTS

Table 1 summarizes the sample analyses. Most results are averages of two determinations, but some are those of single analysis. The errors shown for samples analyzed in duplicate encompass both measured values and include errors estimated from variation in the activity of the monitors. No errors for single analysis are

TABLE 1. GEOGRAPHIC INFORMATION AND IODINE AND URANIUM CONTENT OF SAMPLES

Sample no.	Location	Oklahoma county	Depth (ft)	Geologic formation	Approximate lithology	Iodine (ppm)	Uranium (ppm)	I/U
1	S. 13, T. 18 N., R. 9 W.	Kingfisher	8482	Woodford	Shale	8.25 ± 0.15	1.2 ± 0.2	6.9
2	S. 13, T. 18 N., R. 9 W.	Kingfisher	8523	Woodford	Shale	6.36*	1.87*	3.4
3	S. 13, T. 19 N., R. 10 W.	Blaine	8416	Woodford	Shale	1.40 ± 0.20	8.7 ± 1.3	0.16
4	S. 35, T. 19 N., R. 9 W.	Kingfisher	8325	Woodford	Shale	12.3 ± 1.5	0.98 ± 0.03	13
5	S. 31, T. 21 N., R. 13 W.	Major	7636	Chester	Limestone	1.70 ± 0.15	0.07 ± 0.01	24
6	S. 26, T. 21 N., R. 7 W.	Garfield	7016	Meramec	Limestone	1.76*	0.47*	3.7
7	S. 31, T. 17 N., R. 5 W.	Kingfisher	6389	Oswego	Limestone	8.38*	0.20*	42
8	S. 35, T. 20 N., R. 6 W.	Garfield	6400	Manning	Limestone	10.4*	0.48*	22
9	S. 5, T. 17 N., R. 6 W.	Kingfisher	6525	Oswego	Limestone	2.0 ± 0.4	0.39 ± 0.06	5.2
10	S. 27, T. 22 N., R. 23 W.	Ellis	7570	Oswego	Limestone	0.86 ± 0.14	0.30 ± 0.04	2.9

*Single analysis

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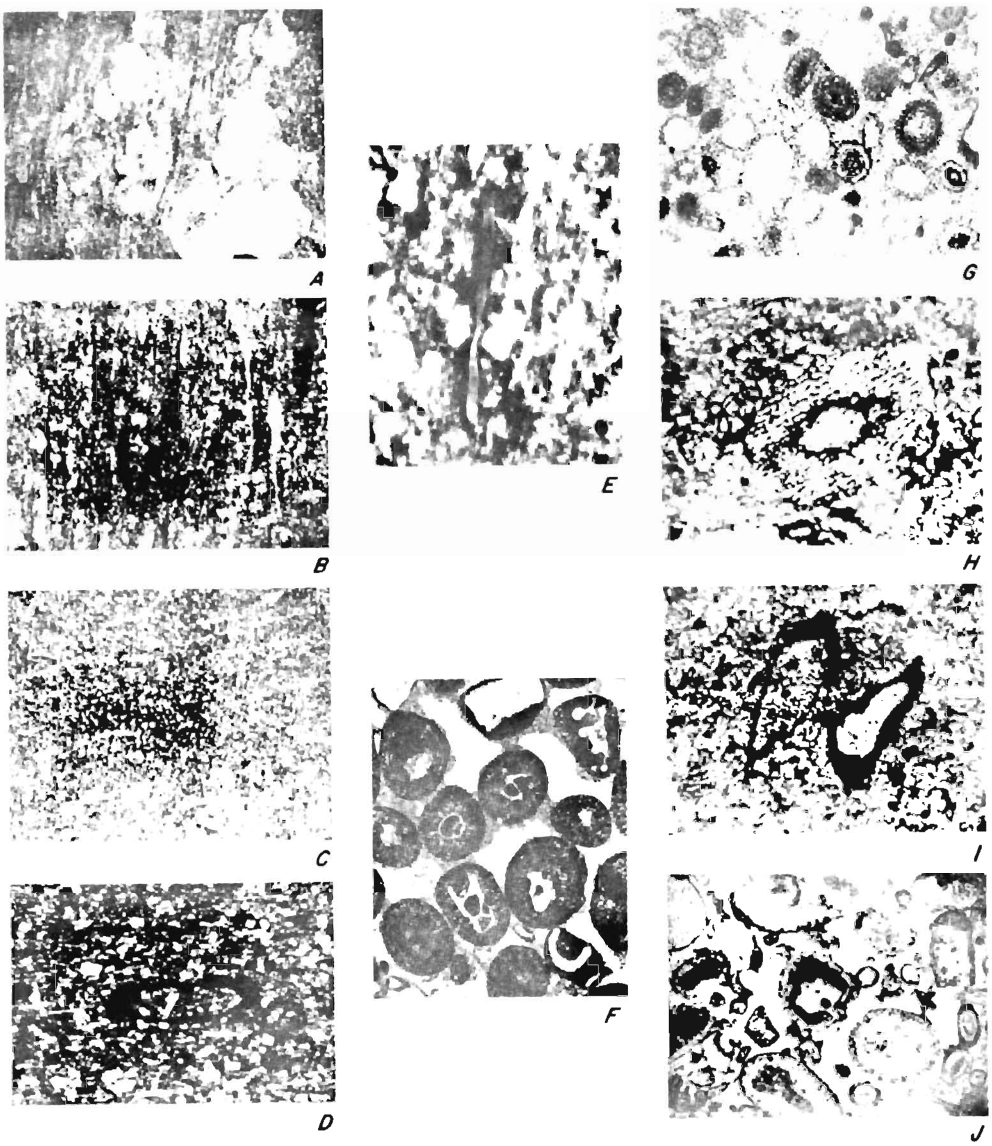

Figure 1. Photomicrographs of rocks at approximately 368 magnification. A, B, and C are from sample no. 3; D and E are from sample no. 4; F is from sample no. 5; G and H are from sample no. 7; and I and J are from samples nos. 8 and 9, respectively. The sample numbers are the same as those listed in Table 1.

shown in Table 1, but they are estimated to be about ±20 percent.

Iodine concentrations range from 0.86 ppm for sample no. 10 to 12.3 ppm for sample no. 4. In a recent study of iodine in sedimentary rocks, Bennett and Manuel (1968) found that iodine in deep-sea sediments varied from 10.9 to 49 ppm. In other sedimentary rocks, Becker and others (1970) report iodine contents of 0.023 to 8.0 ppm, with the iodine content of sediments decreasing as follows: deep-sea sediments > carbonates > shales > sandstones. Cosgrove (1970) reported iodine content in Kimmeridge shale samples as high as 34 ppm and said that the iodine content correlates with organic carbon.

Uranium concentrations range from 0.07 ppm in sample no. 5 to 8.7 ppm in sample no.

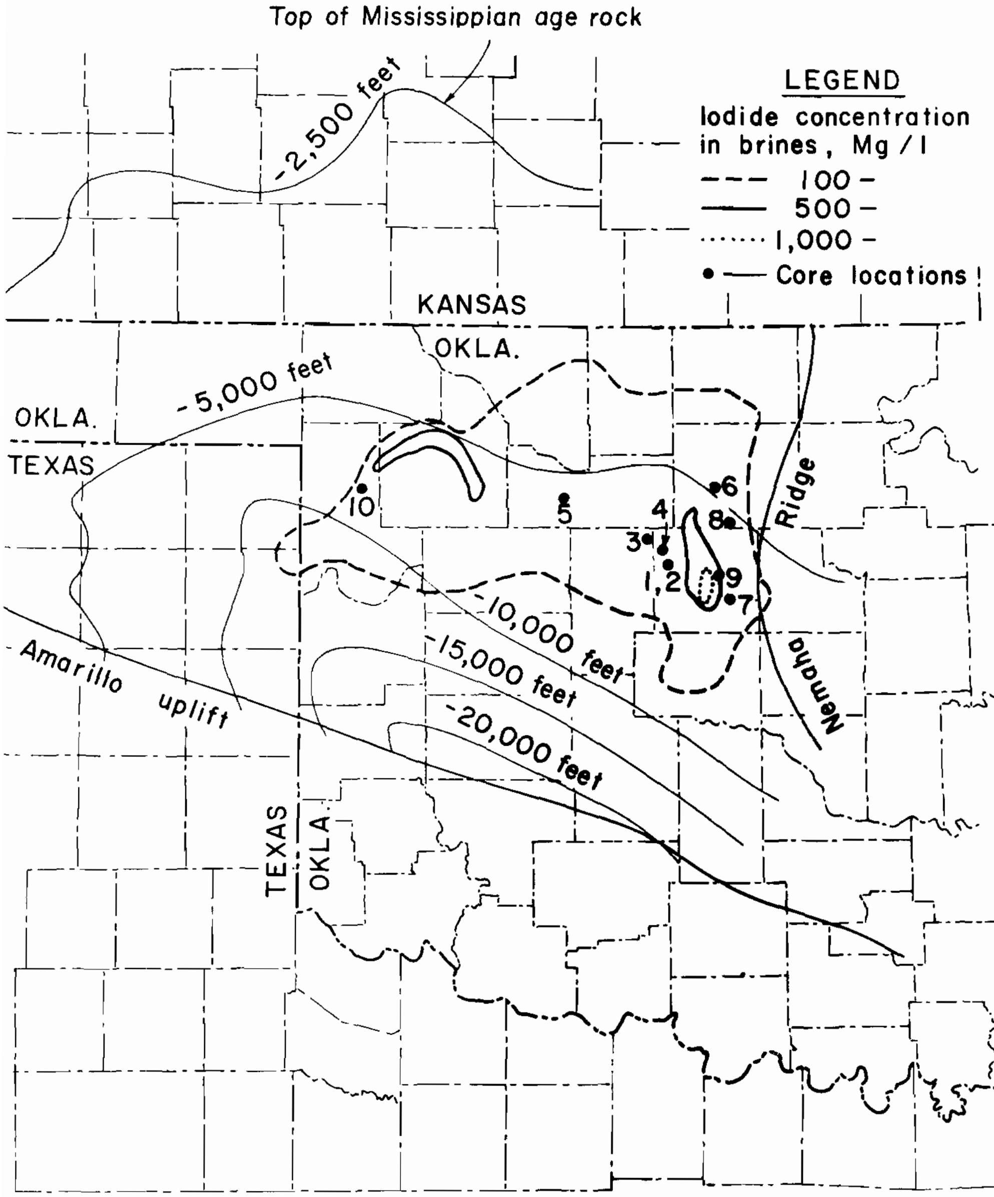

Figure 2. Location of sample cores are compared with iodide isoconcentration contours for subsurface brines from Mississippian and Pennsylvanian age formations.

3, and are within values common to sedimentary material (Horn and Adams, 1966). The wide range of values for the I/U ratio indicates that these elements are geochemically unrelated and that their total concentrations are not the result of a common "carrier" mineral enriched in both elements.

Table 2 presents identified microfossils shown in photomicrographs in Figure 1 taken at approximately 368 magnification. Figure 1A is a section of sample no. 3 and shows algal masses, possibly blue-green types. In Figure 1B, from sample no. 3, brown algal filaments are visible. Figure 1C is from sample no. 3 and

TABLE 2. MICROFOSSILS IN THE SAMPLES

Sample No.	Identified Microfossils
1	not examined
2	none identifiable
3	detrital layers
	algal strands
	algal masses
4	algal strands
5	algal oölites
	foraminifera
6	algal fragments
7	algal oölites
	algal strands
8	algal strands
9	algal oölites
	algal fragments
10	foraminifera

shows a detrital band. Figure 1D is from sample no. 4, and the dark ring in the center probably is a brown algal stem section. Figure 1E is from sample no. 4, and a brown algal tubule is visible in the center. Figure 1F, from sample no. 5, shows the presence of algal oölites around various muclei. In Figure 1G, from sample no. 7, algal oölites are visible. Figure 1H is also from sample no. 7 and shows an algal stem section cut at a slight angle. Figure 1I, from sample no. 8, shows algal stems cut at angles. Figure 1J shows the presence of algal oölites in sample no. 9.

In comparing the results of the micropaleontological examinations from Table 2 with the iodine contents from Table 1, it is apparent that of the samples examined all of the more iodine-rich ones (nos. 4, 7, and 8) contain algal strands. Vascular plant spores and pollen were absent in the samples investigated, indicating a depositional environment far from land. The low iodine content of sample no. 10 and the identification of only foraminifera in this sample suggest that the high iodine content of the other samples is not related to the presence of these rhizapods. The contribution of oölites to the total iodine cannot be distinguished except to note that only about 1 ppm of iodine is associated with the large oölites in sample no. 5.

Figure 2 compares the location of the rock samples studied with isoconcentration contours of iodide in brines taken from the same strata (Collins, 1969).

CONCLUSIONS

The results of this investigation show a correlation between the iodine content of sedimentary rocks, microfossils, algae, and iodide-rich subsurface brines. Although this correlation does not unambiguously define a single cause and effect relationship, our results appear to confirm an association of iodine-rich waters with algae in sedimentary rocks.

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