 0030-0950/81/0002-0078 $2.00/0

CHEMICAL COMPOSITION OF THE ROCKY RIVER NEAR CLEVELAND, OHIO[1]

HOWARD H. LO and FREDERICK M. SOSTER,[2] Department of Geological Sciences, Cleveland State University, Cleveland OH 44115

Abstract. On 29 and 30 October 1978, 44 water samples were collected from the Rocky River and selected tributaries. We investigated the distribution of K, Na, Ca and Sr with respect to location along the river and found that the Lower Rocky River has the highest average concentrations of K, Na and Ca, compared to the East Branch and West Branch, a finding probably attributable to cultural inputs from waste water and industrial dumps. The higher average concentrations of K, Na and Ca in the West Branch relative to the East Branch of the Rocky River may be caused by the agricultural and industrial input. The sharp drop of element concentrations near the mouth of the Rocky River may be the result or mixing of lake water with the river water. The average concentrations of K, Na, Ca and Sr found in the Lower Rocky River were 7.4, 62.0, 59.0, and 0.15 ppm, respectively. These values are comparable with those of the Lower Cuyahoga River but are considerably higher than those reported for the midlake water of Lake Erie.

OHIO J. SCI. 81(2): 78, 1981

The East Branch of the Rocky River has its headwaters in Medina County, approximately 30 miles south of Lake Erie. It flows essentially northwest, and upon entering Cuyahoga County it flows through residential areas. The headwaters of the West Branch of the Rocky River are located just south of the Cuyahoga-Lorain County line. Unlike the East Branch, the West Branch flows north through a predominately agricultural rural area. The East and West Branches join approximately 6 miles south of Lake Erie near the Brookpark-North Olmsted municipality boundary. From here, the Rocky River (referred to as Lower Rocky River in this paper) flows northeast through residential and industrial areas and finally enters Lake Erie. Our purpose was to make a systematic sampling and to investigate the composition of the Rocky River and selected tributaries in Cuyahoga County. We present data on the distribution and concentrations of K, Na, Ca and Sr in the Rocky River system and examine the possible contribution of local agriculture and industries to the composition of the Rocky River.

METHODS AND PROCEDURES

During 29 and 30 October 1978, a period of relatively dry weather and of no surface runoff, we collected 44 water samples from the Rocky River and selected tributaries. Samples were taken at about 0.5- to 1.0-mile intervals along the river (see figure 1 for location of sample sites). Because the river is relatively narrow and shallow, only one sample was collected at each site. The sample was taken from the part of the river where the strongest current appeared to be flowing. All samples were filtered through Whatman No. 2 filter paper, stored in polyethylene bottles, and kept in a freezer below 0 °C until analyzed.

Using an atomic absorption spectrophotometer (IL Model 253), we analyzed samples for K, Na, Ca and Sr following the methods described by Angino and Billings for fresh water (1972). Calibration curves of known standards were used to determine elemental concentrations. Detection limits (in ppm) for the elements analyzed are: K: 0.003, Na: 0.0008, Ca: 0.002, and Sr: 0.005. The accuracy of analyses expressed as percent of error for the elements analyzed are: K: 4.5, Na: 3.0, Ca: 2.5, and Sr: 7.0.

RESULTS

We analyzed a total of 44 samples from the Rocky River system in Cuya-

---

[1]Manuscript received 26 November 1979 and in revised form 21 April 1980 (#79-55).

[2]Present address: Dept. of Earth Sciences, Case Western Reserve University, Cleveland OH 44106.

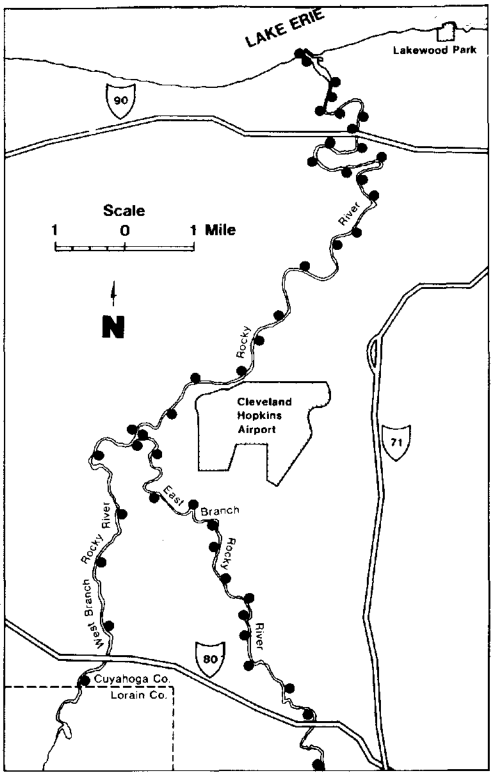

FIGURE 1. Map of Rocky River near Cleveland, showing locations of sample collection as indicated by solid circles.

hoga County for K, Na, Ca and Sr. The river samples were from the Lower Rocky River (23 samples) and selected tributaries, the East Branch (15 samples), and West Branch (6 samples). The average concentrations of K, Na, Ca and Sr, together with the average concentrations of the same elements in the Lower Cuyahoga River (Lo and Shong 1976) and in Lake Erie (Weiler and Chawla 1968), are listed in table 1. Within the Rocky River system, the Lower Rocky River had the highest average concentrations of K, Na and Ca (higher than the East Branch and West Branch).

The concentrations of K, Na, Ca and Sr in the Lower Rocky River versus distance from the river's mouth were plotted in figure 2. All elements showed a sharp drop in concentration beginning 0.2 miles above the mouth of the river

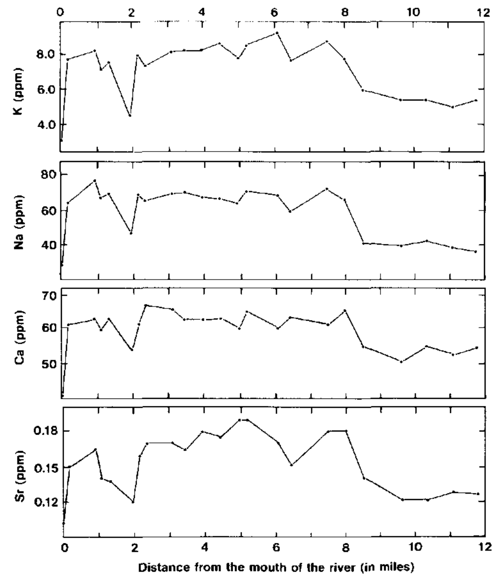

FIGURE 2. K, Na, Ca and Sr in Lower Rocky River as a function of distance from the mouth of the river.

TABLE 1

Average concentrations of K, Na, Ca and Sr in the Rocky River systems, lower Cuyahoga River, and mid-lake water of Lake Erie.

Elements (ppm)	Rocky River System: East Branch (15 samples)	West Branch (6 samples)	Lower Rocky River (23 samples)	Lower Cuyahoga River*	Lake Erie**
K	5.0	5.7	7.4	6.2	1.3
Na	44.2	56.5	62.0	60.8	11.8
Ca	58.0	58.6	59.0	58.2	38.7
Sr	0.14	0.17	0.15	—	0.1

*Data from Lo and Shong (1976).
**Data from Weiler and Chawla (1968).

and continued to decrease towards the mouth of the river. High concentrations for all elements (neglecting the sample at 2.0 miles) occurred from 0.2 to 8.0 miles, and low concentrations occurred from 8.0 to 11.8 miles from the mouth of the river. The sample taken at about 2.0 miles from the river's mouth showed anomalously low concentrations of all elements.

The concentrations of K, Na, Ca and Sr in the East and West Branches versus the distance from the confluence of the rivers are plotted in figures 3 and 4. In the East Branch, higher concentrations of K, Na and Ca occurred from 0.5 to 3.0 miles, and lower concentrations of these elements were found from 4.0 to 8.0 miles from the confluence of the rivers. In the West Branch, concentrations of all elements appeared to be gradually increasing from 0 to 5.0 miles from the confluence of the rivers. A comparison between the East and West Branches showed that the concentrations of K, Na, Ca and Sr in the West Branch increased towards the headwaters, while the concentrations of these elements in

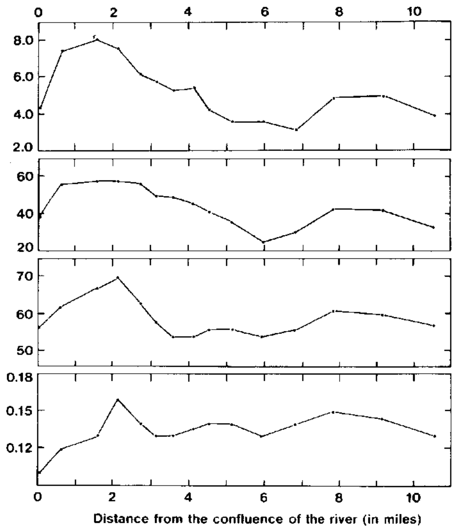

FIGURE 3. K, Na, Ca and Sr in East Branch of the Rocky River as a function of distance from the confluence of the rivers.

the East Branch fluctuated moderately but remained at relatively low concentrations.

DISCUSSION

It is generally understood that there are two major sources of chemicals in rivers and lakes. One is the natural contribution that includes the constituents evolved by the weathering of naturally-occurring soils and bedrocks and the organic solution derived from the biota of the drainage basin. The other is the cultural contribution including agricultural and industrial wastes that are washed or discharged into the rivers and lakes. Agricultural wastes consist of inorganic constituents such as phosphates, nitrates, ammonia and lime, and organic constituents such as fertilizers, pesticides, and animal wastes. Urban effluents consist of a complex array of wastes that include industrial municipal sewage, scour, incidental inputs from commercial and recreational activities, fallout from the atmosphere, and storm sewer discharge.

The higher average concentrations of K, Na and Ca found in the Lower Rocky River (table 1) were probably attributable to the increased input of cultural wastes from the residential and industrial areas located along the river. The mixing of lake water with the river water apparently caused dilution of river water and accounted for the sharp decrease of element concentrations near the mouth of the river (fig. 2). The average element concentrations for K, Na, Ca and Sr in Lake Erie were much lower than those found in the Lower Rocky River (see table 1). The low concentration of all elements found in the sample at about 2.0 miles from the river's mouth (fig. 2) suggested that some local activity was causing dilution of the river water. Field work in the area revealed that numerous springs occurred throughout this region, a fact also reported by Cushing, Leverett and van Horn (1931). It is possible that local springs in the riverbed were contributing groundwater. Winslow, White and Webber (1953) reported the chemical properties of Cuyahoga County groundwater indicating that groundwater near this area contained 36 ppm Ca, 32 ppm Na, and 2.8 ppm K. This groundwater with relatively low concentrations of K, Na, Ca and Sr would cause dilution of the river water and would therefore account for the anomalously low concentrations at this point.

We found relatively low concentrations of all elements beginning at the confluence of the East and West Branches and extending downstream to a point 8.0 miles from the mouth of the river (fig. 2). This interval of low concentrations extended a few miles up the West Branch (see fig. 4). This section of the river, consisting of the uppermost 4 miles of the Lower Rocky River and the lowermost few miles of the West Branch, may actually represent the closest approach to natural unpolluted river water in the system.

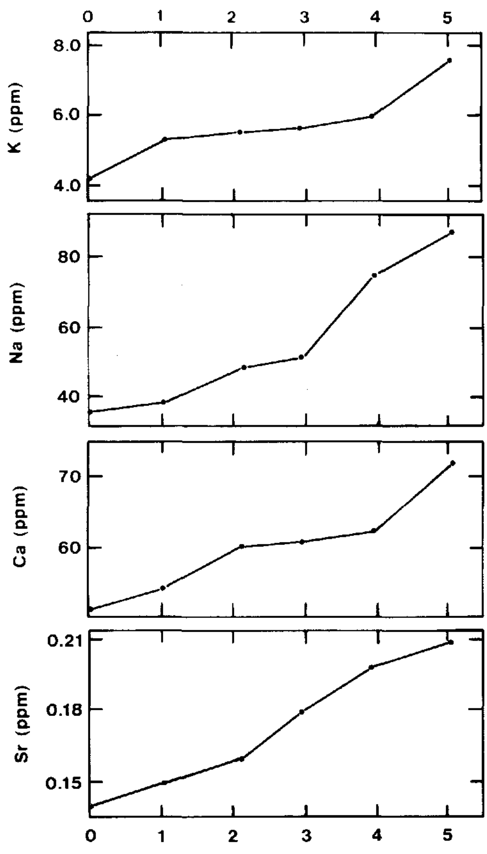

FIGURE 4. K, Na, Ca and Sr in West Branch of the Rocky River as a function of distance from the confluence of the rivers.

The high concentrations of K, Na, Ca and Sr found in the lower East Branch (fig. 3) were probably due to the dumping of waste water from the City of Berea waste water treatment plant (which is located on the East Branch about 3.0 miles above the confluence). These elements reached their highest concentrations in the section of the East Branch approximately 1.2 miles below the point of waste discharge and then gradually decreased towards the confluence. The decrease in concentrations of K, Na, Ca and Sr would be expected when there is an addition of groundwater and runoff containing lower concentrations of these elements. This occurrence probably explains the lower concentrations of these elements found on the upper four miles of the Lower Rocky River (fig. 2) and on the middle 5 miles of the East Branch (fig. 3).

The increasing concentrations of K and Ca in the West Branch are probably related to the fact that the area through which it flows is primarily agricultural. Viets (1971) pointed out that K was one of the major constituents of fertilizers. Upchurch (1972) noted that high Ca concentrations occurred in the lakes near the mouths of tributaries that drained agricultural areas, and low Ca concentrations occurred near the mouth of streams in undeveloped basins. Runoff from the agricultural areas adjacent to the West Branch is apparently contributing much of the K and Ca to the river system. Fertilizers cannot account for the increasing concentrations of Na in the West Branch because Na is not a major chemical constituent contained in fertilizers. Upchurch (1972), however, reported that Na was derived in the same manner as K, plus a major contribution in the Great Lakes area from street salting and industrial use of brines. These factors may offer an adequate explanation for the increasing concentration of Na found in the West Branch.

The natural input of K, Na and Ca also may be related to the bedrock through which the river flows. Most of the Rocky River system flows through Upper Devonian and Lower Mississippian shale formations. The Devonian Chagrin Shale Formation contains blue to darkgray silty shales scattered with iron carbonate concretions and thin calcareous sandstone layers, and the Mississippian Bedford Shale Formation contains soft blue-gray shales and calcareous lenses of sandstone. Cushing, Leverett and van Horn (1931) presented data on the chemical composition of shales from the vicinity of Cleveland. Their figures showed that the Bedford shale contains 1.00% CaO, 4.10% Na_2O, and 1.00% K_2O. It is very likely that the weathering of shales and the calcareous sandstones of these formations in the Cleveland area are making important contributions of K, Na and Ca in the Rocky River.

It is noted that the average concentrations of K, Na and Ca in the Lower Rocky River and Lower Cuyahoga River are nearly the same (table 1). In comparing the elemental concentrations of the Lower Rocky River with those of the midlake water from Lake Erie, it can be seen that the concentrations of K and Na in the river water are about 5.5 times greater than those in the lake, and the river's concentrations of Ca and Sr are about 1.5 times greater than the Lake Erie concentrations. As reported by Weiler and Chawla (1968), the composition of lake water in Lake Erie was quite homogeneous except for some areas close to the shores and the western basin. The much higher concentrations of K, Na, Ca and Sr found in the Lower Rocky River apparently make a significant contribution of these elements to Lake Erie.

LITERATURE CITED

Angino, E. E. and G. K. Billings 1972 Atomic Absorption Spectrometry in Geology, 2nd ed. Elsevier Pub. Co., New York. 191 pp.

Cushing, H. P., F. Leverett and F. R. van Horn 1931 Geology and mineral resources of the Cleveland district, Ohio. U.S. Geol. Survey Bull. No. 818, 138 pp.

Lo, H. H. and A. A. Shong 1976 Geochemical investigation of the lower Cuyahoga River, Cleveland, Ohio. Ohio J. Sci. 76: 57–62.

Upchurch, S. B. 1972 Chemical characteristics of the Great Lakes. Limnology of Lakes and Embayments, Great Lakes Basin Framework Study: 417–656.

Viets, F. G., Jr. 1971 Water quality in relation to farm use of fertilizer. Bioscience 21: 460–467.

Weiler, R. R. and V. K. Chawla 1968 The chemical composition of Lake Erie. Proc. 11th Conf. on Great Lakes Res. at Milwaukee, Wisc., Internat. Assoc. Great Lakes Res.: 593–608.

Winslow, J. D., G. W. White and E. E. Webber 1953 The water resources of Cuyahoga County, Ohio. U.S. Geol. Survey Bull. 26, 123 pp.