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Chemical Characteristics of Bottom Sediments in the Colorado River Upstream from the Price-Stubb Diversion Dam near Palisade, Colorado, October–November 1998

INTRODUCTION

The Colorado River from Palisade upstream to Rifle, Colorado, is a historical habitat for native fish. Some of these fish, the Colorado River pikeminnow and the razorbacked sucker, are currently on the threatened and endangered list. Irrigation diversion dams built in the early 1900's have effectively cut off fish migration in the Colorado River upstream from Palisade. The Price-Stubb diversion dam is located just upstream from Palisade (fig. 1) and currently is not in use. Removal of the Price-Stubb diversion dam has been proposed by the Bureau of Reclamation (BOR) to aid in the recovery efforts of the Colorado pikeminnow and razorbacked sucker by allowing access to historical habitat for spawning.

Removal of the dam could release fine sediments (<0.0625 mm) that have been stored upstream from the dam into the Colorado River. There is no information available about the chemical characteristics of these bottom-material sediments. Because the Colorado River downstream from Palisade through the Grand Valley has been designated as critical habitat for recovery of the Colorado pikeminnow, the release of the sediments and possibly toxic elements in interstitial water associated with removal of the dam is a concern of the BOR. Municipal drinking-water providers downstream are also concerned that release of the sediments and possibly toxic elements could create a public health hazard.

Information derived from the characterization of these bottom-material sediments and associated interstitial waters is needed for planning to avoid any potential damage to threatened and endangered fish or municipal drinking-water systems. Consequently, bottom-sediment samples were collected by the U.S. Geological Survey as part of a cooperative program with the BOR. The sampling sites and data-collection activities and the chemical characteristics are described in the following sections of the report.

SAMPLING SITES AND DATA COLLECTION

Field reconnaissance determined that the finer bottom materials were located along both banks of the Colorado River from 100 to 300 feet upstream from the diversion dam and ranged in depth from 2 to 20 inches. The locations of the deeper deposits of fine material were scattered and very random. Core samples of bottom-

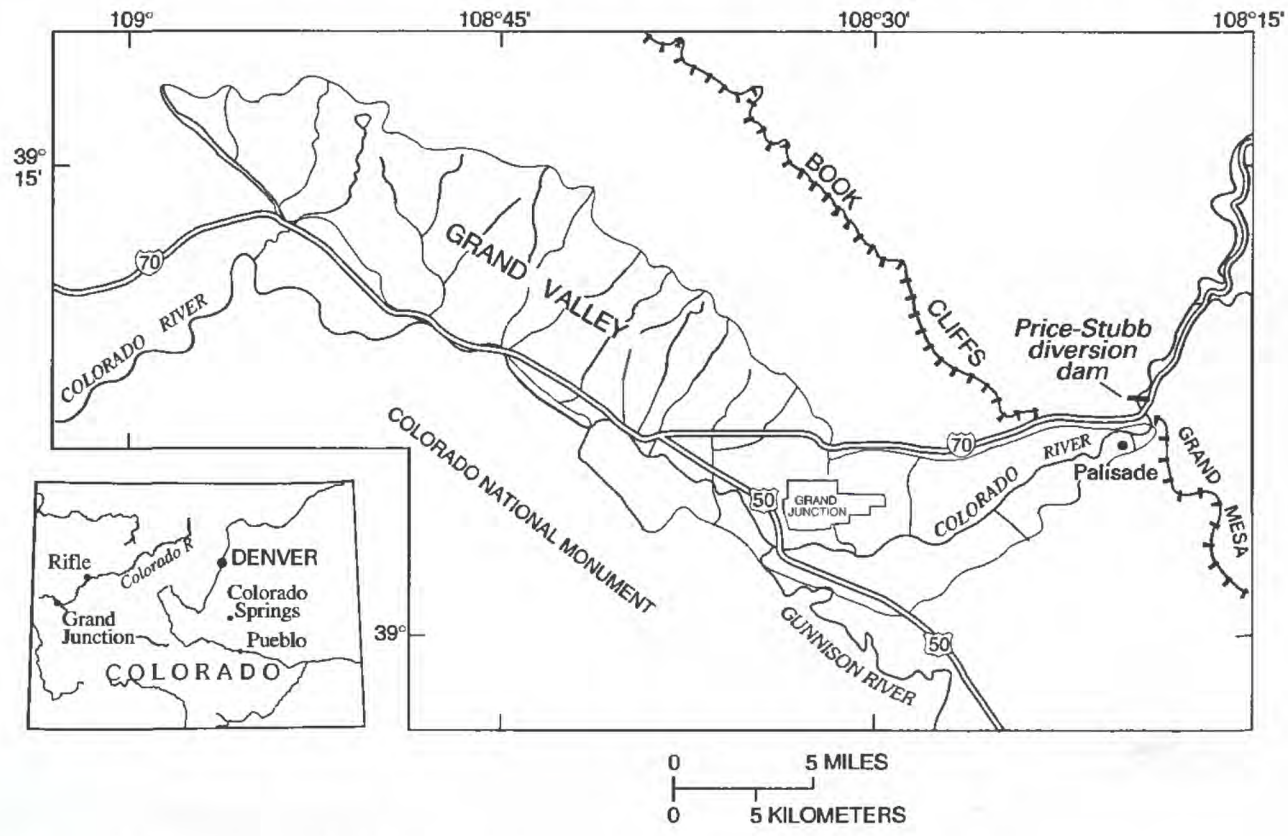

Figure 1. *Location of the Grand Valley and the Price-Stubb diversion dam.*

material sediments were collected at four sites—two along the left bank and two along the right bank—during October and November 1998 (fig. 2). The core samples were taken from depths between 2.4 and 9.8 inches.

It is possible that other layers of fines exist below the streambed, but due to the composition of most of the streambed material (coarse cobbles and boulders) it was not possible to sample at greater depths. Chemical characteristics of fine material that may be present between the existing streambed and pre-dam streambed are unknown. Attempts to sample interstitial water from the bottom sediments were unsuccessful because of the fine-grained material present.

Site PSDG1 is about 50 feet upstream from the end of the diversion wall on the right bank and 10 feet streamward. Site PSDG2 is on the right bank about 200 feet upstream from the end of the diversion wall and about 8 feet streamward. Site PSDG3 is on the left bank about 200 feet upstream from the diversion dam and about 10 feet streamward. Site PSDG4 is along the left bank about 150 feet upstream from PSDG3 and about 6 feet streamward. An additional sample, PSDG4a, was collected near site PSDG4 and analyzed for quality-control purposes.

CHEMICAL CHARACTERISTICS OF BOTTOM SEDIMENTS

Each core sample was analyzed at incremental depths for 28 constituents at the USGS sediment partitioning laboratory. Results of the analyses are listed in table 1. As a quality-control procedure, duplicate analyses were performed on parts of the samples at sites PSDG1 and PSDG3. Results of the chemical analyses were compared to data for reference samples that have been collected across the United States. These reference samples were selected for comparison because they were about the same sediment size and chemical composition as the core samples.

The reference sample from the Cody Shale (SCO-1) is from a site in Wyoming. It is typical of Upper Cretaceous silty marine shales, intermediate between fine-grained offshore marine shales and coarser nearshore marine siltstone and sandstone. The reference sample for shale (SDO-1) is from the Huron Member of the Ohio Shale in Kentucky. It can be used to establish analytical accuracy in the analysis of organic- and sulphur-rich sedimentary rocks. The reference sample for marine sediment (MAG-1) is a fine-grained, gray-brown, clayey mud from the Gulf of Maine. The reference sample NIST 2709 is agricultural soil from the San Joaquin Valley in California.

The reference samples can be used to establish background values of different constituents. The comparison of concentrations between the reference samples and the core samples indicated that the bottom sediments upstream from the Price-Stubb diversion dam are at the same level or less than the reported values of the reference samples. No unusually high concentrations were determined.

Figure 2. *Location of sampling sites upstream from the Price-Stubb Diversion Dam near Palisade, Colorado. Flow is right to left.*

Table 1. List of constituents and results of chemical analyses

[cm, centimeters; ppm, parts per million; Wt., %, percent by weight; <, less than; ND, not determined]

Sampling site (fig. 2)	Sample depth (cm)	Total silver (ppm)	Total copper (ppm)	Total lead (ppm)	Total zinc (ppm)	Total cadmium (ppm)	Total chromium (ppm)	Total cobalt (ppm)
PSDG1	0–5cm	<0.5	13	20	61	0.2	25	6
PSDG1	5–10cm	<0.5	13	20	58	0.2	26	7
PSDG1	10–15	<0.5	14	21	57	0.2	26	7
PSDG1	15–20	<0.5	13	22	52	0.2	24	6
PSDG1	20–25	<0.5	14	20	51	0.1	25	6
PSDG2	0–5	<0.5	11	23	48	0.2	21	6
PSDG2	5–8	<0.5	13	23	61	0.2	24	7
PSDG2	8–11	<0.5	15	22	54	0.2	24	8
PSDG3	0–4	<0.5	13	42	62	0.2	28	6
PSDG3	4–6	<0.5	15	21	61	0.2	28	7
PSDG3	6–10	<0.5	14	20	52	0.2	26	6
PSDG4	0–2.5	<0.5	13	25	63	0.2	25	7
PSDG4	2.5–4	<0.5	15	22	60	0.2	28	7
PSDG4	4–6	<0.5	15	24	59	0.2	27	8
PSDG4a	0–5	<0.5	13	29	53	0.1	25	7
PSDG4a	5–10	<0.5	14	23	57	0.2	26	7
PSDG4a	10–15	<0.5	15	22	57	0.2	29	7
PSDG4a	15–19	<0.5	14	22	53	0.2	27	7
DUPLICATE SAMPLES								
DUP PSDG1	10–15	<0.5	14	23	52	0.2	26	7
DUP PSDG3	6–10	<0.5	14	21	53	0.2	24	7
REFERENCE MATERIALS								
Cody Shale								
USGS SCO-1 reported value		0.1	29±2	31±3	100±10	0.2±0.1	68±5	11±1
USGS laboratory USGS SCO-1		<0.5	26	34	100	<0.1	58	13
Shale								
USGS SDO-1 reported value		0.2	60±10	28±5	64±7	<2 – <10	66±8	47±6
USGS laboratory USGS SDO-1		<0.5	54	30	63	<0.1	57	48
Marine sediment								
USGS MAG-1 reported value		0.08±0.02	30±3	24±3	130±6	0.2±0.03	97±8.0	20±2
USGS laboratory USGS MAG-1		<0.5	26	28	130	0.2	94	23
Agricultural soil								
NIST 2709 reported value		<0.5	35±1	19±1	106±30	0.4±0.01	130±4	13±1
USGS laboratory NIST 2709		<0.5	32	19	110	0.3	100	14

Table 1. List of constituents and results of chemical analyses—Continued

Sampling site (fig. 2)	Sample depth (cm)	Total iron (Wt. %)	Total manganese (ppm)	Total aluminum (Wt. %)	Total titanium (Wt. %)	Total organic (Wt. %)	Total carbon (Wt. %)	Total sulfur (Wt. %)
PSDG1	0–5cm	1.8	350	4.9	0.24	0.8	1.7	<0.1
PSDG1	5–10cm	1.8	360	4.7	0.23	0.7	1.8	<0.1
PSDG1	10–15	1.9	380	4.9	0.25	0.5	1.5	<0.1
PSDG1	15–20	1.7	370	5.0	0.20	0.6	2.0	<0.1
PSDG1	20–25	1.8	380	5.1	0.22	1.2	2.6	<0.1
PSDG2	0–5	1.6	320	4.4	0.23	0.3	1.2	<0.1
PSDG2	5–8	1.8	360	4.7	0.22	1.1	1.8	<0.1
PSDG2	8–11	1.9	380	5.0	0.23	1.7	3.0	<0.1
PSDG3	0–4	1.8	320	4.7	0.24	0.7	1.7	<0.1
PSDG3	4–6	2.0	380	5.1	0.27	0.9	2.1	<0.1
PSDG3	6–10	1.8	350	4.7	0.24	1.7	2.6	<0.1
PSDG4	0–2.5	1.8	310	4.7	0.25	0.8	1.7	<0.1
PSDG4	2.5–4	2.0	340	5.1	0.26	0.9	2.0	0.1
PSDG4	4–6	2.0	430	5.0	0.25	0.4	1.4	<0.1
PSDG4a	0–5	1.9	330	4.9	0.26	0.5	1.4	<0.1
PSDG4a	5–10	2.0	350	5.0	0.25	0.7	1.8	<0.1
PSDG4a	10–15	2.1	390	5.1	0.28	0.3	1.5	<0.1
PSDG4a	15–19	1.8	360	4.7	0.30	0.5	1.6	<0.1
				DUPLICATE SAMPLES				
DUP PSDG1	10–15	1.8	370	4.9	0.25	0.5	1.4	<0.1
DUP PSDG3	6–10	1.8	350	4.7	0.24	1.2	2.3	<0.1
				REFERENCE MATERIALS				
Cody Shale								
USGS SCO-1 reported value		3.6±0.1	410±30	7.2±0.1	0.38±0.04	0.8±0.1	0.8±0.1	0.1
USGS laboratory USGS SCO-1		3.7	420	7.3	0.34	1.1	1.1	0.1
Shale								
USGS SDO-1 reported value		6.5±0.2	320±40	6.5±0.1	0.43±0.02	10±0.4	10±0.4	5.4±0.4
USGS laboratory USGS SDO-1		6.7	330	6.5	0.38	9.8	9.5	5.1
Marine sediment								
USGS MAG-1 reported value		4.8±0.2	760±70	8.7±0.2	0.45±0.04	2.15±0.4	2.15±0.4	0.4±0.1
USGS laboratory USGS MAG-1		5.0	730	8.6	0.42	2.3	2.2	0.2
Agricultural soil								
NIST 2709 reported value		3.5±0.1	540±20	7.5±0.1	0.34±0.02	1.2	1.2	0.1
USGS laboratory NIST 2709		3.5	540	7.5	0.33	1.1	1.1	0.1

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Table 1. List of constituents and results of chemical analyses—Continued

Sampling site (fig. 2)	Sample depth (cm)	Total nickel (ppm)	Total barium (ppm)	Total vanadium (ppm)	Total lithium (ppm)	Total beryllium (ppm)	Total molybdenum (ppm)	Total phosphorus (ppm)
PSDG1	0–5cm	11	660	57	19	1.0	<5	510
PSDG1	5–10cm	12	630	56	19	1.0	<5	560
PSDG1	10–15	13	660	59	18	1.1	<5	580
PSDG1	15–20	12	650	47	26	1.0	<5	570
PSDG1	20–25	13	630	48	31	1.1	<5	600
PSDG2	0–5	9	690	48	15	0.9	<5	520
PSDG2	5–8	13	640	57	18	1.0	<5	540
PSDG2	8–11	13	620	58	18	1.0	<5	520
PSDG3	0–4	11	690	55	17	1.0	<5	520
PSDG3	4–6	14	640	62	21	1.1	<5	610
PSDG3	6–10	12	650	56	18	1.0	<5	570
PSDG4	0–2.5	11	610	55	18	1.0	<5	500
PSDG4	2.5–4	13	620	61	22	1.1	<5	590
PSDG4	4–6	14	650	61	18	1.1	<5	570
PSDG4a	0–5	12	680	58	19	1.0	<5	520
PSDG4a	5–10	13	640	60	20	1.1	<5	570
PSDG4a	10–15	13	640	63	21	1.1	<5	620
PSDG4a	15–19	12	770	57	17	1.0	<5	770
DUPLICATE SAMPLES								
DUP PSDG1	10–15	13	650	59	17	1.0	<5	610
DUP PSDG3	6–10	12	620	56	17	1.0	<5	620
REFERENCE MATERIALS								
Cody Shale								
USGS SCO-1 reported value		24±4	570±30	130±10	45±3	1.9±0.1	1	900±90
USGS laboratory USGS SCO-1		27	560	130	47	1.6	<5	870
Shale								
USGS SDO-1 reported value		100±10	400±40	160±20	29±6	3.3±0.6	130±20	480±31
USGS laboratory USGS SDO-1		100	49	160	33	2.6	160	460
Marine sediment								
USGS MAG-1 reported value		53±8	480±41	140±6	79±4	3.2±0.4	2±2	710±90
USGS laboratory USGS MAG-1		52	480	140	79	2.5	<5	760
Agricultural soil								
NIST 2709 reported value		88±5	970±40	112±5	ND	ND	(2)	620±50
USGS laboratory NIST 2709		85	940	110	57	4.0	<5	760

Table 1. List of constituents and results of chemical analyses—Continued

Sampling site (fig. 2)	Sample depth (cm)	Total strontium (ppm)	Total arsenic (ppm)	Total antimony (ppm)	Total selenium (ppm)	Total mercury (ppm)	Total thallium (ppm)	Total uranium (ppm)
PSDG1	0–5cm	140	4.9	0.8	0.3	0.05	<50	<50
PSDG1	5–10cm	140	5.2	0.8	0.3	0.04	<50	<50
PSDG1	10–15	120	5.5	0.9	0.2	0.03	<50	<50
PSDG1	15–20	200	6.7	0.7	0.2	0.02	<50	<50
PSDG1	20–25	240	8.1	0.7	0.3	0.03	<50	<50
PSDG2	0–5	120	4.6	0.7	0.2	0.01	<50	<50
PSDG2	5–8	130	5.2	0.8	0.2	0.01	<50	<50
PSDG2	8–11	130	5.0	0.8	0.3	0.02	<50	<50
PSDG3	0–4	130	4.6	0.8	0.3	0.03	<50	<50
PSDG3	4–6	150	5.4	0.8	0.3	0.01	<50	<50
PSDG3	6–10	130	4.9	0.9	0.3	0.02	<50	<50
PSDG4	0–2.5	140	4.8	0.8	0.3	0.01	<50	<50
PSDG4	2.5–4	150	5.6	0.9	0.3	0.04	<50	<50
PSDG4	4–6	120	5.6	1.0	0.3	0.02	<50	<50
PSDG4a	0–5	140	4.8	0.8	0.2	0.02	<50	<50
PSDG4a	5–10	140	5.3	0.9	0.2	0.02	<50	<50
PSDG4a	10–15	140	5.6	0.9	0.2	0.03	<50	<50
PSDG4a	15–19	110	5.3	0.9	0.2	0.02	<50	<50
DUPLICATE SAMPLES								
DUP PSDG1	10–15	120	5.6	0.9	0.2	0.02	<50	<50
DUP PSDG3	6–10	120	5.1	0.8	0.3	0.02	<50	<50
REFERENCE MATERIALS								
Cody Shale								
USGS SCO-1 reported value		170±20	12.4±1.4	2.5±0.1	0.9±0.1	0.05	1	3
USGS laboratory USGS SCO-1		160	12	2.5	0.9	0.07	<50	<50
Shale								
USGS SDO-1 reported value		75±11	69±9	4.1–4.8	1.9–6.8	0.19±0.08	8	49±7
USGS laboratory USGS SDO-1		71	78.0	4.1	1.6	0.16	<50	<50
Marine sediment								
USGS MAG-1 reported value		146±15	9.2±1.2	1.0±0.1	1.2±0.1	(0.02)	<50	<50
USGS laboratory USGS MAG-1		130	9.0	0.9	1.2	0.05	<50	<50
Agricultural soil								
NIST 2709 reported value		230±2.0	18±1	7.9±0.6	1.6±0.1	1.40±0.08	(1)	(3)
USGS laboratory NIST 2709		210	18	6.2	1.5	1.4	<50	<50