U. S. DEPARTMENT OF THE INTERIOR

U. S. GEOLOGICAL SURVEY

MINERALOGICAL CHARACTERISTICS AND ACID-NEUTRALIZING POTENTIAL OF DRILL CORE SAMPLES FROM EIGHT SITES CONSIDERED FOR METAL-MINE RELATED WASTE REPOSITORIES IN NORTHERN JEFFERSON, POWELL, AND LEWIS AND CLARK COUNTIES, MONTANA

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George A. Desborough[1] and Rhonda Driscoll[1]

Open-File Report 98-790

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[1] Denver, Colorado

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ABSTRACT

Twenty seven samples of drill core selected from eight drill core sites were studied in the laboratory. This was done to determine mineralogical characteristics of the igneous rocks that affect the selection of sites suitable for subsurface encapsulation of base-metal mining-related wastes in areas proximal to these wastes. The two most important aspects considered here are the acid-neutralizing capacity, or acid-buffering capacity of the rocks, and the presence or abundance of pyrite in the rocks. Pyrite present in the rocks would eventually produce acidic water if oxidized. The measured acid-neutralizing potential of the 27 samples varied by 10 fold. Four of the samples studied contained significant or abundant pyrite which was found by making heavy-mineral concentrates. Several of the igneous rock core samples had been modified by acidic hydrothermal alteration which largely removed the minerals that could have provided acid-neutralizing capacity.

INTRODUCTION

Drill core samples 1.88 inches (48 mm) in diameter were obtained from eight sites by Maxim Technologies, Inc. for the U.S. Forest Service (USFS) during August, 1998; these were sampled with Ray Tesoro (USFS) in September, 1998. Small (5-10 cm) lengths of core were selected to represent both typical and atypical samples. The depth of coring ranged from about 45-81 feet. Detailed lithologic descriptions of the cores were provided by Maxim Technologies, Inc.; their well number designations are used here. Drill site locations are shown on Figure 1.

LABORATORY METHODS

The core samples were split with a rock saw and about ¼ of each was pulverized in tungsten carbide-lined ball mills with tungsten carbide balls. A <325 mesh (<0.044 mm) fraction was obtained by sieving with stainless steel sieves. This fraction was used for measuring acid-neutralizing potential and afterward the same fraction was used to obtain a heavy mineral concentrate that was examined in a binocular microscope (80X) for mineral identification.

For acid-neutralizing potential measurements, a 0.4 gram sample of the <0.044 mm fraction of each sample was exposed to 240 ml of acidic (pH = 2.70) leachate for 48 hours. This solid:liquid ratio of 1:600 was used in previous acid-neutralizing studies of Desborough and others (1998) for igneous rocks in the area. The acidic leachate used here was prepared using a mixture of <2 mm waste from the Bullion and Daily West mines in a waste:deionized water ratio of 1:20 (Desborough and Fey, 1997). This leachate was filtered through a 0.45 micron filter prior to exposure to the <0.044 mm samples studied here for measurement of acid-neutralizing potential.

The acidic leachate (pH = 2.70) was poured onto the <0.044 mm fraction of the core samples, stirred for 5 seconds after one hour and left at rest for 47 hours, when the final pH was measured. Between each final pH measurement, the pH of a reference acidic leachate was also measured.

RESULTS AND DISCUSSION

Table 1 shows the results of the heavy-mineral concentrate tests and the acid-neutralizing potential tests for the 27 samples studied. Those samples with only zircon, or no heavy minerals, have been hydrothermally altered; those with pyrite have also been hydrothermally altered (Table 1). Those 12 samples with abundant magnetite have not been affected by hydrothermal alteration, except for the Bullion Park "A" (BPA-1-35.8 ft., Table 1), which contains significant pyrite in the heavy mineral concentrate. Those 13 samples with magnetite have a mean H^+ neutralizing potential of 0.26 millimoles g^{-1} of rock., or 13.0 mg $CaCO_3$ g^{-1} of rock. Those 15 samples with no magnetite have a mean H^+ neutralizing potential of only 0.11 millimoles g^{-1} of rock, or 5.5 mg $CaCO_3$ g^{-1} of rock (table 1).

The results of the present study, in terms of pyrite in core samples is in good agreement with the lithologic descriptions of Maxim Technologies, Inc. with the exception of the BRW-1 Beatrice Ridge core. We found no pyrite in the four samples we studied of that core(table 1); these four samples also had good acid-neutralizing potential indicating that they were not significantly affected by hydrothermal alteration. However, Maxim Technologies, Inc. reported minor disseminated pryite for the 4.0-10.2 ft. interval, the 25.0-57.0 ft. interval, and the 57.0-68.0 ft. interval. Thus our samples did not adequately assess pyrite presence, or the appropriate acid-neutralizing potential of this drill core.

Based on the present study and the lithologic descriptions of Maxim Technologies, Inc., of the eight sites tested, the Bullion Site (BMW-1, table 1) has the most favorable rock characteristics for waste isolation, based on acid-generating potential and acid neutralizing potential.

SUMMARY

The igneous rock characteristics studied here consider only two factors that may be important to selection of site suitability for base-metal mining waste repository selection based on drill-core samples obtained from each of the eight sites. Acid-neutralizing potential, and pyrite content of igneous rock underlying the repository waste will be important to the long-term containment and abatement of ground-water contamination from the wastes.

Table 1. Heavy minerals and acid-neutralizing potential of 27 core samples from eight sites considered for metal-mine waste repositories in northern Jefferson, Powell, and Lewis and Clark Counties, Montana.

		Acid Neutralizing Potential	
Sample No. depth	Heavy Mineral Concentrate	H^+ neutralized, in millimoles g^{-1} of rock	Equivalent $CaCO_3$ g^{-1} of rock
JRW-2 Jack Ridge, T7N, R5W, S 19			
JRW-2-24.5 ft.	Zircon	0.09	4.5
JRW-2-44.7 ft.	None	0.03	1.5
JRW-2-66.2 ft.	Zircon	0.15	7.5
BMW-1 Bullion, T7N, R6W, S 13			
BMW-1-20 ft.	Magnetite, zircon	0.33	16.5
BMW-1-40 ft.	Magnetite, zircon	0.42	21.0
BKW-1 Buckeye, T8N, R6W, S 36			
BKW-1-25.5 ft.	None	0.09	4.5
BKW-1-38 ft.	Pyrite abundant	0.09	4.5
BKW-1-59.5 ft.	Pyrite abundant	0.15	7.5
BKW-1-62.3 ft.	Pyrite abundant	0.09	4.5
BKW-2 Buckeye, T8N, R6W, S 36			
BKW-2-20.5 ft.	None	0.06	3.0
BKW-2-35 ft.	None	0.12	6.0
BKW-2-42.9 ft.	None	0.09	4.5
BRW-1 Beatrice Ridge, T8N, R6W, S 1			
BRW-1-10.2 ft.	Magnetite, zircon	0.21	10.5
BRW-1-26 ft.	Magnetite	0.39	19.5
BRW-1-39.5 ft.	Magnetite, zircon	0.57	28.5
BRW-1-56.1 ft.	Zircon, magnetite	0.30	15.0
BRW-2 Beatrice Ridge, T8N, R6W, S 1			
BRW-2-15 ft.	Goethite (?)	0.21	10.5
BRW-2-20 ft.	Magnetite, zircon	0.06	3.0
BRW-2-34.5 ft.	None	0.21	10.5
BRW-2-38 ft.	None	0.09	4.5
BPAW-1 Bullion Park "A", T8N, R6W, S 12			
BPA-1-14.8 ft.	Magnetite, zircon	0.21	10.5
BPA-1-21 ft.	Magnetite, zircon	0.12	6.0
BPA-1-35.8 ft.	Pyrite, magnetite	0.09	4.5
BPA-1-38.3 ft.	Magnetite, zircon	0.21	10.5
BPBW-1 Bullion Park "B", T8N, R6W, S 12			
BPB-1-17.4 ft.	Magnetite, zircon	0.15	7.5
BPB-1-24.5 ft.	None	0.12	6.0
BPB-1-34.3 ft.	Magnetite, zircon	0.30	15.0

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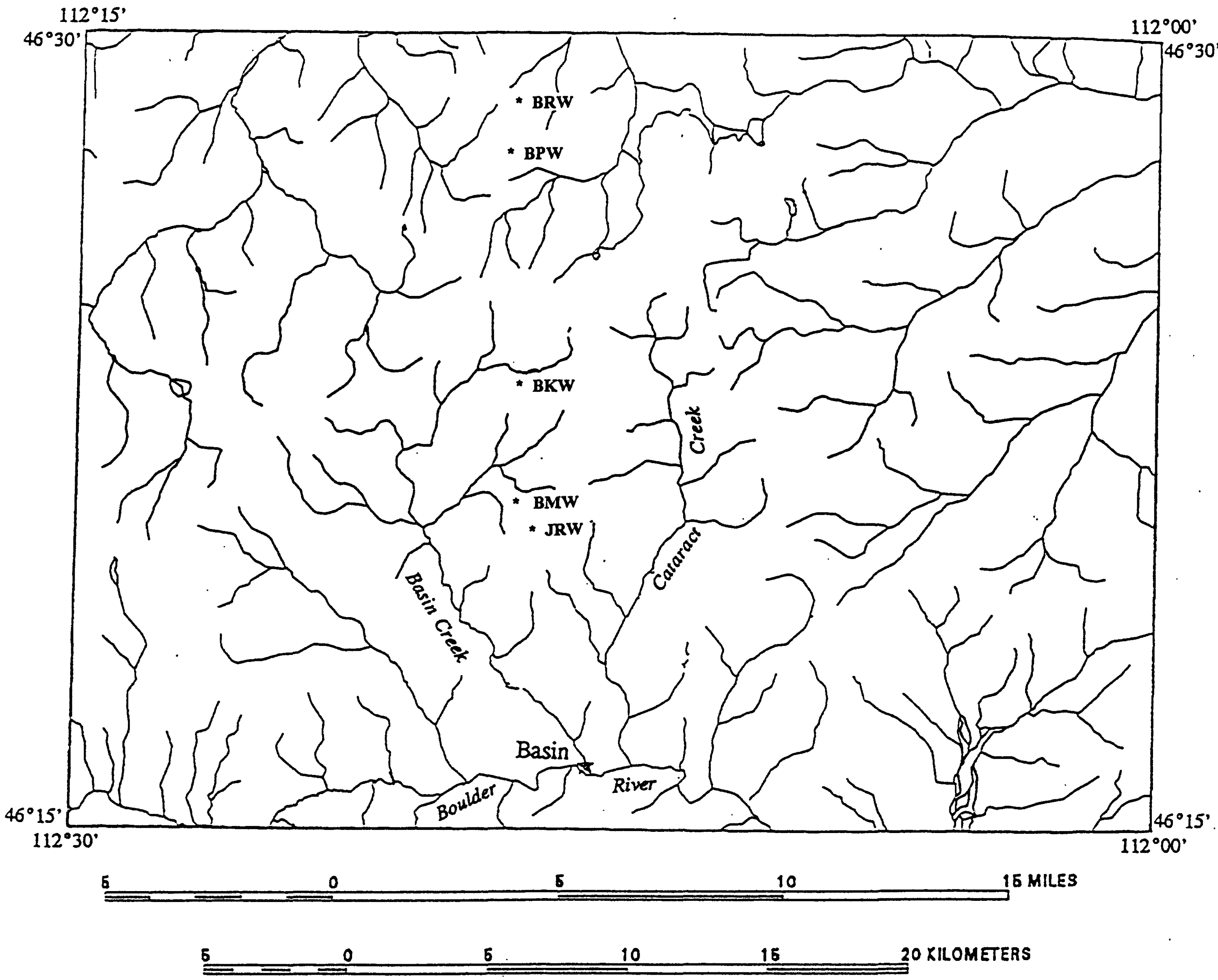

Figure 1. Locations of core-drilled potential mining-related waste repository sites in the Basin Creek and Tenmile Creek headwaters of northern Jefferson, Lewis and Clark, and Powell Counties of Montana.