

UNITED STATES DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

GEOCHEMICAL VARIATION IN A COPPER-BEARING REDBED SEQUENCE OF THE  
RAVALLI GROUP (BELT SUPERGROUP), NORTHWESTERN MONTANA  
AND NORTHERN IDAHO

PART B. GEOCHEMICAL DATA

By

Jon J. Connor<sup>1</sup>

with analytical contributions from

Ardith J. Bartel, Elaine Brandt, J. G. Crock, S. Donahey, M. Malcolm,  
G. Mason, V. Merritt, K. Stewart, J. Storey, J. Taggart, and R. B. Vaughn

Open-File Report

91-0028A Geological interpretation (paper copy)  
91-0028B Geochemical data files, ASCII,  
(1) 5 1/4" 360K floppy diskette

1991

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<sup>1</sup>Denver, Colorado

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## INTRODUCTION

This diskette contains 22 files. File README is this short statement. Files TABLE.A through TABLE.W contain geochemical data in text format suitable for printing or viewing on the screen. File GEOCHEM.STP contains the same geochemical data (collectively) but in binary format suitable for reading or manipulating by programs in the IBM PC-based U.S.G.S. STATPAC system (Grundy and Miesch, 1987).

The chemical analyses herein are of rock samples collected from outcrop during a study of a regionally extensive copper-bearing redbed in the Middle Proterozoic Ravalli Group (Belt Supergroup) in northwestern Montana and northeastern Idaho. Specifically, this work focused on rocks in the Spokane, Grinnell, and St. Regis Formations, although a few samples collected from the immediately overlying or underlying strata were analyzed as well. The geological interpretation of these data appear in Part A of this report (Connor, 1990).

The U.S. Geological Survey does not at this time recognize the Grinnell (tables E, M, P, G, H, and N) as a formation and the name here follows the usage of Whipple and others (1984) as a quartzose red-bed sequence immediately below the Empire Formation in Glacier National Park and the Whitefish Range. Similarly, reference to the Appekunny Formation in tables E and G follows the usage of Whipple and others (1984). The regional relations among the Spokane, Grinnell, and St. Regis Formations are not as yet known in detail, but for purposes of geochemical sampling, a rough equivalence of these formations was assumed. Some thoughts on those regional relations engendered during this work may be found in Connor (1982, 1984), Connor and McNeal (1988), Connor and others (1984), Earhart and others (1984), and Whipple and others (1984).

## SAMPLING

The samples were collected from 20 stratigraphic sections spread over the area of study. Each table on this diskette contains sample data from one of those sections. Where possible, these sections are located by both county designation and section, township, and range; sections in Glacier National Park are located by geographic landmark. An index map of section locations is given in Part A (Connor, 1990). Most sections were identified to me through published or unpublished mapping of others, for which I thank them: sections (tables) A, B, and D from M. W. Reynolds, sections F, I, and L from J. W. Whipple, section J from R. G. Schmidt (1978), sections N, Q, R, S, T, U, and W from J. E. Harrison, and section V from R. E. Van Loenen. Sections E, G, H, M, and P (in Glacier National Park) were located by me.

The thickness of each section was estimated prior to sampling, commonly through some combination of meter-stick and map measure. Local structural complications or nonexposure commonly required lateral offset (sometimes large) during measurement and the estimated thicknesses appearing in the tables are probably correct to within 10 percent. Sample locations within sections are given to the nearest 10 percent (decile) of the thickness up from the base. Samples outside the section are identified by formation names other than Spokane, Grinnell, and St. Regis. They are not otherwise stratigraphically located but most fall close to the lower or upper bound of the measured section. A sample in this work consisted of 500-1000 gm of rock collected across a stratigraphic interval of 5-15 cm.

A distinction was made in this work between a "random" and a "typical" sample. A sample located in outcrop by randomization procedures is a random sample; a sample located in outcrop without using such procedures is a typical sample; that is, it was taken to reflect some feature typical of that part of the outcrop. Random samples are particularly important because as a group they purport to faithfully represent the compositional variability of the section from which they were collected. In files TABLE.A through TABLE.W sample numbers ending in "T" indicate typical samples, numbers ending in "R" indicate random samples, and numbers ending in "RX" are analytical splits. The geologic evaluation in Part A (Connor, 1990) was based on the 173 random samples taken from the Spokane, Grinnell, and St. Regis Formations, as identified in files TABLE.A through TABLE.W. Overall, a total of 441 samples was collected during the life of the study, of which 251 were chosen for analysis. Because 38 of these 251 were split into two parts prior to submittal, the files (tables) list a total of 289 analyses.

## CHEMICAL ANALYSIS

The samples collected in this work were analyzed in the Denver laboratories of the U.S. Geological Survey. The major oxides SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, FeTO<sub>3</sub> (total Fe as Fe<sub>2</sub>O<sub>3</sub>), MgO, CaO, Na<sub>2</sub>O, K<sub>2</sub>O, TiO<sub>2</sub>, and P<sub>2</sub>O<sub>5</sub>, were analyzed by X-Ray fluorescence (Taggart and others, 1981), and a host of trace elements were analyzed by inductively coupled argon plasma-atomic emission spectrometry (Crock and others, 1983). Selected samples were analyzed for As and Sb by automated hydride generation-atomic absorption spectroscopy (Crock and Lichte, 1982), for Hg by cold vapor atomic absorption spectrometry (Huffman and others, 1972), for Cl by ion selective electrode (Aruscavage and Campbell, 1983), for FeO by potentiometric titration (Peck, 1964), and for U by neutron activation (Millard, 1975). Also, 14 selected samples of quartzite from the Grinnell Formation were analysed for Au by hydrobromic acid-bromine extraction-atomic absorption spectrometry (Thompson and others, 1968).

The samples were submitted to the laboratories in a randomized sequence in order to effectively transform any time-dependent drift in the analysis into random errors. Such a procedure guards against subsequent attempts to explain laboratory drift as a geologic phenomenon.

Most trace element data in the tables contains at most 2 significant figures and trailing zeros may be safely ignored.

A few elements looked for in the laboratory analysis were not detected in any of the analyses. These are listed below along with the lower limit of analytical detection and the total number of analyses made:

Element	Lower limit of determination	Number of analyses
Cd	2 ppm	289
Ge	10	39
Ho	6	289
Ta	40	289
Tb	20	289
Au	.1	14

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