Geochemistry and U-Series Geochronology of Hydrothermal and Hydrogenous Metal-Rich Deposits From the Pacific Ocean

A Thesis Submitted to the Graduate Division of the University of Hawaii in Partial Fulfillment of the Requirements for the Degree of

Master of Science

in Oceanography

December 1989

By

William Edward Murphy III

Thesis Committee:

Gary M. McMurtry, Chairman
Yuan-Hui Li
Alexander Malahoff
Rodey Batiza

Chapter 2

Temporal Variability of Hydrothermal Mineral Deposition in the Escanaba Trough Region of the Gorda Ridge

Introduction

The assignment of absolute ages to geologic materials is of paramount importance in the study of geology and geologic processes. Radiometric dating techniques exploiting disequilibria in the uranium and thorium-series decay chains have been used to determine the age of deposition for various hydrothermal minerals including volcanogenic massive sulfides and sulfates (Lalou and Brichet, 1982). Both sulfides and sulfates have been discovered during several sampling expeditions to the Escanaba Trough, which is a slow spreading ridge located close to the continental margin of western North America.

The primary objectives of this study are: (1) to determine the absolute ages of hydrothermal deposition for this suite of sediment-hosted massive sulfides and sulfates from the Escanaba Trough using the $^{210}Pb/Pb$, $^{210}Pb/^{226}Ra$, and $^{228}Ra/^{226}Ra$ geochronometers; (2) to study the growth history of a barite chimney using autoradiography, and detailed radial subsampling; and (3) to study the evolution of the hydrothermal system(s) in the Escanaba Trough by comparing the mineral facies/time changes with mineral phase vs. temperature relationships (Barton and Skinner, 1979; Janecky and Seyfried, 1984;

Janecky and Shanks, 1988). The chronology of mineral deposition along a ridge segment provides a view of the thermal evolution of that segment (Lalou et al., 1985). Also, an understanding of the duration and periodicity of hydrothermal activity is important in determining the fluxes of elements to the ocean (Lalou and Brichet, 1982). Interpretive geochronologies of hydrothermal systems have been offered for the Galapagos Mounds (Lalou et al., 1983), East Pacific Rise (EPR) 21°N (Lalou and Brichet, 1982), EPR 13°N (Lalou et al., 1985), EPR 18°S (Marchig et al., 1988), TAG area (Scott et al., 1976 and Lalou et al., 1986), Juan de Fuca Ridge (JdF) (Kadko et al., 1985), Axial Seamount CASM Site (Grasty et al., 1988), and the Endeavour Ridge (Kadko and Moore, 1988; Kim and McMurtry, submitted). The time scale of hydrothermal processes and geologic events at mid-ocean ridges has been summarized by Rona (1988).

Geologic Setting

The Escanaba Trough is the southern segment of the Gorda Ridge (Fig. 1). It is characterized as a slow-spreading (3.0 cm/y, Riddihough, 1980) ridge similar in morphology to the Mid-Atlantic Ridge, with a deep axial valley flanked by ridges with relief of 1200 - 1700 m (Koski et al., 1988). The southern ridge axis is infilled with up to 500 m of turbidite sediments from the continental margin of North America (Koski et al, 1988)