# FAULT-RELATED OCEANIC AND EMPLACEMENT-AGE SERPENTINIZATION IN THE JOSEPHINE OPHIOLITE OF NW CALIFORNIA AND SW OREGON

by

Angela J. Coulton, B.A.

A Dissertation
Submitted to the State University of New York at Albany
in Partial Fulfillment
of the Requirements for the Degree of
Doctor of Philosophy

College of Arts and Sciences
Department of Geological Sciences
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**ABSTRACT**

Field, petrographic, geochemical and stable isotopic evidence for timing of serpentinization in the 162 Ma Josephine ophiolite of NW California and SW Oregon are presented in this study. Detailed studies of brittle and ductile serpentinized shear zones have revealed a complex serpentinization history, beginning at the oceanic stage. Dikes intruded into serpentinized shear zones provide time markers for serpentinization and deformation and are of two types: 1) Fe-Ti enriched dikes with N-MORB magmatic affinity, geochemically similar to the uppermost lavas and a late Fe-Ti dike within the crustal sequence, and 2) hornblende-bearing, calc-alkaline dikes intruded during ophiolite emplacement. Cross-cutting relationships between dikes and serpentinites indicate serpentinization of upper mantle peridotites took place prior to the latest magmatic pulse, during periods of amagmatic extension, at temperatures <300°C. The ultramafic cumulate sequence was completely serpentinized prior to ophiolite emplacement and the paleomoho in the Josephine ophiolite may be a serpentinization boundary. The occurrence of oceanic serpentinites intruded by Fe-Ti basalts may indicate a minor propagating ridge-tip setting, possibly associated with overlapping spreading centers.

Lizardite ± chrysotile serpentinites, interpreted as oceanic based on field and geochemical evidence, exhibit a wide range of δD values (-79 to -126), outside the range of modern oceanic serpentinites. Comparison of field and isotope data strongly suggests hydrogen isotopes in lizardite and chrysotile have partially to completely equilibrated with modern meteoric waters, by low-temperature, diffusive, hydrogen isotope exchange. δD values for antigorite (-24 to -47) are compatible with formation by interaction with oceanic or regional metamorphic fluids, and indicate that antigorite is resistant to post-crystallization hydrogen isotope exchange. $\delta^{18}O$ values for lizardite ± chrysotile serpentinites are within the range of oceanic serpentinites and calculated $\delta^{18}O_{fluid}$ values indicate they could have formed by interaction with modified oceanic hydrothermal fluids at w/r ratios < 0.5. Field, petrographic and stable isotope data are compatible with formation of antigorite during ophiolite emplacement and regional metamorphism. The findings of this study necessitate re-evaluation of timing of serpentinization in ophiolites, and caution against the use of hydrogen isotope data alone as an indicator of timing of serpentinization.

# TABLE OF CONTENTS

TABLE OF CONTENTS (CONT'D)

TABLE OF CONTENTS (CONT'D)

Page

# LIST OF FIGURES

LIST OF FIGURES (cont'd)

# LIST OF TABLES

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