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The geology of the northern part of North Arm Massif, Bay of Islands Ophiolite Complex, Newfoundland: with application to upper oceanic crust lithology, structure, and genesis

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THE GEOLOGY OF THE NORTHERN PART OF NORTH ARM MASSIF, BAY OF ISLANDS OPHIOLITE COMPLEX, NEWFOUNDLAND: WITH APPLICATION TO UPPER OCEANIC CRUST LITHOLOGY STRUCTURE, AND GENESIS

by

Eric J. Rosencrantz

Abstract of a Dissertation
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in Partial Fulfillment of
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ABSTRACT

Detailed mapping (1:15,800) of the northern half of North Arm Massif shows the area to be underlain with a complete, although thin, ophiolite assemblage consisting, from top to base, of basalts, sheeted diabase dikes, isotropic and layered gabbroic rocks, layered ultramafic rocks and harzburgite tectonite. The assemblage represents a preserved piece of Cambrian oceanic crust analogous to present-day oceanic crust. Sheeted dikes and isotropic gabbros comprise the majority of the rocks exposed, with this sequence at present flat-lying to gently warped into open, uprift but nonsystematic folds. Basalts occupy a shallow discontinuous N-S trending trough within the west-central part of the area. The remaining lithologies are exposed in lesser amounts along the western, eastern and northeastern edges of the surveyed area.

Volcanics consist of pillowed lavas, massive flows and breccias plus intercalated red sediment, all crudely layered, with layer attitudes intersecting the lower horizon of the unit with large angles. Volcanics are fed by underlying diabase dikes, and grade into sheeted dikes by downward increase in numbers of dikes across a transition generally less than 50 m thick. The sheeted dikes unit consists entirely of multiple diabase dikes of .90 m mean thickness, subparallel throughout and trending NNW-SSE across the massif. The dike intrusion process includes a mode wherein several dikes each intrude the previous dikes, with the position of these very narrow, short term spreading axes episodically shifting within a wider but still narrow overall zone of intrusion and spreading. Dikes intersect the upper and lower contacts of the unit with mean angles of 60^{o} and 75^{o} respectively, and dip away from the spreading center, located to the west of the present position

of the section on the basis of dikes attitudes and chill margin analysis. The sheeted dikes unit ranges between 400 and 600 m thick. An estimated 40% of the diabase shows extensive _in situ_ fracturing in distinct zones subparallel to dikes trends. Major zones of fracturing extend downward into gabbro metamorphosed to foliated and lineated amphibolite. This fracturing is interpreted to reflect oceanic crustal fissuring and faulting. Sheeted diabase dikes grade downward into isotropic gabbro across a complex transition wherein numbers of dikes decrease downward with corresponding increase of thickness of intervening screens of gabbro, with complete transition commonly occurring over as little as several meters, and wherein gabbro locally intrudes and stopes overlying sheeted diabase. Largely homogeneous throughout, isotropic gabbros near the base of the dikes unit vary widely in texture and locally show extensive development of ductile shear zones.

The lithology and igneous structure of the upper units of the ophiolite and the sense of tilting of the sheeted dikes suggest that upper oceanic crust, viewed as forming as a floating roof zone, or lid, to a spreading center magma chamber, behaves as a rigid beam and forms by accretion along a narrow central zone with subsequent subsidence and rotation away from the accretion axis as a consequence of loading of the lid by extrusives. Continued steady-state spreading of a lid forming in this manner generates a lid surface topography and structural morphology identical to that observed at present-day spreading centers and an internal structure which is consistent with that of ophiolites. The model indicates that the zone of dike intrusion and basalt extrusion is narrow and remains so with continual spreading. Because the model predicts a specific internal geometry of sheeted dike and volcanic layering attitudes, it can be tested against other detailed reconstructions of upper oceanic crustal structure as such attitudes would affect magnetics inclinations in oceanic crust.

State University of New York at Albany

COLLEGE OF ARTS AND SCIENCES

The dissertation submitted by

Eric J. Rosencrantz

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has been read by undersigned. It is hereby recommended for acceptance to the Faculty of the University in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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Kevin Burke, Chairman.

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Recommendation accepted by the Dean of Graduate Studies for the Graduate Academic Council.

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Church (1972)

Optimum Optimorum Principle: There comes a time when one must stop suggesting and evaluating new solutions, and get on with job of analyzing and finally implementing one pretty good solution.

Dickson (1978), p. 138