International Geology Review ›
Volume 46, 2004 - Issue 4

Original Articles

Multi-Stage Origin of the Coast Range Ophiolite, California: Implications for the Life Cycle of Supra-Subduction Zone Ophiolites

John W. Shervais, David L. Kimbrough, Paul Renne, Barry B. Hanan, Benita Murchey, Cameron A. Snow, ...show all

Pages 289-315 | Received 02 Oct 2007, Published online: 14 Jul 2010

Download citation https://doi.org/10.2747/0020-6814.46.4.289

Abstract

The Coast Range ophiolite of California is one of the most extensive ophiolite terranes in North America, extending over 700 km from the northernmost Sacramento Valley to the southern Transverse Ranges in central California. This ophiolite, and other ophiolite remnants with similar mid-Jurassic ages, represent a major but short-lived episode of oceanic crust formation that affected much of western North America. The history of this ophiolite is important for models of the tectonic evolution of western

North America during the Mesozoic, and a range of conflicting interpretations have arisen. Current petrologic, geochemical, stratigraphic, and radiometric age data all favor the interpretation that the Coast Range ophiolite formed to a large extent by rapid extension in the fore-arc region of a nascent subduction zone. Closer inspection of these data, however, along with detailed studies of field relationships at several locales, show that formation of the ophiolite was more complex, and requires several stages of formation.

Our work shows that exposures of the Coast Range ophiolite preserve evidence for four stages of magmatic development. The first three stages represent formation of the ophiolite above a nascent subduction zone. Rocks associated with the first stage include ophiolite layered gabbros, a sheeted complex, and volcanic rocks with arc tholeiitic or (more rarely) low-K calc-alkaline affinities. The second stage is characterized by intrusive wehrlite-clinopyroxenite complexes, intrusive gabbros, Cr-rich diorites, and volcanic rocks with high-Ca boninitic or tholeiitic ankaramite affinities. The third stage includes diorite and quartz diorite plutons, felsic dike and sill complexes, and calc-alkaline volcanic rocks. The first three stages of ophiolite formation were terminated by the intrusion of mid-ocean ridge basalt dikes, and the eruption of mid-ocean ridge basalt or ocean-island basalt volcanic suites. We interpret this final magmatic event (MORB dikes) to represent the collision of an active spreading ridge. Subsequent reorganization of relative plate motions led to sinistral transpression, along with renewed subduction and accretion of the Franciscan Complex. The latter event resulted in uplift and exhumation of the ophiolite by the process of accretionary uplift.

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