

Petrogenesis of Franciscan Complex and Coast Range Ophiolite Serpentinites in northern California

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Franciscan Complex serpentinites have been interpreted as eroded pieces of the overriding Coast Range Ophiolite (CRO), off-scraped pieces of the subducting oceanic plate, and as sedimentary serpentinites (e.g., Wakabayashi, 2004); however, most of these interpretations are based on tectonic models and field relationships. Here we present bulk rock major and trace element geochemistry, pyroxene and spinel geochemistry, and stable isotope data (O, H, Cl) for serpentinite samples with the goal of determining protolith origin and subsequent serpentinizing fluid sources of several metasomatized Franciscan and CRO ultramafic rocks in order to decipher the tectonic setting of serpentinization.

We focused on serpentinite bodies found in the Franciscan Complex (west of Cuesta Ridge; south of San Francisco; Tiburon Peninsula; Healdsburg) (n = 12). Three samples from Cuesta Ridge (CRO) were also analyzed for comparison. All samples are >~95% serpentinized and consist of lizardite +/- chrysotile. Relict grains are rarely preserved.

Franciscan serpentinites (Tiburon Peninsula, west of Cuesta Ridge) show positive-sloped REE patterns. This depletion in LREE is typical of abyssal peridotites. Relict clinopyroxenes from Tiburon Peninsula have high HREE concentrations, also supporting an abyssal origin. 2 of the 3 samples from the Cuesta Ridge show flat REE patterns; whereas, one is U-shaped. This enrichment in LREE is similar to forearc peridotites. Spinels from Cuesta Ridge have Cr# > 0.60 also implying a forearc setting; whereas, Franciscan localities have typically have lower Cr# (0.21 to 0.51). All samples show remarkable positive Ce and Y anomalies. We speculate that these anomalies may be due to interaction with ferromanganese nodules and crusts (also high in Ce and Y) on the seafloor prior to subduction.

Cuesta Ridge samples have $\delta^{18}\text{O}$ values between +6.0 to +6.6‰. Franciscan serpentinites (except those south of San Francisco) have $\delta^{18}\text{O}$ values of +5.4 to +7.9‰. These $\delta^{18}\text{O}$ values are similar to typical oceanic serpentinites and likely represent low-T seawater hydration on the seafloor. $\delta^{34}\text{S}$ values of all samples are extremely low (-107 to -90‰) and likely result from post-serpentinization, post-emplacment interaction with meteoric water at low temperature. Samples south of San Francisco lie on the San Andreas fault and have high $\delta^{18}\text{O}$ values (+7.2 to +9.5‰) and low $\delta^{34}\text{S}$ values (-107 to -104‰) likely due to low-T interaction with meteoric water at high fluid-rock ratios. Most of the serpentinites (12 of the 15) have $\delta^{37}\text{Cl}$ values between +0.2 and +0.9‰, typical values for serpentinites formed by interaction with seawater.

Based on bulk rock geochemistry and pyroxene and spinel compositions, serpentinites located within the Franciscan Complex have geochemical characteristics of abyssal peridotites; whereas, those from Cuesta Ridge are more chemically heterogeneous with most having affinity to forearc peridotites. All stable isotope geochemistry indicates seafloor serpentinization by seawater.

Wakabayashi, J., 2004, *International Geology Review*, 46, 1103-1118

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