Contrasting origins of serpentinites in a subduction complex, northern Dominican Republic

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ABSTRACT

Serpentinites in a Tertiary subduction complex in the northern Dominican Republic contain low concentrations of incompatible elements in bulk-rock compositions and high Mg in relict silicate minerals. The forsterite component in olivine ranges from 89.0% to 90.8%, and the enstatite component in orthopyroxene ranges from 89.4% to 91.1%, suggesting that they are mantle peridotites. Two different protoliths are identified for the serpentinites based on the bulk-rock compositions and spinel chemistry: abyssal peridotites and forearc mantle peridotites. Hydrated abyssal peridotites are voluminous and occur in ophiolite complexes in the northern terranes (Puerto Plata Complex and the northern part of the Rio San Juan Complex) and in serpentinite mélanges in the central part of the Rio San Juan Complex. The serpentinite mélanges contain fragments of high-pressure–low-temperature rocks and are interpreted to be tectonic mélanges, representing part of a serpentinite subduction channel. The serpentinites show moderate Al/Si weight ratios (0.026–0.081) in bulk rocks and moderate Cr# (atomic ratio of Cr/[Cr + Al] = 0.20–0.55) in spinel.

Hydrated forearc mantle peridotites occur along major strike-slip faults: the Camú fault zone, and the Septentrional fault zone. They show low bulk-rock Al/Si weight ratios (up to 0.021), high concentration in Ir-group platinum group elements (13.1–24.6 ppb total), and high Cr# (0.48–0.67) in spinel. Raman spectroscopy and X-ray powder diffraction indicate that lizardite is the predominant serpentine species. The absence of antigorite suggests that these serpentinites were derived from a shallow depth (<<35 km) in the mantle wedge. Their occurrence along the major strike-slip fault zones suggests that the faults allowed these serpentinites to protrude from the forearc mantle wedge during oblique transpressive collision of the Caribbean plate with the Bahamas Platform.

INTRODUCTION

Recent studies highlight the importance of serpentinites in subduction zones. Serpentinites can contain up to 13 wt% H_2O and may be stable at depths to 130 km (Wunder and Schreyer, 1997), making them an important host of water and fluid-mobile elements in the mantle (Hattori and Guillot, 2003, 2007). The release of such water during the dehydration of serpentinites may trigger partial melting in the interior of mantle wedges (Hattori and Guillot, 2003). Therefore, serpentinites play a significant role in recycling of elements in subduction zones (Hattori and Guillot, 2007). Furthermore, the volume change associated with this dehydration may be responsible for deep seismic activity in subduction zones (Dobson et al., 2002).

The origin of serpentinites in subduction complexes has been discussed extensively (e.g., Guillot et al., 2000; Ernst, 2004; Hattori and Guillot, 2007). There are three possible protoliths: (1) forearc mantle peridotites hydrated at the base of the mantle wedge by fluids released from subducted slabs, including sediments, (2) abyssal peridotites hydrated at shallow depths near oceanic ridges and the seafloor, and (3) hydrated ultramafic cumulates (e.g., Hattori and Guillot, 2007). An understanding of the origin of serpentinites is important in evaluating the geodynamic evolution of subduction zones and the possible role of serpentinites in the recycling of elements and the global mass balance.

Serpentinites are abundant in the northern Dominican Republic on Hispaniola (Fig. 1), where they belong to one of the largest exposed subduction complexes in the world. This paper presents the distribution, mineralogy, and the compositions of serpentinites in this accretionary complex, and we discuss their origins and the implications for syn- and post-subduction processes.

GEOLOGICAL SETTING

Hispaniola is located on the northern margin of the Caribbean plate (Fig. 1). Until the mid-Cretaceous, it had a location west of its current position, above the NE-dipping Farallon oceanic plate in the Pacific Ocean (Pindell et al., 2005). A major change in the geometry of the plates in the area took place in the mid-Cretaceous. This change involved migration of the arc from the Pacific to the Atlantic Ocean side, reversal of subduction polarity, and the divergence between North and South America, which was partly accommodated by rifting at the proto–Caribbean Ridge (Meschede and Frisch, 1998; Pindell et al., 1988). The proto-Caribbean oceanic lithosphere produced at the ridge subducted beneath the NE-migrating Caribbean plate between the Late Cretaceous and the middle Eocene, until oblique collision of the Caribbean plate with the Bahamas Platform occurred (Goncalves et al., 2000). This produced left-lateral strike-slip faults in northern Hispaniola: the Septentrional fault zone and the Camú fault zone (Mann et al., 1984; Goncalves et al., 2000; Fig. 2A). The Septentrional fault zone is still actively creating displacement along the fault with seismic activity (e.g., Calais et al., 1998).

The northern Dominican Republic (NE margin of Hispaniola; Fig. 1) is mostly covered by sedimentary rocks ranging in age from Miocene to Quaternary (Draper and Nagle, 1991). Only five inliers expose rocks older than middle Eocene (Fig. 1), and these rocks are mostly subduction-related igneous rocks with minor limestones in basins formed during the collision with the Bahamas Platform. The area is in the 1000-km-long Northern serpentinite mélange, which extends from Cuba to Hispaniola (Fig. 1; Lewis et al., 2006). In Cuba, serpentinites are intercalated with fossiliferous mudstones in several locations, and some serpentinite outcrops are interpreted as mudflow and sedimentary breccia deposits (Lockwood, 1971). In northern Dominican Republic, the occurrences of serpentinite blocks are reported in sedimentary

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