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A Jurassic oceanic core complex in the high-pressure Monviso ophiolite (western Alps, NW Italy)

Andrea Festa[1], Gianni Balestro[1,*], Yildirim Dilek[2], and Paola Tartarotti[3]

[1]DIPARTIMENTO DI SCIENZE DELLA TERRA, UNIVERSITÀ DI TORINO, VIA VALPERGA CALUSO, 35, 10125 TORINO, ITALY
[2]DEPARTMENT OF GEOLOGY AND ENVIRONMENTAL EARTH SCIENCE, MIAMI UNIVERSITY, OXFORD, OHIO 45056, USA
[3]DIPARTIMENTO DI SCIENZE DELLA TERRA, UNIVERSITÀ DI MILANO, VIA MANGIAGALLI, 34, 20133 MILANO, ITALY

ABSTRACT

The eclogite-facies Monviso ophiolite in the western Alps displays a complex record of Jurassic rift-drift, subduction zone, and Cenozoic collision tectonics in its evolutionary history. Serpentinized lherzolites intruded by 163 ± 2 Ma gabbros are exposed in the footwall of a thick shear zone (Baracun shear zone) and are overlain by basaltic lava flows and synextensional sedimentary rocks in the hanging wall. Mylonitic serpentinites with sheared ophicarbonate veins and talc-and-chlorite schist rocks within the Baracun shear zone represent a rock assemblage that formed from seawater-derived hydrothermal fluids percolating through it during intra-oceanic extensional exhumation. A Lower Cretaceous calc-schist, marble, and quartz-schist metasedimentary assemblage unconformably overlies the footwall and hanging-wall units, representing a postextensional sequence. The Monviso ophiolite, Baracun shear zone, and the associated structures and mineral phases represent core complex formation in an embryonic ocean (i.e., the Ligurian-Piedmont Ocean). The heterogeneous lithostratigraphy and the structural architecture of the Monviso ophiolite documented here are the products of rift-drift processes that were subsequently overprinted by subduction zone tectonics, and they may also be recognized in other (ultra)high-pressure belts worldwide.

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INTRODUCTION

Submersible surveys, geophysical studies, and deep ocean drilling projects during the last two decades have provided new insights into the mode and nature of magmatic, tectonic, and hydrothermal processes that occur along slow- to ultraslow-spreading ridges (e.g., Cannat, 1993; Tucholke et al., 1998; Dilek, 2002; Karson et al., 2006). These studies have revealed the occurrence on the seafloor of oceanic detachment faults and associated shear zones with deformed mafic-ultramafic rocks. Detachment faults along nonvolcanic rifted margins and in young oceanic lithosphere accommodate high-magnitude extension, causing the exhumation of lower-crustal gabbros and upper-mantle peridotites on the seafloor, forming oceanic core complexes (Cannat et al., 2006; Karson et al., 2006; Smith et al., 2014). These rocks display mineral assemblages and structural fabrics developed during the interplay of ductile and brittle deformation episodes, fluid-rock interactions, and metasomatism associated with their exhumation (Boschi et al., 2006).

Recognition of detachment faults and core complex structures in fragments of ancient oceanic lithosphere is often difficult because of the multistage, intense deformation and metamorphism they experienced during subduction and subsequent continental collision–related exhumation. Yet, slivers of mafic-ultramafic rock assemblages in collision zones have been widely used in numerous studies to document the occurrence of remnants of oceanic basins and to reconstruct their paleogeographies in the geological past (Decandia and Elter, 1972; Lagabrielle, 1994; Dilek and Thy, 1998; Manatschal et al., 2011; Balestro et al., 2014; Dilek and Furnes, 2014). However, results of such reconstructions may lead to misleading interpretations for the tectonic settings of the investigated ophiolites and for the extent of the inferred ocean basins in which they formed, if the primary seafloor structures of these ophiolites go undetected.

In this paper, we document the internal structure of the eclogite-facies Monviso ophiolite in the western Alps (Fig. 1), and we show that despite the overprint of high-pressure subduction-zone metamorphism and deformation of its lithological units, this ophiolite displays a well-preserved record of the intra-oceanic extensional tectonics that affected it during the opening of the Ligurian-Piedmont Ocean. We further discuss the crustal architecture and the occurrence of a talc-and-chlorite schist shear zone (i.e., Baracun shear zone of Balestro et al., 2015) in Monviso, which represent evidence of Jurassic oceanic core complex development, documented for the first time in the eclogitized ophiolite units in the western Alps.

REGIONAL GEOLOGY OF THE WESTERN ALPS AND THE MONVISO OPHIOLITE

The western Alps (Fig. 1A) evolved between the colliding Adria microplate and the European plate during the late Eocene–early Oligocene. Eastward subduction of the Ligurian-Piedmont oceanic lithosphere during the Early Cretaceous–middle Eocene resulted in ophiolite emplacement (Rosenbaum and Lister, 2005, and reference therein), underthrusting of the European continental margin beneath Adria (Platt et al., 1989), and tectonic imbrication along WNW-vergent thrust faults (Ricou and Siddans, 1986). In the central part of the belt, eclogite-facies ophiolite units (e.g., Zermatt-Saas zone Auctorum) and blueschist-facies metasedimentary units (Combin zone and “Schistes Lustrés” Auctorum) are tectonically sandwiched between European and Adriatic continental margin units (Fig. 1A; Dal Piaz et al., 2003).

The Monviso ophiolite is exposed in the southern part of the western Alps (Fig. 1), where it rests tectonically on the Dora Maira unit, which was part of the European continental margin (Dal Piaz et al., 2003), and below the Queyras Schistes Lustrés unit, which consists of carbonaceous metasedimentary rocks with meta-ophiolite bodies (Lombardo et al., 1978; Tricart and Lemoine, 1991). The Monviso ophiolite includes lherzolitic mantle rocks intruded

*gianni.balestro@unito.it

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