International Geology Review, 2015
Vol. 57, Nos. 5–8, 581–605, http://dx.doi.org/10.1080/00206814.2014.943307

Taylor & Francis
Taylor & Francis Group

Tectonic significance of different block-in-matrix structures in exhumed convergent plate margins: examples from oceanic and continental HP rocks in Inner Western Alps (northwest Italy)

Gianni Balestro[a], Andrea Festa[a]* and Paola Tartarotti[b]

[a]*Dipartimento di Scienze della Terra, Università di Torino, Torino, Italy;* [b]*Dipartimento di Scienze della Terra, Università di Milano, Milano, Italy*

(*Received 14 March 2014; accepted 7 July 2014*)

In the Inner Western Alps, three different types of block-in-matrix structures (BIMs) formed sequentially through time at a convergent plate margin. These show the superposition of progressive deformation from (i) subduction to eclogite-facies depths, (ii) collision, accretion, and exhumation of oceanic crust, represented by the Monviso Meta-ophiolite Complex, to (iii) collision, accretion, and exhumation of the continental Dora Maira units. The Type 1 occurs in the metasedimentary cover of the Dora Maira Unit and consists of a map-scale broken formation with boudinaged 'native' blocks of marble (Early Jurassic) in a calcschist matrix. It results from the tectonic overprinting of exhumation-related folding (D2-stage) on an earlier subduction-related dismembered succession (D1-stage). Type 1 also includes 'non-mappable' BIMs with 'exotic' blocks, resulting from the gravitational collapse of the Triassic carbonate platform of European Continental Margin, triggered by the Early Jurassic rifting. In the Monviso Meta-ophiolite Complex, Types 2 and 3 represent tectonically induced broken and dismembered formations, respectively. They differ from each other in the degree of stratal disruption of primary interbedded horizons of mafic metabreccia (Type 3) and mafic metasandstone (Types 2 and 3) sourced by the Late Jurassic–Early Cretaceous denudation of an oceanic core complex. Dismembered interbeds (Type 2) and isolated blocks were mixed together (Type 3) by the overlap of D2 tectonics and late- to post-exhumation extensional shearing (D3-stage). Development of these types of BIMs may be common in many exhumed convergent plate margins, where severe tectonics and metamorphic recrystallization under high-pressure conditions normally prevent the reconstruction of BIMs or mélange-forming processes. Our findings show that documenting the mode and time of the processes forming BIMs is highly relevant in order to reconstruct the oceanic seafloor morphology and composition of associated stratigraphic successions, and their control in the evolution of those convergent plate margins.

Keywords: broken formation; mélange; meta-ophiolite; subduction; exhumation; Western Alps

1. Introduction

Chaotic rock units with block-in-matrix structure (BIMs), commonly known as mélanges and broken formations, are one of the hallmarks of many exhumed convergent plate margins in both Circum-Pacific and Tethyan regions (e.g. Silver and Beutner 1980; Raymond 1984; Cowan 1985; Suzuki 1986; Kusky and Bradley 1999; Pini 1999; Alonso *et al.* 2006; Festa *et al.* 2010a; Wakabayashi and Dilek 2011; Dilek *et al.* 2012; Wakabayashi 2012). They may commonly form at different tectonic settings and structural levels during the evolution of convergent plate margins, reflecting a close relationship between the active processes (tectonic, sedimentary, and diapiric), the physical and mechanical conditions (e.g. water content, overpressure, strength of sediments, P–T conditions, etc.), and the strain rate (e.g. Hsü 1968; Cloos 1982; Raymond 1984; Cowan 1985; Cloos and Shreve 1988a, 1988b; Festa *et al.* 2012, 2015; Ukar and Cloos 2013; Wassmann and Stöckhert 2013). Hence, systematic and process-oriented, inter-disciplinary studies of chaotic rock units with block-in-matrix structure may provide much-needed information about convergent plate margin evolution (e.g. Dilek *et al.* 2012).

The relationships between the final BIM structures and process of their formation are, however, controversial in several cases because of their complex and seemingly chaotic nature (e.g. Silver and Beunter 1980; Cloos 1982; Raymond 1984; Cowan 1985; Pini 1999; Festa *et al.* 2010a; Wakabayashi 2012). In addition, the overlap of shearing, tectonic mixing, and metamorphic recrystallization may lead to the reworking and change of existing BIMs formed by original different processes (e.g. sedimentary or diapiric), and to the formation of polygenetic mélange types. As a matter of fact, BIMs formed by sedimentary processes may be hard to recognize to non-distinguishable when placed, for example, in an accretionary wedge or in a subduction channel (e.g. Cowan and Page 1975; Cowan 1985; Dilek and Thy 2006; Burg *et al.* 2008; Cowan and Brandon 2011; Wakabayashi 2011, 2012; Prohoroff *et al.* 2012; Festa *et al.* 2013; Platt

*Corresponding author. Email: andrea.festa@unito.it