Perspective

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Polygenetic mélanges: a glimpse on tectonic, sedimentary and diapiric recycling in convergent margins

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Abstract: A significant part of mélanges recognized in exhumed convergent margins around the world has been recently documented to have chiefly originated from masse transport and subsurface remobilization and disruption (i.e. mélanges, from sedimentary and mud–serpentinite diapiric processes and from *in situ* fluidification–disruption). Tectonic and/or sedimentary processes occurring during subsequent multiple deformational events of convergent margin evolution commonly overprint and significantly rework the primary (sedimentary or diapiric) mélange fabric, forming polygenetic mélanges. This ultimately complicates their distinction from true tectonic mélanges, masking part of the recorded tectono-sedimentary evolution of the associated convergent margin. The contributions gathered in this thematic collection explore with different approaches (from field structural and stratigraphic observations to geophysical analyses) different types of polygenetic mélange, at various scales, around the world. These studies conclude that the understanding of this type of mélange may provide crucial insights for a more detailed interpretation of the evolution of ancient and modern convergent margins, and of processes and mechanisms triggering potential natural hazards (earthquakes and tsunamis). Case studies include the Apennines in the Central Mediterranean region, the Carpathians in Central Europe and the Nankai Prism in Japan.

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Tectonic, sedimentary and (mud and serpentinite) diapiric processes form different types of mélange, each of which shows different diagnostic block-in-matrix fabric and composition according to their geodynamic setting of formation (Festa *et al.* 2010). During the multistage evolution of convergent margins, the alternation of these different processes, which commonly combine into complex interactions, overprints and reworks the primary (original) fabric of tectonic, sedimentary and (mud and serpentinite) diapiric mélanges (Fig. 1), forming polygenetic mélanges (e.g. Raymond 1984; Cowan 1985; Dilek *et al.* 2012; Festa *et al.* 2013, 2019*b*; Balestro *et al.* 2015; Platt 2015; Ernst 2016; Tartarotti *et al.* 2017).

Although various mutual interlinks between the different mélange-forming processes may occur (e.g. Camerlenghi & Pini 2009; Osozawa *et al.* 2009; Festa *et al.* 2012; Prohoroff *et al.* 2012; Moore *et al.* 2019; Raymond 2019), in most cases, tectonics represents the last and more pervasive overprinting process, conferring to polygenetic mélanges their typical block-in-matrix resemblance, sometimes virtually indistinguishable from that of true tectonic mélanges (Fig. 1). This resemblance is at the base of a long-lasting debate on the nature and mode of processes leading to the formation of block-in-matrix rock units, particularly in those sectors of well-preserved exhumed convergent margins such as the Western US Cordillera, the Circum-Pacific and the Circum-Mediterranean regions. The main aspect of the debate is whether the block-in-matrix arrangement of such exhumed chaotic rock units is the result of tectonic shearing and mixing alone, acting at different depths, or the product of tectonic reworking and 'recycling' of primary heterogeneous mass-transport deposits (i.e. sedimentary mélanges and olistostromes) or diapiric mélanges (e.g. Berkland *et al.* 1972; Hsü 1974; Raymond 1984, 2019; Cowan 1985; Barber *et al.* 1986; Pini 1999; Bettelli *et al.* 2004; Alonso *et al.* 2006; Festa *et al.* 2010, 2016; Wakabayashi 2011, 2019; Barber 2013; Balestro *et al.* 2015; Krohe 2017; Tartarotti *et al.* 2017).

To complicate this debate, evidence from explorations in trench systems and modern convergent margins documents that the different deformational processes affecting water-saturated and partially lithified sediments contribute to form a strong morphological convergence of block-in-matrix fabrics between tectonic, sedimentary and diapiric products (e.g. Maltman 1994; Alonso *et al.* 2006; Ogata *et al.* 2014, 2020*b*; Festa *et al.* 2019*c*; Ogawa 2019). Regardless of the process of formation, different meso-scale features and structures (e.g. boudins, asymmetrical rootless folds, pseudo-SC structures, duplex types and imbricated structures, low-angle shear zones, etc.) form as a result of soft-sediment deformation in undrained, water-saturated and poorly consolidated to unconsolidated sediments (e.g. Maltman 1994; Ogata *et al.* 2016, 2019*a*, *b*; Ogawa 2019). The block-in-matrix arrangements of mélanges developed under these physical and mechanical conditions may thus appear highly similar in the field, creating confusion and uncertainty in their interpretation.

Further complications to this scenario are related to the fact that the abundance and size of (mud and serpentinite) diapiric and sedimentary mélanges in ancient convergent margins, as well as heterogeneous mass-transport deposits (MTDs) in modern ones, are poorly considered. Sedimentary mélanges and heterogeneous MTDs are described to reach >10 000 km^2 with a thickness ranging from hundreds of metres to about >1000 m (e.g. Woodcock 1979; Urgeles & Camerlenghi 2013; Festa *et al.* 2015,