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Role of structural inheritance in the gravitational deformation of the Monviso meta-ophiolite Complex: the Pui-Orgiera serpentinite landslide (Varaita Valley, Western Alps)

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ABSTRACT

Depending on its chemical and mineralogical composition, the serpentinite represents a peculiar rocky material, which plays a significant role in influencing pedogenetic weathering, vegetation ecology, geo-mechanical and tectonic processes, as well as gravitational slope failure. In serpentinite-bearing environments the response to gravitational stress is more effective than in other rock types. In the Monviso meta-ophiolite Complex (Western Alps), a close relation between landsliding and serpentinite rock occurrences is particularly evident. Our geological map (Main Map), at a scale 1:10,000, illustrates the geology and geomorphological features of the Pui-Orgiera giant (2.98 km^2) complex landslide, located on the southern slope of the Monviso Massif. This map clearly documents that the characteristics and kinematics of the landslide are closely associated to the anomalous thickening and widening increase of the Baracun Shear Zone, a remnants of an intra-oceanic detachment fault which separates serpentinite and meta-intrusives from metabasalt and metasediments of the Monviso meta-ophiolite Complex.

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1. Introduction

The serpentinite represents a very unique rocky material in terms of pedogenic processes (Alexander & DuShey, 2011; Alexander, Coleman, Keeler-Wolf, & Harrison, 2007; Lee, Graham, Laurent, & Amrhein, 2004), plant ecology (D'Amico & Previtali, 2012; Kruckeberg, 1984), and tectonic processes (Hilairet et al., 2007). Depending on its chemical composition and the crystallographic specificity of serpentine minerals (Guillot, Schwartz, Reynard, Agard, & Prigent, 2015), the serpentinite favours the formation of localized mechanical and rheological weakness horizons, which may act as lubricant surfaces (Amiguet, Van De Moortèle, Cordier, Hilairet, & Reynard, 2014), concentrating short to long-lived tectonic and gravitational deformation. In subaerial serpentinite-bearing environments the response to gravitational stress is more effective than in other rock types as well-documented by both large-scale mass wasting occurrences in various ophiolitic complexes (Cowan & Mansfield, 1970; Yamagishi & Ito, 1994; Yatabe, Yagi, & Yokota, 1997) and the close relationships between landslides and pervasive deformed serpentinite (Brandolini, Nosengo, Pittaluga, Ramella, & Razzore, 1999; Coleman, 1996; Cowan & Mansfield, 1970; Dickinson, 1966; Fioraso, Tararbra, & Negro, 2010; Phipps, 1984; Stark, Newman, de la Peña, & Hillebrandt, 2011; Yatabe, Bhandary, & Okamura, 2007).

In the Italian Alps, the IFFI project (Inventory of Landslide Phenomena in Italy; http://www.isprambiente.gov.it/en/projects/soil-and-territory/iffi-project) outlines a close relation between landsliding and serpentinite rock occurrences as particularly evident in the Monviso meta-ophiolite Complex (MO hereafter; see Balestro et al., 2014; Balestro, Fioraso, & Lombardo, 2011, 2013) (Figure 1), which represents a remnant of the Jurassic Alpine Tethys stacked in the Western Alps (Balestro, Festa, Dilek, & Tartarotti, 2015; Festa, Balestro, Dilek, & Tartarotti, 2015; Lombardo, Rubatto, & Castelli, 2002).

In this paper and related geological map at 1:10,000 scale (Main Map), we illustrate the geology and geomorphological features of the Pui-Orgiera giant complex landslide, located on the left side of the Varaita Valley (southern slope of the Monviso Massif) between the hamlets of Confine and Villar (Figure 2). It represents one of the most impressive instability phenomena in ophiolite rock units of the Alps, in terms of size, kinematics and morphological evolution. This landslide, in turn, is located in a slope extensively affected by an imposing deep-seated gravitational deformation. In addition to Quaternary deposits and morphological

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