

## The St. Marcel Valley, Western Alps: metaophiolites, metasedimentary sequence and tectonic setting

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### ABSTRACT

In the Southern Aosta Valley, the St. Marcel Valley metaophiolites consist of mainly metavolcanics and their sedimentary cover metamorphosed under HP subduction-related metamorphism. A detailed geological map carried out in the St. Marcel Valley reveals that the metasedimentary cover, although transposed by the Alpine tectonics, is essentially made of three main terms, that are Mn-rich metaquartzites, marble, and calcschists. The metasedimentary sequence is quite comparable with the unmetamorphosed sequence made of radiolarian cherts, Calpionella limestones and Palombini shales covering the Ligurian ophiolites. The St. Marcel Valley metaophiolites represent the upper crustal section of the Mesozoic Tethyan ocean and its pelagic sedimentary cover, overthrusting the serpentinite unit of the Mount Avic, to the East. Within the Piemonte nappe stack, the St. Marcel metaophiolites are located at the higher structural level.

**KEY WORDS:** Western Alps, metaophiolites, eclogite, Piemonte Nappe.

### INTRODUCTION

The 1:10,000 scale geological map of the lower St. Marcel Valley (southern Aosta Valley, Italian Western Alps) covers an area of ca. 15 km<sup>2</sup> and includes the contact between oceanic units and their original sedimentary cover. These units pertain to the Piemonte Nappe, a composite nappe stack of metaophiolites and metasediments representing the fossil oceanic lithosphere of the Mesozoic Tethyan ocean. The St. Marcel metaophiolites overlie the Penninic Gran Paradiso basement nappe and are in turn overthrust by the Austroalpine Mt. Emilius and Glacier Rafray klippen (Martin & Tartarotti, 1989; Dal Piaz et al., 2001; Martin et al., 2008). In the geological sheet 091 "Chatillon" (Dal Piaz et al., 2010) at scale 1:50,000 the St. Marcel metaophiolites are regarded as part of the Zermatt-Saas Unit (although this latter has been originally defined in the Zermatt area; Bearth, 1967; Dal Piaz & Ernst, 1978), because of the well preserved HP subduction-related mineral assemblages which characterize the metaophiolites of the Zermatt-Saas Fee zone. In the St. Marcel

metaophiolites, different units were recognized, consisting of oceanic basement rocks (metagabbro, metabasalt, serpentinite, metasomatic rocks, hydrothermal mineralizations, metasediments) with blueschist/eclogite facies rocks retrogressed to greenschists-facies, covered by quartzite, marble, and calcschists. These latter three rock types, although tectonically transposed, are always strictly associated all over the St. Marcel Valley, as well as in many areas of the Piemonte Nappe. The sedimentary sequence, although intensely tectonized and metamorphosed, recalls the wellknown sedimentary cover of the Ligurian ophiolites consisting of radiolarian cherts, Calpionella limestone, and "Palombini" shale (e.g., Abbate et al., 1980; Cortesogno et al., 1987) as already suggested for the Cotian Alps ophiolites (e.g., Lagabrielle et al., 1984; Polino & Lemoine, 1984).

The map here presented is based on a field work undertaken on the metaophiolites and their metasedimentary cover, including detailed lithostratigraphic sections performed on the metamorphosed cover sequence. The main purpose is to document the lithostratigraphy of these metasediments and to compare them with other calcschist sequences exposed in the nearby areas of the southern Aosta Valley. This map also allows to relate the St. Marcel metaophiolites with analogue units with the main purpose of unravelling the internal structure of the Piemonte nappe stack in the southern Aosta Valley.

### GEOLOGICAL SETTING

The St. Marcel Valley is located in the southern side of the Aosta Valley (Italian Western Alps) and is characterized by ocean-type metaophiolitic basement covered by a metasedimentary sequence attributed to the Piemonte Nappe. The St. Marcel metaophiolites are divided into three main units, exposed from north to south: 1) the Fontillon-Servette unit, consisting of oceanic blueschist-eclogite facies rock assemblages, i.e., garnet-glaucophanite with eclogite boudins,

metagabbro-derived rocks, garnet-chloritoid chloriteschists and talcschists hosting a Cu-Fe sulphide deposit covered by metasomatic rocks, quartz-rich micaschists with ophiolitic detrital levels, carbonate-rich micaschist, and calcschist. The Cu-Fe mineralization has been attributed to oceanic hydrothermal alteration (Martin et al., 2008). 2) The Mt. Roux-Mt. Corquet unit consists of dominant blueschist/greenschists-facies metabasite (mainly metagabbro), with rare eclogite relics, and actinolite-schists covered by basal manganiferous metacherts, garnet-chloritoid-micaschists, fine-grained pale-grey marble and calcschists characterized by typical dm- to m-thick marble layers alternating with carbonaceous schists. 3) The Plan Ruè-Grand Avert unit shows an ophiolitic basement consisting of fine-grained, massive garnet-glaucophane-bearing metabasite which preserve relict pillow-lava structures. At Plan Ruè, the metabasites constitute the core of a spectacular 50m-width recumbent fold (Fig. 1). The sedimentary cover is here made of Mn-rich-metatactite, marble and calcschists. In the Mt. Grand Avert area, however, metatactites and quartz-rich micaschists are dominant.

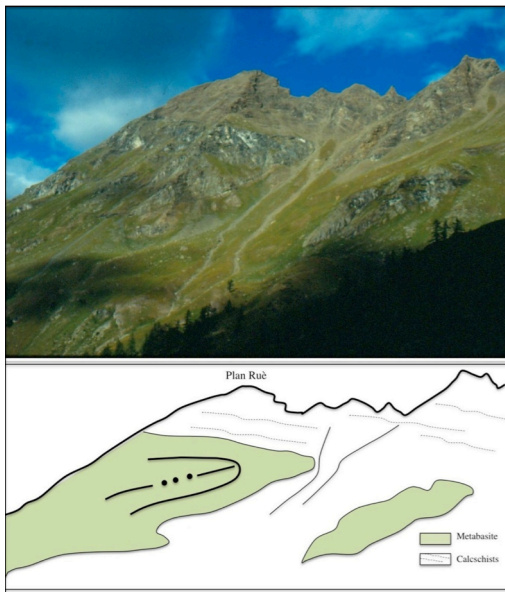


Fig. 1 – The D3 fold of Plan Ruè exposing metabasite and calcschists on the right side of the St. Marcel Valley.

### STRUCTURAL DATA

Structural investigations in the St-Marcel Valley suggest that at least three main ductile phases are responsible for the structures recognizable at the outcrop scale. D1 phase produced HP fabrics with (locally mylonitic) foliation and boudinage, well visible in the Fontillon-Servette unit. D1 structures are mostly North-South trending. D2 phase is superposed to the eclogitic foliation producing recumbent folds with axial surface and axes which are gently dipping towards NW. D3 phase is responsible for the rotation of older structures towards E-W. In

the St. Marcel Valley, moving from the northern Fontillon-Servette unit to the southern Plan Ruè-Grand Avert unit, North-South trending structures underwent a regional-scale rotation towards an East-West trend. East-West trending structures are then prevailing in the Champorcher-Urtier area located southwards. Late brittle structures have only minor effects in the St. Marcel Valley, differently from other sectors of the southern Aosta Valley where recent tectonics is mainly linked to the regional scale E-W trending Aosta-Ranzola-Colle Joux fault.

Our results suggest that, differently from most metaophiolites exposed in the southern Aosta Valley, which are dominated by mantle-derived serpentinites (e.g., the Mount Avic unit), the St. Marcel metaophiolites represent the shallowest parts of the Tethyan oceanic lithosphere, consisting of metavolcanic rocks and their sedimentary cover. In spite of tectonic transposition, we also suggest that metasediments exposed in the St. Marcel Valley may represent the original pelagic sediments covering the ocean crust, probably emplaced not far away a spreading center (mid-ocean ridge) allowing the formation of hydrothermal vents.

Geological sections across the ophiolites in the southern Aosta Valley reveal that the Piemonte Nappe may be divided into several tectonic units, as suggested by Dal Piaz et al. (2010) in the “Chatillon” Geological Sheet. We here suggest that the St. Marcel Valley metaophiolites are located in the upper structural levels within the Piemonte nappe stack, i.e., they overthrust the Mount Avic serpentinite unit to the East, continue below the Sesia-Lanzo Zone enclosing the Glacier-Rafay, Tour Ponton and Acque Rosse Austroalpine slices to the south, overthrust the blueschists-facies Aulletta unit to the West. The Grivola-Urtier unit, although comparable for its metamorphic imprint to the St. Marcel Valley units, occurs at the lowest structural level within the Piemonte Nappe, overthrusting the upper Penninic Gran Paradiso nappe.

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