

SUPPLEMENTARY DATA 1

FIELD RELATIONSHIPS AND SAMPLE DESCRIPTION

Different metasediments, their associated mafic boudins and intrusive bodies were sampled along the southern and the central part of the EMC (Fig. S1-1a). The main focus was on the polycyclic metasediments as they preserve pre-Alpine metamorphic relics (e.g., garnet cores, zircon cores) and on the associated mafic rocks that record only Alpine metamorphism.

Malone Valley

The studied outcrop is located in the southern part of the EMC, near Alpe Mecio, ~ 2.5 km South-West of Monte Soglio (Fig. S1-1). Garnet-bearing micaschists are associated with strongly foliated glaucophane-rich schists parallel to quartz layers around which lawsonite pseudomorphs (composed by zoisite $\pm$ paragonite $\pm$ garnet) are preserved (Fig. S1-2). Decimetric eclogite boudins are found within the glaucophane schists and are typically surrounded by an epidote-rich, cm-thick rim.

AV16-44 is fine grained glaucophane-epidote schist (referred to as Gln-Ep-schist, mineral abbreviations from Whitney and Evans 2010). Garnet displays two distinct microtextures: (a) sub-millimetric garnet distributed within the foliation and rich in epidote inclusions, and (b) mm-sized garnet porphyroblasts surrounded by the foliation, preserving a fractured core and an inclusion-rich rim (Fig. S1-3). AV16-45 is a quartz-rich, garnet-bearing micaschist with phengite, paragonite, chlorite and allanite defining a foliation that wraps around mm-sized garnet porphyroblasts (Fig. S1-3). Sample AV16-47 is a mafic boudin embedded in metasediments. The matrix is weakly foliated and is dominated by glaucophane, epidote and euhedral, inclusion-rich garnet crystals with a size of 100 – 500 μm . It contains lenses of omphacite surrounded by epidote (Fig. S1-3). Omphacite is characterized by dark, cloudy cores and bright rims.

Ivozio Complex

The Ivozio complex is a metagabbro body with a diameter of ~ 500 m (Pognante et al. 1980; Zucali et al. 2004). This mafic complex is associated to scarce ultramafic rocks and is surrounded by micaschists (Fig. S1-1). Mafic lithologies mainly consist of glaucophane, omphacite and garnet in various proportions, with subordinate white mica, zoisite and quartz; locally lawsonite pseudomorphs are recognizable (Fig. S1-4). The primary layering and original compositional distinction between a more cumulitic gabbro and a more evolved gabbro are preserved (Fig. S1-4).

AV16-21 (Fig. S1-5) consists of two domains: (1) a glaucophane-bearing eclogite, dominated by pale rose, inclusion-poor garnet and omphacite, with minor rutile, phengite and pyrite, and (2) a quartz-rich domain containing millimetre sized, deformed phengite grains and garnet with an inclusion-rich core (mainly quartz, phengite and rutile) and an inclusion-free rim (Fig. S1-5).

Chiusella Valley

VC10-04 was collected in the Chiusella Valley, west of Cima Bonze near Alpe Solanger. Here, the EMC pelitic basement is intruded by abundant Carboniferous and Permian granitoids and gabbros (Venturini et al. 1994; Rubatto 1998; Zucali 2002). This basement association is deformed jointly with the mono-metamorphic Scalero Unit rocks (Regis et al. 2014). Mafic rocks form most of the walls on the western side of Cima Bonze in the Chiusella valley, cropping out as a series of bands with thicknesses ranging between 50 and 500 m. This band consists of *HP* metagabbros and glaucophane-rich eclogites with minor associated metasediments. Locally metagabbros are associated with thin horizons of Mn-rich quartzite (such as sample VC10-04) with pink Mn-rich garnet (~10 wt% MnO) and glaucophane ($\pm$ cm-sized pleochroic allanite). Sample VC10-04 is characterized by an intense millimetre to submillimetric foliation marked by iso-oriented elongated glaucophane blasts and quartz and garnet layers (Fig. S1-6). It contains pink garnet crystals with atoll texture (Fig. S1-6), and accessory allanite and zircon.

Lys Valley

Samples FG1249 and FG1315 are micaschists, respectively from the South-East and the North-West parts of the Internal Complex (as defined by Giuntoli and Engi 2016), corresponding to the

central part of the EMC (Fig. S1-1). Typical eclogitic micaschists found in this area are compositionally banded, with an alternation of strongly foliated phyllosilicate-rich layers, quartz-rich gneissic layers and mafic layers. The thickness of the banding ranges from the centimetre to the meter scale.

A detailed textural and mineralogical description of these samples is given in (Giuntoli et al. 2018b, a). FG1249 is a garnet-bearing micaschist with phengite, paragonite, allanite, and rutile defining an intense foliation that wraps around garnet of several millimetres size (Fig. S1-7). FG1315 is a garnet-bearing micaschist with a pervasive foliation marked by phengite, paragonite and allanite. Garnet is present as both mm-sized grains preserving a porphyroclastic core overgrown by multiple rims and atoll grains a few hundred microns in size (Fig. S1-7).

Monte Mucrone

The area located between Albergo Savoia and Bocchetta del Lago is dominated by micaschists and paragneisses including centimetric to metric mafic lenses and boudins (Fig. S1-1) and locally preserving relics of migmatitic textures. Eclogite lenses s.s. are often surrounded by a glaucophane-garnet-phengite domain or by garnetite associated with quartz lenses and crosscut by phengite pods and veins. Coarse grained micaschists are found around the eclogites (Fig. S1-8).

AV17-07 is a garnet-micaschist containing quartz, large (several hundreds of microns size) phengite, lozenge-shape aggregates of fine-grained paragonite, accessory rutile, allanite and zircon (Fig. S1-9). In this sample, two main garnet textures are observed: (1) millimetre porphyroclastic cores surrounded by euhedral smaller garnet crystals (Fig. S1-9) and (2) submillimetre euhedral grains locally forming atoll garnet textures. AV17-16 is a decametric eclogite layer composed of glaucophane, garnet, omphacite, paragonite, phengite and minor rutile, (Fig. S1-9) that contains pods and veins of coarse-grained iso-oriented phengite, garnet and glaucophane (Fig. S1-9). Garnet is characterized by cloudy, inclusion-rich cores and brighter rims.

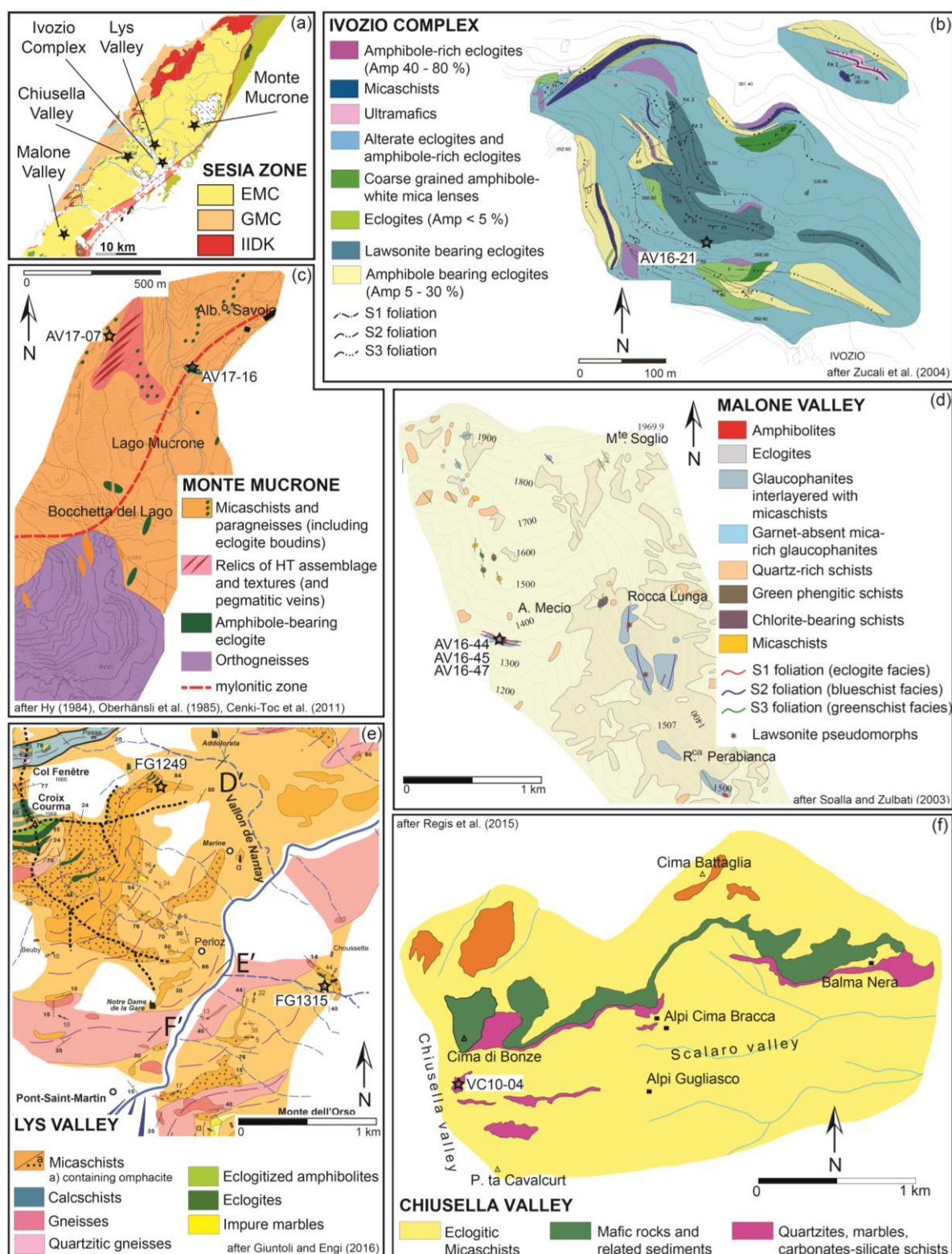


Figure S1-1. Localities and location of the samples investigated in this study. (a) Schematic map of the Sesia Zone with the investigated localities. Structural and lithological maps of: (b) Ivoizio complex (after Zucali et al. 2004); (c) Monte Mucrone (after Hy 1984; Oberhänsli et al. 1985; Cenko-Tok et al. 2011); (d) Malone Valley (after Spalla and Zulfati 2003); (e) Lys Valley (after Giuntoli and Engi 2016) and (f) Chiusella Valley and Cima di Bonze (after Regis et al. 2015). The location of the samples is marked by red stars.

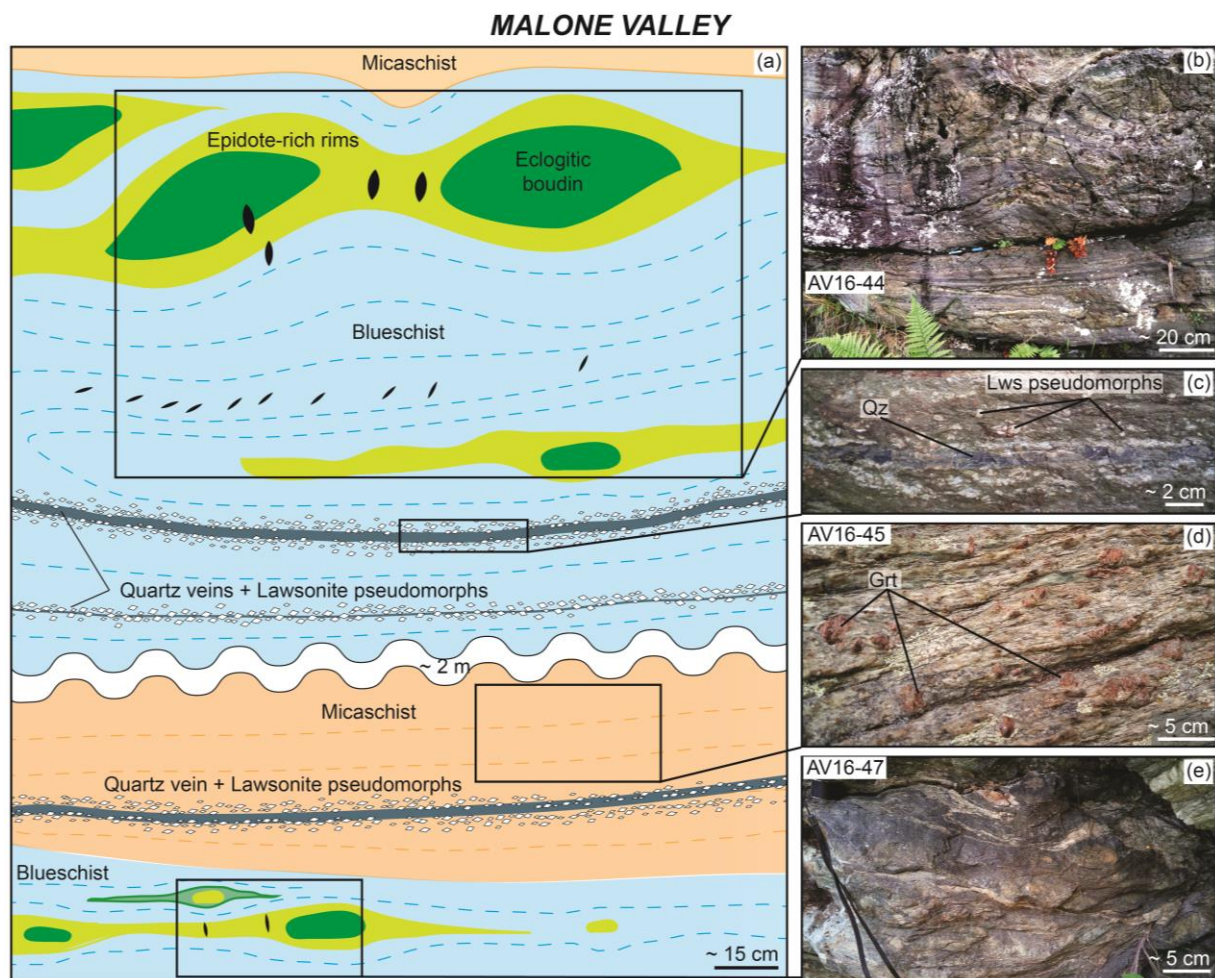


Figure S1-2. Malone Valley outcrop. (a) Sketch of the studied outcrop. (b,c,d,e) Field pictures of the sampled lithotypes (AV16-44, AV16-45 and AV16-47) and of a layer of well-preserved lawsonite pseudomorphs. Mineral abbreviations are from Whitney and Evans (2010).

MALONE VALLEY

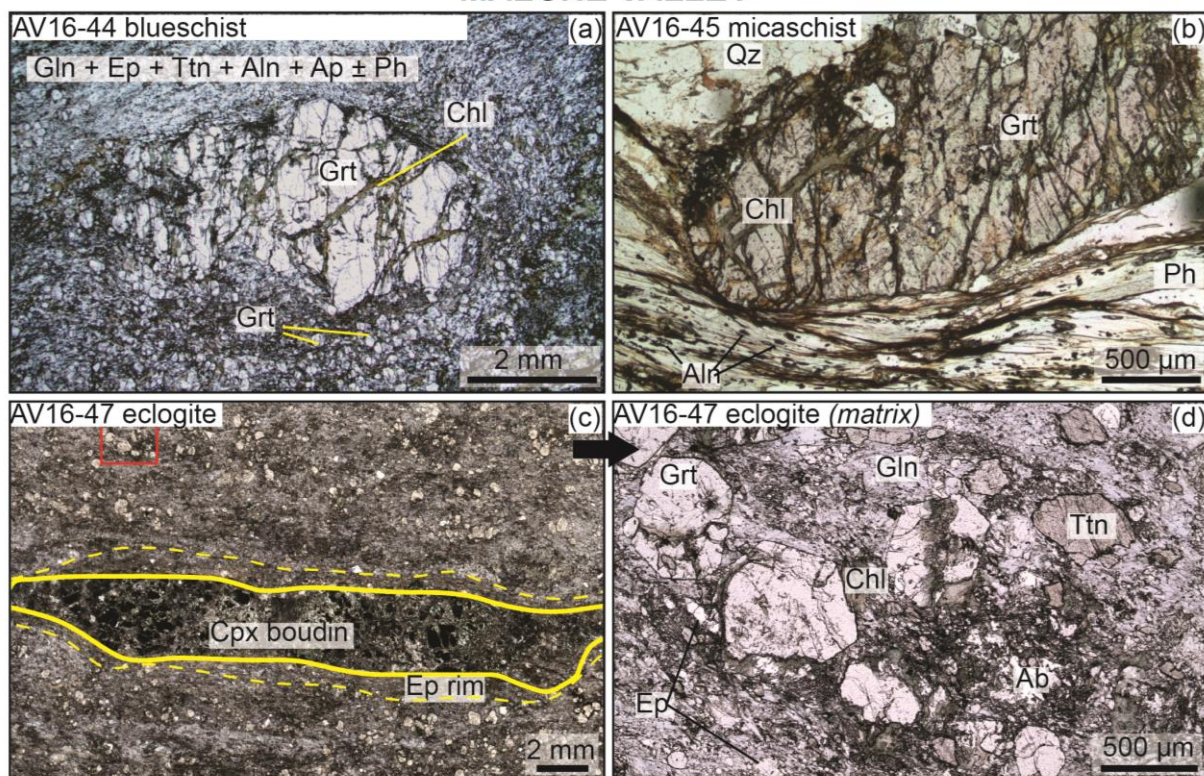


Figure S1-3. Microphotographs of the samples from Malone Valley (parallel polarized light). (a) Blueschist AV16-44. A plurimillimeter porphyroblast is surrounded by the foliation marked by preferred orientation of glaucophane and epidote. Sub-millimetric euhedral garnet crystals are visible within the foliation. (b) Micaschist AV16-45: garnet porphyroblast surrounded by a foliation marked by phengite, chlorite, paragonite and allanite. (c,d) Eclogite AV16-47: boudin of clinopyroxenes with cloudy cores, rimmed by an epidote layer and surrounded by a weakly foliated matrix of garnet + glaucophane + titanite and retrograde albite and chlorite. Mineral abbreviations are from Whitney and Evans (2010).

IVOZIO COMPLEX

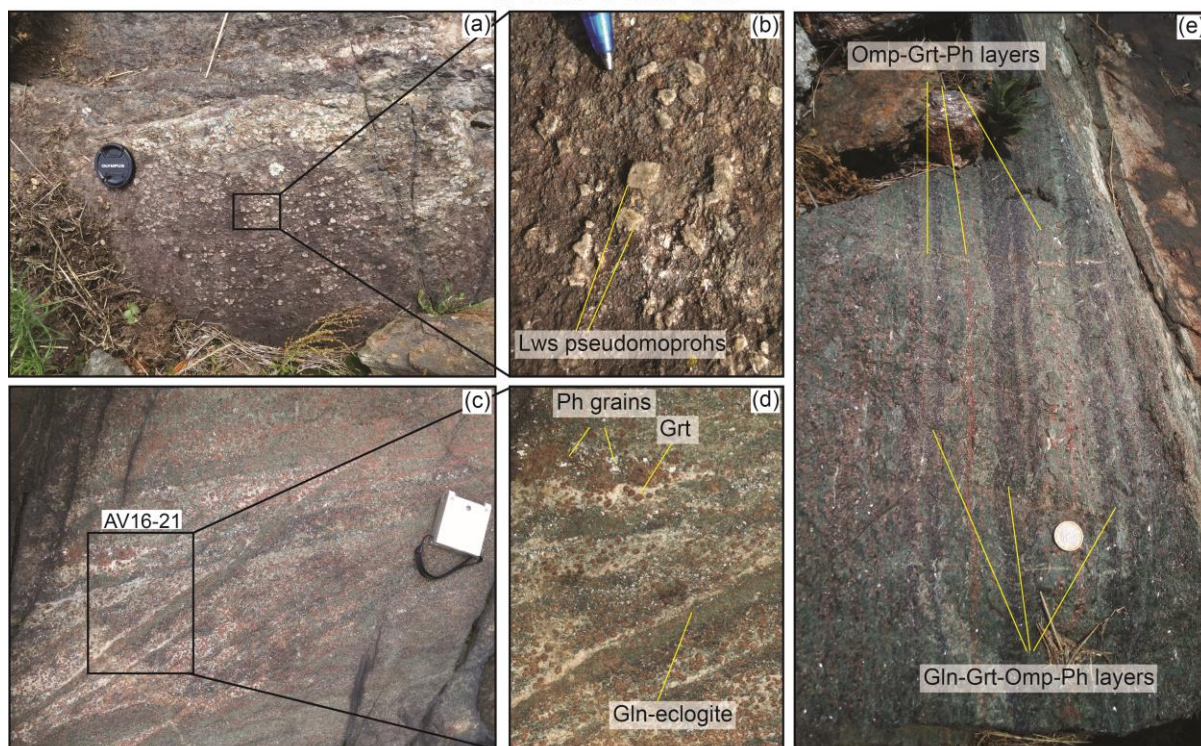


Figure S1-4. Field pictures of Ivozio Complex. (a,b) Well preserved lawsonite pseudomorphs. (c,d) Eclogite with phengite- and quartz-rich layers (sample AV16-21). (e) Magmatic layering preserved in a metagabbro from the Ivozio Complex. Mineral abbreviations are from Whitney and Evans (2010).

IVOZIO COMPLEX

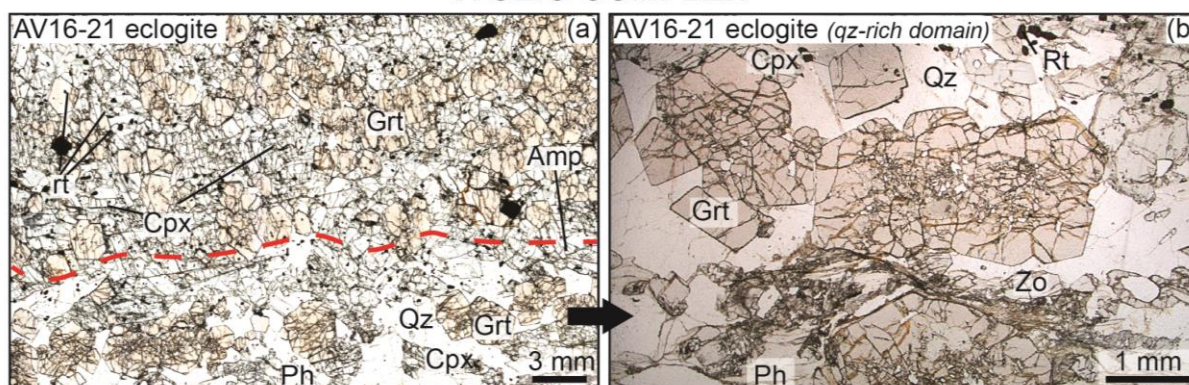


Figure S1-5. Microphotographs of the samples from Ivozio Complex (parallel polarized light). (a) Sample AV16-21 has two distinct domains (separated by a red dashed line): a garnet + omphacite + rutile domain (upper part of the picture) and a garnet + quartz + phengite + amphibole domain (lower part). (b) Zoom in the quartz-rich domain; garnet shows an inclusion-rich core and a bright rim. Mineral abbreviations are from Whitney and Evans (2010).

CIHIUSELLA VALLEY

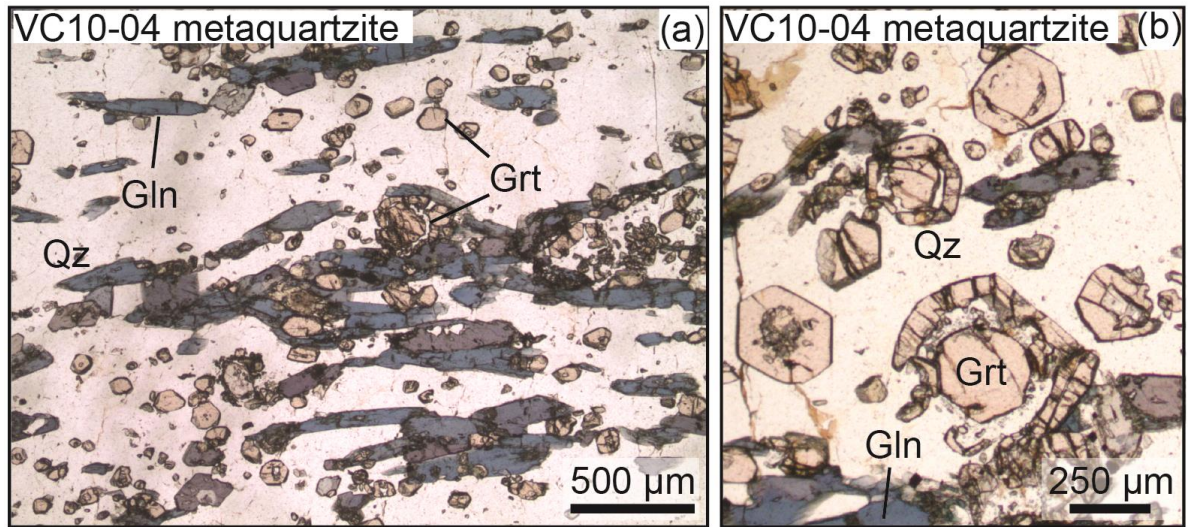


Figure S1-6. Microphotographs of sample VC10-04 from Chiusella Valley (parallel polarized light). (a,b) Mn-rich metaquartzite VC10-04 containing elongated glaucophane blasts with a preferred orientation and parallel quartz and garnet layers. Details of the garnet atoll texture are shown in (b). Mineral abbreviations are from Whitney and Evans (2010).

LYS VALLEY

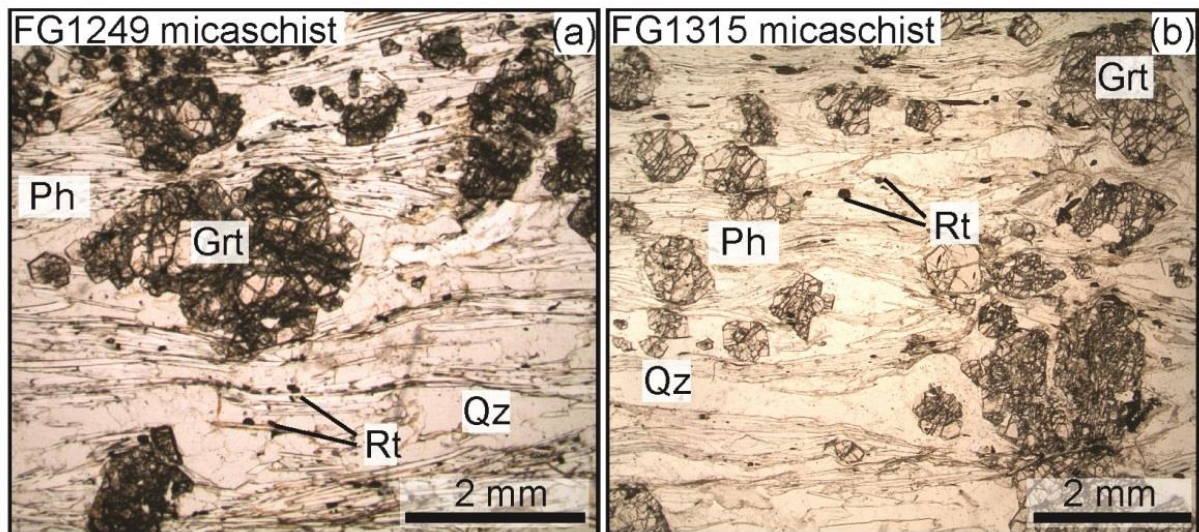


Figure S1-7. Microphotographs of samples from Lys Valley (parallel polarized light). (a) Micaschist FG1249 showing an intense foliation wrapping around garnet porphyroclasts. (b) Micaschist FG1315 containing both large garnet grains and euhedral grains a few hundred microns in size. Mineral abbreviations are from Whitney and Evans (2010).

MONTE MUCRONE

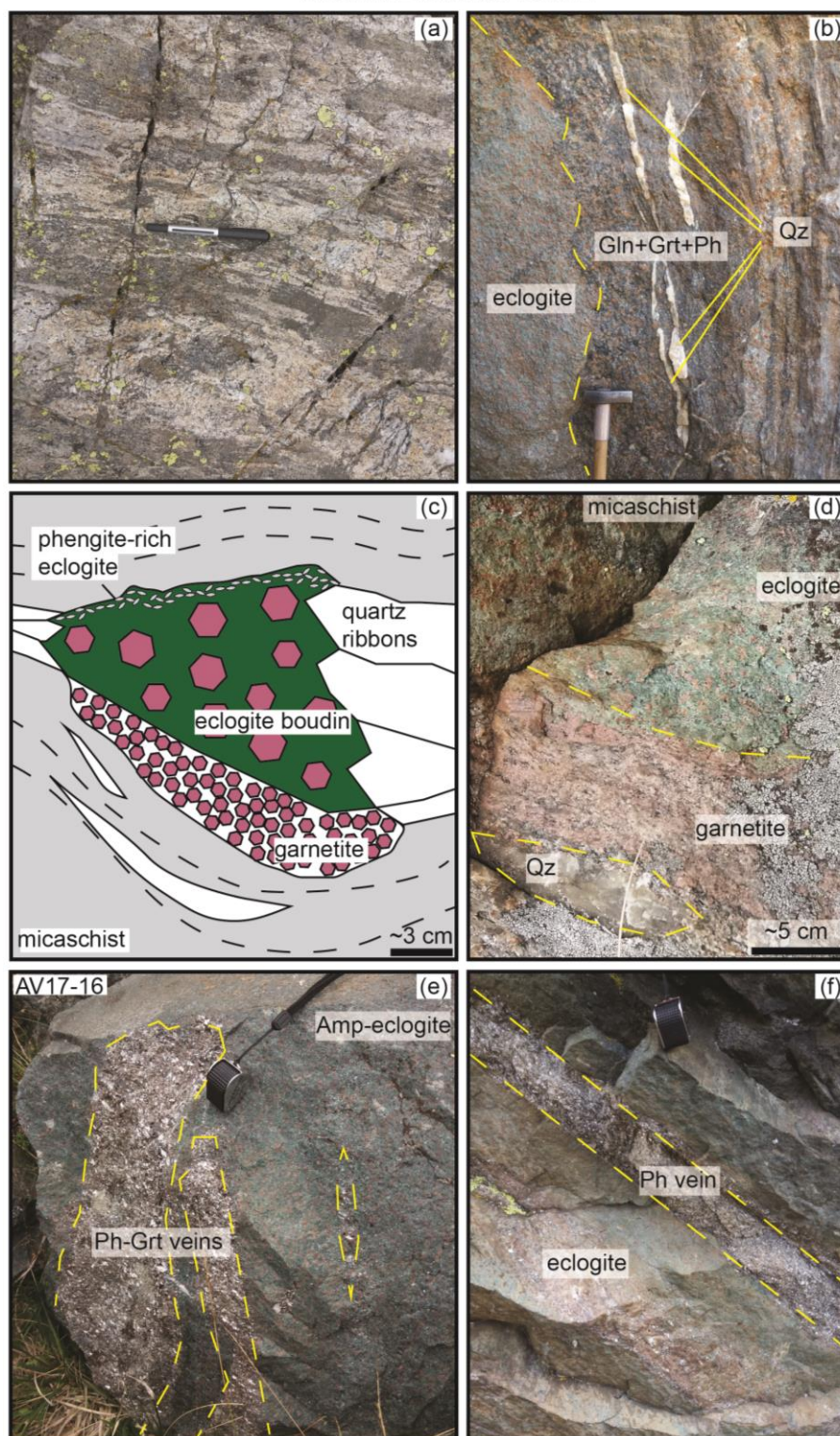


Figure S1-8. Field pictures and sketch of rocks and outcrops from Monte Mucrone. (a) Preserved migmatitic to granulitic textures in metasediments. (b) Transition between a “dry” eclogite (garnet + omphacite dominated) and a glaucophane-phengite-rich eclogite. At the transition, quartz ribbons are visible. (c) Sketch of the typical lithotype distribution around eclogite lenses: the eclogite is often enriched in phengite toward the rim and quartz veins, or occasionally quartz and garnet layers, are abundant around the lens. The surrounding micaschists display an increase in abundance and size of phengite toward the eclogite. (d) Field picture of an eclogite boudin with the characteristics outlined in (c). (e,f) Eclogite lens cut by phengite + garnet + glaucophane veins (sample AV17-16). Mineral abbreviations are from Whitney and Evans (2010).

MONTE MUCRONE

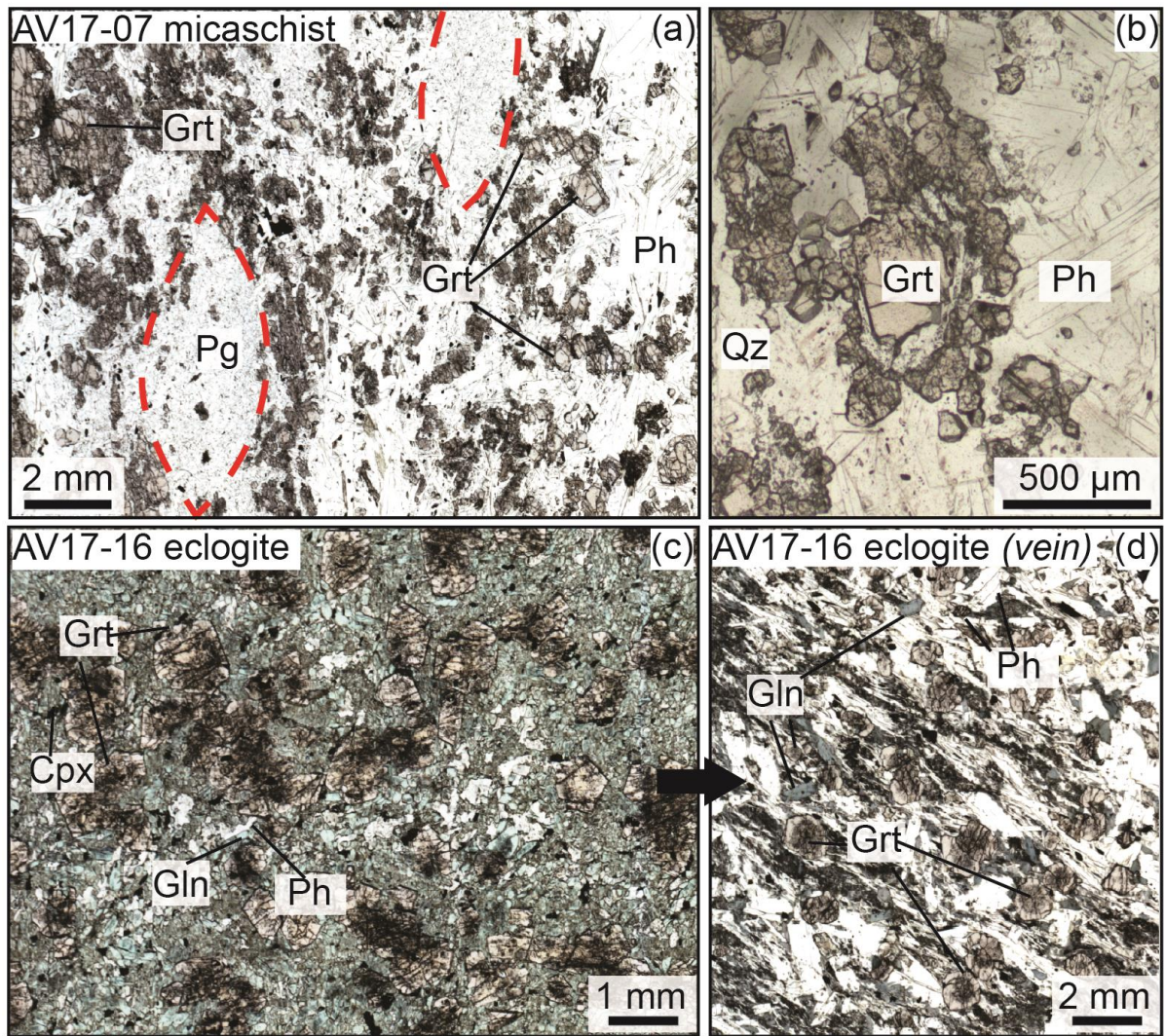


Figure S1-9. Microphotographs of samples from Monte Mucrone (parallel polarized light). (a,b) Micaschist AV17-07 containing large phengite grains and lozenge-shape aggregates of fine-grained paragonite. Garnet consists of millimetre porphyroclastic cores surrounded by euhedral smaller grains (detail shown in (b)) and as submillimetre euhedral grains with quartz inclusion distribution between core and rim (forming atoll garnet). Mineral abbreviations are from Whitney and Evans (2010).

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