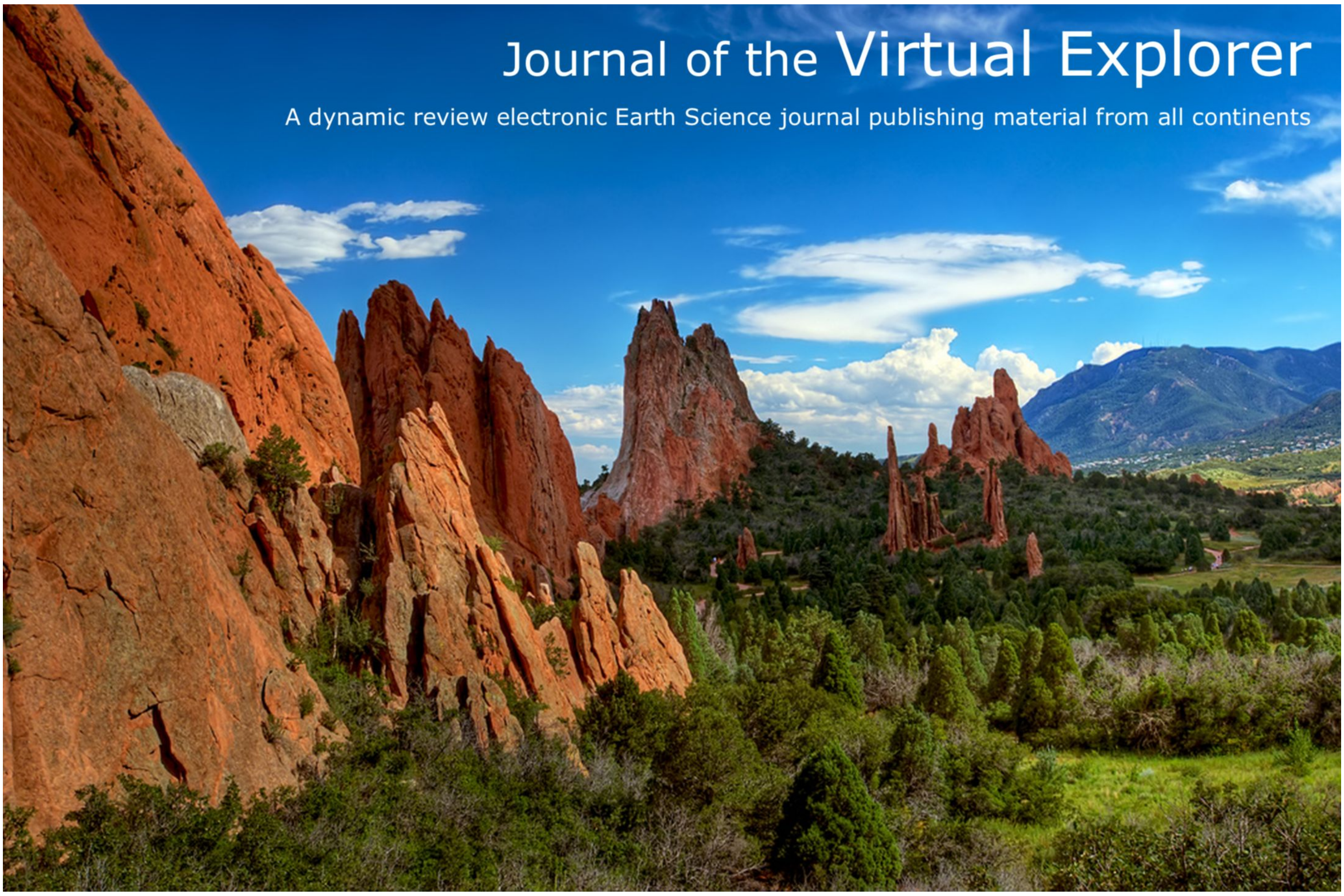

Field Trip 1 - Geology and petrology of Ocean Continent Transition (OCT) zones metamorphosed under eclogite facies conditions

Alberto Vitale Brovarone, Jacques Malavieille, Marco Beltrando, Giancarlo Molli, Roberto Compagnoni

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Field Trip 1 - Geology and petrology of Ocean Continent Transition (OCT) zones metamorphosed under eclogite facies conditions

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Abstract: CorseAlp 2011 was held in April 2011. A link to the website is here: CorseAlp 2011. The CorseAlp field trips were designed to introduce the participants to the general features of the geology of Alpine Corsica and to recent specific discoveries.

Field trip 1 focused on the geology of the Ocean-Continent Transition preserved in the Monte San Petrone, in Central Corsica, which was subducted to eclogite facies conditions during the Alpine orogeny. Field Guide 1 itinerary: Bastia, Golo Valley, Piedicroce, M.S.Petrone and S.Florent.

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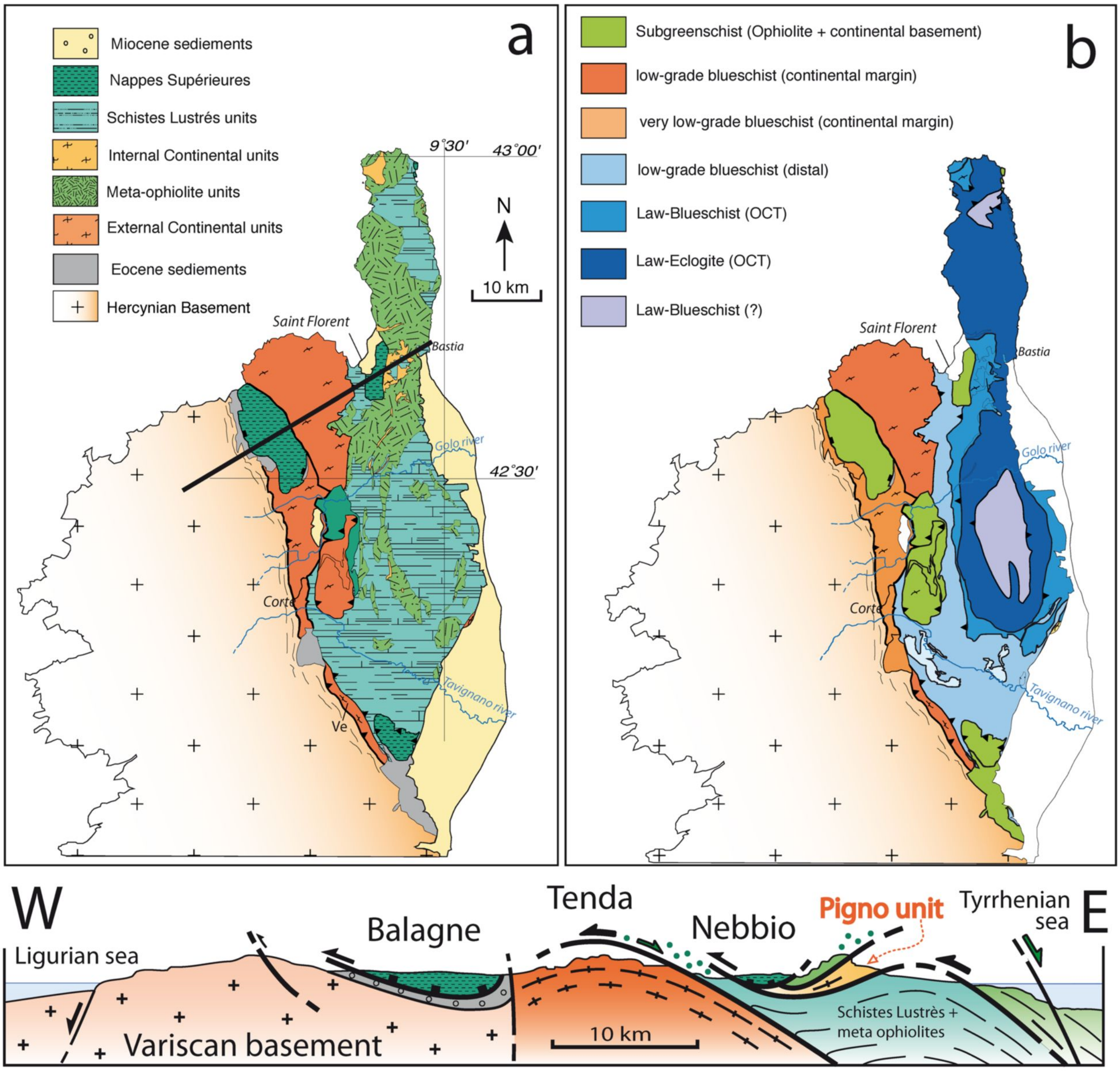
Geology and architecture of the Schistes Lustrés complex.

The Schistes Lustrés (SL) complex of Alpine Corsica occupies the eastern part of the belt and consists of a stack of variably metamorphosed units derived from the Western Tethys (e.g. Caron & Delcey, 1979; Jolivet *et al.*, 1990; Lahondère, 1996) (Fig. 1.1a). The SL complex is juxtaposed to the continent-derived units of the Corsican margin (e.g. Tenda, Corte units), and is overlain by the very low-grade uppermost units (Fig 1.1a). Within the SL complex, four main homogeneous tectono-metamorphic units are defined on the basis of petrological data (e.g. Lahondère, 1996; Vitale Brovarone *et al.*, submitted). They are folded together in a wide antiformal structure which post-dates their juxtaposition. Metamorphism ranges from the low-grade blueschist conditions (e.g. Lahondère, 1996; Levi *et al.*, 2007; Vitale Brovarone *et al.*, in prep) up to lawsonite eclogite conditions (Péquignot & Potdevin, 1984; Lahondère, 1996; Ravna *et al.*, 2010; Vitale Brovarone *et al.*, 2011a, b) (Fig. 1.1b). The lowermost structural position is occupied by the “Castagniccia” unit, which crops out in the axial culminations of the SL antiform in both the southern (i.e. the so-called Castagniccia region) and northern Alpine Corsica (i.e. the Cap Corse region). Notably, while all the metasediment-rich terranes of the southern and northern part of Alpine Corsica were traditionally ascribed to this unit (ref.), the definition of ‘Castagnoccia’ unit adopted here is somewhat restricted. This unit mostly consists of metasediments showing a temperature (T) of about 480°C in the southern Alpine Corsica and *T* of about 380°C in the Cap Corse region (Vitale Brovarone *et al.*, submitted). As the Castagniccia unit mostly consists of monotonous metasediments, its paleogeographic origin is still under debate. The Castagniccia unit is overlain by the lawsonite-eclogite unit (Morteda-Farinole-Volpajola unit for the French authors) (Péquignot & Potdevin, 1984; Lahondèere, 1996; Vitale Brovarone *et al.*, 2011a, b). This unit, which consists of metaophiolites, continental basement slivers and associated metasediments, originated from a Tethyan Ocean-Continent Transition zone (Vitale Brovarone *et al.*, 2001b). This domain underwent Alpine metamorphism at ca.520°C and 2.3 GPa. The age of this H*P* event is debated, ranging from the Cretaceous (ca. 83 Ma; Lahondere & Guerrot., 2007, to the Eocene-Oligocene boundary (~ 35 Ma ; Brunet *et al.*, 2000; Martin *et al.*, 2011). The lawsonite-eclogite unit is overlain by a lawsonite-blueschist unit (Campitello-Morosaglia unit for the French authors) that, similarly to the underlying lawsonite-eclogite unit, consists of a complex lithological association referred to an inherited Ocean-Continent transition zone (Lahondère, 1996; Vitale Brovarone *et al.*, 2011b). This unit equilibrated at *T* ~ 420°C (Vitale Brovarone *et al.*, submitted) at *P* ~ 0.8 GPa (Lahondère, 1996). The uppermost structural position of the SL complex is occupied by a low-grade blueschist unit (Lento-Caseluna unit for the French authors). This unit is characterized by a typical distal oceanic sequence consisting of ophiolites and associated metasediments. The only continent-derived material found in this unit, whose origin is still under debate, is observed to the east of the Tenda massif, in the Santo Pietro di Tenda area (e.g. Caron & Delcey, 1979). Rocks from this unit equilibrated at around 350°C (Vitale Brovarone *et al.*, in prep) and 0.6-0.8 GPa (Levi *et al.*, 2007).

Figure 1.1. Simplified tectonic map of Alpine Corsica.

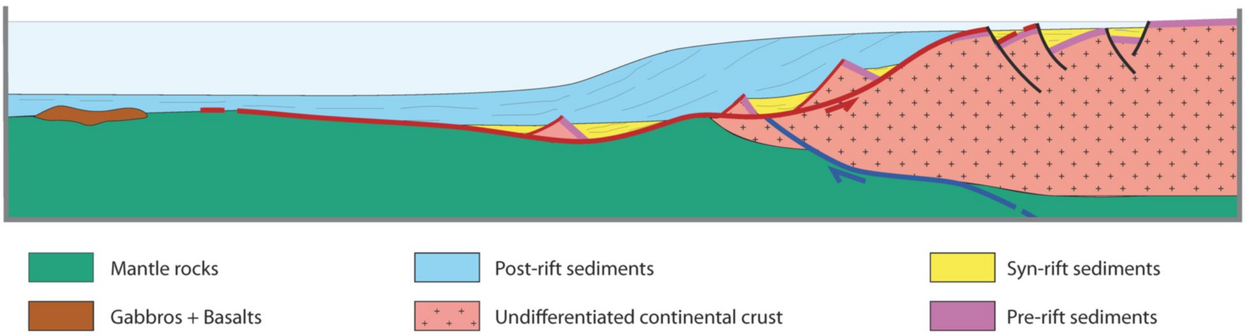


Modified after Miller *et al.*, 2000. (b) Simplified tectono-metamorphic map of Alpine Corsica. Modified Vitale Brovarone (2011).

Origin of associated metaophiolites and continental basement slivers.

Continent-derived rocks are commonly found within the H*P* units of the Schistes Lustrés of Alpine Corsica, (e.g. Caron *et al.*, 1981; Caron & Delcey, 1979; Malavieille, 1983; Sedan, 1983; Péquignot & Potdevin, 1984; Lahondère, 1996; Vitale Brovarone *et al.*, 2011b). The origin of this particular lithological association of ophiolitic and continental basement rocks, also extensively documented in the Western Alps (e.g. Dal Piaz, 1999; Beltrando *et al.*, 2010, geology), has been matter of debate since a long time in both orogenic belts. In Alpine Corsica, during the last forty years, two main interpretations have been proposed: i) they originated as tectonic mixes during Alpine subduction (e.g., Sauvage-Rosemberg, 1977; Durand-Delga, 1978; Faure & Malavieille, 1981; Mattauer *et al.*, 1981; Cohen *et al.*, 1981; Malavieille, 1983; Durand-Delga, 1984; Péquignot & Potdevin, 1984), or ii) they correspond to the more distal part of thinned continental margins primarily associated or close to ophiolitic rocks (e.g. Lahondère *et al.*, 1992; Lahondère, 1996; Lahondère and Guerrot, 1997). However, the strong metamorphic overprint and the lack of a detailed knowledge of passive margins left this debate open, with a general tendency to favour an orogent-related juxtaposition. Following a significant number of studies on present-day (e.g., Boillot *et al.*, 1980, 1987; Péron-Pinvidic and Manatschal, 2009) and fossil Ocean-Continent Transition (OCT) zones (e.g., Florineth and Froitzheim, 1994; Froitzheim and Manatschal, 1996; Hermann and Müntener, 1996; Manatschal *et al.*, 2006; Mohn *et al.*, 2010), the second interpretation has been recently reconsidered in the H*P* units of both the Western Alps and Alpine Corsica (Beltrando *et al.*, 2010; Vitale Brovarone *et al.*, 2011b), pointing to the presence of preserved OCT zones. The term "OCT" refers to portions of rifted margins where "typical" continental and oceanic lithosphere are separated by regions of exhumed mantle rocks locally overlain by slivers of continental basement, which are known as 'continental extensional allochthons' (e.g., Manatschal *et al.*, 2004) (Fig. 1.2). This juxtaposition is related to rift-related lithospheric thinning (e.g. Florineth and Froitzheim, 1994; Froitzheim and Manatschal, 1996; Hermann and Muntener, 1996; Manatschal *et al.*, 2006; Péron-Pinvidic and Manatschal, 2009). Drilling along the Iberia/Newfoundland margins, and reflection and refraction seismic studies suggest that these domains may extend over >50% of the present-day rifted margins (Péron-Pinvidic and Manatschal, 2009).

Figure 1.2. Schematic representation of magma-poor rifted margin and Ocean-Continent Transition (OCT) zones.

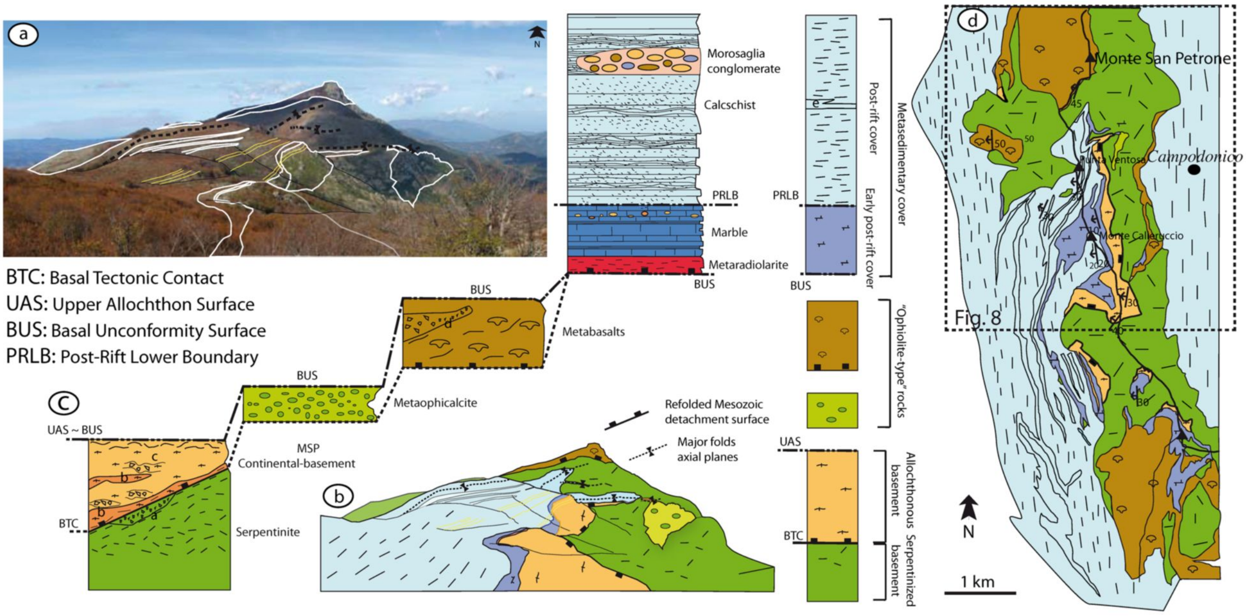


Modified after Péron-Pinvidic & Manatschal (2009).

Geology of the Monte San Petrone area

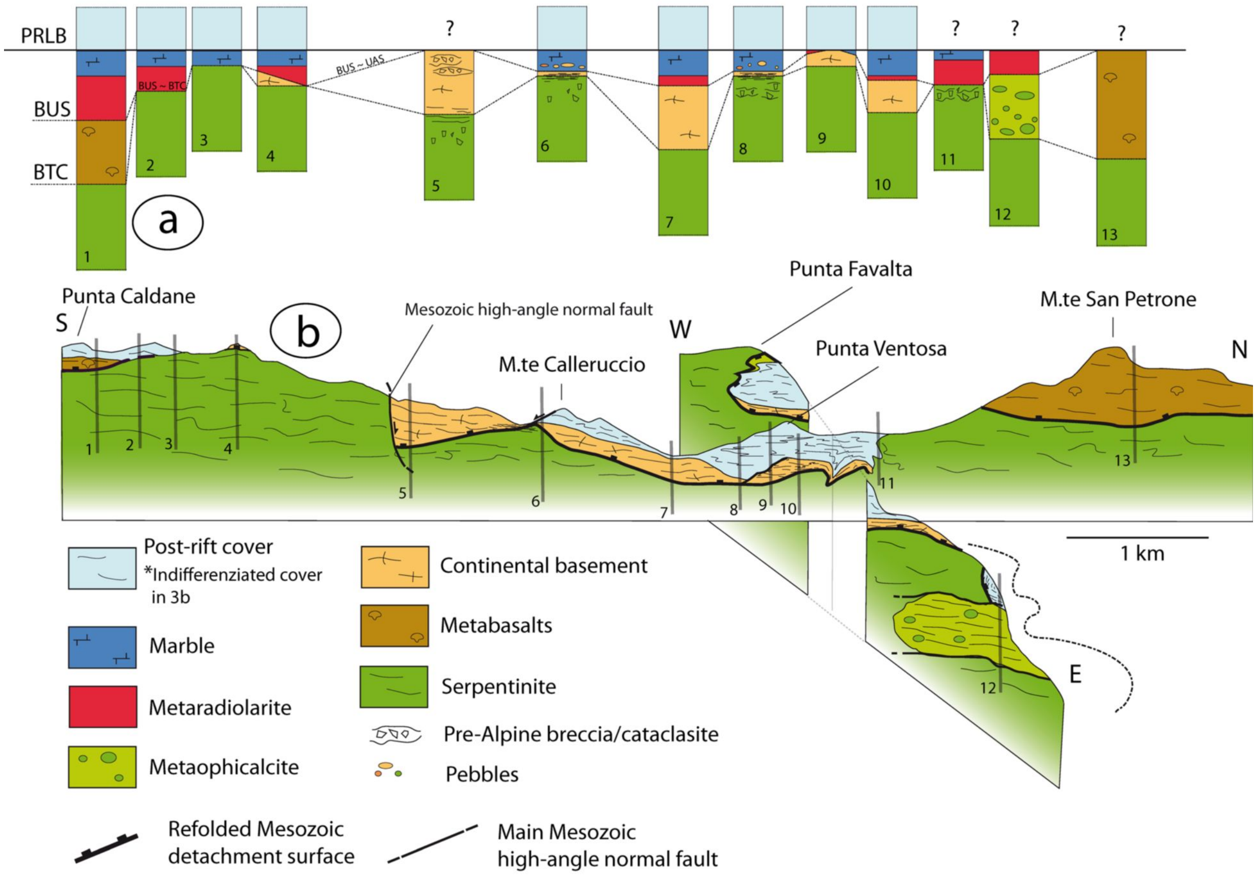
The Monte San Petrone (MSP) area is located in southern Alpine Corsica and belongs to the lawsonite-eclogite unit (Péquignot & Potdevin, 1984; Vitale Brovarone *et al.*, 2011 b). In this area, serpentinized basement, which is overlain by a laterally variable lithostratigraphy comprising: i) a sliver of continental basement, extending for several kilometers in the NS direction, ii) "ophiolite-type" rocks, and iii) a metasedimentary cover (Fig. 1.3, 1.4). The description of these lithologies reported hereafter is largely taken from Vitale Brovarone *et al.* (2011b).

Figure 1.3. Monte San Petrone



(a, b) View of the northern part of the Monte San Petrone (MSP) unit (a), and line drawing (b) showing the MSP architecture. (c) Stratigraphic section of the MSP and simplified column (on the right). (d) Simplified geological map of MSP. Modified from Vitale Brovarone *et al.* (2011b).

Figure 1.4. Cross Section



(a, b) N-S interpretative cross section (b) and stratigraphic columns (a) showing the lateral variability of the MSP tectono-stratigraphy (vertical scale = 2X). The geologic section crosses the main MSP summits reported in Fig. 2.2d. In 2.3b, light blue indicates the undifferentiated metasedimentary cover.

i) Serpentinized oceanic basement

Mantle-derived rocks crop out in the eastern part of the MSP unit as a N-S elongated body that occupy the lowermost structural position of the tectono-stratigraphic sequence. This composite basement mainly consists of massive or foliated serpentinites, serpentinized peridotites and small bodies of metagabbros. The top of the serpentinized basement is defined by a tectonic contact, which will be referred to as Basal Tectonic Contact (BTC in Fig. 1.3, 1.4). This contact has been interpreted by Péquignot and Potdevin (1984) as an Alpine tectonic contact, but ample evidence for its pre-Alpine origin are observed. We interpret this contact as a pre-alpine extensional detachment locally reworked by alpine compressional tectonics (e.g., Vitale *et al.*, 2011).

A serpentinite breccia crops out as lenticular bodies at the top of the serpentinized basement. It is clast-supported with local evidence of jigsaw clasts of serpentinite, indicating *in situ* cataclastic flow. Importantly, this brittle structure pre-dates the development of the Alpine ductile fabrics. Again, this structure has been interpreted by Vitale Brovarone *et al.* (2011) to derive from the pre-Alpine, rifting-related extensional tectonics.

Ophicalcites are locally exposed along the BTC, only where the serpentinized basement is directly in contact with metasediments. These rocks are both tectono-sedimentary breccias (sensu Lemoine *et al.*, 1987) or calcified serpentinites comparable to those described in the Platta Nappe of the Central Alps (Manatschal, 2010). The matrix of this rock consists of carbonates, diopside, green amphibole, chlorite, and rare green uvarovitic garnets grown around detrital Cr-spinels. In some localities (e.g. Punta Favalta), reddish clasts of hematite-rich fibrous carbonates, which are often observed in OC2-type ophicalcites, are also found (e.g. Framura breccia, Folk and McBride, 1976).

ii) Continental basement

Slivers of continental basement, ranging in thickness from less than 2 meters to ~200 meters, rest directly upon the serpentinized ultramafic basement. Their lower contacts coincide with the BTC.

A lithological layering parallel to the BTC is observed, with the lower part of the sliver consisting of polycyclic basement with Permian granulite facies garnet-bearing micaschists and meta-mafic rocks (~290 Ma, Martin *et al.*, 2011). In these rocks, the Alpine assemblage consists of garnet + lawsonite + phengite + chlorite + pumpellyite + quartz. Alpine garnets occur as small crystals or overgrowths on the relict pre-Alpine garnets.

The most common rocks in the continental sliver are metagranitoids and orthogneisses, whose protoliths range in composition from granite to granodiorite. The gneisses, which are generally exposed in the upper part of the continental sliver, usually show an augen structure with porphyroclasts of relict igneous K-feldspar wrapped around by the Alpine foliation mainly consisting of white mica and quartz. In metagranitoids, Alpine H*P*-L*T* assemblages, mainly represented by Na-clinopyroxene, Na-amphibole, phengite and lawsonite, are locally well preserved. Alpine garnet is found only occasionally in these rocks.

Locally, along the lower boundary of this continental basement sliver, relics of brittle structures pre-dating the Alpine fabrics are observed, such as angular clasts of granitic rocks wrapped around by H*P* fabrics. These rocks are especially well exposed in the Bocca di Querciole area, to the south of Monte Calleruccio. These rocks are interpreted as related to the juxtaposition of the continental sliver of the Monte San Petrone on top of the serpentinite basement by brittle faulting related to the rifting extensional tectonics.

Along the BTC, continental basement rocks are locally transformed into a Ca-rich metasomatic rim formed under H*P* conditions and mainly consisting of lawsonite, garnet and omphacite. Zircons from this particular rock show Alpine rims associated with this H*P* metasomatic event giving an age of about 34 Ma (Martin *et al.*, 2011). The same metasomatic rim is also observed in metasediments overlying the serpentinized basement.

The upper part of the continental basement is locally characterized by a phengite-rich rock that is considered to represent the metamorphic equivalent of the so-called “tectono-sedimentary breccia” described along the top of the continental extensional allochthons at Ocean-Continent Transition zones.

iii) “Ophiolite-type” rock units

This group of rocks consists mainly of: i) meta-ultramafic debris, including mostly sedimentary breccias (“OC2-type” of Tricart and Lemoine, 1989), and ii) metabasaltic rocks, such as pillow basalts and pillow breccias, lying above the Basal Tectonic Contact as defined in the previous sections.

Serpentinite sedimentary breccias are particularly abundant in the northern part of the Monte San Petrone, along the track connecting the village of Campodonico and Punta Favalta. They consist of clasts of serpentinites embedded within a carbonate matrix. Serpentinite clasts are mostly rounded and vary in size from a few millimetres to several metres and the clast/matrix ratio is extremely variable suggesting local deposition close to fault scarps.

Metabasaltic rocks are also found in the same structural position as the continental basement, where the latter wedges out both to the north (Monte San Petrone) and to the south (Punta Caldane). They consist both of pillowed and massive lavas and basaltic breccias. Both types of metabasalts are common in the northern and southern parts of the Monte San Petrone unit, where they form a body with a maximum thickness of about 200 meters. Relics of pillows and igneous microstructures, such as varioles and plagioclase phenocrysts are commonly preserved (Vitale Brovarone *et al.*, 2011a).

iv) Metasedimentary cover

A wide range of metasediments is found in the Monte San Petrone Unit. These metasediments stratigraphically overlie the serpentinized basement, the continental basement and the “ophiolite-type” rocks. The lower boundary of the metasedimentary cover, which coincides with both the BTC or the Upper Allochthon Surface depending on the absence/presence of continental basement, respectively, is has been labelled ‘Basal Unconformity Surface’ (BUS in Fig. 1.3, 1.4).

The cover sediments, which display a marked lateral heterogeneity, are subdivided into two main groups: i) early post-rift metasediments, consisting of metaradiolarites and marbles ranging in thickness from a few centimeters to several meters; ii) post-rift metasediments, which consist of calcschists sensu lato and metaconglomerates of both continental and ophiolitic origin (“Morosaglia metaconglomerates”; Sedan, 1983). The two groups are separated by a transitional contact characterized by interlayering of both types of lithologies (i.e. marbles and calcschists) for a minimum thickness of several tens of centimeters.

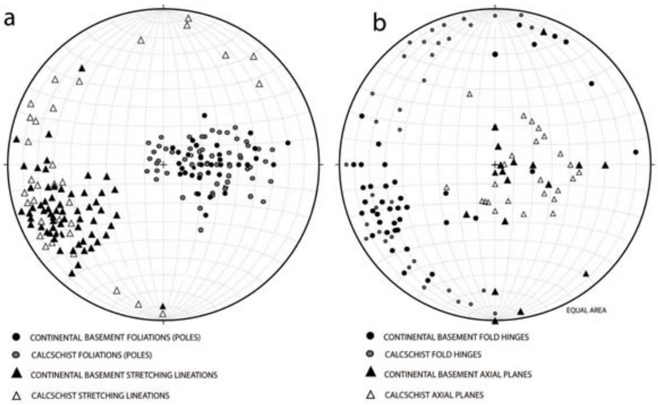
Metaradiolarites are overlain by marbles, which are widely distributed all along the Monte San Petrone unit and vary in thickness from a few tens of centimeters to several meters. The thickest portions commonly contain detrital layers with pebbles ranging in diameter from a few centimeters to a few tens of centimeters (e.g., east of Punta Ventosa, Monte Calleruccio and Aja Rossa). These pebbles, which consist of meta-granitoids and polycyclic basement (to the east of Punta Ventosa and Monte Calleruccio) or basaltic clasts (in the Aja Rossa area), are chemically and petrographically comparable to the rocks of the nearby continental sliver.

The post-rift cover, which is exposed in the western part of the Monte San Petrone unit, consists mainly of calcschists. They are relatively homogeneous, apart from the presence of impure marble layers folded at the hundred-meter scale. Calcschists commonly contain lawsonite porphyroblasts pseudomorphically replaced by aggregates of white micas.

P-T-t-d evolution of the Monte San Petrone Unit

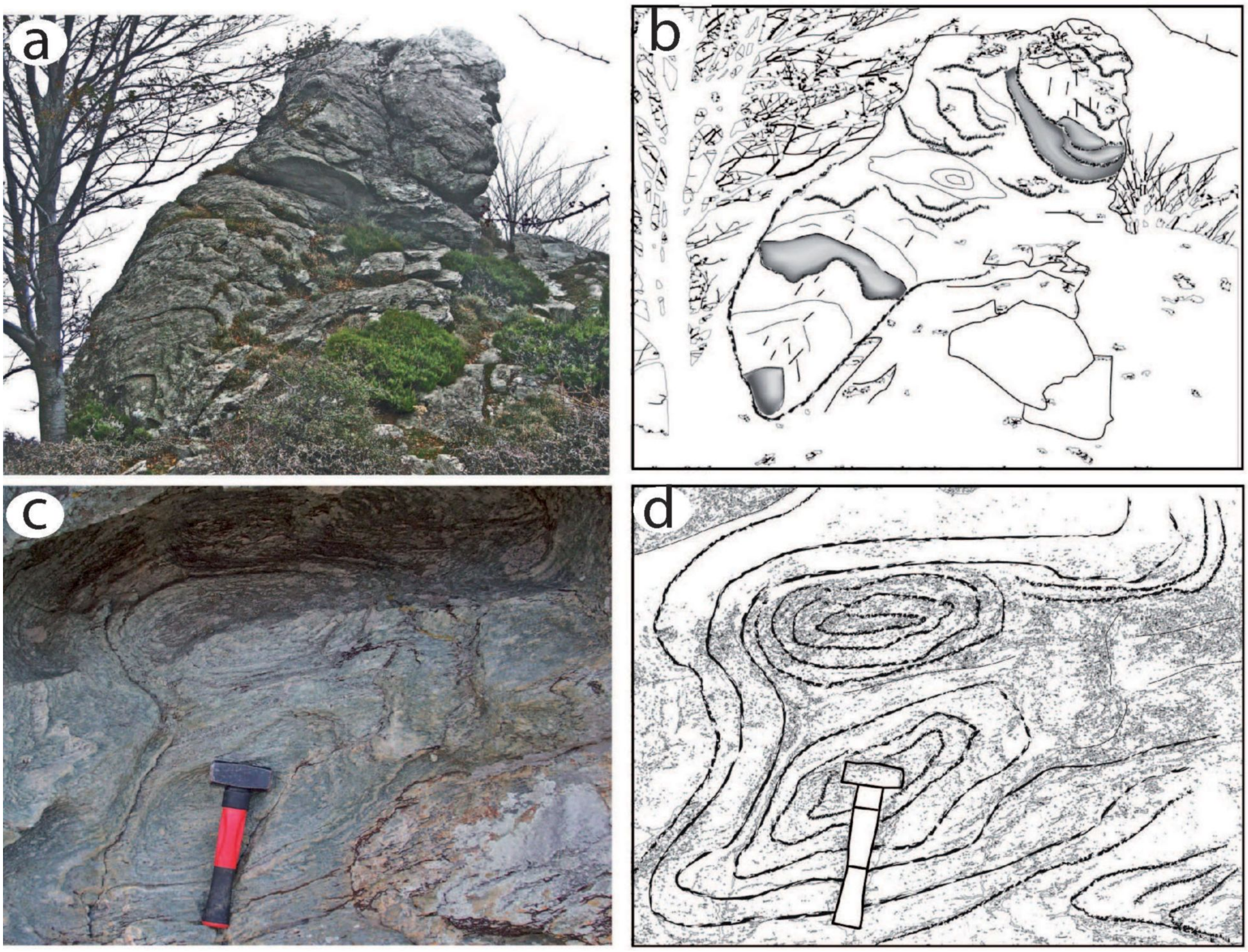
The Monte San Petrone unit is characterized by polyphase H*P* deformation, leading to the formation of west-dipping fabrics (dip direction ~ N270/30) (Fig. 2.5). These fabrics are marked by H*P* minerals, i.e. omphacite, garnet, lawsonite and glaucophane in metabasalts, phengite, lawsonite and jadeite in metagranitoids, indicating lawsonite eclogite-facies conditions. Stretching lineations associated with H*P* conditions, mostly striking at ~ N250/20, are defined by jadeite and Na amphibole in metagranitoids and by elongated quartz rods in calcschists. Metagranitoids are commonly deformed by plurimetric sheath folds (Fig. 2.6). Non-cylindrical folds are typically found within the thickest parts of continental basement, giving rise to meter-scale sheath folds. On the other hand, hundred meter-scale isoclinal folds are commonly observed in the post-rift cover. All folds formed under H*P* conditions are characterized by highly scattered fold hinges, with a maximum orientation coinciding with the mineral stretching lineations, while the orientation of the axial planes is significantly more uniform (poles = ~ 90/70). A late folding event developed under epidote-blueschist facies conditions is then responsible for the formation of large-scale anticlinal and synclinal open folds.

Figure 1.5. Stereoplot



(a) Stereoplot of foliations (circles) and high-pressure stretching lineations (triangles) of continental and metasedimentary rocks. (b) Stereoplot of fold hinges (circles) and axial planes (triangles) of continental and metasedimentary rocks.

Figure 1.6. High-pressure sheath folds



a: High-pressure sheath folds in metagranite. Note the curved fold hinges. b, c: detail of high-pressure sheath folds in metagranite. Modiefied from Vitale Brovarone *et al.* (2011b).

From a metamorphic point of view, the different lithologies of the Monte San Petrone unit underwent a common evolution characterized by a prograde path under H*P*/L*P* conditions culminating at T = 490-550°C and P = 2.2–2.6 GPa (Vitale Brovarone *et al.*, 2011b). The retrograde evolution is characterized by a pervasive retrogression at lawsonite-blueschist to epidote-blueschist facies conditions, followed by more localized re-equilibration at greenschist facies conditions. Eclogitic assemblages are often well preserved in meta-basalts, and consist of coexisting omphacite + lawsonite + garnet + phengite + titanite or glaucophane + actinolite + lawsonite + garnet + phengite + titanite, equilibrated at 520 ± 20°C and 2.3 ± 0.1 GPa (Vitale Brovarone *et al.*, 2011a). The coexistence of these two mineralogical assemblages is interpreted as related to the different petrological behaviour of primary basaltic composition with respect to basaltic rocks variably hydrothermalized at the seafloor (Vitale Brovarone *et al.*, 2011a). Peak metamorphism assemblages are more rarely preserved within continental basement rocks, where they allow to estimate $T \geq 490$°C and $P \sim 24 \pm 2$ Gpa. Calcschists are commonly strongly retrogressed. Raman Spectroscopy of Carbonaceous Material (RSCM) on these metasediments gives a peak metamorphism T at ~510-550°C.

Recent U-Pb dating on zircon from this unit provides a Late Eocene age (~34 ± 0.8 Ma; Martin *et al.*, 2011) for eclogite facie metamorphism.

Day 1.

Geology of the Schistes Lustrés

Itinerary: Bastia – Ponte Leccia – Morosaglia - Piedicroce

Stop 1.

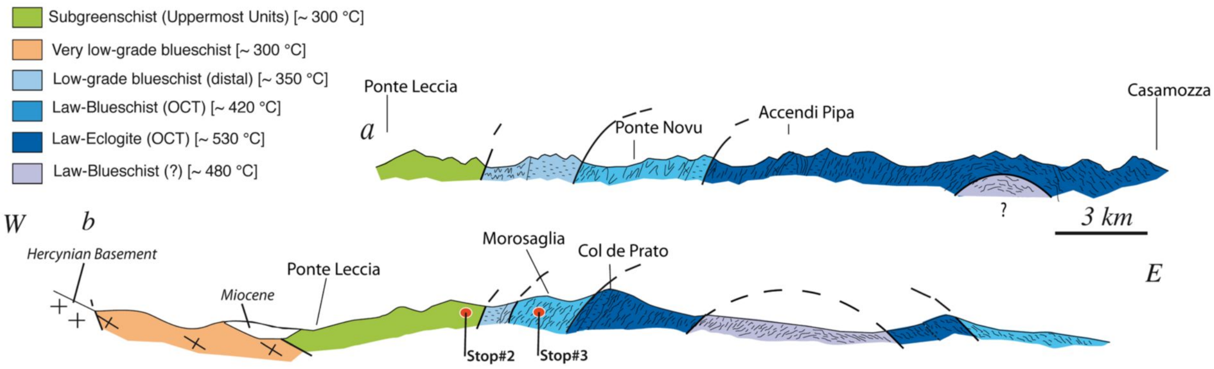
Locality: Bastia

Themes: Introduction to the geology of the Schistes Lustrés in southern Alpine Corsica.

We travel From Bastia along the road 193 in the direction of Ponte Leccia, crossing the units of the Schistes Lustrés complex. From East to West, we will cross most of the major tectonic units of the Schistes Lustrés (SL). These units are folded in a late antiformal structure with N-S striking axis, which is especially well exposed along the Golo valley, which provides a natural cross-section through the SL complex (Fig. 1.7a). Most of the rocks units are pervasively deformed, showing composite foliations locally related to large- to small-scale isoclinal folds. Lineations are scattered and range between 30N and 120N. These structural elements are then affected by the large scale antiformal structure.

Metamorphic conditions decrease progressively from the lowest to the uppermost structural level, with *T*>500°C in the lawsonite-eclogite unit, *T*~430°C in the lawsonite-bluschist unit and *T*~350°C in the low-grade blueschist unit (Vitale Brovarone *et al.*, 2011a; Vitale Brovarone *et al.*, in prep.) The eastern part of the valley, in the so-called Castagniccia region, is characterized by the east-dipping fabrics of the eastern limb of the SL antiform, and entirely consists of metasediments of the lawsonite-eclogite unit. Moving westward, in the western limb, the lithological composition becomes more varied and metaophiolites and continental basement rocks of the other tectono-metamorphic units are also exposed.

Figure 1.7. Schistes Lusrés complex



Geological cross-sections trough the Schistes Lusrés complex. See Fig. 2.1a, b for locations.

Stop 2.

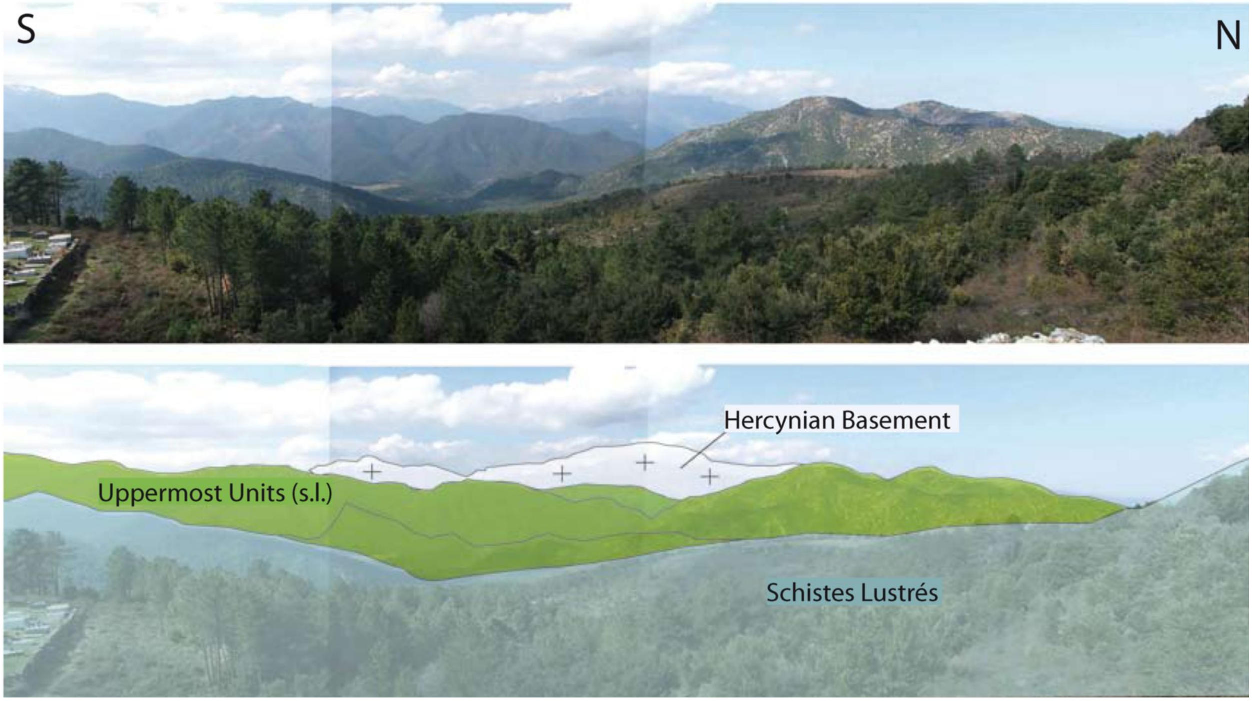
Locality: Road D71, crossroad to Castello di Rostino (UTM 32T 522623 E4699190)

Themes: Geological overview of the Tethys-derived rocks of the Schistes Lustrés complex

In the village of Ponte Leccia, we will turn in the direction of Morosaglia, along the road D71. First we drive across the poorly metamorphosed Uppermost Units, consisting here of serpentinites and gabbros of N-MORB affinity (Saccani *et al.*, 2000). Moving towards the east, we cross the subgreenschist continental basement unit of Caporalino (RSCM temperature = 300°C, Vitale Brovarone *et al.*, in prep). Further to the east, other slices of very low-grade ophiolitic rocks crop out along the road D71, in the proximity of the crossroad to Castello di Rostino (Fig. 2.7b). There, the primary relationships between metabasalts and the early post-rift cover rocks (e.g. radiolarian cherts) can be observed. Well-preserved primary variolitic structures also characteristically found in the outer portion of pillow basalts.

Moving towards the village of Morosaglia we enter in the Schistes Lustrés complex (Fig. 1.7b, 1.8). First we drive across the upper and low-grade units of the Schistes Lustrés (Fig. 1.7b), consisting of lithological associations attributed to the distal Tethyan realm, with serpentinites, basalts and metasedimentary cover rocks. This unit equilibrated at a metamorphic temperature of about 350°C in the low-temperature blueschist facies conditions.

Figure 1.8. Panoramic view from the village of Morosaglia.



Note the hercynian basement on the background and the very low-grade units (in green) overlying the Schistes Lustrés complex (in pale blue).

Stop 3.

Locality: Santa Reparata

Themes: The H*P* units of the Schistes Lustrés and the Morosaglia conglomerates

Moving further towards the village of Morosaglia and down in the tectonic stack, we drive across the lawsonite-blueschist unit of the Schistes Lustrés (peak-metamorphism temperature ~ 430°C), consisting of meta-ophiolite, continent-derived rocks and metasediments, which originated from an Ocean-Continent Transition (OCT) zone. The Morosaglia metaconglomerate, cropping out below the Santa Reparata church, preserves spectacular evidence of continent-derived detrital material. This conglomerate mainly consists of clasts of granitic rocks and minor mafic and carbonate rocks. Metasediments locally contain porphyroclasts of fresh lawsonite. Moving from Morosaglia to the pass of Col De Prato, we cross the boundary separating the lawsonite-blueschist unit and the lawsonite-eclogite unit (*T* at around 520°C), also interpreted to derive from an OCT zone. The contact separating these units is not spectacular in this particular location, since it is located within monotonous metasedimentary sequences. In the lawsonite-eclogite unit, thin slices of continental basement rocks interpreted as rift-related extensional allochthons are scattered along the ridge running N-S and will be the subject of the second day of excursion.

Past Col the Prato pass, towards the hotel in Piedicroce, we drive across the eclogitic metasediments of the Castagniccia region.

Day 2.

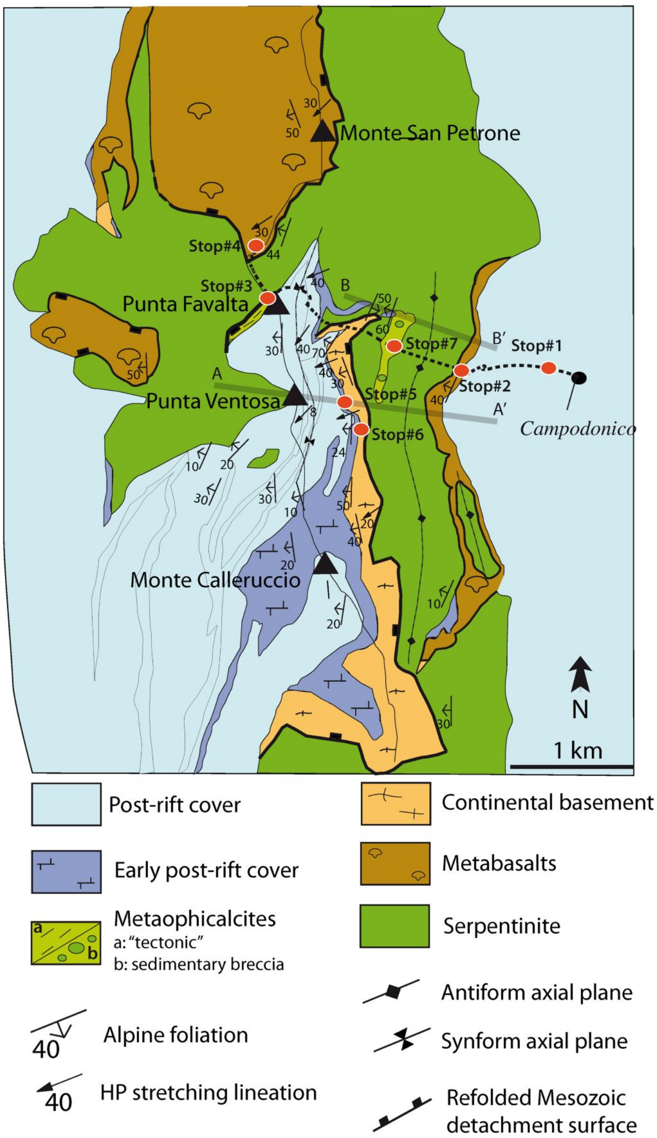
Stop 1.

Locality: Campodonico (UTM 32T 528505 E4691631)

Themes: Introduction to the geology of the Monte San Petrone area

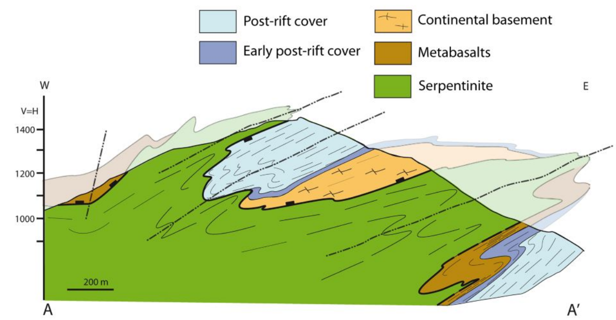
In this stop, a general introduction to the San Petrone area and its main lithological, structural and metamorphic features are given and shown in the landscape (Fig. 1.3, 1.4, 1.9, 1.10). This area is characterized by different lithologies, including ultramafic rocks, continental-basement rocks, metaophiolite and metasediments, which were already juxtaposed in a Mesozoic OCT zone (Fig. 1.11).

Figure 1.9. Monte San Petrone area



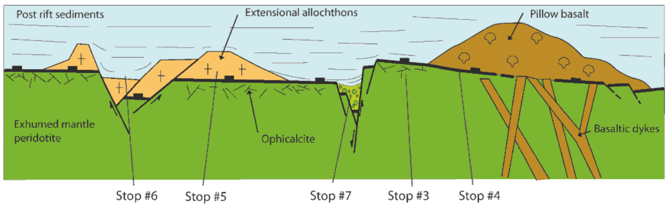
Simplified geological map of the Monte San Petrone area. Modified after Vitale Brovarone *et al.* (2011b).

Figure 1.10. E-W cross-section of the Monte San Petrone area



Interpretative E-W cross-section of the Monte San Petrone area. See Fig. 2.9 for location.

Figure 1.11. Simplified reconstruction



Simplified reconstruction of the primary Mesozoic relationschisp among the different lithologies of the Monte san Petrone area.

Stop 2.

Locality: Track to Monte San Perone (UTM 32T 528040 E4691798)

Themes: The Mandriale shear zone

Climbing to the top, we will walk across the lower limb of a large-scale recumbent antiform formed under retrograde epidote-blueschist conditions (Fig. 1.10, 1.11). The core of this structure consists of a serpentinized basement, which occupies the lowest structural level in the Monte San Petrone tectono-stratigraphic association. The overturned sequence that underlies the ultramafic basement consists of ~50-100 meters-thick layer of highly strained metabasalts followed by a thick metasedimentary sequence. This metabasaltic layer, also known as the "Mandriale unit" or "prasinite unit" for the French authors, represents a major feature of the SL complex, hosting a major shear zone that can be followed throughout Alpine Corsica. To the north, in the Bastia area this shear zone coincides with a major tectonic contact separating the lawsonite-eclogitic unit from the overlying lawsonite-blueschist unit. Otherwise, in the Monte San Petrone area, this shear zone develops on the stretched overturned limb of large antiform within the lawsonite-eclogite unit.

Stop 3.

Locality: Punta Favalta (UTM 32T 526361 E4692271)

Themes: The Basal Tectonic Contact

The Basal Tectonic Contact is one of the main lithological interfaces within the Monte San Petrone Unit. It separates the serpentinized basement from the overlying lithologies, which include continental basement rocks, ophiolite-type rocks and metasediments. Relics of rift-related brittle tectonic structures, such as ophicalcites or serpentinite cataclasites, are locally observed along this contact. In the Punta Favalta area, along the upper limb of a recumbent synform, ophicalcites separate the serpentinized basement from the overlying metasediments (Fig. 1.12). This succession is interpreted as a primary stratigraphic sequence characterized by exhumed mantle rocks, capped by ophicalcites, directly overlain by oceanic sediments.

Figure 1.12. Outcrop of ophicalcite close to Punta Favalta.

These rocks are interprete to correspond to the fractured and hydrothermalized top of the exhumed mantle during the Jurassic rifting.

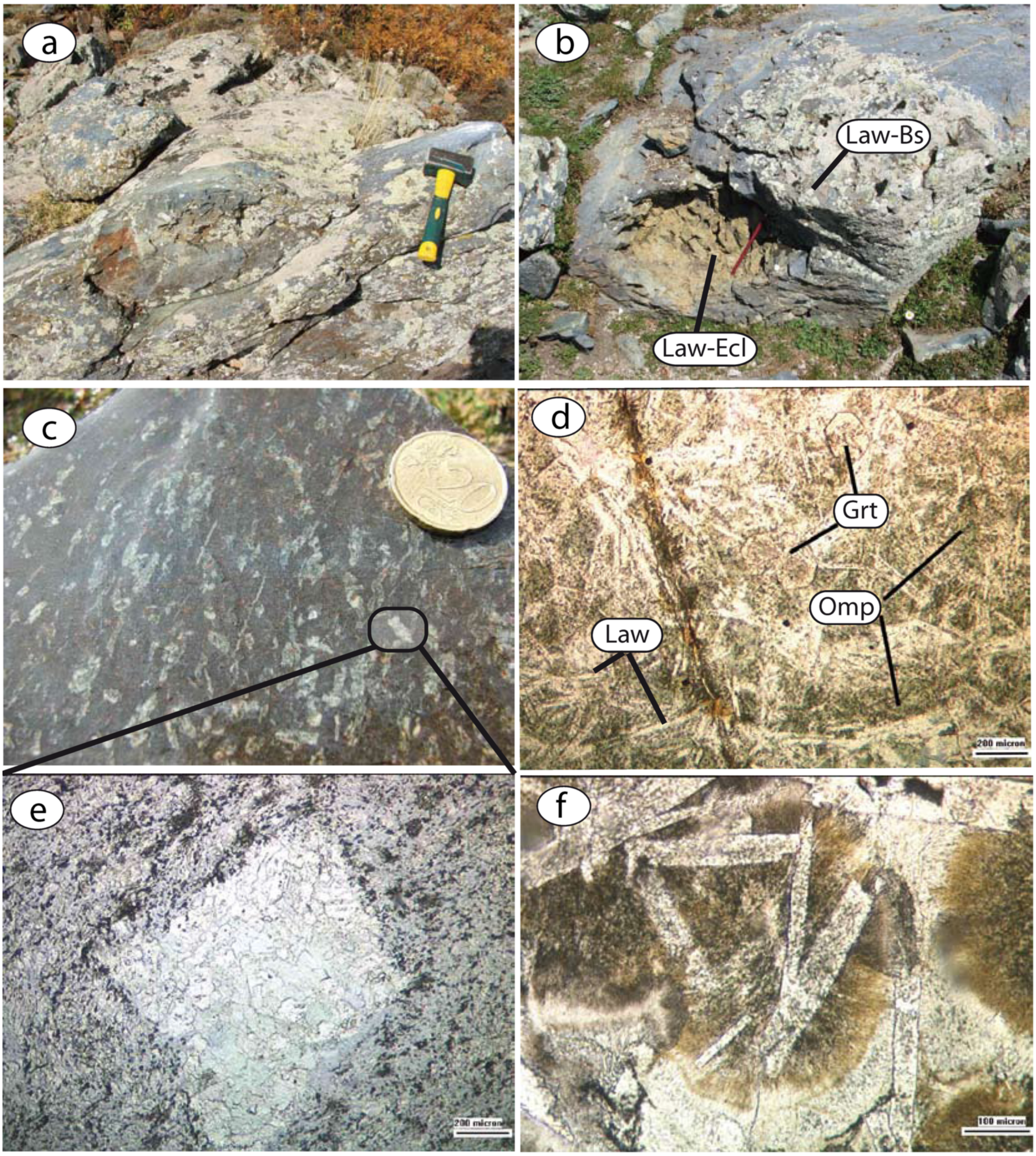
Stop 4.

Locality: Aja Rossa (UTM 32T 526574 E4692900)

Themes: The lawsonite-eclogite facies metabasalts

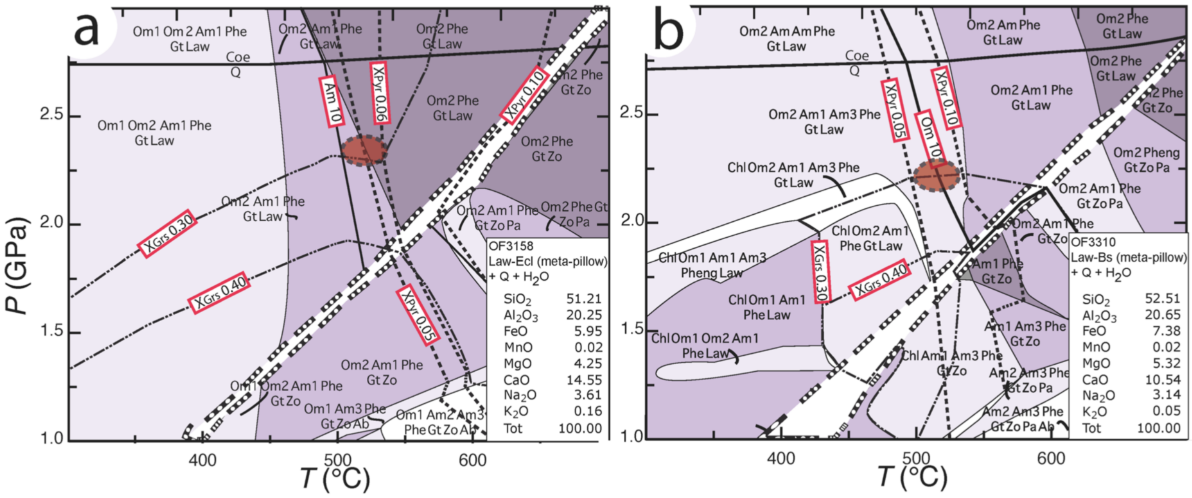
Metabasaltic rocks are well exposed in the northern part of the Monte San Petrone unit, forming a thick body of pillow basalts, lava tubes or pillow breccias re-equilibrated under lawsonite-eclogite facies metamorphic conditions. Differently from the metabasaltic rocks observed during stop#2, these rocks preserve well the primary igneous structures. In the Aja Rossa area, a primary contact separating metabasalts from the underlying serpentinites is observed. Metabasalts consist of well-preserved pillow lava or lava tubes still preserving primary igneous structures at the meso- and micro-scale (Fig. 1.13). As an example, primary sites of the igneous plagioclase, now consisting of lawsonite ± actinolite ± garnet ± phengite aggregates, are common. Two main peak metamorphism mineral assemblages are observed. The first is the typical lawsonite-eclogite paragenesis consisting of omphacite + lawsonite + garnet + phengite + titanite, which characterizes the core of meta-pillows, unaffected by hydrothermal alteration at the seafloor. The second assemblage consists of glaucophane + actinolite + lawsonite + garnet + phengite + titanite and is typical of garnet-bearing lawsonite-blueschists. These two mineral assemblages equilibrated and coexisted at the same *PT* conditions (520 ± 20°C, 2.3 ± 0.1 GPa, Fig. 1.14). Their coexistence is related to minor differences in the bulk-rock composition acquired during seafloor hydrothermal alteration (Vitale Brovarone *et al.*, 2011a).

Figure 1.13. Metabasalts from the Monte San Petrone area.



(a) Preserved lava tube structure. (b) Typical relationships between coexisting lawsonite-eclogite (Law-Ecl) and lawsonite-blueschist (Law-Bs) assemblages. Note that the Law-Ecl occurs in the coreo of primary pillow structures, while the Law-Bs occurs in the outer portion. (c) Primary basaltic structure characterized by abundant preserved plagioclase sites, now mostly consisting of lawsonite (e). (d) Static growth of Law-Ecl minerals on a preserved volcanic structure. Note the assemblage of Omphacite + lawsonite + garnet. (f) Primary undeformed basaltic variolitic structures overgrown by the Alpine lawsonite (white prisms).

Figure 1.14. P-*T* pseudosection



P-*T* pseudosection of coexisting Law-Ecl (a) and Law-Bs (b). Modified after Vitale Brovarone *et al.* (2011a).

Stop 5.

Locality: To the east of Punta Ventosa (UTM 32T 527193 E4691543)

Themes: The continental extensional allochthon

A continental basement sliver characterize the central part of the Monte San Petrone area. The sliver, which is interpreted as a rift-related continental extensional allochthons, is structurally interposed between the serpentinized basement and the metasedimentary cover rocks. This sliver consists of both polycyclic basement rocks, such as garnet-bearing micaschists, and metagranitic rocks. Relics of Permian H*T* metamorphism (age 290 Ma) are found in the micaschists, indicating that this sliver of continental crust has been exhumed from depth up to the ocean floor during Jurassic rifting (Martin *et al.*, 2011).

The most common Alpine H*P* minerals are glaucophane + garnet + lawsonite + phengite ± omphacite in the polycyclic basement rocks and phengite + jadeite + glaucophane ± lawsonite in meta-granitoids.

Evidence of a multi-stage deformation history, characterized by both coaxial and non-coaxial flow, is observed in the continental basement sliver. A beautiful example of non-coaxial deformation occurs East of Punta Ventosa, where well-preserved H*P* sheath folds range in size from ten centimeters to several meters. As a result of this deformation event, H*P* fold axes are scattered, but mostly oriented NE-SW, while H*P* stretching lineations marked by minerals (e.g. glaucophane) and stretched quartz aggregates display little scatter and strike towards ~ 250° (Fig. 1.5). *PT* estimates via pseudosection modeling of a continental basement rock of mafic compositions yields minimum peak metamorphism conditions at around >*T* = 490°C and *P* = 2.2–2.6 GPa. U-Pb geochronology on zircon rims in equilibrium with the H*P* assemblage lawsonite + omphacite + garnet yields an Alpine age of ~ 34 Ma (Martin *et al.*, 2011).

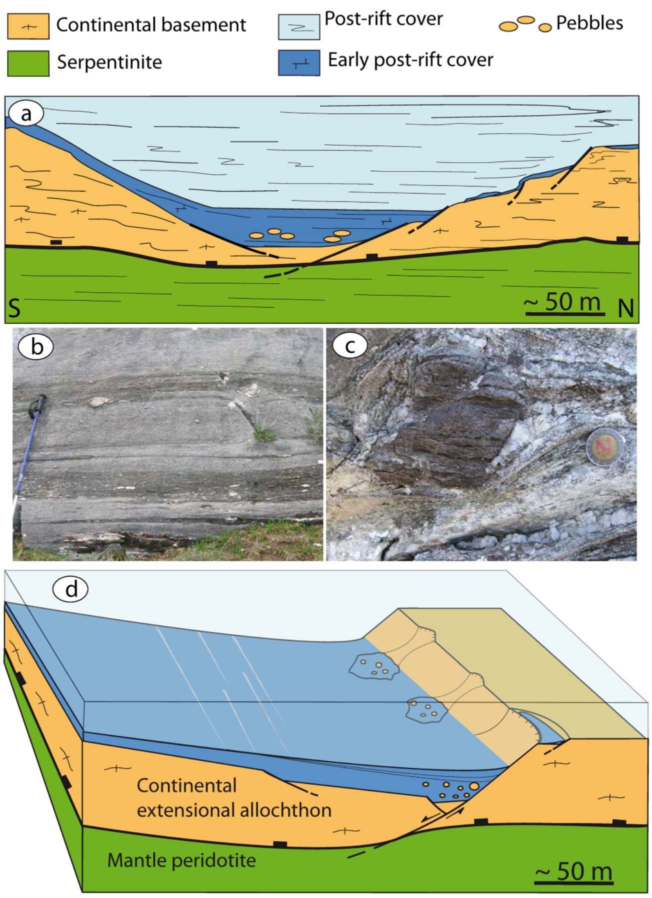
Stop 6.

Locality: To the east of Punta Ventosa (UTM 32T 527167 E 4691255)

Themes: Marble including clasts of continental basement rocks: evidence of a preserved paleo-scarp

Marble of the Monte San Petrone unit locally contains clasts of the underlying rocks (e.g. continental basement rocks or metabasalt). This is especially evident where the continental basement sliver thins to a few meters (e.g. to the east of Punta Ventosa or close to Monte Calleruccio) (Fig. 1.15a). To the east of Punta Ventosa, the thinner the continental basement sliver, the thicker is the marble, and clasts of continental basement rocks are found within this cover rock where the continental basement sliver is the thinnest. More precisely, clasts of both granitic (Fig. 1.15b) and polycyclic basement rocks (e.g. micaschists, Fig. 1.15c) are found. On the contrary, these clasts are never found where the continental basement sliver gets thicker, where particular lithologies, interpreted as meta-condensed sequences, are found. The relative distribution of the continental basement and metasediments described above suggests that syn-sedimentary (i.e. Mesozoic) topographic highs and lows morphologies controlled the deposition of sediments and the erosion of the basement allochthon (Fig. 1.15d). Such high-angle normal faults affecting the sea floor may be responsible for the formation of continental basement clasts found in the carbonatic cover described above. These Mesozoic structures can be still be recognized despite intense Alpine deformation.

Figure 1.15. Punta Ventosa



(a) N-S cross-section to the east of Punta Ventosa. Modified after Vitale Brovarone *et al.* (2011b). Note the occurrence of marbles including clasts of granitic (b) and polycyclic basement rocks (c) on top of the thinnest part of the continental basement sliver. (d) Simplified recontruction of the inherited rifting-related morphologies.

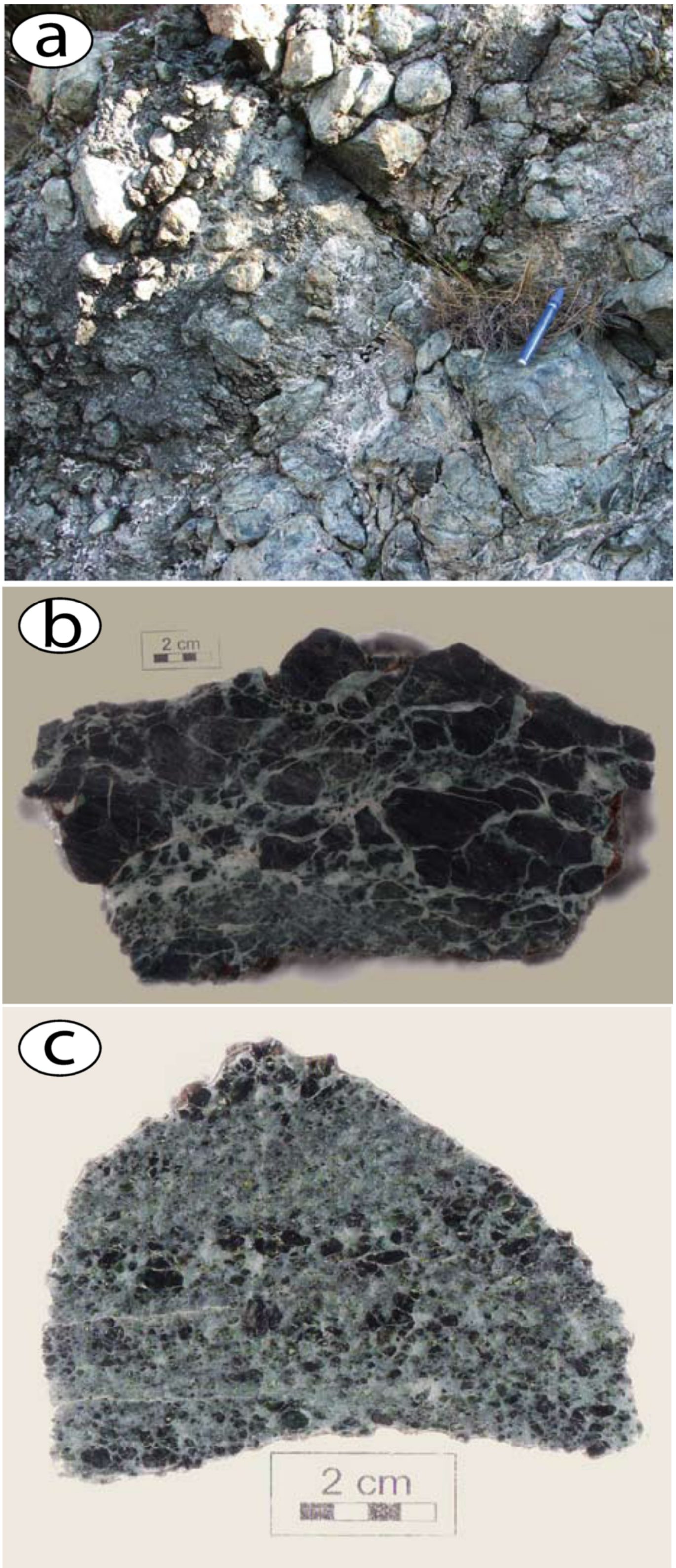
Stop 7 (optional).

Locality: Track to Campodonico (UTM 32T 527534 E4692009)

Themes: Serpentinite metaconglomerate

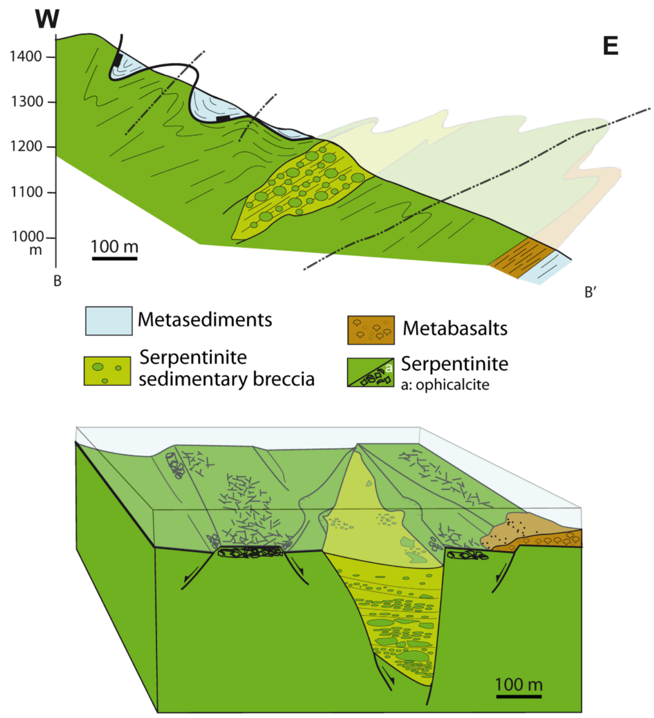
Along the track to “Punta Favalta” or “San Petrone”, a thick body of serpentinite sedimentary breccia can be observed (Fig. 1.9, 1.16, 1.17a). The serpentinite clasts, mostly rounded, range in size from a few millimeters to several meters, and are embedded in a carbonate matrix (Fig. 1.16a, b). The matrix-clasts ratio is extremely variable, and primary sedimentary bedding can be still recognized (Fig. 1.16c). This body is interpreted to derive from a graben-type structure filled by the surrounding ultramafic rocks and carbonate-rich sediments, then inverted and deformed during subduction-related deformation (Fig. 1.17b).

Figure 1.16. Serpentinite sedimentary breccia



In (c), note the primary sedimentary beddings.

Figure 1.17. S-E of Monte San Petrone



(a) Interpretative cross-section to the S-E of Monte San Petrone. See Fig. 2.9 for location. Simplified reconstruction of the inherited Mesozoic morphologies.