Zeitschrift: Schweizerische mineralogische und petrographische Mitteilungen = Bulletin suisse de minéralogie et pétrographie

Band: 74 (1994)

Heft: 1

Artikel: The Central Sesia Lanzo Zone (Western Italian Alps) : new field observations and lithostratigraphic subdivisions

Autor: Venturini, Guido / Martinotti, Giorgio / Armando, Giovanni

DOI: https://doi.org/10.5169/seals-56335

SCHWEIZ. MINERAL. PETROGR. MITT. 74, 115–125, 1994

The Central Sesia Lanzo Zone (Western Italian Alps): new field observations and lithostratigraphic subdivisions*

This work is dedicated to Ugo Pognante who intensively contributed to the critical study of the Sesia Lanzo Zone.

by *Guido Venturini*[1], *Giorgio Martinotti*[2], *Giovanni Armando*[2,3], *Marco Barbero*[2] and *Johannes C. Hunziker*[1]

Abstract

An extensive study of the central part of the Sesia Lanzo Zone has been undertaken to identify pre-Alpine protoliths and to reconstruct the lithologic and tectonic setting of this part of the Western Alps.

Three main complexes have been defined:

1) the *Polymetamorphic Basement Complex*, corresponding to the lower unit of the Sesia Lanzo Zone after Compagnoni et al. (1977), is further subdivided into the three following units: a) an *Internal Unit* characterized by eo-Alpine high pressure (HP) assemblages (Dal Piaz et al., 1972) (Eclogitic Micaschists); b) an *Intermediate Unit* where HP parageneses are partially re-equilibrated under greenschist conditions and c) an *External Unit* where the main foliation is defined by a greenschist paragenesis (Gneiss Minuti auct.).

2) the *Monometamorphic Cover Complex*, subdivided into the followings: a) the *Bonze Unit*, composed of sheared metagabbros, eclogitized metabasalts with MORB geochemical affinity and related metasediments (micaschists, quartzites and Mn-cherts) and b) the *Scalaro Unit*, containing predominantly metasediments of supposed Permo-Triassic age (yellow dolomitic marbles, calcschists and conglomeratic limestones, micaschists and quartzites with thin levels of basic rocks with within plate basalts [WPB] geochimical affinity). Multiple lithostratigraphic sequences for the Monometamorphic Cover Complex are proposed.

The contact between the Bonze and Scalaro Units is defined by repetitions of dolomitic marbles and metabasalts; the ages of the metasediments have been assigned solely by analogy with other sediments of the Western Alps, due to the absence of fossils. The Monometamorphic Cover Complex can be considered as the autochthonous cover of the Sesia Lanzo Zone because of the primary contacts with the basement and because of the presence of pre-Alpine HT basement blocks in the cover sequences.

3) The *pre-Alpine high temperature (HT) Basement Complex* (or "Seconda Zona Diorito-Kinzigitica"), comprises HT Hercynian rocks like kinzigites, amphibolites, granulites and calcite marbles; this Complex is always located between the Internal and the External Units and can be followed continuously for several kilometers south of the Gressoney Valley to the Orco Valley.

A schematic evolution for the Sesia Lanzo Zone is proposed; based on available data together with new geochronological data, this study shows that the internal and external parts of the polymetamorphic basement of the Sesia Zone experienced different cooling histories .

Keywords: Sesia Lanzo Zone, basement-cover relationships, Alpine evolution, geological mapping, metamorphism.

1. Introduction

The Sesia Lanzo Zone is one of the innermost units of the Western Alps and it is related to the Austroalpine system (Plate 1a). Until now, it was thought to be a quite homogeneous slice of continental crust that underwent HP metamorphism during the eo-Alpine stage of the Alpine cycle

* Presented at the Symposium "Metamorphism and Deformation", Basel, October 2, 1992 (see also vol. 73/2).

[1] Institut de Minéralogie, Université de Lausanne, BFSH2, CH-1015 Lausanne, Switzerland.

[2] Dipartimento di Scienze della Terra, Università, Via Valperga Caluso 37, I-10125 Torino, Italy.

[3] Present address: Institut de Minéralogie, Université de Lausanne, BFSH2, CH-1015 Lausanne, Switzerland.

(DAL PIAZ et al., 1972; HUNZIKER, 1974; COMPAGNONI et al., 1977, LARDEAUX and SPALLA, 1991) and only partially re-equilibrated during greenschist metamorphism of meso-Alpine age (45–30 Ma, HUNZIKER et al., 1992).

This basement crust was composed of Hercynian HT metamorphic rocks such as kinzigites – sillimanite, garnet, kyanite bearing gneisses – basic granulites, amphibolites and impure marbles, probably derived from metamorphosed cover sequences of Caledonian age (DAL PIAZ, 1993). These HT metamorphic rocks were intruded by Permo-Carboniferous granitoids (DAL PIAZ et al., 1972). This metamorphic belt was subducted during the Cretaceous forming the HP assemblages, which are well preserved in the internal part of the belt (Complesso dei Micascisti Eclogitici). Only part of the belt was affected by greenschist re-equilibration during uplift (Gneiss Minuti).

Unfortunately the only geological maps available for the Sesia zone are the Official Sheets of the Italian Geological Survey at 1:100'000 scale, compiled at the beginning of the century, despite of some field studies that have been carried on in the area during the last twenty years (MARTINOTTI, 1970; MAFFEO, 1970; DAL PIAZ et al., 1971, GOSSO, 1977; POGNANTE , 1979, LARDEAUX, 1981; PASSCHIER et al., 1981; WILLIAMS and COMPAGNONI, 1983). This is probably due to the fact that, as in many other polymetamorphic terrains, the eclogitic and greenschist Alpine assemblages almost obliterate the original mineralogies and textures of the protoliths, making it difficult to recognize the original lithologies.

In this work we present a new map based on extensive mapping undertaken during the course of this study, revisited existing published and unpublished maps (references in the index sources of map of Plate 1b). The aim of this document is to understand the lateral continuity of the different units described until now in the literature.

2. Geological setting of the Central Sesia Lanzo Zone

Recent descriptions of a cover sequence in the lower Aosta Valley (VENTURINI, 1991; VENTURINI et al., 1991), have been followed by more detailed mapping. Reinterpretation of existing data together with new field data has enabled us to produce a summary map (Plate 1b). The old definitions of the different units composing the Sesia Lanzo Zone, introduced at the beginning of the century and summarised in DAL PIAZ et al. (1972) and COMPAGNONI et al. (1977) have been left, since they arose from the name of the main forming lithologies (e.g. Micascisti Eclogitici, Gneiss Minuti, etc.); further studies have shown that every unit is made of different lithologies showing similar metamorphic characteristics which make the ancient terminology inappropriate.

For these reasons we subdivide the Sesia Lanzo Zone in the following three main complexes (Fig. 1b):

1) the Polymetamorphic Basement Complex
2) the Monometamorphic Cover Complex
3) the pre-Alpine HT Basement Complex

1) The Polymetamorphic Basement Complex is composed of pre-Alpine HT metamorphic rocks affected by the Alpine metamorphism. This complex broadly corresponds to the typical homogeneous lower element of the Sesia Lanzo Zone in the published literature (e.g. COMPAGNONI et al., 1977). It is further subdivided into three units based on different Alpine metamorphic characteristics (after PASSCHIER et al., 1981): a) an Internal Unit showing HP assemblages underlining the principal foliation (the main part of the Micascisti Eclogitici), b) an Intermediate Unit where greenschist (GS) re-equilibration on the HP paragenesis is pervasively developed and c) an External Unit, composed of rocks where the foliation is defined by GS paragenesis (Gneiss Minuti). Evidences of HP assemblages have been described by POGNANTE et al. (1987) and SPALLA et al. (1983, 1991) in the southern portion of the External Unit and in "Verres wedge".

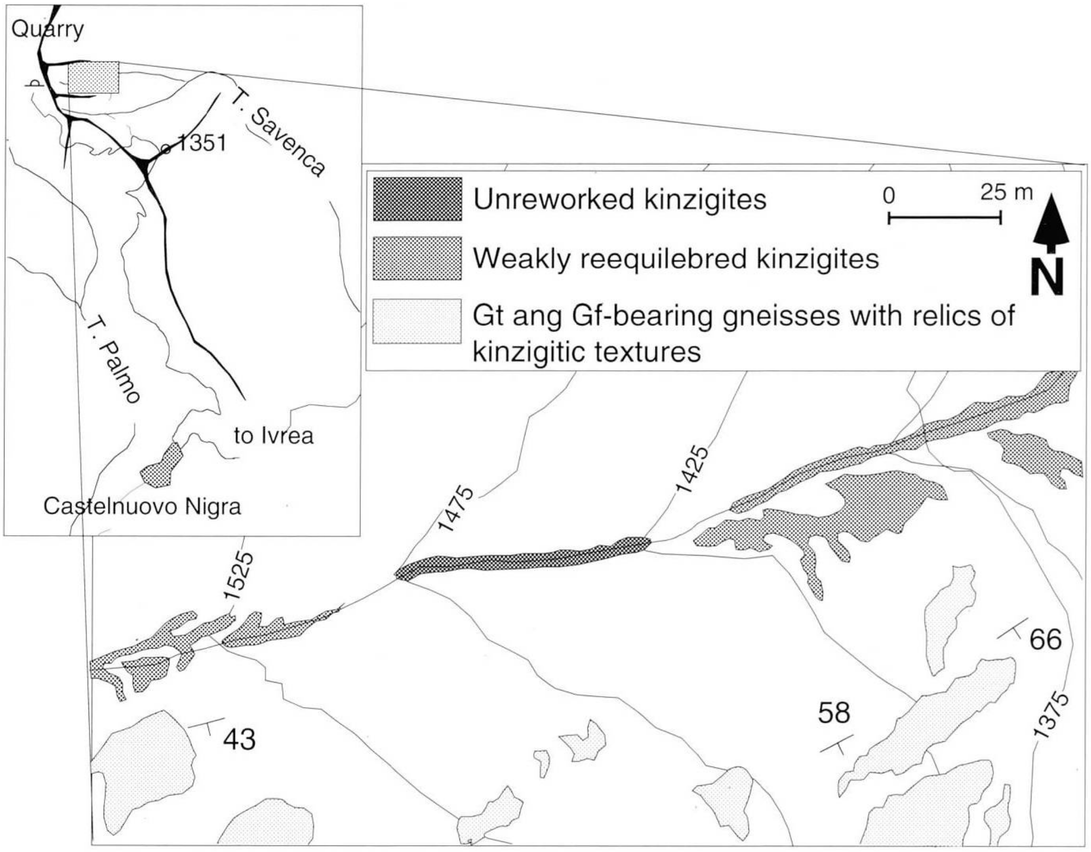
2) The Monometamorphic Cover Complex is formed by different lithologies that have been grouped in two units based on their specific lithologies: the Bonze Unit and the Scalaro Unit (VENTURINI et al., 1991).

a) The Bonze Unit comprises a sequence of extrusive basic rocks such as metabasalts, pillow breccias and related sediments (Mn-calcschists and quartzites), locally associated with tectonic contacts to hectometer-sized bodies of metagabbro slices.

b) The Scalaro Unit is composed of a cover complex characterised by a terrigenous sequence of supposed Permo-Triassic age overlain by Triassic dolomitic marbles, a carbonate conglomerate and a second terrigenous formation of quartzites, micaceous quartzites and metapelites. The contacts between the Scalaro and Bonze Unit are marked by intercalations of the metabasalts and the dolomitic marbles and calcschists.

3) The pre-Alpine HT Basement Complex corresponds to the II Zona Diorito-Kinzigitica (or Upper Element after COMPAGNONI et al., 1977). It is a slice of lower crust usually correlated

a)



b)

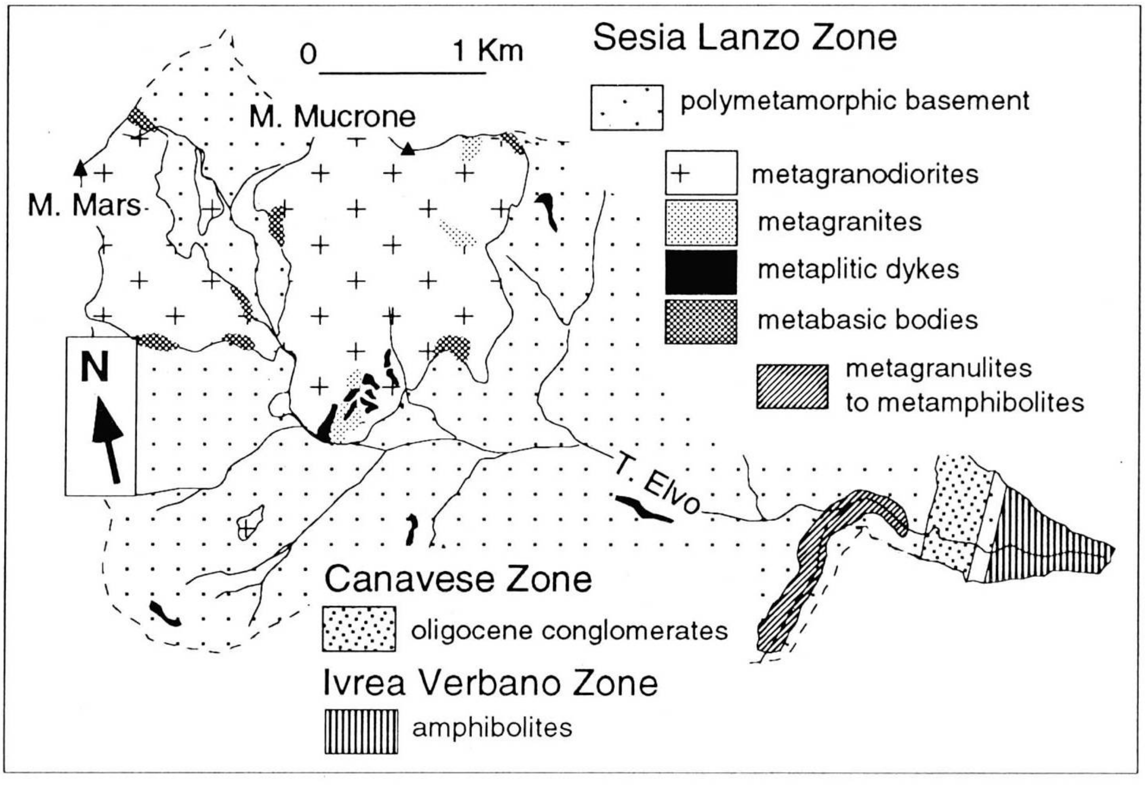


Fig. 1 a) Detailed geological map of the kinzigitic relic outcrops, north to Castelnuovo Nigra (Barbero, 1992). b) Interpretative geological map of the Elvo Valley after Armando (1992).

to the Ivrea Verbano Zone or to the Valpelline Klippe of the Dent Blanche System. It is composed of kinzigites, basic granulites, amphibolites and impure marbles, a lithologic association very similar to the protoliths of the Polymetamorphic Basement Complex, with the exception of the granitoids of late Hercynian age not present in the II DK. In this study no detailed field work has been undertaken on this complex except on the marbles at the contact between the IIDK and the Polymetamorphic Basement Complex, partially considered as part of the Permo-Mesozoic sequence.

The apparent lateral discontinuity of these different complexes on the presented map can either be due to tectonic movement during Alpine deformation or to the lack of mapping in sufficient detail to recognize a continuity.

2.1. THE POLYMETAMORPHIC BASEMENT COMPLEX

The three units of this complex, as described in the geological map, seem to be derived from similar protoliths, with differences related to their Alpine tectono-metamorphic evolution. This is an oversimplification, particularly for the External Unit which will be discussed further in chapter 3.

The protoliths of the basement are a metapelitic sequence with minor bodies and masses of metabasic rocks and marbles, metamorphosed under upper amphibolite to granulite conditions, during the pre-Variscan or Variscan cycle (DAL PIAZ et al., 1972; HUNZIKER, 1974; COMPAGNONI et al., 1977; HUNZIKER et al., 1992). This sequence has been correlated to the "Zona Diorito-Kinzigitica" of the Ivrea Verbano Zone (DAL PIAZ et al., 1972). This correlation was based on the pre-Alpine relics of kinzigite assemblages (biotite, garnet, sillimanite, K-feldspar, plagioclase) in the Mucrone lake area (MARTINOTTI, 1970). Several other occurrences of kinzigite relics have been recorded (GOSSO et al., 1979; LARDEAUX and SPALLA, 1991). In the area of Savenca Valley (Fig. 1a) exceptionally well preserved relics of kinzigites have subsequently been found (BARBERO, 1992). These relics preserve both textures and mineralogy of the HT-assemblages, showing very clearly the evolution from pre-Alpine HT to eo-Alpine HP-conditions.

South of M. Mucrone (Fig. 1b) a kilometric elongated body of basic granulites has been recently mapped (ARMANDO, 1992). The granulitic textures are pervasively well preserved even where HT-assemblages are often completely pseudomorphosed by prograde blueschist paragenesis. The HT complex has been intruded by kilometer-size bodies of granodioritic to granitic composition (OBERHÄNSLI et al., 1985 with ref.). The age of the intrusion has been attributed to the late Variscan (OBERHÄNSLI et al., 1985; HUNZIKER et al., 1992; BUSSY, pers. com.) using U/Pb on zircons and monazites. South of M. Mucrone, clear field relationships between metagranodiorites and metagranites have been described (ARMANDO, 1992) on the basis of well preserved textures and mineral relics. Two different kind of metagranites have been recognized: a) metagranites associated to metagranodiorites (OBERHÄNSLI et al., 1985; PAQUETTE, 1987) and b) leucocratic metagranite dykes showing cross-cutting relationships with the metagranodiorites. Moreover, towards the contact of the metagranitoid bodies there are several decameter-size masses of eclogitic rocks, indicative of eventual magma differentiation. The above described protoliths are found in the three units of this complex.

The main assemblages in the internal unit are associated with well known eo-Alpine HP metamorphism (COMPAGNONI, 1977; COMPAGNONI et al., 1977); only in a few cases protolith textures escaped a complete reequilibration.

For the intermediate unit, field and petrographic relationships show GS assemblages of lower Tertiary age overprinting eo-Alpine HP foliations. These transformations seem to be related to a static growth or a new weak foliation. This unit has to be considered as a transitional zone, with a thickness of 1 to 3 km and it is commonly associated with extended slices of the Monometamorphic Cover Complex and of the pre-Alpine HT Basement Complex (II DK).

The external unit corresponds to the "Gneiss Minuti Complex" of STELLA (1906). It shows an almost complete resetting by the tectono-metamorphic meso-Alpine greenschist event with the development of a pervasive foliation. The protoliths of this unit are often difficult to recognize, because of the very strong greenschist overprint.

SPALLA et al. (1991) did not observe any difference in the pre-greenschist history of this unit in comparison with the more internal ones. POGNANTE et al. (1987), describing the Gneiss Minuti Complex of the southern part of the Sesia Lanzo Zone, suggested that part of the sequence (quartzites, Mn-quartzites, gneisses interlayered with calcschists) could be related to a Mesozoic cover.

The subdivision of the three units (internal, intermediate and external) can be adopted for the examined area, but is no longer applicable in the northern part of the Sesia Lanzo Zone, north of Sesia Valley.

2.2. THE MONOMETAMORPHIC COVER COMPLEX

2.2.1. The lithostratigraphic sequences

Although in the Dent Blanche Nappe a Permo-Mesozoic cover has been described in several classic localities (e.g. M. Dolin, WEIDMANN and ZANINETTI, 1974; Pillonet, DAL PIAZ, 1976; DAL PIAZ and SACCHI, 1970; Roisan Zone, DIEHL et al., 1952), in the Sesia Lanzo Zone only a few contributions refer to some scattered outcrops of a possible Mesozoic origin (GENNARO, 1935; DAL PIAZ et al., 1971).

VENTURINI et al. (1991) described in detail the field relationships of different lithologies and introduced the concept of a Monometamorphic Cover Complex; they also proposed a further subdivision in two units, used also in this work. Prior to this study the cover was considered to be quite localized (lower Aosta Valley), further extensive field work and careful reinterpretation of previous contributions demonstrate the widespread distribution of this complex also in the rest of the Sesia Lanzo Zone (DAL PIAZ et al., 1971; POGNANTE, 1979; PASSCHIER et al., 1981; POGNANTE et al., 1987; BARBERO, 1992).

The Monometamorphic Cover Complex outcrops as a narrow band in the Central Sesia Lanzo Zone, at the contact between the Intermediate and the Internal Unit of the Polymetamorphic Basement Complex, and in several scattered elongated bodies, in the Internal Unit (Plate 1b).

The lithologies of the Monometamorphic Cover Complex display the same Alpine metamorphic characteristics as the surrounding basement rocks, with a strong and pervasive eo-Alpine HP assemblage even if the textural relics of the primary protoliths (both sedimentary and magmatic) are sometimes preserved.

On the map on plate 1b two main lithostratigraphic units have been described on the basis of their lithological constituents: 1) the Bonze Unit and 2) the Scalaro Unit (VENTURINI et al., 1991).

1) The Bonze Unit comprises a sequence of intrusive and extrusive basic rocks such as blastomylonitic metagabbros, eclogitized metabasalts, pillow breccias and related sediments (Mn-quartzites and metapelites). Metabasalts are commonly transformed into glaucophanites, glaucophanic eclogites and garnet epidosites; no microstructural relics have been found even if their macrostructural textures are sometimes well preserved. Geochemistry of major elements and trace elements suggests their correlation to the MORB, as clearly shown in figure 2a by the Rock/MORB spider diagram (PEARCE, 1982).

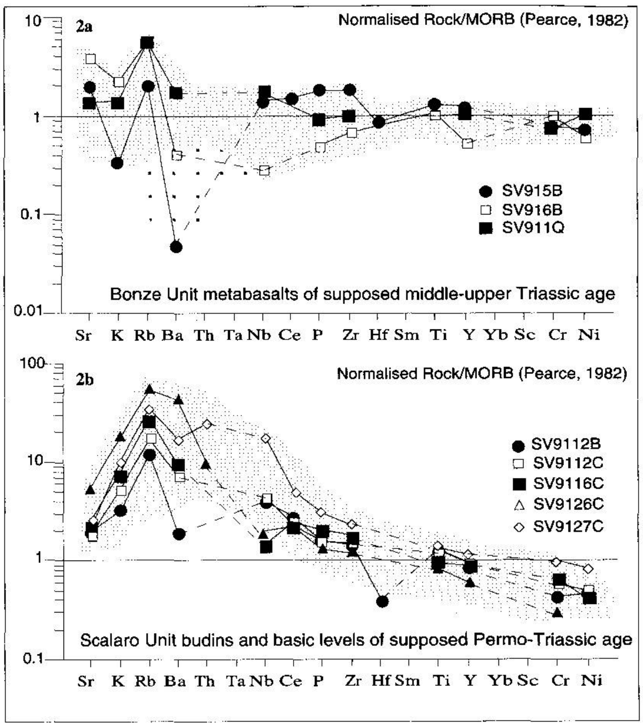


Fig. 2 Spider diagrams normalized to MORB (PEARCE, 1982) for the metabasalts of the Bonze Unit (a) and for the boudins and basic levels of the basal formation of the Scalaro Unit (b). Anomaly of Ba and K in diagram (a) could be explained with their mobility during the metamorphism.

Related to the metabasalts are pillow breccias and thin horizons of Mn-quartzites, characterized by the growth of Mn-rich garnets. Another typical lithology, often at the contact with the other cover units, are centimeter to decimeter boudins of spessartine and calcite-rich rocks in calcschists.

Metagabbros are characterized by a prograde blastomylonitic texture characterized by the growth of Na-pargasite, white mica, Mg-chlorite, clinozoisite and quartz overprinted by the garnet, omphacite, jadeite HP assemblage. Metagabbros form hectometer to kilometer-size bodies and are in structural contact with the metabasalts.

Metabasalts and related sediments are laterally continuous while metagabbros form discontinuous kilometer-sized bodies which are always separated from the other rocks by tectonic contacts.

2) The Scalaro Unit is a Permo-Mesozoic cover sequence. The lowermost part is a terrigenous sequence of supposed Permo-Triassic age composed of interlayered white quartzites and metapelites of centimeter to decimeter thickness, intercalated with decimeter boudins and thin basic selvedges. Trace geochemistry indicates a WPB

origin for these rocks as shown in figure 2b (PEARCE, 1982). A monomictic conglomerate with centimeter to decimeter blocks of leucogranite outcrops west of Croix Courma and seems to be related to this basal repetition (Plate 2 – Courma).

Overlying this terrigenous formation is a presumably Triassic yellow dolomitic marble formation, that in some places is over 30 m thick (Plate 2 – Mombarone). Usually, at the top of the sequence there is a polymictic conglomeratic calcschist. This lithology represents a marker bed for the Scalaro Unit because of the good lateral continuity. This calcareous conglomerate contains blocks of pre-Alpine HT basement, dolomitic marbles, quartzites and metabasites of the Bonze Unit.

The transition from the Scalaro to the Bonze Unit is marked by contacts between the metabasalts and the dolomitic marbles, and by the presence of metric to decameter blocks of basic rocks inside the calcschists.

2.2.2. The age of lithostratigraphic sequences

The ages of metasediments can not be confirmed by fossils, because of the deformation and the degree of metamorphism that these lithologies have suffered. The proposed ages assigned to the different lithologies (Plate 2), are based on the following considerations:

a) the intercalations of quartzites and metapelites with the basic levels that have been found at the contact with the Polymetamorphic Basement Complex are interpreted as vulcano-sedimentary sequence of Permo-Triassic age, whereas dolomitic marbles are related to the Middle-Upper Triassic in analogy with the other dolomitic sequences of the Alps;

b) the metabasalts of the Bonze Unit are probably of Upper Triassic age, because of their intercalation within the dolomitic marbles; moreover relationships between dolomitic marbles and basic rocks have been reported from the eastern part of the Alpine chain (DE ZANCHE and SEDEA, 1972; BARBIERI et al., 1980). In these studies they have been attributed to the Ladinian on the basis of their relationships with the fossiliferous levels as well as some K/Ar age determinations. We consider the Ladinian as a maximum age for the Bonze Unit metabasalts.

c) The conglomeratic calcschists contain blocks of dolomitic marbles, of metabasic rocks of the Bonze Unit and of the Polymetamorphic Basement Complex; so they can be certainly considered monometamorphic and probably younger then the Middle-Upper Triassic.

Therefore we consider the Monometamorphic Cover Complex to be the cover of the Sesia Lanzo Zone on the base of the following considerations:

a) the Complex has a widespread occurrence in "synform" position along all the Central Sesia Lanzo Zone,

b) primary stratigraphical relationships between metasediments and the basement are preserved at some localities (Plate 2 Fenêtre and Cavalcurt 1 and 2); the nature of the pre-metamorphic contacts between the cover sequence and the basement has been largely obliterated by the Alpine tectono-metamorphic reworking,

c) decimeter to meter blocks of basement relics within the carbonate levels of the cover sequences support our interpretation.

2.3. THE PRE-ALPINE HT BASEMENT COMPLEX

The pre-Alpine HT Basement Complex corresponds to the IIDK of the literature (ARTINI and MELZI, 1900; CARRARO et al., 1970; DAL PIAZ et al., 1971). The lithologies of this complex are characterized by HT paragenesis metamorphosed in amphibolite facies and only locally and weakly retromorphosed in greenschist facies (DAL PIAZ et al., 1971). The main lithologies are kinzigites – biotite, garnet, sillimanite, plagioclase and K-feldspar bearing gneisses – and less frequent amphibolites, which occur as metric boudins within the kinzigites. Marbles are commonly observed associated with the paragneiss; their HT paragenesis is constituted by calcite, diopside, garnet, phlogopite and white mica. A small body of harzburgites has been described in the northern part of the pre-Alpine HT Basement Complex (ARTINI and MELZI, 1900). Hectometer-size bodies of gabbros (PASSCHIER at al., 1981; POGNANTE et al., 1987; STÜNITZ, 1989) and slices of the Monometamorphic Cover Complex (e.g. Plate 1b) are common at the contact between the pre-Alpine HT Basement Complex and the other units of the Sesia Lanzo Zone; several slices of the pre-Alpine HT Basement Complex can be observed in the external part of the Sesia Lanzo Zone, near Verres (lower Aosta Valley).

The pre-Alpine HT Basement Complex (or IIDK) was considered by ARGAND (1909) as the root of the more External Valpelline Unit of the Dent Blanche system. CARRARO et al. (1970) attributed the pre-Alpine HT Basement Complex to the Ivrea Verbano Zone on the basis of the tectonic contacts that they observed between this complex and the one below. Their theory was subsequently supported by radiometric data on biotites which indicated a cooling age of 180 Ma (HUNZIKER, 1974; HUNZIKER et al., 1992), ages similar to the data obtained for the Valpelline and for the Ivrea Verbano Zone.

A narrow band of pre-Alpine HT Basement Complex locally re-equilibrated under HP conditions is laterally continuous along the entire length of the Central Sesia Lanzo Zone (Plate 1b). Similar continuity of this complex can be followed in the southern part of the Sesia Lanzo Zone. This narrow band outcrops at the passage between the Internal and Intermediate units with the External Unit. On the internal side of the pre-Alpine HT Basement Complex, east of the Gressoney Valley, HP mylonites have been described (LARDEAUX, 1980), whereas on the external side greenschist re-equilibration on these mylonites can be mapped (LARDEAUX, 1980; PASSCHIER et al., 1981).

3. Discussion and conclusions

The polymetamorphic basement of the Sesia Lanzo Zone has been correlated until now to the Ivrea-Verbano Zone, due to the strong similarity between the HT relics (LARDEAUX and SPALLA, 1991 with ref.). This correlation is widely accepted

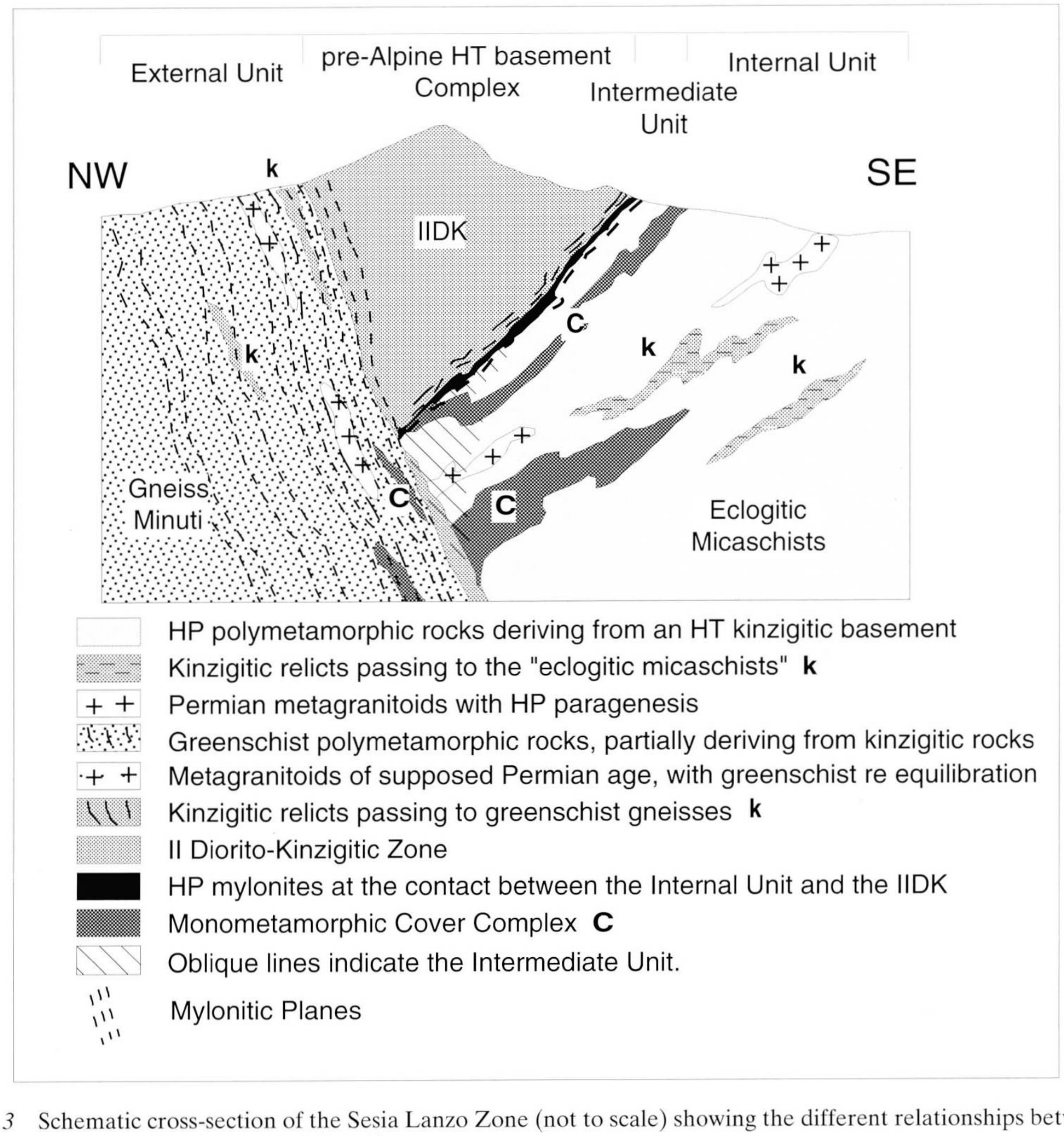


Fig. 3 Schematic cross-section of the Sesia Lanzo Zone (not to scale) showing the different relationships between the units introduced in the map of plate 1b.

for the evolutionary paleogeographic reconstructions (DAL PIAZ et al., 1972; POLINO et al., 1990; STAMPFLI, 1993), but it does not reflect the last Variscan events and the early Alpine ones.

The Ivrea-Verbano Zone is classically considered as deep continental crust thinned during the early Alpine evolution (late Triassic–early Jurassic extension) as evidenced by 180 Ma cooling ages (ZINGG, 1983; ZINGG et al., 1990). This cooling age has also been found in similar rock types in different tectonic settings, i.e., II DK and Valpelline Zone (HUNZIKER, 1974; HUNZIKER et al., 1992; COSCA et al., work in progress). The common cooling ages and lithologic similarities allow us to correlate the Ivrea-Verbano Zone with the II DK and the Valpelline Zone, not only for the lithologies, but also for the common evolution up to 180 Ma.

The Sesia Lanzo Zone basement, although having a similar lithologic composition, has been widely intruded by large late Variscan shallow level granitoid bodies, according to OBERHÄNSLI et al. (1985). Moreover, the existence of a monometamorphic cover sequence of supposed Permo-Triassic to Jurassic age (this paper) further indicates that the Sesia Lanzo Zone basement was already exposed to the surface during the time. These arguments allow us to consider the Sesia Lanzo Zone as an original deep crust already thinned during the late Variscan events. This fact should be taken in account into futher paleogeographic reconstructions.

The differences in the Polymetamorphic Basement Complex of the Sesia Lanzo Zone between the three units (internal, intermediate and external) have been generally correlated to different Alpine evolution of the protoliths. SPALLA et al. (1991) postulated a homogeneous history for the Sesia Lanzo Zone during the eo-Alpine stage under HP conditions, followed by a scattered re-equilibration of the External Unit in greenschist conditions during the meso-Alpine stage. RIDLEY (1989) proposed a more articulate model where the different units of the Sesia Lanzo Zone (either the Polymetamorphic Basement Complex or the pre-Alpine HT Basement Complex) were progressively involved at different metamorphic conditions during successive stages of the Alpine orogeny. According to RIDLEY (1989), figure 3 summarizes the different possibilities of relations between the different complexes and units introduced in the map of plate 1b.

It is postulated that there was a multiple moving of the different units along different major shear zones at different P-T-t conditions and geometry. In the eastern side of the pre-Alpine HT Basement Complex, eclogitic mylonites at the contact with the Polymetamorphic Basement Complex and the Monometamorphic Cover Complex are consistent with an eo-Alpine juxtaposition between the pre-Alpine HT Basement Complex. This juxtaposition occurred at more then 15–20 km depth, as demonstrated by the cooling ages of the Polymetamorphic Basement Complex at 180 Ma (HUNZIKER, 1974) and the internal part of the Polymetamorphic Basement Complex, which cooled below 350 °C between approximately 90–60 Ma (HUNZIKER, 1974; STÖCKHERT et al., 1986; VENTURINI et al., 1992).

The external part of the Sesia Lanzo Zone, in contrast, could have had a more complicated history due to a more pervasive re-equilibration under greenschist conditions; cooling curves for this unit indicate a different T-t path compared to the Internal Unit (VENTURINI et al., 1992). It is possible that the External Unit has also been affected by the eclogitic metamorphism (SPALLA et al., 1991); unfortunately, HP relics represent scattered points in the External Unit and are not supported by radiometric data.

The main episodes of the Austroalpine system of the Western Alps on the basis of the available geological and geochronological data are summarized in figure 4.

The age of the cover sequences of the Monometamorphic Cover Complex is also based on the hypothesis that the association of dolomitic marbles with basalts could be related, as maximum age, to the widespread Ladinian magmatic events, well known in the Eastern Alps (BARBIERI et al., 1980).

The lithological sequences with intercalations of dolomites and basalts, overlyed by conglomeratic calcschists and pillow breccias, are typical of the transtensive rifting contexts (FAVRE and STAMPFLI, 1992); the rifting phase generally brings forward of 20–30 Ma the crustal separation, that for the Alpine Tethys is located at more or less 180 Ma (FAVRE and STAMPFLI, 1992). So, this carbonate cover sequences could represent the relics of a transtensive rifting basin of Middle-Upper Triassic age. In support of this theory are the geochemical results obtained for the basal formation of the Scalaro Unit of supposed Permo-Triassic age, and from the superior metabasalts of the Bonze Unit. The geochemical pattern from the basal formation lithologies of the Scalaro Unit allows to consider them as WPB, in contrast to the MORB origin of the metabasalts (Fig. 2). The evolution from WPB to MORB is the logical consequence of the evolution of a rifting margin, according to our paleogeographical reconstruction.

The upper age limit of the sequence is constrained by the age of the eo-Alpine metamor-

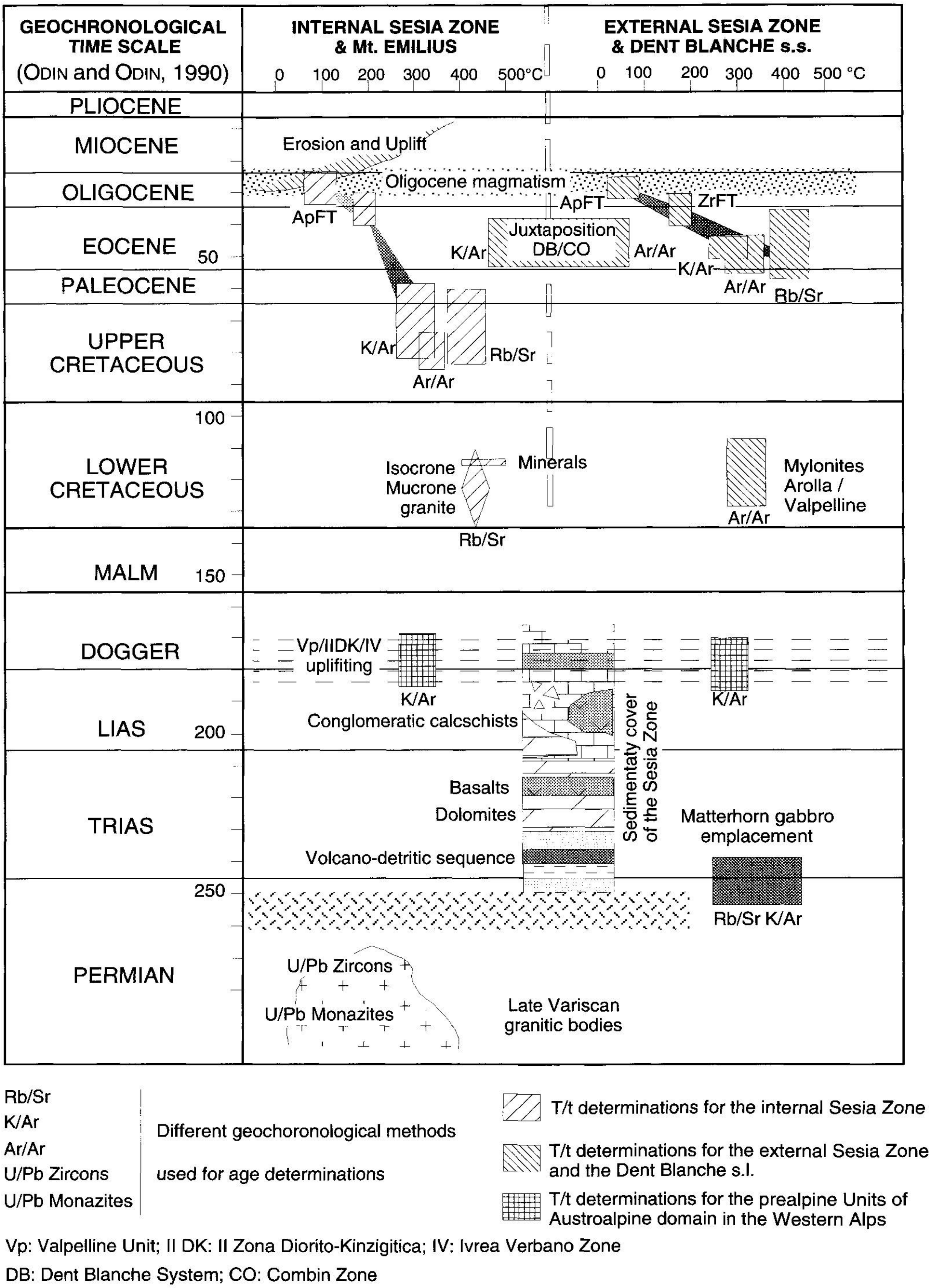


Fig. 4 Summarizing table of the chronological evolution of the Sesia Lanzo Zone and Dent Blanche System after the Permian. The closing temperatures used from the different radiogenic systems are those proposed by HUNZIKER et al. (1992).

phism, due to the lack of stratigraphic markers in the upper part of the preserved sequence. Up to now no geochronological data for the Monometamorphic Cover Complex are available.

The available geochronological data on the Alpine history are homogeneously distributed in space and time. While data on the HP climax are only limited to the specific area of the M. Mucrone and indicate a lower heterogeneous age (OBERHÄNSLI et al., 1985), the data on closing temperatures obtained with different methods are quite numerous and well distributed in the different units both of the Sesia Lanzo Zone and of the Dent Blanche Nappe (HUNZIKER, 1974; STÖCKHERT et al., 1986; VENTURINI et al., 1992). This has allowed us to construct different cooling curves, starting from the Upper Cretaceous age. These curves, which are distinctly different before the Lower Oligocene (Fig. 4), could indicate a different P-T-t path for the Internal and the External Unit of the Sesia Lanzo Zone basement.

Acknowledgements

We would like to thank H. Masson, D. Kirschner, Z. Sharp, H-R. Pfeifer and A. Pillevuit for their critical comments, remarks and corrections to this manuscript. Swiss NSF-grants, as well as Italian MPI 40% grants, are gratefully acknowleged.

References

ACCOTTO, A. (1982): Studio geologico petrografico dell'alta e media Valle di Champorcher (Settore Orientale). Univ. of Torino, unpublished thesis, 186 pp.

ARGAND, E. (1909): L'exploration géologique des Alpes Pennines Centrales. Bull. Soc. Vaud. Scien. Natur. XLV.

ARMANDO, G. (1992): Studio geologico dell'alta valle dell'Elvo (Zona Sesia Lanzo, Alpi Occidentali). Univ. Torino, unpublished thesis, 196 pp.

ARTINI, E. and MELZI, G. (1900): Ricerche geologiche e petrografiche sulla Valsesia. Mem. R. Ist. Lomb. Sci. Lett. Art. 48(1), 113–122.

BARBERO, M. (1992): Geologia dell'alto vallone del Savenca (Zona Sesia Lanzo, Alpi Occidentali). Univ. Torino, unpublished thesis, 156 pp.

BARBIERI, C., V., D.Z., DI LALLO, E., MIETTO, P. and SEOLA, R. (1980): Note illustrative della carta geologica dell'Area di Recoaro alla scala 1 : 20 000. Mem. Sci. Geol. 34, 23–52.

BATTISTON, P., BENCIOLINI, L., DAL PIAZ, G., DE VECCHI, P., MARCHI, G., MARTIN, S., POLINO, R. and TARTAROTTI, P. (1987): Geologia di una traversa dal Gran Paradiso alla Zona Sesia Lanzo in alta Val Soana, Piemonte. Mem. Soc. Geol. It. 29, 209–232.

BIANCHI, A., DAL PIAZ, G.B. and VITERBO, C. (1964): Le masse di anfiboliti gabbriche a gastaldite di Corio e Monastero e di altre località della zona Sesia-Lanzo. Mem. Acc. Sci. Torino, Cl. Sci. M.F.N. (Sez. 4), 1–37.

CARRARO, F., DAL PIAZ, G.V. and SACCHI, R. (1970): Serie di valpelline e II zona diorito-kinzigitica sono i relitti di un ricoprimento proveniente dalla zona Ivrea-Verbano. Mem. Soc. Geol. It. 9, 197–224.

CARRARO, F., DAL PIAZ, G.V. and SACCHI, R. (1970): Serie di valpelline e II zona diorito-kinzigitica sono i relitti di un ricoprimento proveniente dalla zona Ivrea-Verbano. Mem. Soc. Geol. It. 9, 197–224.

CARRARO, F., MEDIOLI, F. and PETRUCCI, F. (1975): Geomorphological study of the Morainic amphiteatre of Ivrea, North Italy. Bull. R. Soc. of New Zealand 13, 89–93.

COMPAGNONI, R. (1977): The Sesia-Lanzo Zone: high pressure–low temperature metamorphism in the austroalpine continental margin. Rend. Soc. It. Mineral. Petrogr. 33(1), 335–374.

COMPAGNONI, R., DAL PIAZ, G.V., HUNZIKER, J.C., LOMBARDO, B. and WILLIAMS, P.F. (1977): The Sesia-Lanzo Zone, a slice of continental crust with alpine high pressure–low temperature assemblages in the western Italian Alps. Rend. Soc. It. Mineral. Petrogr. 33(1), 281–234.

DAL PIAZ, G.V. (1993): Evolution of Austroalpine and upper penninic basement in the north-western alps from Variscan convergence to post-Variscan extension. In VON RAUMER, J. and NEUBAUER, F. (eds): Pre-Mesozoic Geology in the Alps. Springer Verlag, Berlin, 327–344.

DAL PIAZ, G.V. and SACCHI, R. (1969): Osservazioni geologiche sul lembo di ricoprimento del pillonet (Dent Blanche s.l.). Mem. Soc. Geol. It. 8, 835–846.

DAL PIAZ, G.V., GOSSO, G. and MARTINOTTI, G. (1971): La II Zona Diorito-kinzigitica tra la Valsesia e la Valle d'Ayas (Alpi Occidentali). Mem. Soc. Geol. It: 10, 257–276.

DAL PIAZ, G.V., HUNZIKER, J.C. and MARTINOTTI, G. (1972): La zona sesia lanzo e l'evoluzione tettonico-metamorfica delle alpi nordoccidentali interne. Mem. Soc. Geol. It. 11, 433–460.

DAL PIAZ, G., NERVO, R. and POLINO, R. (1979): Carta Geologica del Lembo del Glacier-Rafray alla scala 1 : 12 500 (Dent Blanche s.l.). Litografia Artistica Cartografica, Firenze.

DE ZANCHE, V. and SEDEA, R. (1972): Nuovi aspetti del vulcanesimo triassico nei dintorni di Recoaro (Vicenza). Boll. Soc. Geol. It. 91, 523–532.

DIEHL, E.A., MASSON, R. and STUTZ, A.H. (1952): Contributi alla conoscenza del Ricoprimento Dent Blanche. Mem. Ist. Geol. Min. Univ. Padova, 1–53.

ELTER, G. (1987): Carte Géologique de la Vallée d'Aoste. CNR – Centro Studi sui problemi dell'Orogeno delle Alpi Occidentali.

GENNARO, V. (1925): Micascisti a piemontite nelle valli di Lanzo (Alpi Piemontesi). Rend. R. Acc. Naz. Lincei II, 508–510.

GOSSO, G. (1977): Metamorphic evolution and fold history in the Eclogitic micaschist of upper Gressoney Valley (Sesia-Lanzo Zone, Western Alps). Rend. Soc. It. Mineral. Petrogr. 33(1), 389–407.

GOSSO, G., DAL PIAZ, G.V., PIOVANO, V. and POLINO, R. (1979): High pressure emplacement of Early-Alpine nappes postnappe deformation and structural levels (Internal northwestern Alps). Mem. Ist. Mineral. Petrogr. Univ. Padova 32, 5–15.

HALTER, W. (1992): Etude Géologique et minéralogique au Nord Est d'Alagna Valsesia (Italie). Univ. of Lausanne, unpublished thesis, 269 pp.

HUNZIKER, J.C. (1974): Rb–Sr and K–Ar age determination and the Alpine tectonic history of the western Alps. Mem. Ist. Mineral. Petrogr. Univ. Padova 31, 1–55.

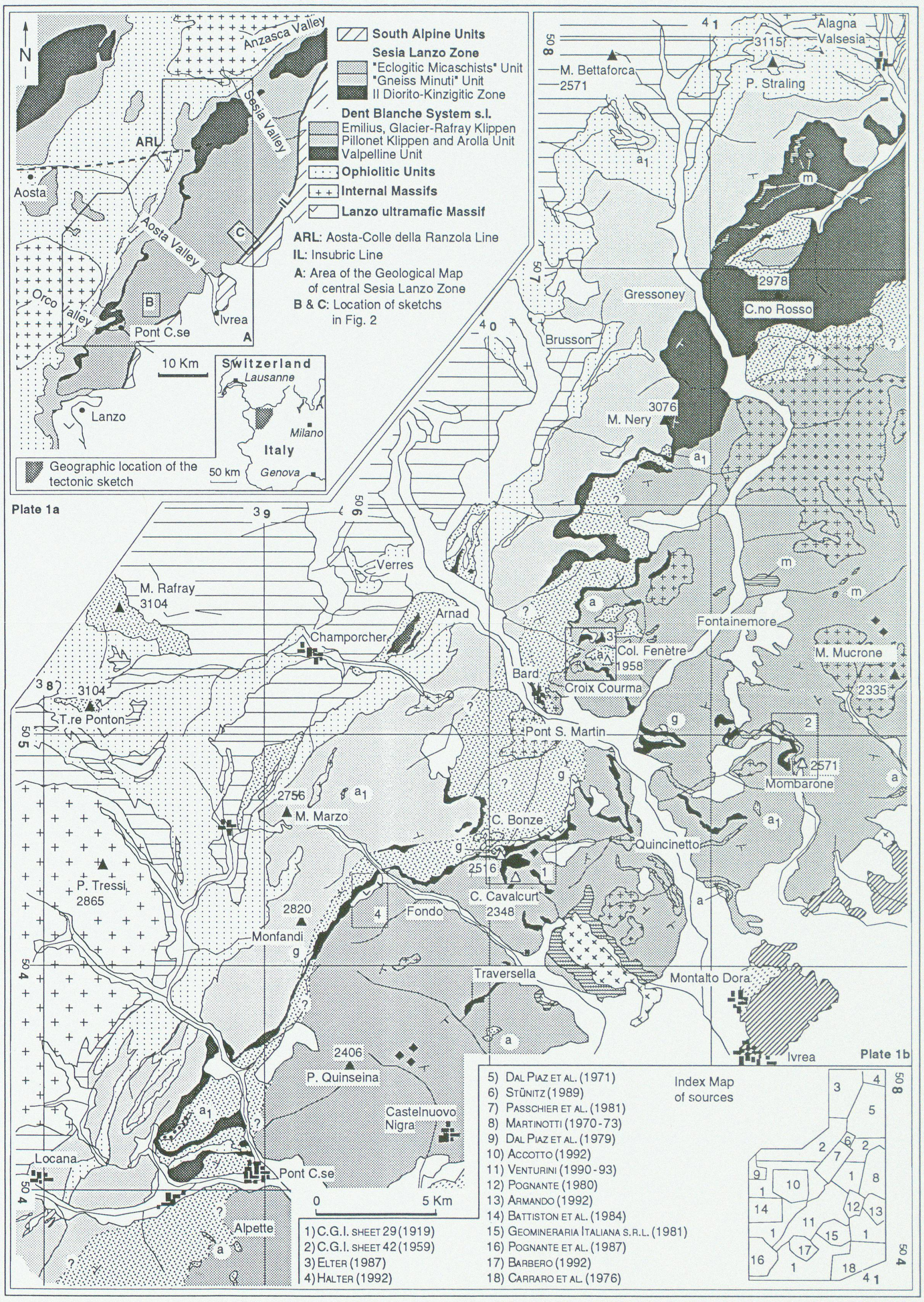
HUNZIKER, J.C., DESMONS, J. and HURFORD, A.J. (1992): Thirty-two years of geochronological work in the Central and Western Alps: a review on seven maps. Mémoires de Géologie (Lausanne) 13, 1–52.
LARDEAUX, J.M. (1981): Evolution tectono-métamorphique de la Zone Nord du Massif Sesia-Lanzo (Alpes Occidentales): un exemple d'éclogitisation de La Croûte Continentale. Mem. Sci. Terre Univ. Pierre et Marie Curie, Paris Thèse 3e Cycle, 226 pp.
LARDEAUX, J.M. and SPALLA, M. (1991): From granulites to eclogites in the Sesia zone (Italian Western Alps): a record of the opening and closure of the Piedmont ocean. J. Metam. Geol. 9, 35–59.
MAFFEO, B. (1970): Studio petrografico dell'ammasso granitico del Monte Mucrone e dei suoi rapporti con i "micascisti eclogitici". University of Torino, unpublished thesis.
MARTINOTTI, G. (1970): Studio petrografico delle eclogiti della zona del Monte Mucrone e dei loro rapporti con i "micascisti eclogitici" incassanti. University of Torino, unpublished thesis.
MARTINOTTI, G. and HUNZIKER, J.C., (1984): The Austroalpine System in Western Alps: a review. Mem. Soc. Geol. It., 29, 233–250.
OBERHÄNSLI, R., HUNZIKER, J.C., MARTINOTTI, G. and STERN, W.B. (1985): Geochemistry, geochronology and petrology of Monte Mucrone: an example of eo-Alpine eclogitization of permian granitoids in the Sesia-Lanzo Zone, Western Alps, Italy. Chemical Geology (Isotope Geoscience Section) 52, 165–184.
ODIN, G.S. and ODIN, C. (1990): Echelle Numérique des temps géologiques. Géochronique, 35, 12–21.
PAQUETTE, J.L. (1987): Comportement des systèmes isotopiques U/Pb et Sm/Nd dans le métamorphisme éclogitique. C.A.E.S.S. Mém. Docum., 14, 189 pp.
PASSCHIER, C.W., URAI, J.L., VAN LOON, J. and WILLIAMS, P.F. (1981): Structural Geology of central Sesia Lanzo Zone. Geologie en Mijnbouw 60, 497–507.
PEARCE, J.A. (1982): Trace element characteristic of lavas from destructive plate boundaries. In: Andesites (R.S. THORPE, Ed.), 525–547.
POGNANTE, U. (1979): Studio geologico petrografico del Complesso dei "Micascisti Eclogitici" lungo la valle d'Aosta tra Quincinetto, Ivozio e la Colma di Mombarone. Univ. of Torino, unpublished thesis.
POGNANTE, U. (1989a): Lawsonite, blueschist and eclogite formation in the southern Sesia zone (Western Alps, Italy). Eur. J. Mineral. 1, 89–104.
POGNANTE, U. (1989b): Tectonic implications of lawsonite formation in the Sesia zone (Western Alps). Tectonophysics 162, 219–227.
POGNANTE, U., COMPAGNONI, R. and GOSSO, G. (1980): Micro-mesostructural relationships in the continental eclogitic rocks of the Sesia-Lanzo Zone: a record of a subduction cycle. Ren. Soc. It. Min. Petr. 36, 169–186.
POGNANTE, U., TALARICO, F., RASTELLI and FERRATI, N. (1987): High-pressure metamorphism in the nappes of the Valle dell'Orco traverse (Western Alps collisional belt). J. Metamorphic Geol. 5, 397–414.
POLINO, R., DAL PIAZ, G.V. and GOSSO, G. (1990): Tectonic erosion of the Adria margin and accretionary processes for the Cretaceous orogeny of the Alps. Vol. spec. Soc. Geol. It. 1, 345–367.
RIDLEY, J. (1989): Structural and metamorphic history of a segment of the Sesia-Lanzo zone, and its bearing on the kinematics of Alpine deformation in the western Alps. Geol. Soc. Spec. Publ. 45, Alpine Tectonics, 189–201.
SPALLA, M.J., DE MARIA, L., GOSSO, G., MILETTO, M. and POGNANTE, U. (1983): Deformazione e metamorfismo della Zona Sesia-Lanzo meridionale al contatto con la falda piemontese e con il massiccio di Lanzo, Alpi Occidentali. Mem. Soc. Geol. It. 26, 499–514.
SPALLA, M.J., LARDEAUX, J.M., DAL PIAZ, G.V. and GOSSO, G. (1991): Métamorphisme et tectonique à la marge externe de la Zone Sesia-Lanzo. Memorie di Scienze Geologiche XLIII, 361–369.
STAMPFLI, G.M. (1993): Le Briançonnais: terrain exotique dans les Alpes. Eclogae geol. Helv. 86, 1–45.
STÖCKERT, B., JÄGER, E. and VOLL, G. (1986): K–Ar age determinations on phengites from the internal part of the Sesia Zone, Western Alps, Italy. Contrib. Mineral. Petrol. 92, 456–470.
STÜNITZ, H. (1989): Partitioning of metamorphism and deformation in the boundary region of the "Seconda Zona Diorito-Kinzigitica", Sesia Zone, Western Alps. Ph. D. Thesis Diss. ETH No. 8817, 244 pp.
VENTURINI, G. (1991): I protoliti dei "Micascisti Eclogitici" sul versante destro della bassa Valle d'Aosta (Zona Sesia-Lanzo, Alpi Occidentali). Univ. Torino, unpublished thesis, 224 pp.
VENTURINI, G., MARTINOTTI, G. and HUNZIKER, J.C. (1991): The Protoliths of the "Eclogitic Micaschists" in the lower Aosta Valley (Sesia-Lanzo Zone, Western Alps). Mem. Sci. Geol. 43, 347–359.
VENTURINI, G. and HUNZIKER, J.C. (1992): Geology and geochronology of the central part of the Sesia Lanzo Zone: the state of the art. Géologie Alpine, Série Spec. Résumés et colloques, Univ. Grenoble 1, 102–103.
WEIDMANN, M. and ZANINETTI, L. (1974): Quelques données nouvelles sur la série du Mont-Dolin. Description des Foraminifères Triasiques. Eclogae geol. Helv. 67, 597–603.
WILLIAMS, P. and COMPAGNONI, R. (1983): Deformation and metamorphism in the Bard area of Sesia-Lanzo Zone, Western Alps, during subduction and uplift. Journ. Metam. Geology 1, 117–140.
ZINGG, A. (1983): The Ivrea and Strona Ceneri Zones (Southern Alps, Ticino and N-Italy) – A Review. Schweiz. Mineral. Petrogr. Mitt. 63, 361–392.
ZINGG, A., M.R., H., HUNZIKER, J.C. and SCHMID, S.M. (1990): Tectonometamorphic history of the Ivrea Zone and relationship to the crustal evolution of the Southern Alps. Tectonophysics 182, 169–192.

Manuscript received March 20, 1993; revised manuscript accepted December 6, 1993.

Leere Seite
Blank page
Page vide

G. VENTURINI, G. MARTINOTTI, G. ARMANDO, M. BARBERO and J.C. HUNZIKER

Plate 1: Geological sketch of the Austroalpine system in the Western Alps (1a) and geological map of Central Sesia Lanzo Zone (1b).



GEOLOGICAL MAP OF THE CENTRAL SESIA LANZO ZONE

G. Venturini, G. Martinotti, G. Armando, M. Barbero, J. C. Hunziker

Strike and dip of foliations

Location of lithostratigraphic columns of Plate 2

POST METAMORPHIC MAGMATIC ROCKS

Diorites and Andesites of Lower Oligocene age

Contact aureole of Traversella Diorite Intrusion

CANAVESE ZONE

Permo-Mesozoic Cover

IVREA VERBANO ZONE

Basic granulites and amphibolites

SESIA LANZO ZONE

POLYMETAMORPHIC BASEMENT COMPLEX

a m (i) a1

Internal Unit
Main foliation defined by HP assemblages

Intermediate Unit
GS assemblages overprinting the HP paragenesis

External Unit
Main foliation defined by GS assemblages

Metapelites with major metabasic bodies (a), metagabbros (a_1) and impure marbles (m), intruded and crosscut by late Hercynian granitoids and dykes (i).
Rhombs show relicts of pre-Alpine HT assemblages.
Dashed lines and questionmarks indicate inffered and extrapolated limits.

MONOMETAMORPHIC COVER COMPLEX

Scalaro Unit: Permo-Triassic carbonatic and terrigenous sequences

g **Bonze Unit:** Metabasalts, pillow lavas, pillow breccias and metagabbros (g), with related sediments

PREALPINE HT BASEMENT COMPLEX

Sillimanite-biotite-garnet-bearing gneisses ("kinzigites"), amphibolites and impure marbles (m).

OPHIOLITIC COMPLEX

Undifferentiated Mesozoic cover

Undifferentiated basic and ultrabasic rocks with related sediments

PENNINE DOMAIN

Undifferentiated Gran Paradiso, Arcesa-Brusson and Monte Rosa Units

Leere Seite
Blank page
Page vide

G. VENTURINI, G. MARTINOTTI, G. ARMANDO, M. BARBERO and J.C. HUNZIKER

Plate 2: Lithostratigraphic sections of the Monometamorphic Cover Complex of the Sesia Lanzo Zone. Analysed samples of figure 4 have been collected in the Cavalcurt 1 section and in the Bonze 7 section.

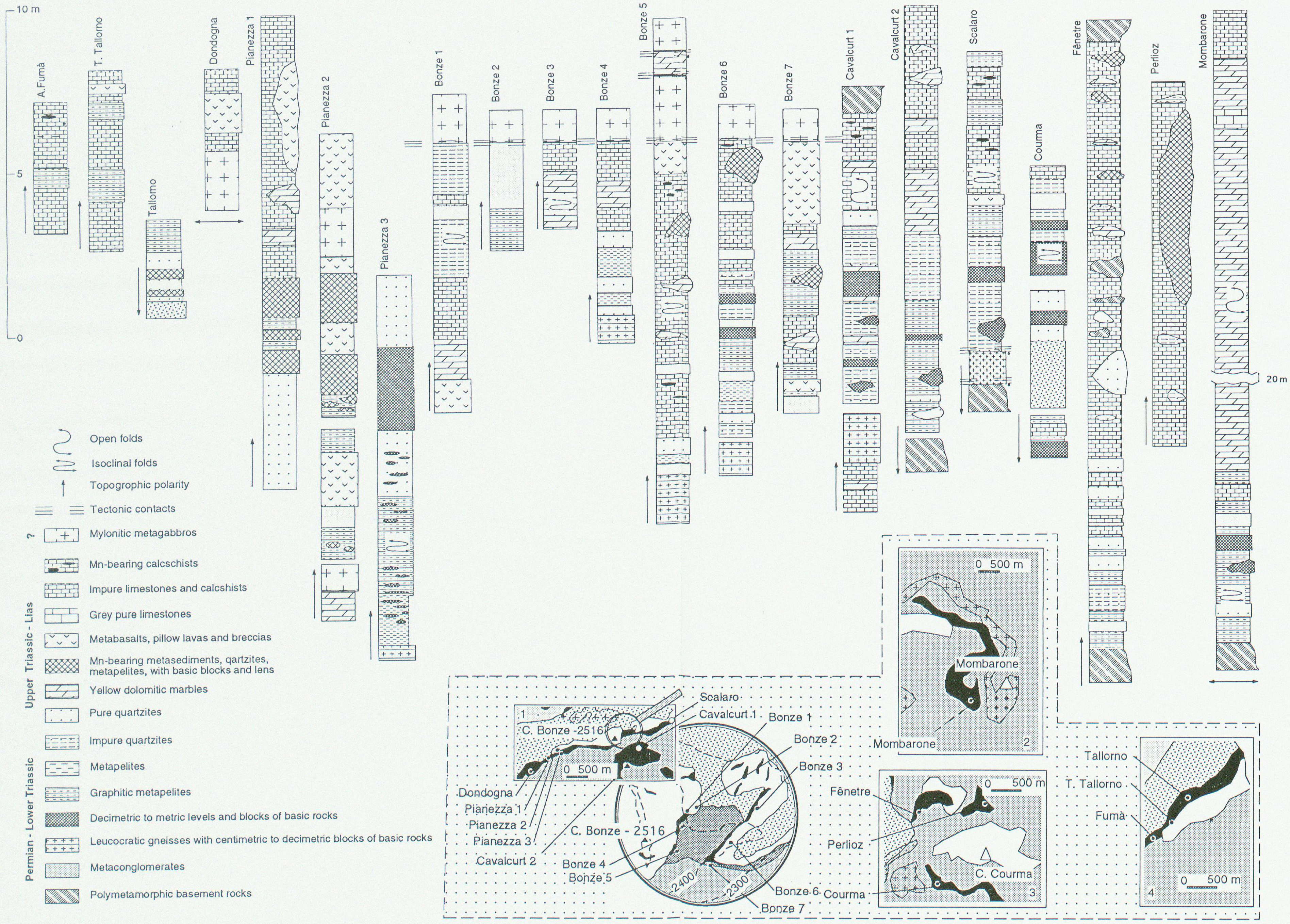


Plate 2