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Excursion Pontresina - Bernina Pass - Tirano

3 Fig.

by RUDOLF TRÜMPY*

1. General situation

The Upper Engadine, the Bregaglia and Poschiavo valleys expose a complete section through the Middle Penninic to Upper Austroalpine nappes, with both Cretaceous and Tertiary structures and metamorphism. Due to the axial pitch toward the east, and also due to considerable E to W thrusting, the following units succeed each other, roughly from W to E:

— The Suretta basement nappe, with a scanty cover;
— The Malenco serpentinite body and the Avers ophiolites and schistes lustrés;
— The strongly deformed, «Ultrapenninic» Margna basement nappe and its sliced cover (Lower Austroalpine p.p. in fig. 1);
— The Platta ophiolite nappe, wedging out southwards. Whether its present position is primary, isolating a Margna «mini-continent», or due to late backthrusting still needs to be discussed;
— The Lower Austroalpine Err and Bernina (s.l.) basement nappes and their cover;
— The Upper Austroalpine (or Central Austroalpine) Languard and Campo basement nappes.

All of these nappes are affected by the Tertiary Malenco antiform, south of which they bend into the subvertical position of the «root zone».

The Oligocene Bregaglia intrusives were emplaced in the acute, transtensive angle between the sinistral Engadine and the dextral Tonale faults. On their northeastern, upper side they cut discordantly into Penninic and Ultrapenninic units, while on their southwestern, lower side they are almost concordant with the country rocks, which were still hot and ductile at this time.

This region has become famous through the works of RUDOLF STAUB** (1916, 1924, 1946). Older and more detailed descriptions are found in STAUB (1934) and ROESLI (1967); see also TRÜMPY & TROMMSDORFF (1980).

Most of the excursion route lies in the Lower Austroalpine Bernina nappe (s.l.), which comprises four digitations: Sella, Corvatsch, Bernina (s.s.) and Stretta. North of the Engadine Line, Bernina s.s. continues into Julier (Güglia), Corvatsch into Grevasalvas. The relations of the apparently lower Err nappe with the units south of the line are unclear.

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** In a recent paper (1991, footnote 11) I have made guesses on the meaning of certain passwords relating to a field trip of Staub and Argand, in 1923. I thank Herbert Strohbach (Trin) for pointing out that Scimingot (coord. 802 100 / 135 000) and Sclupetoir (825 200 / 131 300) were localities in the Poschiavo valley, visited by these two great geologists.

The basement rocks of the Bernina nappe (SPILLMANN & BÜCHI, in press) comprise an older group of rather monotonous metapelites and augen gneisses, marked by an antegranitic metamorphism of amphibolite to greenschist grade. They were intruded by great bodies of Variscan granitoids, which convey a bold character to these peaks, the easternmost ones reaching the 4000 m mark. The predominant rocks belong to a calcalkaline diorite — granodiorite suite; an alkaline assemblage, reaching from syenites to alkali granites, is slightly younger and represented especially on the eastern, upper side of the Bernina nappe s.s. The age of intrusion is mid-Carboniferous (326 m.a.).

Uplift and erosion occurred after the emplacement of the granites. A rhyolite sheet of variable thickness is of Early Permian age (285 m.a.).

Mafic dykes cut not only through the granites, but also through the rhyolites; they may be related to the Triassic volcanism.

The Mesozoic rocks, occurring mainly on Piz Alv and on Sassalbo, have been studied by SCHÜPBACH (1970), ZEHNDER (1975) and NAEF (1987). Marine sedimentation started only in Middle Triassic time. The Middle Triassic carbonates and cornieules are very thin, marking the site of a rise which separated the Austroalpine - South Alpine and Briançonnais Triassic basins. Flows and tuffs of alkaline basaltic composition occur in the Ladinian and in the Carnian formations. The most prominent Upper Triassic formation is the Norian Hauptdolomit (up to 400 m), which here shows a well-bedded, mainly intratidal to supratidal development with partings of green shale. The Rhetian Kössen beds and coral limestones are present, though thin.

With the beginning of the Jurassic, strong rifting produced a highly differentiated paleogeographic pattern. In the frontal part of the Lower Austroalpine (Err nappe), listric faults generally hade towarde the W or NW, i.e. toward the opening Piemont Ocean, in the area visited rather toward the E, away from it (EBERLI, 1988). Chaotic proximal breccias, of Late Sinemurian to Pliensbachian age, will be seen on Piz Alv. They grade eastwards into turbiditic slope breccias and finally into the basinal facies of the Allgäu Formation, with turbidite intercalations.

The post-Liassic formations — radiolarian cherts, thin Maiolica limestones, Lower Cretaceous shales, all of these with breccia intercalations, Rotalipora marl, shales and flysch — will only be seen from afar, in the Samedan Zone between the Err and Julier nappes. The youngest sediments of the Bernina nappe are of Turonian age.

The excursion will also touch the basement rocks of the Languard and Campo nappes*. The two nappes are often difficult to separate, due to the scarcity of Mesozoic dividers. Their basement is complex; both phyllites (similar to the Quarzphyllit of the Eastern Alps) and higher-grade metasediments and metagranites occur. North of Sondalo, in the upper Valtellina, the country rock gneisses are cut by massive plutonic bodies, including a large gabbro massif, of Late Variscan age. Internal thrusting is documented by sharp breaks in lithology and by limestone mylonites (Fliesskalke), especially at the base of the Grosina nappe, which may be either a Variscan or an Alpine (Cretaceous) structure.

Alpine metamorphism in the Bernina Pass region is weak (low greenschist grade) and presumably of eo-alpine (Cretaceous) age.

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* Especially in the upper Valtellina, between Tirano and Sant'Antonio Morignano. No detailed description of this part of the excursion route is given here.

2. Pontresina to Alp Bernina

Pontresina lies on a terrace above the diorites of the Bernina basement. View toward the NW (Samedan Zone and Err basement) and toward the SW (Val Roseg, with the Corvatsch and Sella digitations of the Bernina nappe in the background).

SE of Pontresina, the valley, bordered by outwash gravel terraces, runs between granodiorites to the SW and alkaline granites to the NE. Stop at Montebello: white granites with dykes and inclusions of hornfels and dark gneisses. Alpine stilpnomelane replaces mafic minerals. Beautiful view of the Morteratsch glacier, with its 1820 moraines just behind the railway station. High peaks of the Bernina range; from left to right: Piz Palü - Bellavista - Piz Zupò - Crast'Agüzza - Piz Bernina - Piz Morteratsch.

Pink granites further along the road. To the left, Piz Albris, with a subvertical intrusive contact of alkaline granites against gneisses. Ibex may be seen on its cliffs, marmots in the valley below.

Stop at Curtinatsch at the southern foot of Piz Alv (station of Lagalb cable car). The Mesozoic rocks of Piz Alv lie between the Bernina nappe (s.s.), to the N and W, and the Stretta lobe, to the S and E; stratigraphic contacts with the basement rocks of both digitations are preserved. The upper, inverted limb of the synform is more complete than the lower one. A subhorizontal, secondary thrust runs below the summit block. NE of Curtinatsch, a fairly complete section shows Hauptdolomit, with limestone intercalations in its upper part (Plattenkalk), Rhetian Kössen beds with coquinas, grey, platy limestones (dated as Sinemurian by a single ammonite) and finally the spectacular Alv Breccia.

The Alv Breccia can be studied in a boulder field to the N of the parking lot. It contains angular fragments of Hauptdolomit, from sand size to slabs measuring 400 by 50 m; some of the latter have been confounded with tectonic slices, but the contacts are definitely stratigraphic. Several generations of cracks are observed in the fragments. The matrix consists of red or yellow micrite, calcitic or mor often dolomitic, with dolomite sand. The Alv Breccia was apparently formed at the proximal edge of an Early Jurassic fault scarp. Schüpbach (1970) and 1973) considered a terrestrial environment, invoking phreatic and vadose cementation. Some of his arguments, based on Fe^{++} - and Fe^{+++} - distributions, are questionable, as they neglect the influence of metamorphism. Even if the initial breakup of the Hauptdolomit took place above sea-level, the infilling of the red and yellow micrite must have occurred under marine conditions, as attested by belemnites and crinoids.

3. Alp Bernina to Poschiavo

South of Curtinatsch, the yellow-weathering sediments of the Alv Zone run into Val d'Arlas, separating the Stretta nappe of Sassal Mason from the Bernina nappe s.s. of the high peaks of the Piz Palü — Piz Cambrena range. The latter are particularly impressive seen from Alp Grüm, on the Bernina railway line.

The landscape around Bernina Pass is marked by the transfluence of Engadine ice, and by the capture of the Bernina valley torso from the deep lying erosion base to the south. The local geology is rather uninspiring: green augen gneisses, with intercalations of dark, metapelitic gneisses, belonging to the Stretta digitation. Good view toward the south, white cliffs of Sassalbo, to its left the pyramid of Pizzo Teo and in the east the high Corn da Camp, type locality of the Campo nappe. To the S, the panorama is closed by the Catena Orobica, belonging to the Southern Alps.

Near Poschiavo, the effects of a 1987 mud-and-boulder flow, out of the Valle di Verona, are still conspicuous.

Stop south of Poschiavo: view of the Sassalbo mountain from the SW. Its mesozoic sediments separate the basement rocks of the Stretta lobe from those of the Languard nappe; its structural position is thus higher than the similar synform on Piz Alv. SPITZ & DYHRENFURTH (1913) interpreted Sassalbo as a recumbent syncline open to the west, a view contested by STAUB (1920) but confirmed by ZEHNDER (1975). N to S movements are superposed on the primary, north-striking synform, which links Lower and Upper Austroalpine nappes. The upper limb, which is in stratigraphic contact with the Languard basement, is well developed, whereas the lower limb is apparently partly cut out by a lag (= flat-lying normal fault). On the other hand, the lower limb is duplicated by a later and minor thrust. Stratigraphic contacts with the Stretta basement are also present.

The succession on Sassalbo contains «Verrucano» (Chazforà formation), thin Middle Triassic carbonates and fairly thick Hauptdolomit. The latter encloses grey and pink, monogenic breccias, apparently formed in situ, which habe been confounded with the Jurassic Alv Breccia. The Rhetian is represented by Kössen beds and by a thin but persistent layer of green shale, possibly a volcanic tuff. The core of the syncline is formed by well bedded cherty limestones; belemnite rostra sometimes show a remarkable parallel alignment, due to their transport by turbidity currents. Breccias are intercalated at various levels; the older ones contain only dolomite fragments, the younger (Middle Jurassic ?) ones also components of basement rocks and of Chazforà sandstones. A Jurassic fault scarp may be assumed W of Sassalbo. The presence of Upper Jurassic and Cretaceous formations, shown on Staub's 1946 map, was not confirmed by ZEHNDER.

4. Poschiavo to Tirano

Near the village of Le Prese, slices of Mesozoic rocks are exposed; they belong to the strongly deformed cover of the Margna nappe (Fex slices). These are the easternmost outcrops of coherent Penninic nappes (s.l.), in the core of the east-pitching Malenco (or Passo d'Ur) antiform. Malenco serpentinites are quarried SW of Poschiavo. Beyond the antiform, the nappes begin to plunge, gently at first and then steeply, into the Austroalpine «root zone».

The lake of Poschiavo is dammed by an interstadial landslide, which broke away from the right (SW) side of the valley and ran up the opposite slope.

The granodiorites around Brusio are attributed to the Bernina nappe s.s.. Further south come metasedimentary gneisses of high amphibolite grade, with an amphibolite body on the Swiss-Italian border. From here to Tirano, gneisses and micaschists are more or less vertical and even overturned. Distinction between individual Austroalpine nappes becomes difficult, as no Mesozoic rocks occur along this section.

Tirano lies about 5 km north of the Tonale Line, which runs over the flat mountain of Monte Padrio. It marks the late underthrust of the Adriatic plate, coupled with a dextral displacement of about 80 km. The «Tonale series» is found persistenly just north of the Line. It is characterized by metapelites of high amphibolite grade, with marbles and calcsilicate rocks, amphibolites and pegmatites. Similar rocks of deep crustal origin occur in the west (e.g. Valpellina series of the Dentblanche nappe) and in the east (e.g. Pastori series of the Umbrail region).

References

EBERLI, G. (1988): The evolution of the southern continental margin of the Tethys Ocean as recorded in the Allgäu Formation of the Austroalpine Nappes of Graubünden. - Eclogae geol. Helv., **81**/3, 175-214.

NAEF, M.H. (1987): Ein Beitrag zur Stratigraphie der Trias-Serien im Unterostalpin Graubündens. - Thesis ETHZ, Nr. 8236, 206 pp.

ROESLI, F. (1967): Exk. 43, Celerina (Schlarigna) - Berninapass - Tirano. - In: Geol. Führer Schweiz (Wepf, Basel), 883-892.

SCHÜPBACH, M. (1970): Der Sedimentzug Piz Alv - Val da Fain. - Vierteljschr. Naturf. Ges. Zürich, **115**/2, 231-237.

—, (1973): Comparison of slope and basinal sediments of a marginal cratonic basin (Pedregosa Basin, New Mexico) and a marginal geosynclinal basin (Bernina nappe, Switzerland). - Ph. D. thesis, Rice Univ. (Houston).

SPILLMANN, P. & BÜCHI, H.J. (in press) The pre-Alpine Basement in the Bernina Massif (provisional title). - In: The Pre-Mesozoic evolution of the Alps (F. Neubauer & J. von Raumer, eds.); Springer, Heidelberg.

SPITZ, A. & DYHRENFURTH, G. (1913): Die Triaszonen am Berninapass und im östlichen Puschlav.—Verh. k. k. geol. Reichsanstalt, **16**, 403-415.

STAUB, R. (1916): Tektonische Studien im östlichen Berninagebirge. - Vierteljschr. Naturf. Ges. Zürich **61**, 224-407.

—, (1920): Zur Geologie des Sassalbo im Puschlav. - Eclogae geol. Helv., **15**/4, 501-507.

—, (1924): Der Bau der Alpen, - Beitr. geol. Karte Schweiz, N.F. **52**, 373 pp.

—, (1934): Exk. Nr. 100 A, Pontresina - Berninapass - Poschiavo (Puschlav) - Tirano. - In: Geol. Führer der Schweiz, Schweiz. Geol. Ges., 1130-1139.

TRÜMPY, R. (1991): In the footsteps of Emile Argand: Rudolf Staub's Bau der Alpen (1924) and Bewegungsmechanismus der Erde (1928). - Eclogae geol. Helv., **64**/3, 661-670.

TRÜMPY, R. & TROMMSDORFF, V. (1980): Excursion no. IV, Alps of Eastern Switzerland. - In: Geology of Switzerland (Wepf, Basel), 211-260 (esp. 243-244).

ZEHNDER, K. (1975): Zur Geologie des Sassalbo (Val Poschiavo, Graubünden). - Vierteljschr. Naturf. Ges. Zürich, **120**/3, 189-194.

Geological maps

STAUB, R. (1921): Geologische Karte der Val Bregaglia (Bergell), 1:50 000. - Spez. - Karte **90**, Schweiz geol. Komm.

—, (1946): Geologische Karte der Bernina-Gruppe und ihrer Umgebung im Oberengadin, Bergell, Val Malenco und Livigno, 1:50 000. - Spez. - Karte **118**, Schweiz. geol. Komm.

Carta geologica d'Italia, 1:100 000 (1969): Foglio 19, Tirano.

—, (1970): Foglio 8, Bormio.

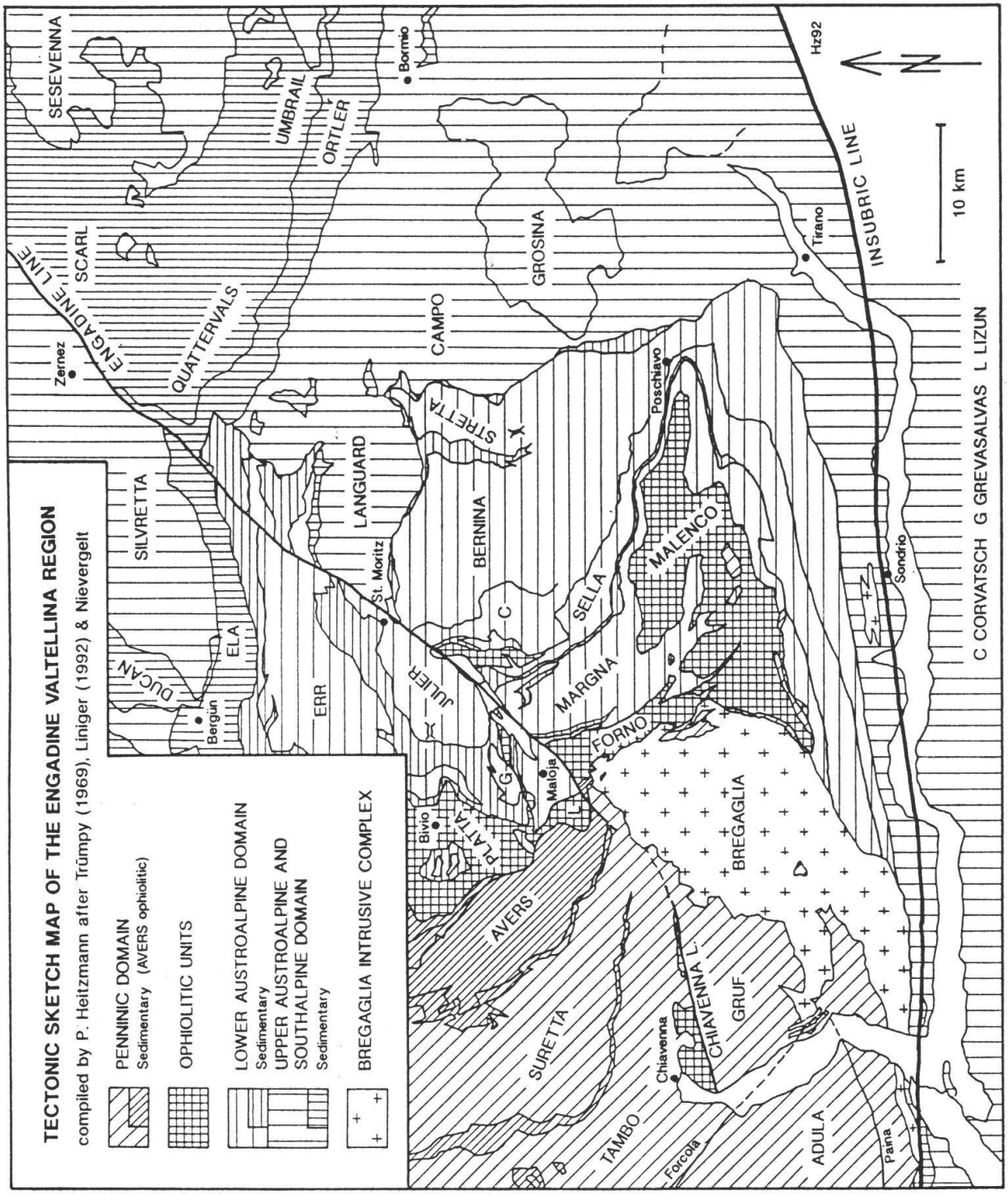

Fig. 1 Tectonic map of the Engadin, eastern Switzerland

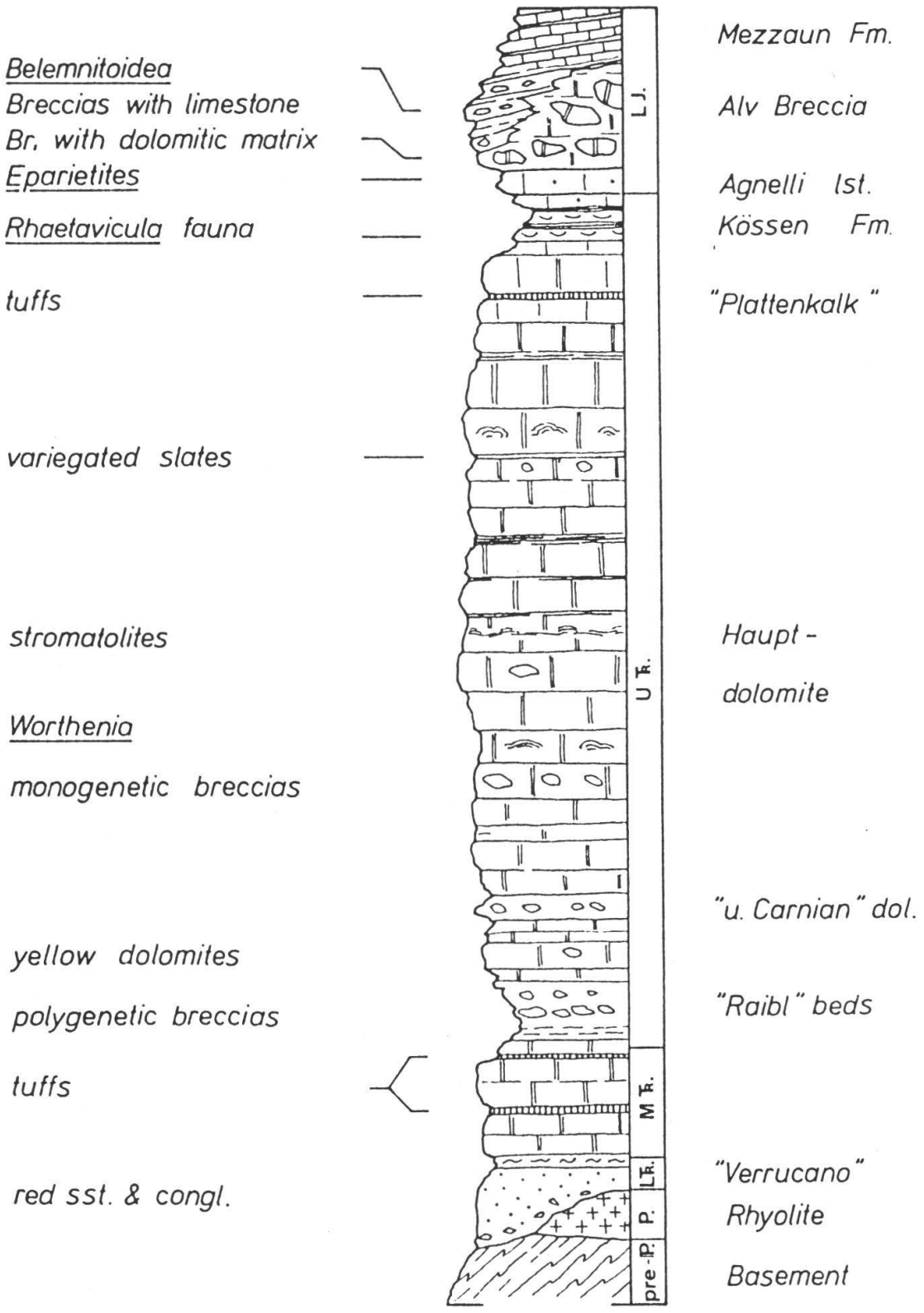

Fig. 2: Stratigraphic section of Piz Alv. After M. SCHÜPBACH 1970 and manuscript from TRÜMPY and TROMMSDORFF, 1980, Fig. 21 p.3. Total thickness ca 300 m.

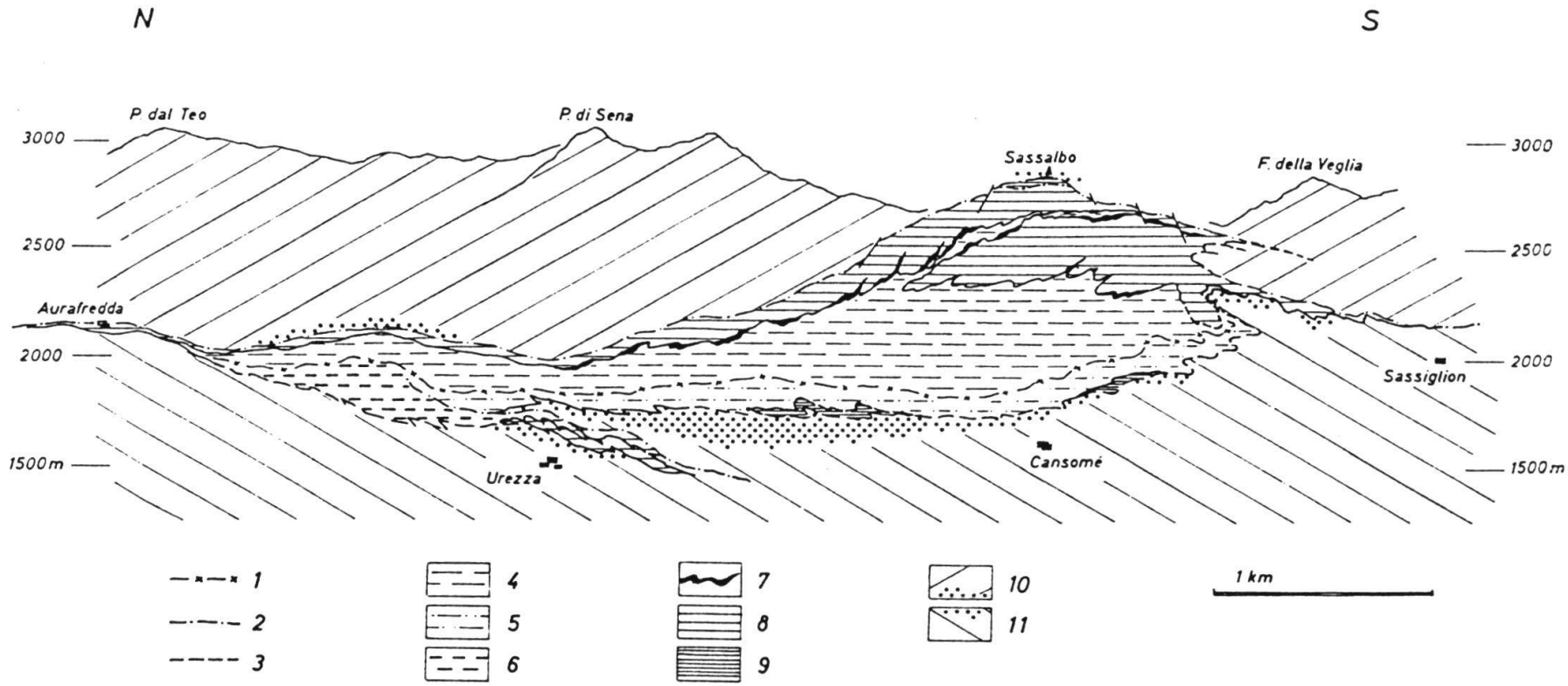

Fig. 3 Ansicht der Sassalbo-Zone von Westen (Parallelprojektion auf eine senkrechte Nord-Süd-Ebene, from: ZEHNDER 1975.
1: Mittlere Faltenzone; 2. Überschiebungsfläche; 3. Kontakt nicht sichtbar; 4-6: Kalke des Lias-?, gegliedert in 4: Verkehrt-Schenkel, 5: Normal-Schenkel, 6: Urezza-Schuppe; 7: grüne Mergel (ob Rhät?); 8: ob. Trias (Hauptdolomit und Bunte Breccie); 9: mittl. Trias; 10-11: Kristallin, mit Verrucano (punktiert), gegliedert in 10: Campo-Decke, 11: Bernina-Decke.