GORTANIA
Geologia, Paleontologia, Paletnologia 42 (2020) 5-24 Udine, 28.XII.2020 ISSN: 2038-0410

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GEOLOGY OF MOUNT ZERMULA MASSIF (CARNIC ALPS, NE ITALY)

GEOLOGIA DEL MASSICCIO DEL MONTE ZERMULA (ALPI CARNICHE, ITALIA NORD-ORIENTALE)

Abstract - In Mt Zermula area rocks of Ordovician to Carboniferous age belonging to the Pre-Variscan sequence of the Carnic Alps crop out. The whole area was overturned during the Variscan orogeny and the higher parts of Mt Zermula represent Devonian shallow water rocks thrusted on top of an Upper Ordovician to Lower Carboniferous succession showing mostly basin to slope depositional environments. This distal sequence is well exposed in the southern flank of Mt Zermula and in the eastern and western sides of the study area. The lithostratigraphic units and their relationships are described. A geological map of the southern part of Mt Zermula is provided, as well as a stratigraphic scheme.
Key words: Pre-Variscan sequence, Palaeozoic, Lithostratigraphy, Geological map, Carnic Alps

Riassunto breve - *Nell'area del M. Zermula affiorano rocce di età compresa tra l'Ordoviciano e il Carbonifero, appartenenti alla sequenza Pre-Varisica delle Alpi Carniche. L'intera area è stata ribaltata e deformata tettonicamente durante l'Orogenesi Varisica: le cime del M. Zermula, costituite da rocce devoniane di mare basso, sono sovrascorse su una sequenza di mare aperto datata all'Ordoviciano-Carbonifero. Questa sequenza distale è ben esposta nel versante meridionale del M. Zermula e alle estremità occidentale e orientale dell'area studiata. In questo lavoro vengono descritte le unità litostratigrafiche affioranti e le loro relazioni. Lo studio è corredato da una carta geologica comprendente anche lo schema stratigrafico.*
Parole chiave: *Sequenza Pre-Varisica, Paleozoico, Litostratigrafia, Carta Geologica, Alpi Carniche*

Introduction

Mount Zermula massif is a prominent mountain ridge located in the Italian side of the central Carnic Alps (Figs 1 and 2) extending for about 5 km from NW to SE, more or less parallel to state border. The succession in the area ranges from Upper Ordovician to Carboniferous and belongs to the Pre-Variscan sequence of the Carnic Alps. Mount Zermula represents one of the four "Devonian reefs" of the Carnic Alps, but the study area can be roughly subdivided into two parts separated by an important regional overthrust: the northern part, representing the main peaks, is characterized by shallow water Devonian rocks; the southern part exposes a more distal sequence from Upper Ordovician to Carboniferous age.

The area is included in a few geological maps (e.g., Gortani 1920; Gortani & Desio 1927; Selli 1963b; Venturini 1990; Venturini et al. 2002) but never in great detail and often the lithostratigraphic units are grouped according to their age and/or facies. In this paper the geology of the southern side of the Mt Zermula area is described according to the present lithostratigraphic scheme of the Pre-Variscan sequence (Corradini & Suttner 2015) and a geological map at 1:15.000 scale is included. Geological maps of two

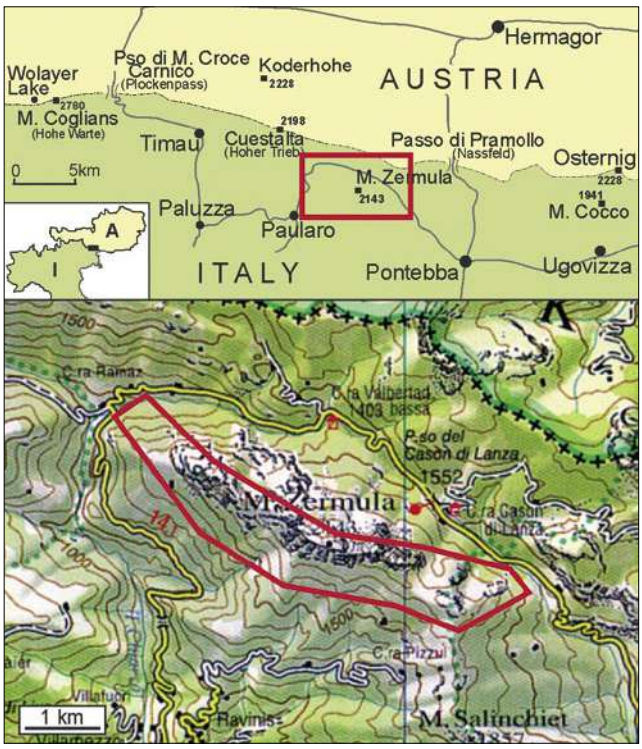


Fig. 1 - Location map of the studied area. Highlighted area roughly represents the region mapped in the geological map (Fig. 4).
- *Ubicazione dell'area studiata. La carta geologica (Fig. 4) si riferisce alla zona evidenziata.*

extremities of the studied area were recently provided by Pondrelli et al. (2015a) and Corradini et al. (2016): aim of this work is to fill the gap between these areas focusing on the southern part of Mt Zermula in order to constrain the lateral continuity of the units, both in terms of lithological content and stratigraphic distribution, and the tectonic framework of the area. It should be pointed out that the northern flank of the area is constituted by undifferentiated Devonian shallow water rocks, beside Quaternary covers.

Previous studies

The oldest geological studies on Mt Zermula area date back to the second half of XIX century. For long time the main goal of scientists was the reconstruction of the stratigraphic sequence of the Carnic Alps, and the age of the calcareous cliffs was estimated on the basis of the lithological similitude with the other mountains of the area and the fossil remains collected from the underlying units. In this respect, the calcareous cliffs of Mt Zermula were considered either Carboniferous (e.g., Stur 1856; Pirona 1861; Taramelli 1878, 1881, 1882; Pantanelli 1882), or Triassic (Frech 1894). Finally, Taramelli (1895) recognized the Devonian age of Mt Zermula on the basis of the stratigraphy of the area.

At the beginning of the XX century the Palaeozoic sequence in the Mt Zermula area was widely investigated by Michele Gortani and Paolo Vinassa de Regny, who considered the area as part of the "central core of the Carnic Alps", and published dozens of papers on various geological and palaeontological topics. Among them, they described the stratigraphic sequence of the area (Vinassa de Regny & Gortani 1905, 1908; Gortani 1913, 1915, 1920), discriminating for the first time the Silurian pelites from the Carboniferous sediments and published a geological map of the area (Vinassa de Regny & Gortani 1905). Futhermore, Vinassa de Regny (1910) described several Ordovician fossil groups.

After a break of several years, the area was investigated in the sixties as part of mapping projects (Selli 1963a), especially focusing on the Permo-Carboniferous sequence (Selli 1963b). In the same time biostratigraphic researches on conodonts were carried on various time intervals, from early Ordovician to Early Carboniferous (Serpagli & Greco 1965; Manzoni 1965, 1966; Ferrari & Vai 1966; Serpagli 1967). Devonian corals were studied by Ferrari (1968).

More recently researches were focused on the eastern and western extremities of Mt Zermula massif: the areas of Mt Pizzul/Zuc di Malaseit and La Valute, respectively. The stratigraphic sequence of the two areas were described and mapped by Carta (2011), Pondrelli et al. (2015a) and Corradini et al. (2016); conodont stratigraphy of several Silurian and Devonian sections was published by Corriga et al. (2011), Mossoni et al. (2012), Suttner et al. (2017a, 2017b) and Corradini et al. (2016, 2017); fossils from different groups and ages were described: orthoconic cephalopods (Gnoli & Histon 1997), loboliths (Corradini et al. 2005), corals (Kido et al. 2011a, 2011b; Corradini et al. 2019) and graptolites (Piras et al. 2012).

Finally, geochemical and geophysical studies across the Kacak Event (an important oceanic-extinction event connected with sharp eustatic fluctuations across the Eifelian-Givetian boundary) were carried on by Kido et al. (2012) and Suttner et al. (2017a) on the Zuc di Malaseit Basso section.

Structural frame

The study area is part of a larger sector of the Carnic Alps that was overturned during the Variscan orogeny. The thrusts and folds present in this area show a

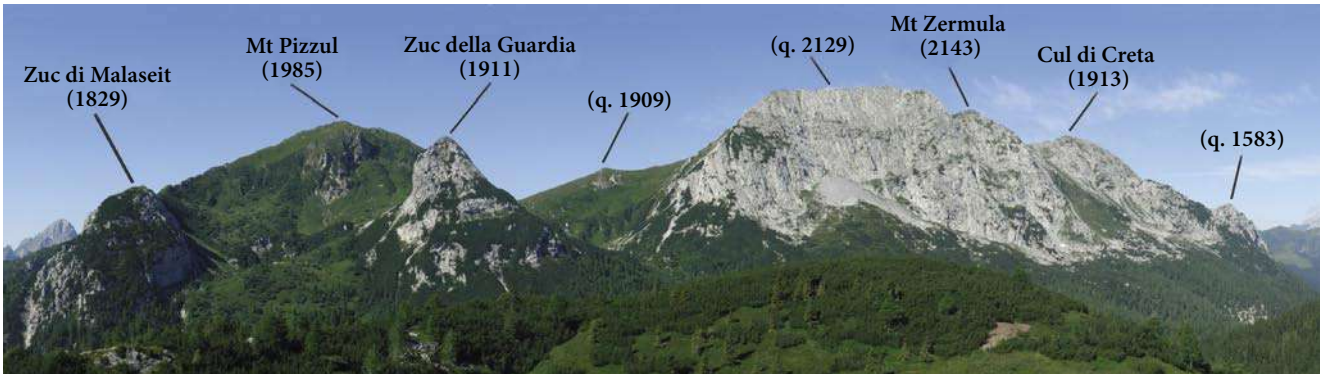


Fig. 2 - Panoramic view of the northern side of Mt Zermula massif. The white cliffs in front are constituted by Devonian shallow water rocks; the darker sediments in the back represent the more distal Ordovician to Carboniferous sequence.
- *Veduta panoramica del versante nord del massiccio di M. Zermula. Le pareti chiare in primo piano sono costituite da calcari devoniani di acqua bassa; i sedimenti scuri in secondo piano sono la successione più distale di età compresa tra l'Ordoviciano e il Carbonifero.*

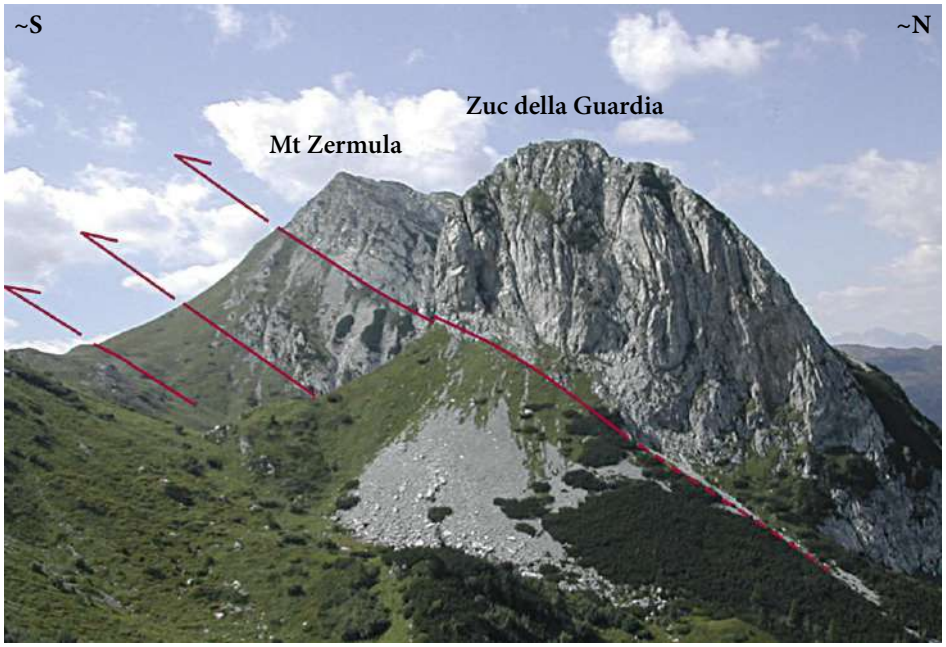


Fig. 3 - North dipping Alpine thrust of Tortonian-Serravallian age. The Eifelian?-Frasnian whitish shallow water rocks overthrust the Upper Ordovician-Carboniferous distal sequence. The whole sequence is overturned.
- *Il sovrascorrimento alpino, di età Tortoniana-Serravalliana, immergente a Nord. Le rocce chiare di mare basso del Devoniano sovrascorrono sopra a una sequenza di età compresa tra l'Ordoviciano e il Carbonifero. L'intera successione è rovesciata.*

constant top to the south vergence (Venturini 1990). The higher parts of Mt Zermula represent Devonian platform rocks thrusted on top of an Upper Ordovician to lower Carboniferous succession showing mostly basin to slope depositional environments (Fig. 3). This thrust is associated to fold propagation folding from the centimetric to the decametric scale, consistent with the top to the south deformation.

The original NW-SE trending structures were later reactivated during Alpine times as compressive structures during the Tortonian-Serravallian phase and as dextral strike slip during the Plio-Pleistocene phase (Venturini 1990).

Lithostratigraphy

The succession is carbonate dominated, except for most of the Upper Ordovician and the lower Carboniferous. Deposition was quite uniform along the area with the exception of the Eifelian-Frasnian where the basin differentiated in a proximal shallow water part passing distally to slope and then to pelagic deposits. The thirteen formations discriminated are here briefly described in stratigraphic order, starting from the oldest. Their stratigraphic relations are sketched in the stratigraphic scheme associated to the geological map (Fig. 4).

Valbertad Formation (Katian)

The Valbertad Formation (Schönlaub & Simonetto 2015) crops out in a narrow belt along the footwall of major thrusts, both in the eastern and western sectors of the studied area. It consists of greyish, brownish and greenish siltstones to arenaceous shales, and rare fine-grained graywackes and sandstones (Fig. 5a). In the upper part (roughly the last 3 m) of the unit, the pelites are increasingly interbedded with thin to very thin nodules of medium light grey mudstone and wackestone. Nodules become more abundant, thicker and with more lateral continuity going upward emphasizing a gradual transition to the following Uqua Formation.

Fossils are abundant in some levels, and are mainly represented by brachiopods, bryozoans, trilobites and rare cystoids and gastropods (Fig. 6).

In the Mt Zermula area the unit maximum thickness is about 7 m in the eastern flank of the Zuc di Malaseit, but the lowermost limit (here like everywhere in the Carnic Alps) is always tectonic. In other areas of the Carnic Alps the Valbertad Formation is up to 130 m thick (Schönlaub & Simonetto 2015).

Uqua Formation (Katian-Hirnantian?)

The Uqua Formation (Schönlaub & Ferretti 2015a) crops out at the top of Mt Pizzul (Fig. 5b), west of the Forca di Lanza and in the La Valute area. It consists of thin to very thin beds of medium light grey nodular mudstone and wackestone with very thin beds of light olive fine-grained graywacke interlayered. Conodonts are the only abundant fossils, which allowed to assign the unit to the *ordovicicus* Zone (Manzoni 1965; Serpagli 1967).

The transition to the following Plöcken Formation is marked by a distinct change in colour between light olive grey and medium dark grey shales. However, the shales are very poorly exposed in the study area, so the nature of the contact is not clear.

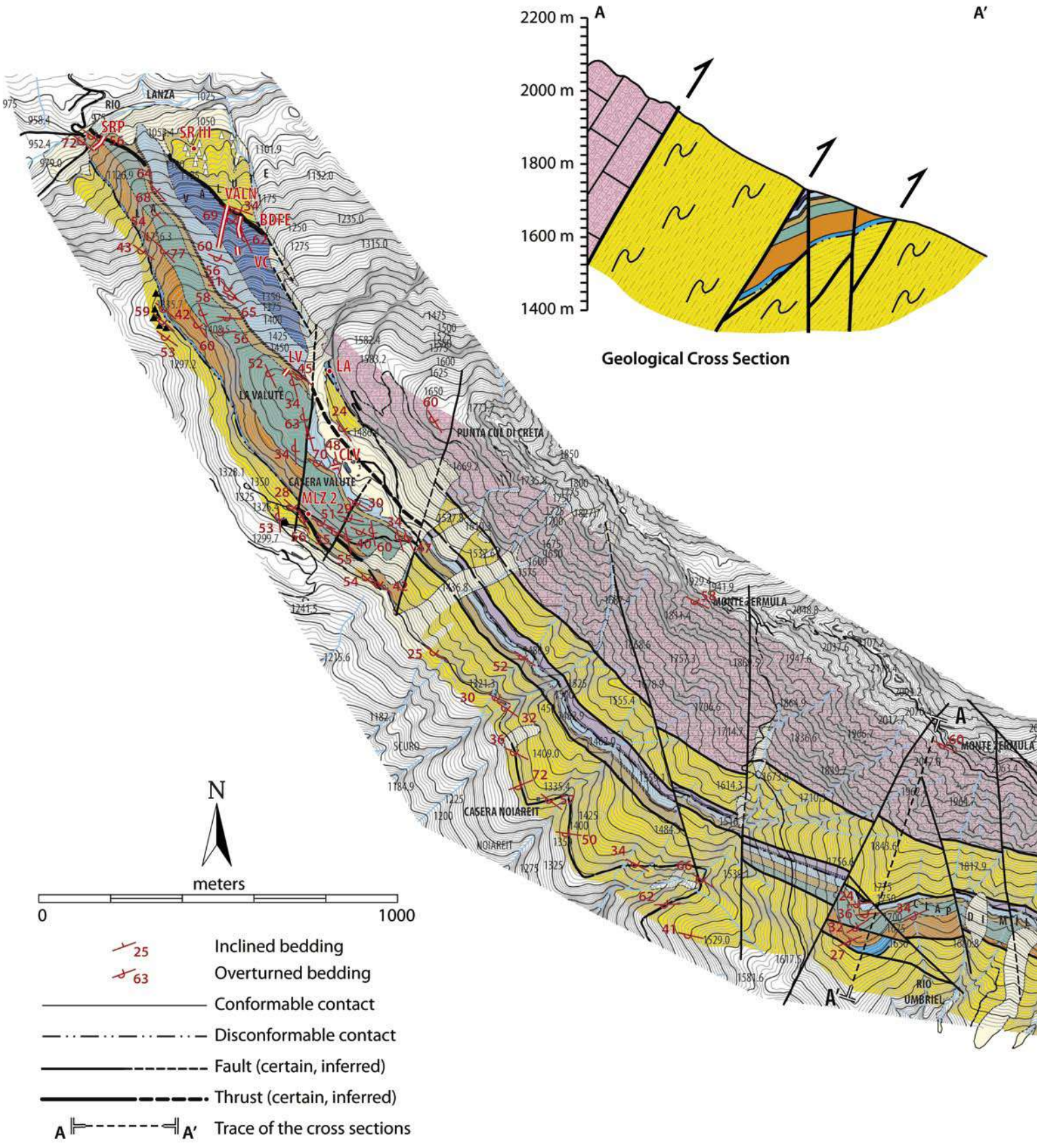
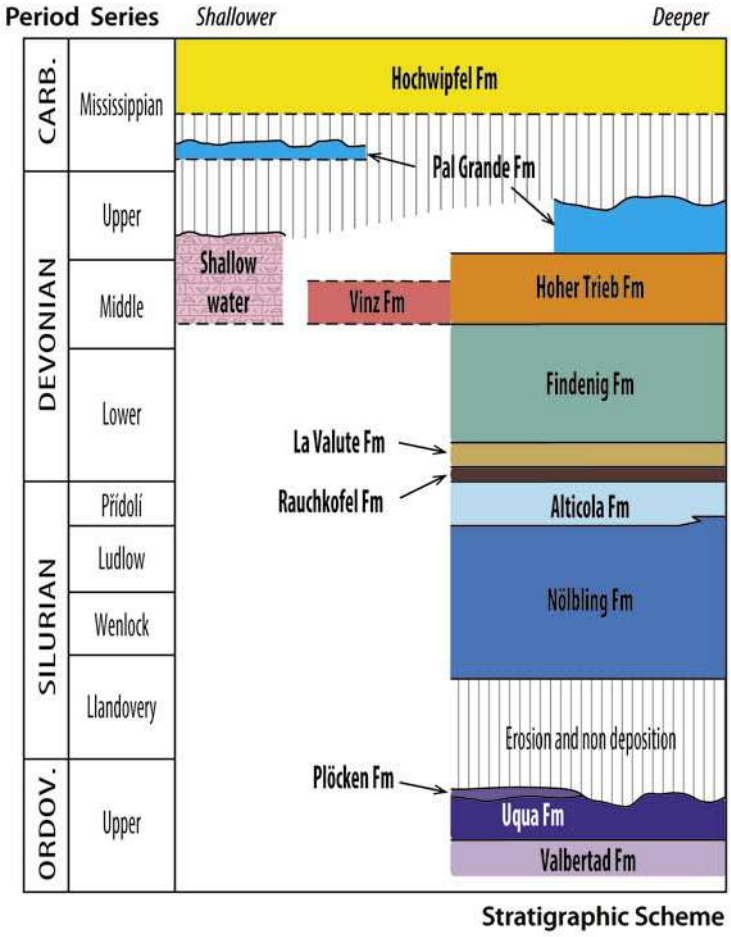


Fig. 4 - Geological map of the southern flank of Mt Zermula massif and stratigraphic scheme.
- *Carta geologica del versante meridionale del massiccio di M. Zermula e schema stratigrafico.*


Period Series
Shallower
Deeper
CARB.
Mississippian
DEVONIAN
Upper
Middle
Lower
SILURIAN
Přídolí
Ludlow
Wenlock
Llandovery
ORDOV.
Upper
Hochwipfel Fm
Pal Grande Fm
Shallow water
Vinz Fm
Hoher Trieb Fm
Findenig Fm
La Valute Fm
Rauchkofel Fm
Alticola Fm
Nölbling Fm
Erosion and non deposition
Plöcken Fm
Uqua Fm
Valbertad Fm
Stratigraphic Scheme


Legend
Quaternary (undifferentiated)
Hochwipfel Fm
Visean-Bashkirian
Pal Grande Fm
Frasnian-Tournaisian
Shallow water (undifferentiated)
Eifelian?-Frasnian
Hoher Trieb Fm
Eifelian-Frasnian
Vinz Fm
Eifelian
Findenig Fm
Lochkovian-Eifelian
La Valute Fm
Lochkovian
Rauchkofel Fm
Lochkovian
Alticola Fm
Přídolí
Nölbling Fm
Telychian?-Přídolí
Plöcken Fm
Hirnantian
Uqua Fm
Katian
Valbertad Fm
Katian

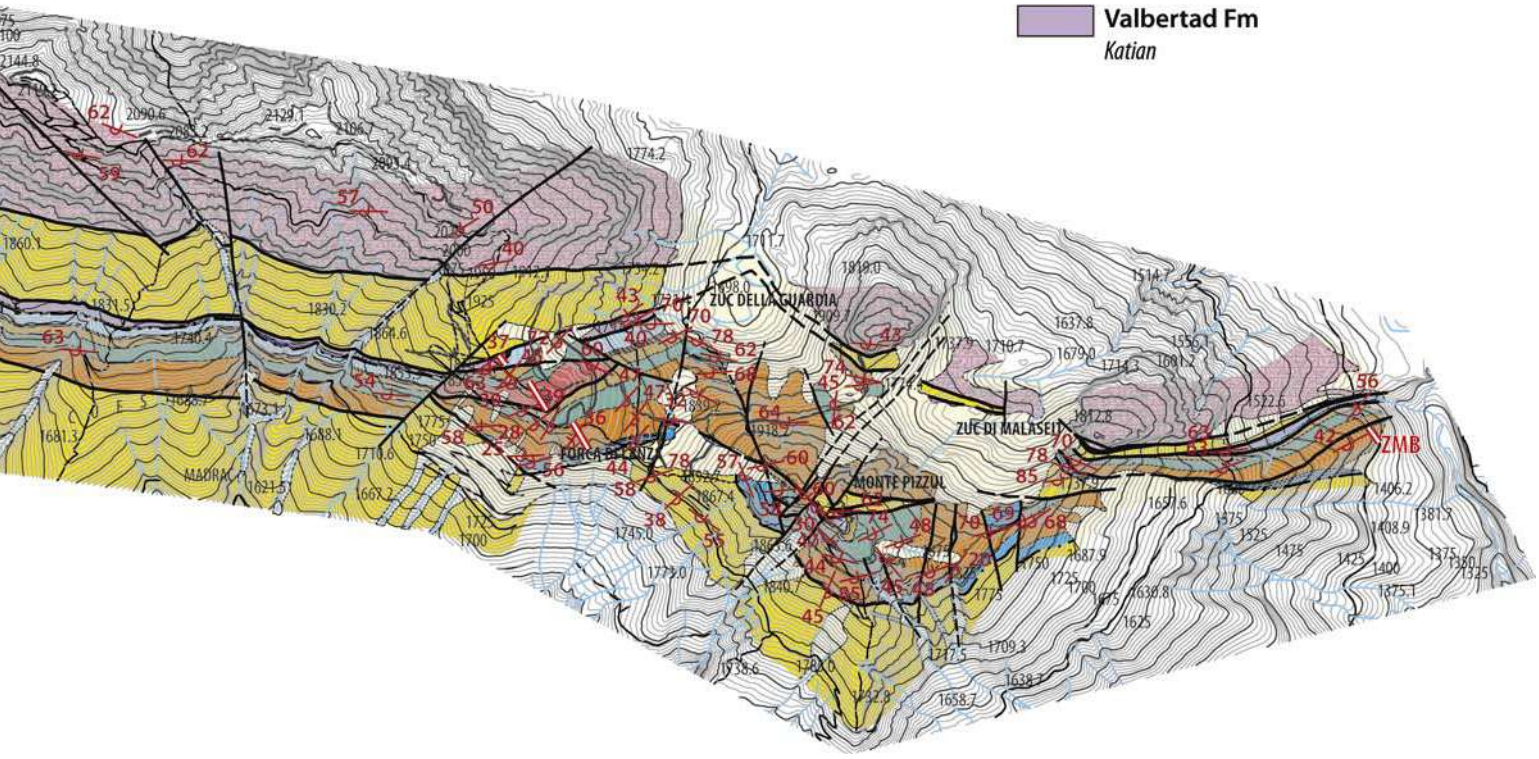

ZUC DELLA GUARDIA
ZUC DI MALASEIT
MONTE PIZZUL
ZMB

Fig. 5 - a) The classical fossiliferous outcrop of the Valbertad Fm. at the top of Mt Pizzul. b) The nodular limestone of the Uqua Fm. near Mt Pizzul summit. c) Calcareous sandstones of the Plöcken Fm. west of Forca di Lanza. d) The Alticola Fm. at Cadin di Lanza (CAD II locality). e) The Nölbling Fm. in the lower part of the La Valute Nord (VALN) section.
- *a) L'affioramento fossilifero della Fm. di Valbertad in vetta al M. Pizzul. b) I calcari nodulari della Fm. di Uqua nei pressi della vetta del M. Pizzul. c) Arenarie calcaree della Fm. del Plöcken a ovest di Forca di Lanza. d) La Fm. ad Alticola nel Cadin di Lanza (località CAD II). e) La Fm. di Nölbling nella parte bassa della sezione La Valute Nord (VALN).*

The maximum thickness of the Uqua Formation is about 3.5 m west of the Forca di Lanza.

Plöcken Formation (Hirnantian)

In the study area the Plöcken Formation (Schönlaub & Ferretti 2015b) is documented only in a small outcrop west of the Forca di Lanza, where is 5.5. m thick, and, possibly, in the eastern flank of Zuc di Malaseit where a loose block was found in the detritus.

The unit consists mainly of calcareous sandstone (Fig. 5c). The calcareous sandstones are moderately sorted and medium- to fine-grained at the base passing upward to medium-, coarse and then very coarse-grained in

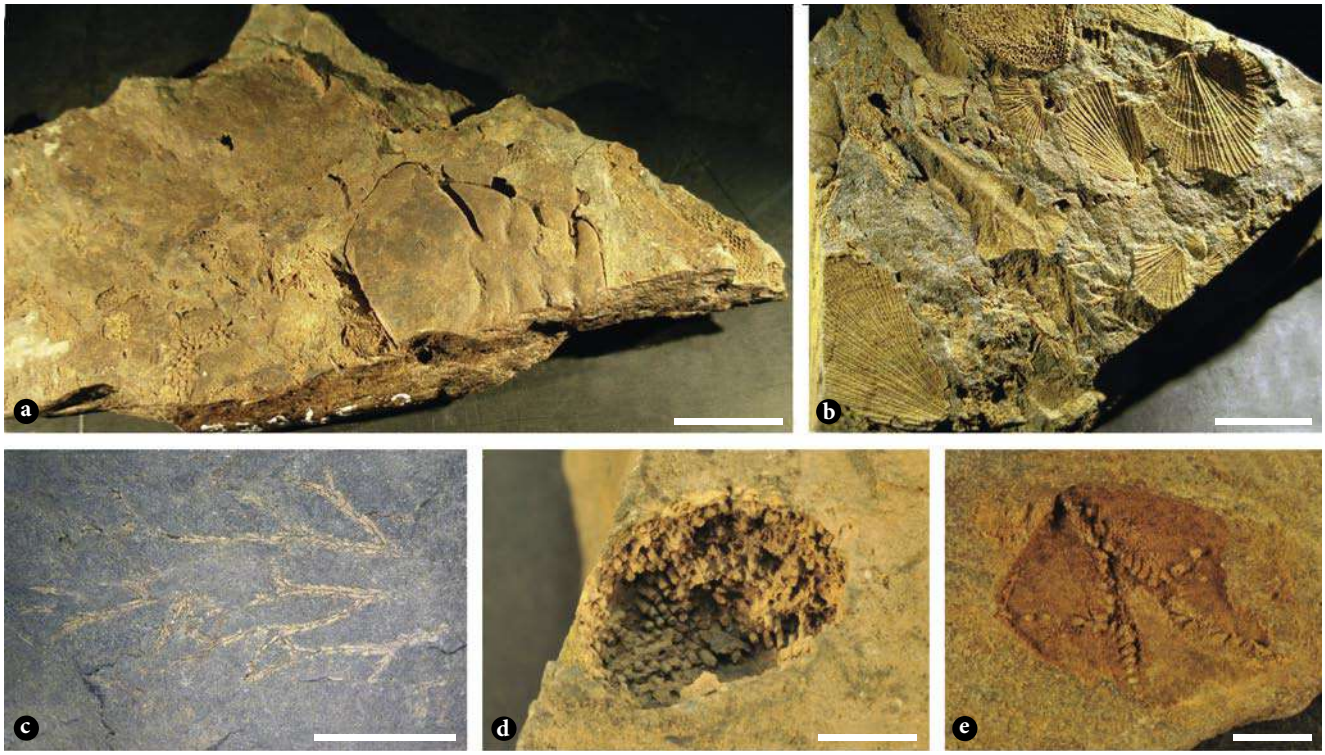


Fig. 6 - Selected Ordovician fossils from Mt Zermula area. a) Slab with a fragment of a large trilobite cephalon and bryozoans remains MFSNgp 33345; west of Forca di Lanza, Valbertad Fm.; scale bar = 10 mm. b) Slab with several remains of brachipods (*Longvillia mediterranea* Havlíček, 1981 and *Dolerorthis intermedia* (Meneghini, 1857)) and bryozoans MFSNgp 26844; top of Mt Pizzul, Valbertad Fm.; scale bar = 10 mm. c) Dendroid bryozoan colony MFSNgp 35050; top of Mt Pizzul, Valbertad Fm.; scale bar = 10 mm. d) Bryozoan colony MFSNgp 28859; 30 cm below the base of the BDFE section, Valbertad Fm.; scale bar = 2 mm. e) Isolated plate of cystoid MFSNgp 28865; 30 cm below the base of the BDFE section, Valbertad Fm.; scale bar = 2 mm.

- *Fossili ordoviciani dall'area del Monte Zermula. a) Blocchetto con un frammento di un cephalon di trilobite di grandi dimensioni e resti di briozoi, MFSNgp 33345; ovest di Forca di Lanza, Fm. di Valbertad; scala = 10 mm. b) Campione con numerosi resti di brachiopodi (*Longvillia mediterranea *Havlíček, 1981 e* Dolerorthis intermedia *(Meneghini, 1857) e briozoi, MFSNgp 26844; vetta del M. Pizzul, Fm. di Valbertad; scala = 10 mm. c) Colonia dendroide di briozoi MFSNgp 35050; vetta del M. Pizzul, Fm. di Valbertad; scala = 10 mm. d) Colonia di briozoi MFSNgp 28859; 30 cm sotto la base della sezione BDFE, Fm. di Valbertad; scala = 2 mm. e) Placchetta isolata di cistoide MFSNgp 28865; 30 cm sotto la base della sezione BDFE, Fm. di Valbertad; scala = 2 mm.*

correspondence of the topmost bed, thus defining a coarsening upward succession (Pondrelli et al. 2015b). In the lowermost part of the unit hummocky cross-stratification appears to be present; in the upper part of the succession, both high-angle and low-angle cross-stratifications are present, with only low-angle cross-stratification in the uppermost layer. Disarticulated fossil debris (mainly brachiopods) is very common.

Nölbling Formation (Telychian?- Přídolí)

The Nölbling Formation (Schönlaub et al. 2015a) is widely exposed in the western sector of the study area, whereas elsewhere only a small outcrop in the eastern flank of Zuc di Malaseit is documented. The Nölbling Formation lies on top of the Uqua Formation with a disconformable contact and consists of dominantly dark organic-rich shales, with interbedded black cephalopod-bearing limestone lenses and layers (Fig. 5e).

At La Valute, the western part of the studied area, the total thickness of the unit is more than 50 m. Nautiloids, ostracods, conodonts and rare trilobites and bivalves (Fig. 7) were documented in the limestones (Corradini et al. 2016), whereas graptolites have been collected from the shales (Piras et al. 2012).

Combining data from graptolites and conodonts, the age of this unit in La Valute area was constrained to the Silurian (Telychian?-Přídolí; Corradini et al. 2016).

Alticola Formation (Přídolí)

The Alticola Formation (Ferretti et al. 2015) is exposed in a narrow discontinuous strip in the whole studied area. It is mainly represented by thin- to rarely medium-bedded grey to pink and light brown cephalopod-bearing mudstone to wackestone (Fig. 4d). Beside cephalopods (Gnoli & Histon 1998), the only abundant fossils documented in the study area are


a
b
c
d
C. Arion. subnem.
e
a
Arion. affine
b
f
g
i
h
j
k

conodonts (Serpagli & Greco 1965; Manzoni 1965; Carta 2011; Corradini et al. 2016), but rare bivalves, brachiopods, echinoderms and trilobites have been observed (Fig. 7).

In the eastern and western part of the studied area the Alticola Formation rests on top of the Nölbling Formation with a sharp transition, whilst in the area between Mt Pizzul and Forca di Lanza the unit rests disconformably on top of Ordovician units, due to a top to the south thrust deformation that deleted the sedimentary unconformable boundary. The upward transition to the Rauchkofel Formation is never exposed in the study area, but in nearby areas (e.g., Rio Malinfier West section, Corradini et al. 2019), it is very well exposed and marked by a distinct and sharp change in colour.

In the Mt Zermula area, the age of the Alticola Formation is limited to Přídolí, and the maximum thickness is about 10 m at Mt Pizzul.

Rauchkofel Formation (Lochkovian)

The presence of the Rauchkofel Formation (Corradini et al. 2015a) in the studied area has been detected only thanks to a few decimeters of dark limestone and shales compressed between the limestones of the Alticola and La Valute formations close to La Valute summit and Casera La Valute, and a few loose blocks in the debris north of Forca di Lanza (Fig. 9a) and near Stua Ramaz bridge. The unit is represented by dark, well-bedded, platy limestone with intercalation of black shales and marls, and locally pack-grainstones and cherts, with huge lateral variations along the whole Carnic Alps.

Beautifully preserved loboliths (Fig. 11f, g), dated to the *Icr. hesperius* conodont Zone, have been collected from loose blocks (Corradini et al. 2005, 2016) in the north-western part of the area.

La Valute Formation (Lochkovian)

The La Valute Formation (Corradini et al. 2015b), whose name derives from the westernmost part of Mt Zermula, crops out extensively in the study area. It consists of thin-bedded medium dark grey and brownish grey nodular mudstone to wackestone (Fig. 9b). In the uppermost couple of meters of the unit, beds become very thin to thin with silty and marly intercalations and then gradually pass to the Findenig Formation.

The La Valute Formation yields sponge spicule, trilobites, articulated ostracod shells, orthocone nautiloids, some strongly fragmented crinoid stem plates and brachiopod shells, dacryoconarids and conodonts (Corriga et al. 2011).

The La Valute Formation, that is about 18 m thick is fully exposed. The La Valute Cave section (Corriga et al. 2011; Corradini et al. 2016), where the transition with the overlying Findenig Formation is exposed (Fig. 9c), is the reference section for the upper boundary of the unit (Corradini et al. 2015c). On the basis of its conodont content, this unit is assigned to the middle and upper Lochkovian (*Ad. carlsi-M. pandora* β zones) (Carta 2011; Corriga 2011; Corriga et al. 2011; Pondrelli et al. 2015b; Corradini et al. 2016).

Findenig Formation (Lochkovian-Eifelian)

The Findenig Formation (Spalletta et al. 2015b) crops out extensively in the study area. It consists of

Fig. 7 - Selected Silurian fossils from Mt Zermula area. Scale bar = 5 mm. a) *Arionoceras* sp. MFSNgp 33382; Casera La Valute area, Loose block close to CLV section, Nölbling Fm. b) Undetermined orthoceratid cephalopod MFSNgp 27480; loose block in the northern part of La Valute area, Nölbling Fm. c) *Michelinoceras meneghini* (Barrande, 1866) IPUM-MZ-BK 2a; southern flank of Mt Zermula, Alticola Fm. d) *Arionoceras submoniliforme* (Meneghini, 1857) IPUM-MZ-BK 1c; southern flank of Mt Zermula, Alticola Fm. e) *Arionoceras affine* (Meneghini, 1857) IPUM-MZ-BK 1a (a) and *Arionoceras submoniliforme* (Meneghini, 1857) IPUM-MZ-BK 1b (b); southern flank of Mt Zermula, Alticola Fm. f) Pyritized shell of orthoconic cephalopod, MFSNgp 23320; loose block at Rio di Lanza, Stua Ramaz area, Nölbling Fm. g) Cephalon of a harpid trilobite, MFSNgp 28286; loose block at Rio di Lanza, Stua Ramaz area, Nölbling Fm. h) Pygidium of an encrinurid trilobite, MFSNgp 28285; loose block at Rio di Lanza, Stua Ramaz area, Nölbling Fm. i) *Cardiola* sp., MFSNgp 37767; loose block in Stua Ramaz area, Nölbling Fm. j) *Retiolites geinitzianus* Barrande, 1850, MFSNgp 45735; loose block at SR I locality, Nölbling Fm. k) *Monoclimacis flumendosae* (Gortani, 1923), MFSNgp 42473; 20 m above the base of the VALN section, Nölbling Fm.

- *Fossili siluriani dall'area del Monte Zermula. a)* Arionoceras *sp. MFSNgp 33382; area di Casera La Valute, blocco isolato vicino alla sezione CLV, Fm. di Nölbling. b) Cefalopode ortoceratide indeterminato MFSNgp 27480; blocco isolato nella parte nord dell'area de La Valute, Fm. di Nölbling. c)* Michelinoceras meneghini *(Barrande, 1956) IPUM-MZ-BK 2a; versante meridionale del M. Zermula, Fm. ad Alticola. d)* Arionoceras submoniliforme *(Meneghini, 1857) IPUM-MZ-BK 1c; versante meridionale del M. Zermula, Fm. ad Alticola. e)* Arionoceras affine *(Meneghini, 1857) IPUM-MZ-BK 1a (a) e* Arionoceras submoniliforme *(Meneghini, 1857) IPUM-MZ-BK 1b (b); versante meridionale del M. Zermula, Fm. ad Alticola. f) Conchiglia piritizzata di un cefalopode ortocono, MFSNgp 23320; blocco isolato nel Rio di Lanza, area di Stua Ramaz, Fm. di Nölbling. g) Cephalon di un trilobite harpide, MFSNgp 28286; blocco isolato nel Rio di Lanza, area di Stua Ramaz, Fm. di Nölbling. h) Pigidio di un trilobite encrinuride, MFSNgp 28285; blocco isolato nel Rio di Lanza, area di Stua Ramaz, Fm. di Nölbling. i)* Cardiola *sp., MFSNgp 37767; blocco isolato nell'area di Stua Ramaz, Fm. di Nölbling. j)* Retiolites geinitzianus *Barrande, 1850, MFSNgp 45735; blocco isolato nella località SR I, Fm. di Nölbling. k)* Monoclimacis flumendosae *(Gortani, 1923), MFSNgp 42473; 20 m dalla base della sezione VALN, Fm. di Nölbling.*

thin to very thin-bedded moderate pink to moderate red nodular mudstone to wackestone with interlayered thin to medium beige marly laminae (Fig. 9d). In places grainstone intervals ("allodapic layers"; Vai 1980) occur in the lower part of the unit, and breccia beds in the upper part. The fauna is not abundant and is dominated by dacryoconarids, while fragments of trilobites, ostracods, small orthocone cephalopods and crinoid stem-plates are less abundant. Conodonts, although present, are quite rare.

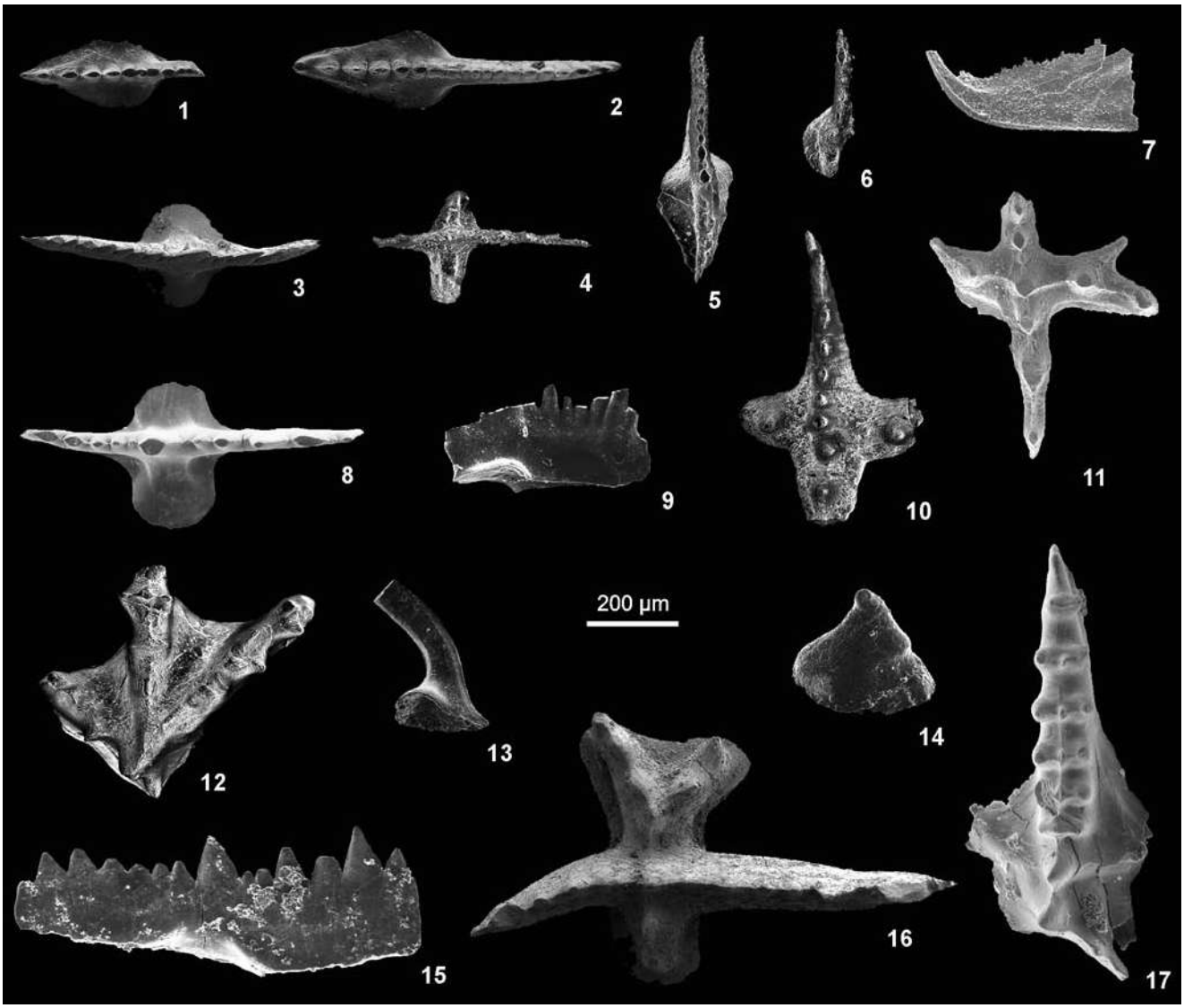
This unit is overlain by the Vinz Formation in the peak at 1909 m of elevation, located just west of Forca di Lanza and by the Hoher Trieb Formation in the rest of the study area. The upper boundary with the Vinz Formation is sharp, while the upper transition to the Hoher Trieb Formation is gradual and the boundary is conventionally located just above the last pink layer.

The Findenig Formation may reach up to 70 m of thickness, but due to its lithological character, it is often folded and thrusted, so that it is frequently subjected to either structural thickening or thinning. The age spans from the upper Lochkovian (*M. pandora* β Zone; Corriga et al. 2011) to the Eifelian (*P. costatus* Zone, Pondrelli et al. 2015a).

Vinz Formation (Eifelian)

The Vinz Formation (Pondrelli et al. 2015a) crops out only in a single location at the top of the hilltop at 1909 m elevation west of Forca di Lanza along the path to Mt Zermula. The unit consists of various facies, all of them of medium grey color (Fig. 11a, b): thick-bedded clast-supported and disorganized breccia in a fine-grained grainstone matrix; medium-bedded packstone to locally laminated grainstone with interlayered rare thin- to medium-bedded fine-grained breccia; very thick-bedded clast-supported breccia locally displaying an erosional base; mostly crinoidal grainstone and/or fine-grained breccia, passing upward to clast-supported breccia.

The fauna is dominated by the presence of disarticulated crinoid stems and corals, and a few fragmented shells



are observable in thin sections. Conodonts are present, although not abundant, and allowed to date the central part of the unit to the late Eifelian (*kockelianus* Zone) (Pondrelli et al. 2015b).

The upper limit of the Vinz Formation here is not observable, because of tectonic elision. The overall thickness of the unit in the study area is difficult to measure, again because of tectonic reasons, but we can roughly estimate a maximum thickness of about 25 m.

Shallow water undifferentiated units (Givetian-Frasnian?)

In the northern part of the study area shallow-water Middle Devonian limestones crop out extensively (Fig. 9c). The detailed analysis of these units was beyond the goals of this work, so we simply grouped all the shallow-water facies in a single unit without distinguish the different formations. However, preliminary studies suggest that the greatest part of these rocks can be assigned to the Spinotti Formation (Pohler et al. 2015), while, possibly, a few outcrops to the Kellergrat Formation (Kido et al. 2015). Both these formations were described from the shallow-water complex of Mt Coglians, but their characteristics looks similar in the Mt Zermula reefal facies.

According to Ferrari & Vai (1966), the facies association consists of thick-bedded *Amphipora* bafflestone (Fig. 11d), algal laminites, floatstone with micritic matrix and fenestral loferite. The succession is tectonically sliced at the base and at the top and repeated by E–W trending thrusts, so the reconstruction of its stratigraphy and facies evolution necessitates a more detailed study.

Calcareous algae, foraminifers, stromatoporoids, rugose and tabulate corals, gastropods, ostracods and brachiopods (Ferrari & Vai 1966; Corradini et al. 2012; Lamberty 2013; Pondrelli et al. 2015b) are present in the mapped area (Fig. 10d-e, h). The overall thickness of this unit in the study area can be only roughly estimated, due to tectonic cuttings, to approximatively 250 m.

Fig. 8 - Silurian and Lochkovian conodonts from the Mt Zermula area. 1) *Ozarkodina sagitta rhenana* (Walliser, 1964); upper view of P1 element; Bosc dai Floriz section, sample BDFE 4, Nölbling Fm. 2) *Ozarkodina sagitta sagitta* (Walliser, 1964); upper view of P1 element; Bosc dai Floriz section, sample BDFE 9, Nölbling Fm. 3) "*Ozarkodina" eosteinhornensis* s.l. (Walliser, 1964); upper view of P1 element; La Valute Nord section, sample VALN 9, Nölbling Fm. 4) *Lanea telleri* (Schulze, 1968); upper view of P1 element; La Valute Cave section, sample LV 2, La Valute Fm. 5) *Flajsella schulzei* (Bardashev, 1989); upper view of P1 element; La Valute Cave section, sample LV 1, La Valute Fm. 6) *Flajsella streptostygia* Valenzuela-Rios & Murphy, 1997; upper view of P1 element; La Valute Cave section, sample LV 3, La Valute Fm. 7) *Belodella resima* (Philip, 1965), lateral view of P1 element; Cadin di Lanza, sample CAD II, Alticola Fm. 8) *Zieglerodina planilingua* (Murphy & Valenzuela-Rios, 1999); upper view of P1 element; Stua Ramaz III locality, MZ Lob block, Rauchkofel Fm. 9) *Kockelella ortus sardoa* Serpagli & Corradini, 1999; lateral view of P1 element; Casera La Valute section, sample CLV 2, Nölbling Fm. 10) *Ancyrodelloides transitans* Bischoff & Sannemann, 1958; upper view of P1 element; Valute Cave section, sample LV 2, La Valute Fm. 11) *Ancyrodelloides murphyi* Valenzuela-Rios, 1994; upper view of P1 element, Cadin di Lanza, sample CAD III, La Valute Fm. 12) *Pedavis* sp. A Corriga et al., 2011; upper view of P1 element; La Valute Cave section, sample LV 9, Findenig Fm. 13) *Dvorakia amsdeni* Barrick & Klapper, 1992; lateral view of element; Casera La Valute section, sample CLV 5, Alticola Fm. 14) *Pseudooneotodus beckmanni* (Bischoff & Sannemann, 1958); lateral view of element; Casera La Valute section, sample CLV 3, Alticola Fm. 15) *Zieglerodina remscheidensis* (Ziegler, 1960); lateral view of P1 element; Stua Ramaz III locality, MZ Lob block, Rauchkofel Fm. 16) *Kockelella variabilis ichnusae* Serpagli & Corradini, 1998; upper view of P1 element; Stua Ramaz area, loose block MZ-BK 2, Nölbling Fm. 17) *Icriodus hesperius* Klapper & Murphy, 1975, upper view of P1 element; Stua Ramaz III locality, MZ Lob block, Rauchkofel Fm.

- *Conodonti siluriani e lochkoviani dell'area del M. Zermula. 1)* Ozarkodina sagitta rhenana *(Walliser, 1964); veduta superiore dell'elemento P1; sezione Bosc dai Floriz, campione BDFE 4, Fm. di Nölbling. 2)* Ozarkodina sagitta sagitta *(Walliser, 1964); veduta superiore dell'elemento P1; sezione Bosc dai Floriz, campione BDFE 9, Fm. di Nölbling. 3)* "Ozarkodina" eosteinhornensis *s.l. (Walliser, 1964); veduta superiore dell'elemento P1; sezione La Valute Nord, campione VALN 9, Fm. di Nölbling. 4)* Lanea telleri *(Schulze, 1968); veduta superiore dell'elemento P1; sezione La Valute Cave, campione LV 2, Fm. de La Valute. 5)* Flajsella schulzei *(Bardashev, 1989); veduta superiore dell'elemento P1; sezione La Valute Cave, campione LV 1, Fm. de La Valute. 6)* Flajsella streptostygia *Valenzuela-Rios & Murphy, 1997; veduta superiore dell'elemento P1; sezione La Valute Cave, campione LV 3, Fm. de La Valute. 7)* Belodella resima *(Philip, 1965), veduta laterale dell'elemento P1; Cadin di Lanza, campione CAD II, Fm. ad Alticola. 8)* Zieglerodina planilingua *(Murphy & Valenzuela-Rios, 1999); veduta superiore dell'elemento P1; località Stua Ramaz III, MZ Lob block, Fm. del Rauchkofel. 9)* Kockelella ortus sardoa *Serpagli & Corradini, 1999; veduta superiore dell'elemento P1; sezione Casera La Valute, campione CLV 2, Fm. di Nölbling. 10)* Ancyrodelloides transitans *Bischoff & Sannemann, 1958; veduta superiore dell'elemento P1; sezione Valute Cave, campione LV 2, Fm. de La Valute. 11)* Ancyrodelloides murphyi *Valenzuela-Rios, 1994; veduta superiore dell'elemento P1, Cadin di Lanza, campione CAD III, Fm. de La Valute. 12)* Pedavis *sp. A Corriga et al., 2011; veduta superiore dell'elemento P1; sezione La Valute Cave, campione LV 9, Fm. del Findenig. 13)* Dvorakia amsdeni *Barrick & Klapper, 1992; veduta laterale dell'elemento P1; sezione Casera La Valute, campione CLV 5, Fm. ad Alticola. 14)* Pseudooneotodus beckmanni *(Bischoff & Sannemann, 1958); veduta laterale dell'elemento P1; sezione Casera La Valute, campione CLV 3, Fm. ad Alticola. 15)* Zieglerodina remscheidensis *(Ziegler, 1960); veduta superiore dell'elemento P1; località Stua Ramaz III, MZ Lob block, Fm. del Rauchkofel. 16)* Kockelella variabilis ichnusae *Serpagli & Corradini, 1998; veduta superiore dell'elemento P1; area di Stua Ramaz area, loose block MZ-BK 2, Fm. di Nölbling. 17)* Icriodus hesperius *Klapper & Murphy, 1975; veduta superiore dell'elemento P1; località Stua Ramaz III, MZ Lob block, Fm. del Rauchkofel.*

Fig. 9 - a) Slab of the Rauchkofel Fm. with several lobolith in the Cadin di Lanza area. b) Well bedded limestones of La Valute Fm. in the La Valute Cave (LV) section. c) The transition between La Valute Fm. and Findenig Fm. in the La Valute Cave (LV) section. d) Reddish nodular limestones with interbedded gray breccia levels in the upper part of the Findenig Fm. northeast of Casera Zermula. e) Alternation of limestones, cherts and black shales across the Kacak Event in the Hoher Trieb Fm. in the Zuc di Malaseit Basso (ZMB) section. f) Tentaculitid limestone in the Hoher Trieb Fm. at Cadin di Lanza Parete (CAD P) section.

- *a) Blocco della Fm. del Rauchkofel con numerosi resti fossili di loboliti nell'area del Cadin di Lanza. b) I calcari bel stratificati della Fm. de La Valute nella sezione La Valute Cave (LV). c) La transizione tra la Fm. de La Valute e la Fm. del Findenig nella sezione La Valute Cave (LV). d) Calcari nodulari rossi con intercalati livelli grigi di brecce nella parte alta della Fm. del Findenig affiorante a nordest di Casera Zermula. e) Alternanze di calcari, selci e peliti nere nell'intervallo dell'Evento Kacak esposti nella Fm. del Hoher Trieb nella sezione Zuc di Malaseit Basso (ZMB). f) Calcari a tentaculiti nella Fm. del Hoher Trieb esposti nella sezione Cadin di Lanza Parete (CAD P).*

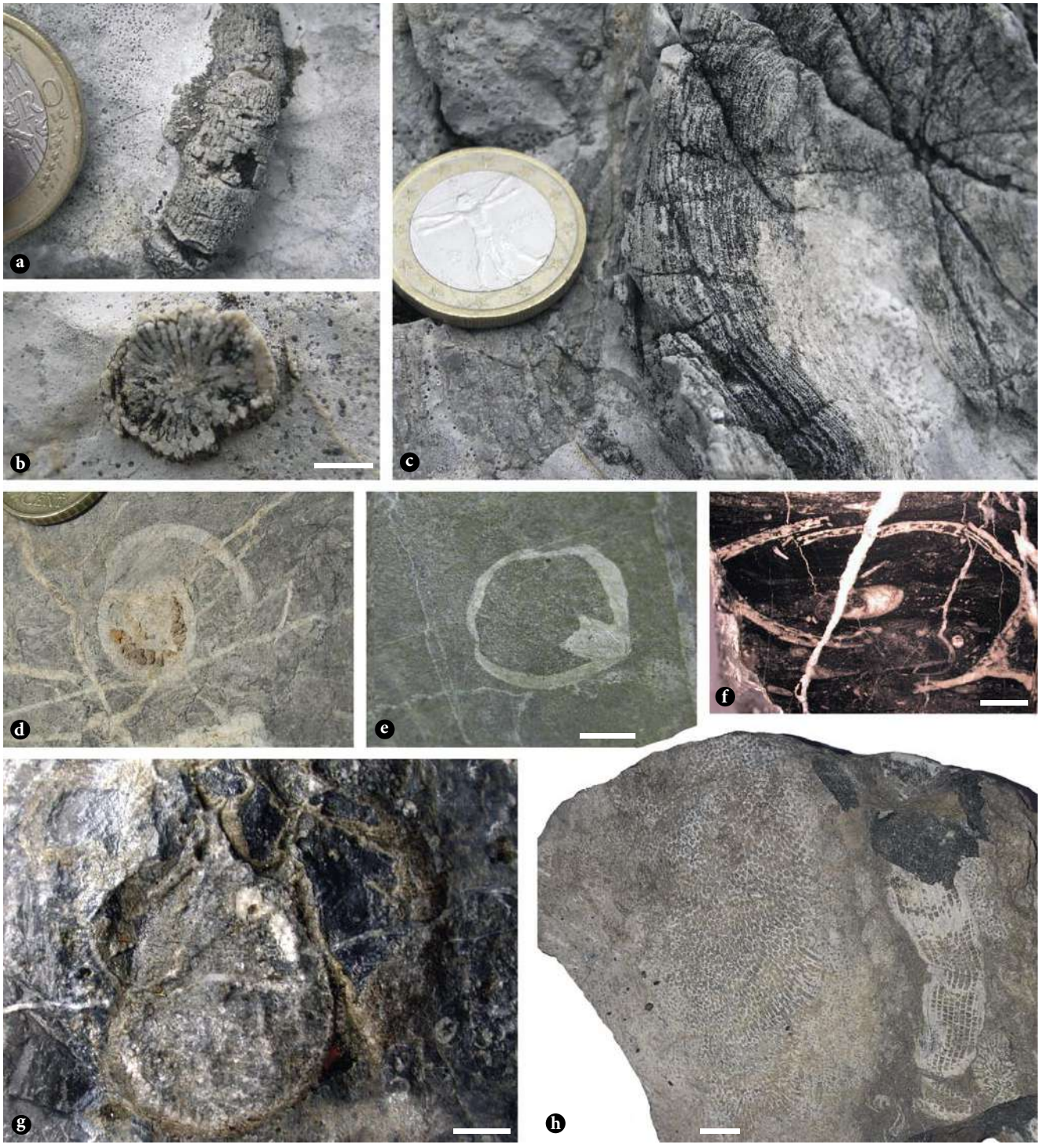


Fig. 10 - Selected Devonian fossils from Mt Zermula area. a) Silicified Rugosa; CAD P section, Hoher Trieb Fm. b) Silicified Rugosa; CAD P section, Hoher Trieb Fm. c) Silicified Tabulata; Mt Pizzul area, Hoher Trieb Fm. d) Gastropod; Cason di Lanza Pass, Spinotti Fm. e) *Stringocephalus* sp.; Cason di Lanza Pass, Spinotti Fm.; scale bar = 5 mm. f) Polished section of a lobolith broken by diagenesis, MFSNgp 27484; "Lobolite creek", loose block near SR III locality, Rauchkofel Fm.; scale bar = 10 mm. g) Lobolith preserved in cross section showing six chambers arranged around a larger one; MFSNgp 27479. "Lobolite creek", loose block near SR III locality, Rauchkofel Fm.; scale bar = 10 mm.h) Slab with Rugosa and Tabulata MFSNgp 23684; Mt Zermula, Kellergrat Fm.; scale bar = 5 mm.

- *Fossili devoniani dall'area del M. Zermula. a) Rugosa silicizzato; sezione CAD P, Fm. del Hoher Trieb. b) Rugosa silicizzato; sezione CAD P, Fm. del Hoher Trieb. c) Tabulata silicizzato; area di M. Pizzul, Fm. del Hoher Trieb. d) Gasteropode; Passo del Cason di Lanza, Fm. dello Spinotti. e)* Stringocephalus *sp.; Passo del Cason di Lanza, Fm. dello Spinotti; scala = 5 mm. f) Sezione lucida di un lobolite rotto dalla diagenesi, MFSNgp 27484; "Rio dei Loboliti", blocco isolato vicino alla località SR III, Fm. del Rauchkofel; scala = 10 mm. g) Lobolite conservato in sezione, in cui si osservano sei camere attorno a una più grande; MFSNgp 27479; "Rio dei Loboliti", blocco isolato vicino alla località SR III, Fm. del Rauchkofel; scala = 10 mm. h) Blocco con Rugosa e Tabulata MFSNgp 23684; M. Zermula; Fm. del Kellergrat; scala = 5 mm.*

Hoher Trieb Formation (Eifelian-Frasnian)

The Hoher Trieb Formation (Pondrelli et al. 2015c) crops out extensively in the western and eastern parts of the study area. In the latter it represents the best exposed unit, with several easily reachable sections for the different parts of the unit and a section located west of Forca di Lanza where the unit is completely exposed. The Zuc di Malaseit Basso (ZMB) section (Fig. 9e), where the Kacak event (Eifelian-Givetian boundary) is well exposed was studied in great detail (Suttner et al. 2017a, b).

The Hoher Trieb Formation consists of several intercalated facies: alternations of pack-grainstones, float-rudstones, wackestones, cherts and laminated black shales, deposited at the toe-of-slope of a carbonate apron (Pondrelli et al. 2015b); breccias are interlayered with medium grey thin to thickbedded grainstone to packstone locally passing upward to wackestone and/or mudstone with thick laminae of silt/shale interbeds.

Reworked silicified corals (Fig. 10a-c) are relatively abundant in the breccia beds (Kido et al. 2011a, 2011b); dacryoconarids (Fig. 10f), calcispheres, foraminifera, sponge spicules, algae, trilobites, bivalves, crinoids, brachiopods and ostracods have been detected in the wackestone to packstone beds. Conodonts are always present and very abundant in some levels (Carta 2011; Pondrelli et al. 2015a; Suttner et al. 2017a, 2017b).

This unit passes upward to the Pal Grande Formation with a sharp boundary, marked by a grain size decrease to mudstone–wackestone on top of the breccia level IV. This sharp transition, often a preferential surface of decollement type faulting, is preserved west of Forca di Lanza, where is marked by a slump at the base of the Pal Grande Formation.

In the Mt Zermula area, the Hoher Trieb Formation is about 35-50 m thick depending on the location. This large variation is mostly likely due to either structural thickening and/or thinning, or to variations in depositional thicknesses of breccia units. The age spans from the Eifelian to the early Frasnian.

Pal Grande Formation (Frasnian-Tournaisian)

The Pal Grande Formation (Spalletta et al. 2015a) crops out extensively in the eastern part of the area, whereas south of Mt Zermula and in La Valute area is limited to small, poorly preserved discontinuous outcrops along a narrow belt between the Hoher Trieb and the Hochwipfel formations. Also, at places it disconformably lies on top of the shallow water units. The unit of the Pal Grande Formation (Fig. 11e-f) consists of light grey to moderate pink and red very thin- to medium-bedded mudstone to wackestone at places nodular (Mossoni et al. 2013; Pondrelli et al. 2015b).

The sharp basal transition from the Hoher Trieb Formation is often tectonically omitted because of the different lithologic characteristics at the boundary, but - when preserved - the first level of the Pal Grande Formation is characterized by a convoluted and contorted bedding interpreted as a slump deposit by Pondrelli et al. (2015b). The upper boundary with the Hochwipfel Formation is always disconformable as evidenced by the sudden lithological change and by a hiatus that in the study area ranges from the Famennian (conodont data up to the *Pa. m. utahensis* Zone) presumably up to the Visean, as in the whole Carnic area the start of the deposition of the Hochwipfel Formation is thought to have occurred within the Visean (Venturini 1990; Spalletta et al. 2015c).

The fauna is characterized by the presence of clymenids and conodonts (Manzoni 1966; Mossoni et al. 2013), but bivalves, ostracods, radiolarians, brachiopods, trilobites and crinoids are also observed in thin sections.

The Pal Grande Formation ranges from Frasnian to late Tournaisian, but some intervals have not been documented (Mossoni et al. 2013; Pondrelli et al. 2015b) The reddish nodular levels occur in the lower and middle Famennian (*Pa. subperlobata* to *Pa. m. marginifera* zones, Mossoni et al. 2013; Corradini et al. 2017). The outcrops that lies disconformably above the shallow water units are always dated to the late Tournaisian (Manzoni 1966; Corradini et al. 2016).

Hochwipfel Formation (Visean-Bashkirian)

The Hochwipfel Formation (Spalletta et al. 2015c) crops out extensively in the study area. It consists of very thin to medium (very rarely thick) bedded, yellowish-grey lithic sandstones and greywackes interbedded with dark grey laminated shales. The sandstone beds are frequently normally graded and sometimes show evidence of planar or ripple lamination and/or ripple marks. Locally, some levels of breccia with centimetre-scale cherty clasts have been found. In the north-western part of the study area, megabreccia deposits with limestone clasts and boulders up to several metres in size were found and mapped within the dark shales of the Hochwipfel Formation. Fossils are rare in this unit and limited to remains of plants, very rare in the study area.

The Hochwipfel Formation as a whole has been interpreted as a flysch-type unit, partly made of turbiditic deposits (e.g., Spalletta et al. 1980; van Amerom & Schönlaub 1992; Spalletta et al. 2015c; Kabon & Schönlaub 2019; Pasquarè Mariotto & Venturini 2019).

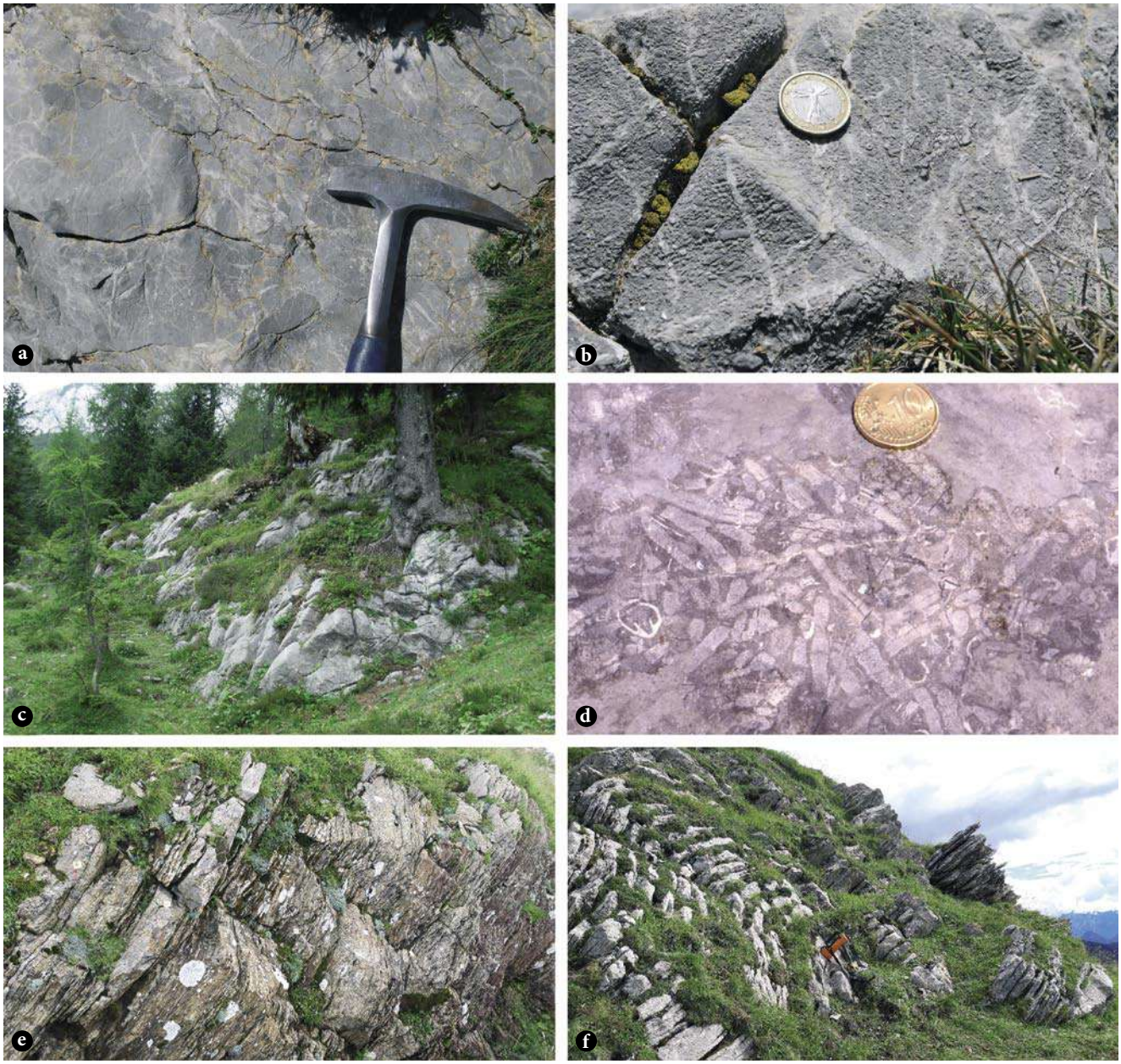


Fig. 11 - a) Clast supported breccia of the Vinz Fm. at the summit at q. 1909 west of Forca di Lanza. b) Crinoidal fine grained breccia within the Vinz Fm. west of Forca di Lanza. c) Shallow water limestones (Spinotti Fm.) south of Cason di Lanza pass. d) Detail of the "Amphipora limestones" within the Spinotti Fm. at the beginning of the path from Cason di Lanza to Mt Zermula. e) Alternation of red and gray nodular limestone in the Pal Grande Fm in the Pizzul West (PZW) section. f) Well bedded folded beds of the Pal Grande Fm. on the southwestern flank of Mt Pizzul.

- *a) Breccia grossolana nella Fm. del Vinz nel cocuzzolo a q. 1909 a ovest di Forca di Lanza. b) Breccia fine a crinoidi nella Fm. del Vinz a ovest di Forca di Lanza. c) Calcari di mare basso (Fm. dello Spinotti) a sud del Passo del Cason di Lanza. d) Dettaglio dei "Calcari ad Amphipora" della Fm. dello Spinotti all'inizio del sentiero tra il Cason di Lanza e M. Zermula. e) Alternanze di calcari nodulari rossi e grigi nella Fm. di Pal Grande nella sezione Pizzul West (PZW). f) Calcari ben stratificati piegati nella Fm. di Pal Grande nel versante sudoccidentale del M. Pizzul.*

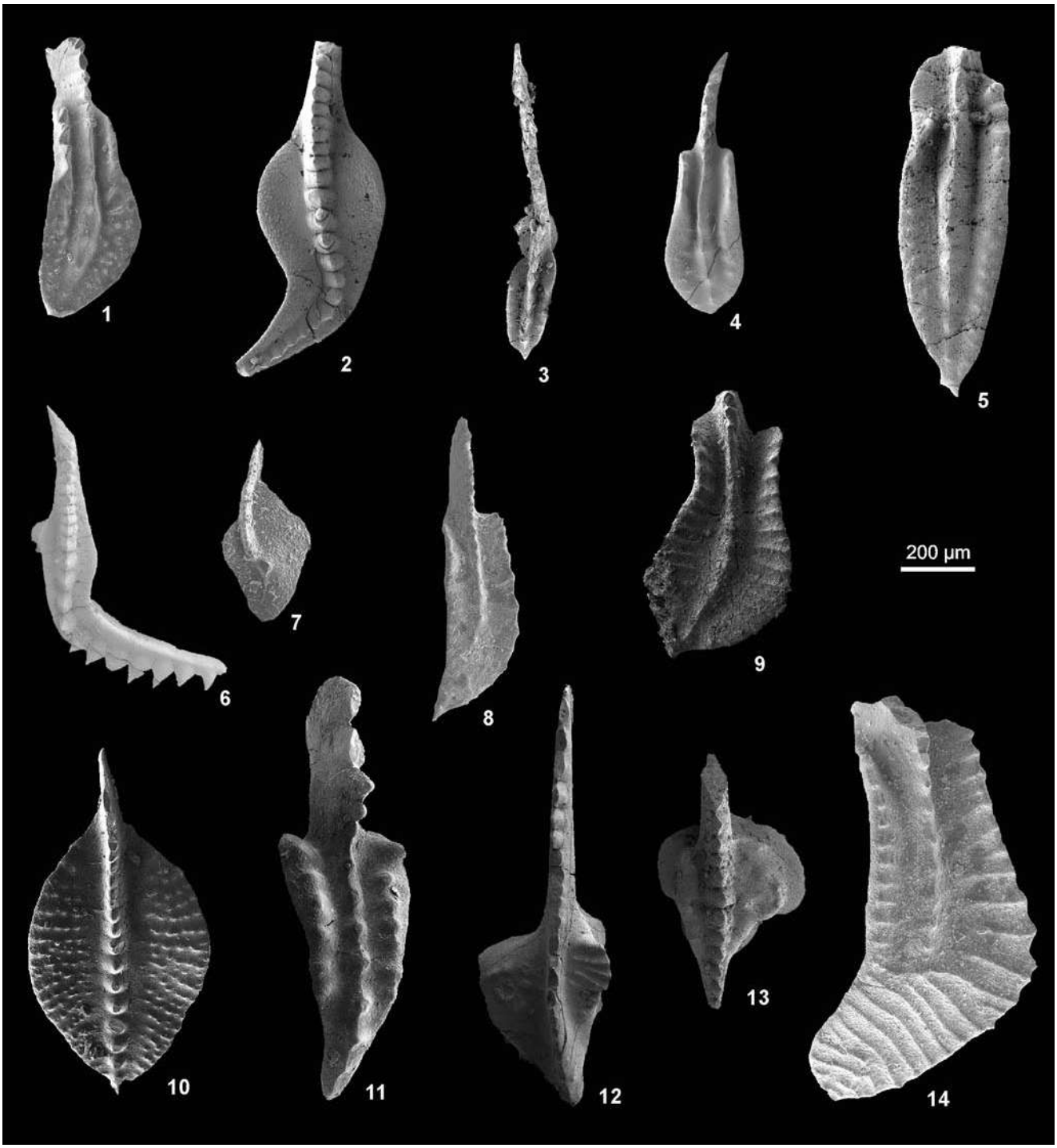
Discussion and Conclusive Remarks

The geological map presented here fills the gap between the two previously mapped areas of Mt Pizzul and La Valute, that represent the easternmost and westernmost part of the study area, respectively. Thirteen units have been recognized and mapped across the study area, following the new lithostratigraphic subdivision proposed by Corradini et al. (2015b), with the exception of the shallow water units and the Quaternary, which were undifferentiated.

The map allowed to recognize a good lateral continuity of the main structural elements, notably the top to the south roughly NW trending faults that bound the shallow water units and the other carbonate units. These faults probably formed as thrusts during

Variscan time (Venturini, 1990), and were partly reactivated and verticalized during alpine times. Most of the stratigraphic units show a good lateral continuity, except for the Vinz Formation which crops out only in a single locality close to Forca di Lanza and was not found elsewhere. This implies either a complete tectonic elision or a deposition geographically localized. Since in this part of the basin, the Vinz Formation has been found only in this locality, we prefer the hypothesis of a localized deposition, which is also consistent with the sedimentological characters of the unit. This unit is in fact entirely made by beds reflecting high-energy transport, that might have been deposited in correspondence of a channel sourcing from the shallow water units.

A special comment deserves the succession of the Silurian units, where the Nölbling Formation is followed by the Alticola Formation. It is the same sequence described by Wenzel (1997) for the "Findenig facies", where interbedded black graptolitic shales, marls and blackish limestone beds are documented up to the Ludlow and is followed by the Alticola Formation in the Přídolí. This facies was established in Mt Lodin/ Findenigkofel area in Austria and is interpreted to



represent the transition from siliciclastic to carbonate pelagic deposition.

The transition from the Nölbling to the Alticola formations suggests a passage to shallower oxygenated water possibly associated to a regressive context. The Mount Zermula massif represents the most southern and eastern area of the Carnic Alps where the Findenig facies occurs.

Manuscript received on 20.X.2020, accepted on 18.XII.2020.

Ringraziamenti

We are indebted with all the members of the 'Formal Lithostratigraphic Units in the Pre-Variscan Sequence of the Carnic Alps' science group for fruitful, open and enthusiastic discussions. We warmly thank Francesca, Silvio, Laura, Roberta and all the other wonderful people of the Cason di Lanza for their hospitality and support, during several years of research in the area. Paolo Serventi helped with Silurina Cephalopods. Corrado Venturini and Maurizio Ponton provided useful comments and indications to improve the manuscript. Finally, thanks to the Editrice Tabacco (Tavagnacco, Ud) for the use of the topographic map.

This paper is a contribution to IGCP Project n. 652 "Reading geologic time in Paleozoic sedimentary rocks"

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Fig. 12 - Devonian and Carboniferous conodonts from the Mt Zermula area. 1) *Polygnathus eiflius* Bischoff & Ziegler, 1957, upper view of P1 element; Cadin di Lanza Parete section, sample CAD P 2, Hoher Trieb Fm. 2) *Tortodus kockelianus kockelianus* (Bischoff & Ziegler, 1957), upper view of P1 element; Zuc di Malaseit Basso section, sample ZMB 28, Hoher Trieb Fm. 3) *Polygnathus rhenanus* Klapper, Philip & Jackson, 1970, upper view of P1 element; Zuc di Malaseit Basso section, sample ZMB 4E top, Hoher Trieb Fm. 4) *Polygnathus ensensis*, Ziegler & Klapper, 1976; upper view of P1 element; Zuc di Malaseit Basso section, sample, ZMB 6 base, Hoher Trieb Fm. 5) *Polygnathus timorensis* Klapper, Philip & Jackson, 1970, upper view of P1 element; Zuc di Malaseit Basso section sample ZMB 4E top, Hoher Trieb Fm. 6) *Tortodus kockelianus australis* (Jackson, in Pedder et al., 1970), upper view of P1 element; Zuc di Malaseit Basso section, sample ZMB 12 D, Hoher Trieb Fm. 7) *Palmatolepis rhomboidea* Sannemann, 1955, upper view of P1 element; Pizzul West section, sample PZW 5, Pal Grande Fm. 8) *Polygnathus nothoperbonus* Mawson, 1987 upper view of P1 element; Pizzul Sud section, sample PZS 2, Findenig Fm. 9) *Polygnathus pseudofoliatus* Wittekindt, 1965, upper view of P1 element; Stua Ramaz Ponte section, sample SRP 7, Hoher Trieb Fm. 10) *Klapperina ovalis* (Ziegler & Klapper in Ziegler, Klapper & Lindström, 1964), upper view of P1 element; Forca di Lanza section, sample FL 7, Hoher Trieb Fm. 11) *Schmidtognathus wittekindti* Ziegler, 1966, upper view of P1 element; Forca di Lanza section, sample FL 6, Hoher Trieb Fm. 12) *Gnathodus pseudosemiglaber* Thompson & Fellows, 1970, upper view of P1 element; 150m east of La Valute top, Pal Grande Fm. 13) *Gnathodus typicus* Cooper, 1939, upper view of P1 element; Pizzul West section, sample PZW H, Pal Grande Fm. 14) *Polygnathus linguiformis linguiformis* Hinde, 1876, upper view of P1 element; Forca di Lanza summit locality, sample FL 1, Vinz Fm.

- C*onodonti devoniani e carboniferi dell'area del M. Zermula. 1)* Polygnathus eiflius *Bischoff & Ziegler, 1957, veduta superiore dell'elemento P1; sezione Cadin di Lanza Parete, campione CAD P 2, Fm. del Hoher Trieb. 2)* Tortodus kockelianus kockelianus *(Bischoff & Ziegler, 1957), veduta superiore dell'elemento P1; sezione Zuc di Malaseit Basso, campione ZMB 28, Fm. del Hoher Trieb. 3)* Polygnathus rhenanus *Klapper, Philip & Jackson, 1970, veduta superiore dell'elemento P1; sezione Zuc di Malaseit Basso, campione ZMB 4E top, Fm. del Hoher Trieb. 4)* Polygnathus ensensis*, Ziegler & Klapper, 1976; veduta superiore dell'elemento P1; sezione Zuc di Malaseit Basso, campione, ZMB 6 base, Fm. del Hoher Trieb. 5)* Polygnathus timorensis *Klapper, Philip & Jackson, 1970, veduta superiore dell'elemento P1; sezione Zuc di Malaseit Basso, campione ZMB 4E top, Fm. del Hoher Trieb. 6)* Tortodus kockelianus australis *(Jackson, in Pedder et al., 1970), veduta superiore dell'elemento P1; sezione Zuc di Malaseit Basso, campione ZMB 12 D, Fm. del Hoher Trieb. 7)* Palmatolepis rhomboidea *Sannemann, 1955, veduta superiore dell'elemento P1; sezione Pizzul West, campione PZW 5, Fm. di Pal Grande. 8)* Polygnathus nothoperbonus *Mawson, 1987 veduta superiore dell'elemento P1; sezione Pizzul Sud, campione PZS 2, Fm. del Findenig. 9)* Polygnathus pseudofoliatus *Wittekindt, 1965; veduta superiore dell'elemento P1; sezione Stua Ramaz Ponte, campione SRP 7, Fm. del Hoher Trieb. 10)* Klapperina ovalis *(Ziegler & Klapper in Ziegler, Klapper & Lindström, 1964), veduta superiore dell'elemento P1; sezione Forca di Lanza, campione FL 7, Fm. del Hoher Trieb. 11)* Schmidtognathus wittekindti *Ziegler, 1966, veduta superiore dell'elemento P1; sezione Forca di Lanza, campione FL 6, Fm. del Hoher Trieb. 12)* Gnathodus pseudosemiglaber *Thompson & Fellows, 1970; veduta superiore dell'elemento P1; 150m a est di cima La Valute, campione LA 2, Fm. di Pal Grande. 13)* Gnathodus typicus *Cooper, 1939, veduta superiore dell'elemento P1; sezione Pizzul West, campione PZW H, Fm. di Pal Grande. 14)* Polygnathus linguiformis linguiformis *Hinde, 1876; veduta superiore dell'elemento P1; cucuzzolo a ovest di Forca di Lanza, campione FL 1, Fm. del Vinz.*

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