| Jb. Geol. B.-A. | ISSN 0016-7800 | Band 131 | Heft 4 | S. 637-647 | Wien, Dezember 1988 |
|---|---|---|---|---|---|

# Conglomeratic Sequences in the Hochwipfel Formation: A New Palaeogeographic Hypothesis on the Hercynian Flysch Stage of the Carnic Alps

By CLAUDIA SPALLETTA & CORRADO VENTURINI*)

With 8 Figures

*Österreichische Karte 1 : 50.000*
*Blätter 197, 198*

*Austria*
*Carnic Alps*
*Hercynian Flysch*
*Lower Carboniferous*
*Conglomerates*
*Palaeogeography*

**Contents**



**Zusammenfassung**

Sechs neue Profile aus den Hochwipfel-Schichten, im Karbon der Karnischen Alpen, wurden gemessen und genauer sedimentologisch untersucht.

Das wichtigste Resultat besteht in der Anerkennung einer bisher unbeschriebenen konglomeratischen Lithofazies, welche man von den seit lange bekannten Hochwipfelbrekzien ziemlich genau unterscheiden kann.

Diese konglomeratische Fazies erlaubt wesentliche Änderungen in der Deutung der Herzynischen Flysch-Becken-Entwicklung während der Ablagerung der Hochwipfel-Schichten. Die frühere Hypothese einer regelmäßigen Subsidenz durch einfache Bruchtektonik wird zugunsten eines komplizierten geodynamischen Bildes geändert.

Möglicherweise erlebten Anteile des Beckens schnelle Hebungen bis zur Emersion. Solche gemischte Hebungs- und Subsidenz-Bedingungen können auf Transkurrenz-Bewegungen zurückgeführt werden, bei welchen Spannungs- und Druckverhältnisse an verschiedene Stellen und in verschiedenen Zeiten entstehen.

**Abstract**

Some new stratigraphical and sedimentological data collected along six measured sections of Hochwipfel Formation scattered along the Palaeocarnic Chain are presented and discussed. The most important result is the recognition of a conglomeratic lithofacies with large, well rounded clasts, never identified before as an independent one, among the ruditic facies of the Hochwipfel Formation.

Since now the evolution of the Hercynian Flysch basin of the Carnic Alps was believed as ruled by extensional faults producing only subsiding blocks. The new data seem to support evidence of sprightly tectonic activity responsible of rise and emersion of part of the basin fitting in a more complex geodynamic context, tentatively interpreted as a transcurrent one.

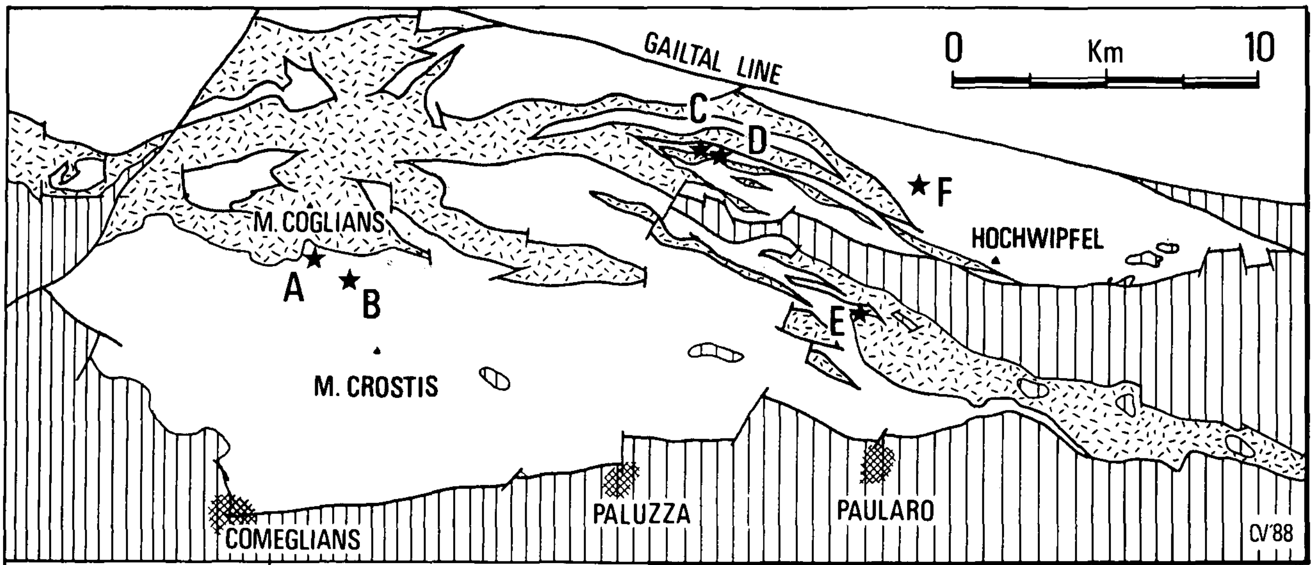
**Riassunto**

Nel presente lavoro vengono esposti nuovi dati sedimentologici sulla formazione del Hochwipfel, tratti dallo studio di sei sezioni stratigrafiche misurate in varie località della porzione paleozoica delle Alpi Carniche. Il nuovo dato più importante desunto da questo studio è il riconoscimento di una litofacies conglomeratica che finora non era mai stata descritta come facies indipendente tra le ruditi della formazione del Hochwipfel, genericamente descritte come brecce. La presenza dei conglomerati consente di modificare sostanzialmente l'interpretazione relativa all'evoluzione del bacino del Flysch ercinico durante la deposizione della formazione del Hochwipfel. La precedente ipotesi di un bacino subsidente, regolato da tettonica esclusivamente distensiva, viene modificata a favore di un quadro geodinamico più complesso. I nuovi dati permettono di avanzare l'ipotesi che alcuni settori del bacino fossero soggetti a rapidi sollevamenti, con locali documentabili emersioni. Tali condizioni di coesistenza di aree in compressione ed emersione e aree subsidenti si possono collocare in un contesto dinamico di moto trascorrente, lungo una fascia regolata da transtensioni seguite da transpressioni.

## 1. Introduction

In the old Palaeozoic sequence of the Carnic Alps the main volumetrical contribute is represented by the Hercynian Flysch. It exceeds 70 % of the entire volume. It is formed by two different units mappable on lithological and petrological features: the Hochwipfel

*) Authors' addresses: Dr. CLAUDIA SPALLETTA, CORRADO VENTURINI, Dipartimento di Scienze Geologiche, Università di Bologna, Via Zamboni 67, I-40127 Bologna.



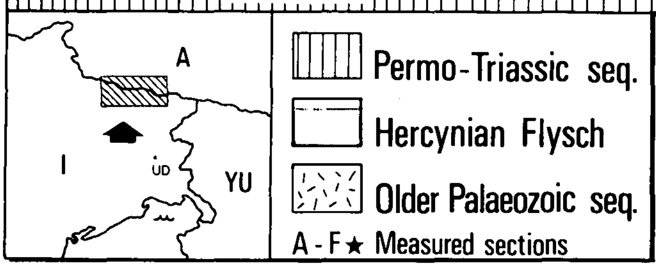
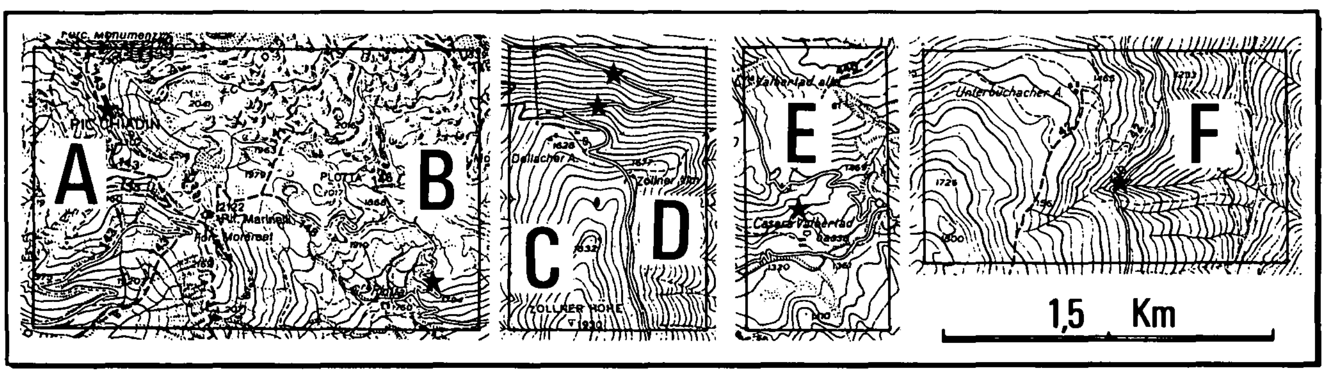
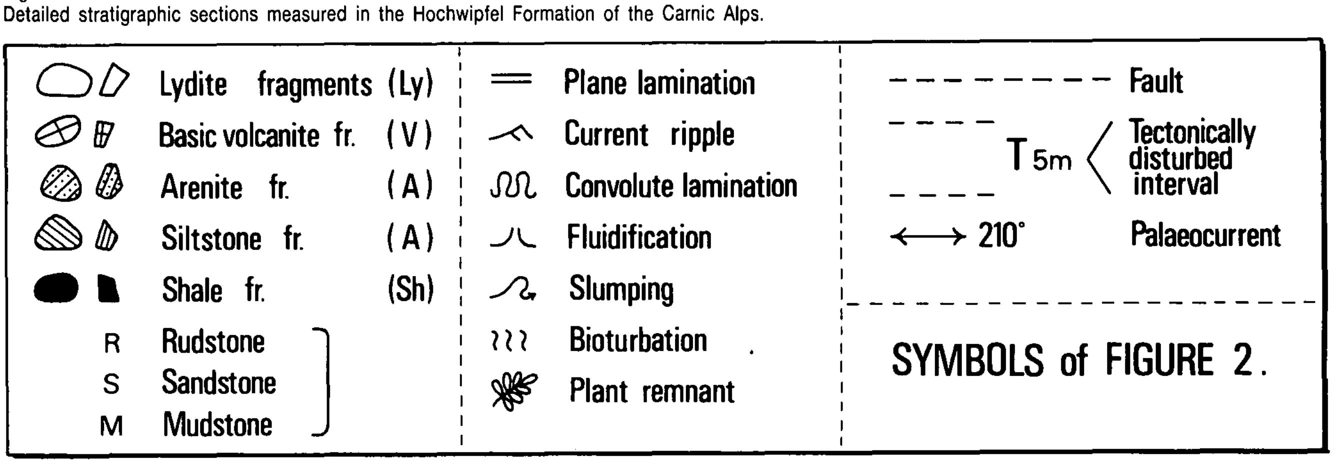




Fig. 1.
Schematic geological map of the Carnic Alps with location of the measured sections (above), and location of the sections on topographic base (below, from "Alpi Carniche – Carta topografica per escursionisti, scala 1 : 25.000", Foglio 09, courtesy by Tabacco Publishing, Udine).
A = Pic Chiadin; B = Casera Plotta; C = Dellacher Alm; D = Dellacher Alm N; E = Unterbuchacher NE; F = Casera Valbertad.

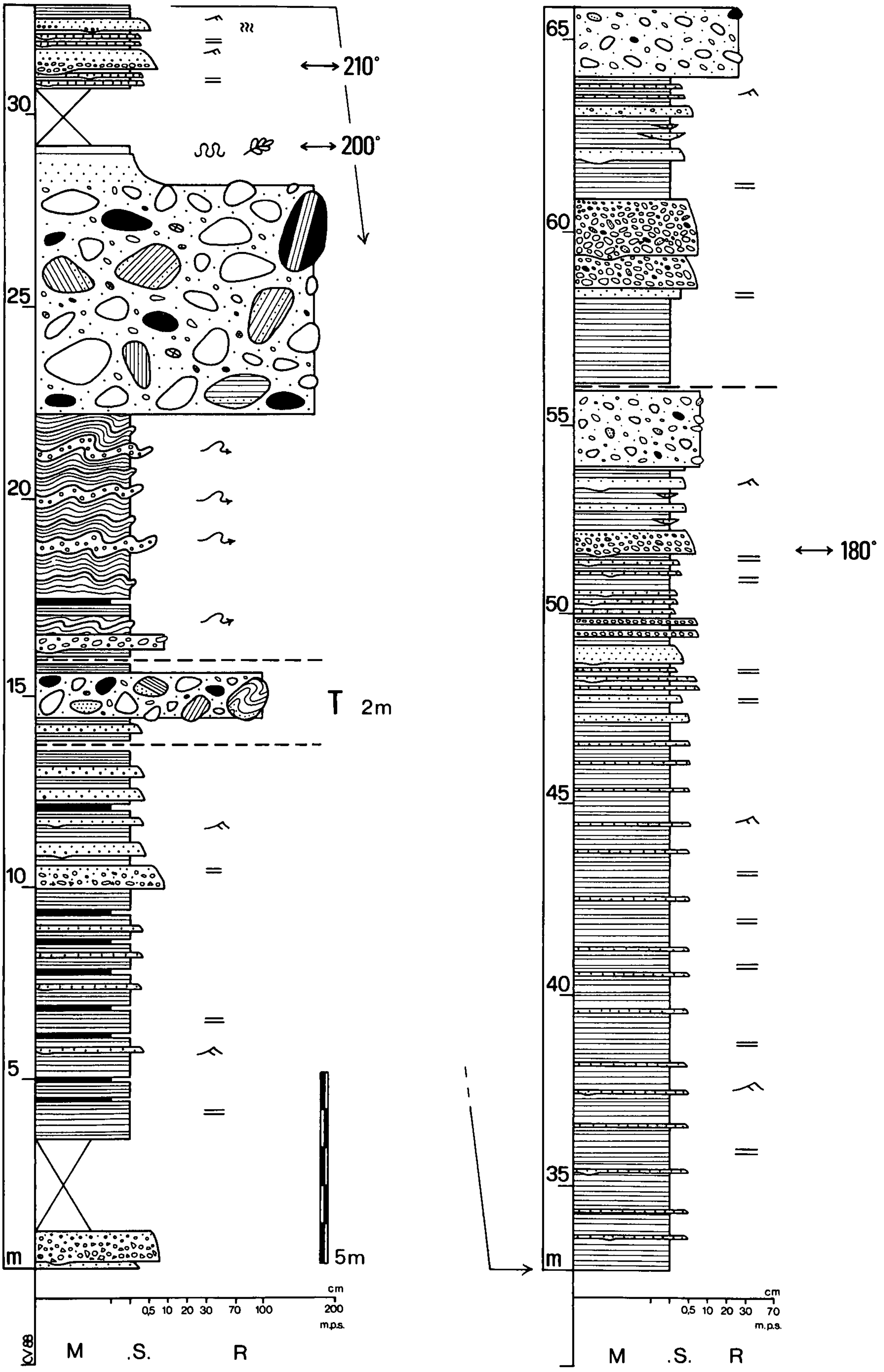



and the Dimon Formations (R. SELLI, 1963; G. GENTILI & R. PELLIZZER, 1964; E. CERETTI, 1965; F. CAPORALETTI & R. PELLIZZER, 1967; G. B. VAI, 1976; H. P. SCHÖNLAUB, 1979; C. SPALLETTA et al., 1980) not yet formally subdivided because of the strong tectonic stress they suffered during the Hercynian and Alpine orogenies. They outcrop in a continuous E–W oriented band across the Carnic Alps for a length of 70 km and a width of 10 km. They are northerly restricted by the Periadriatic Line and are covered by younger sediments to the South.

Fig. 2.
Detailed stratigraphic sections measured in the Hochwipfel Formation of the Carnic Alps.

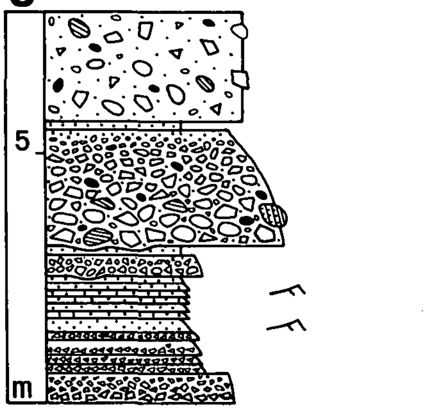


# CASERA PLOTTA
## B



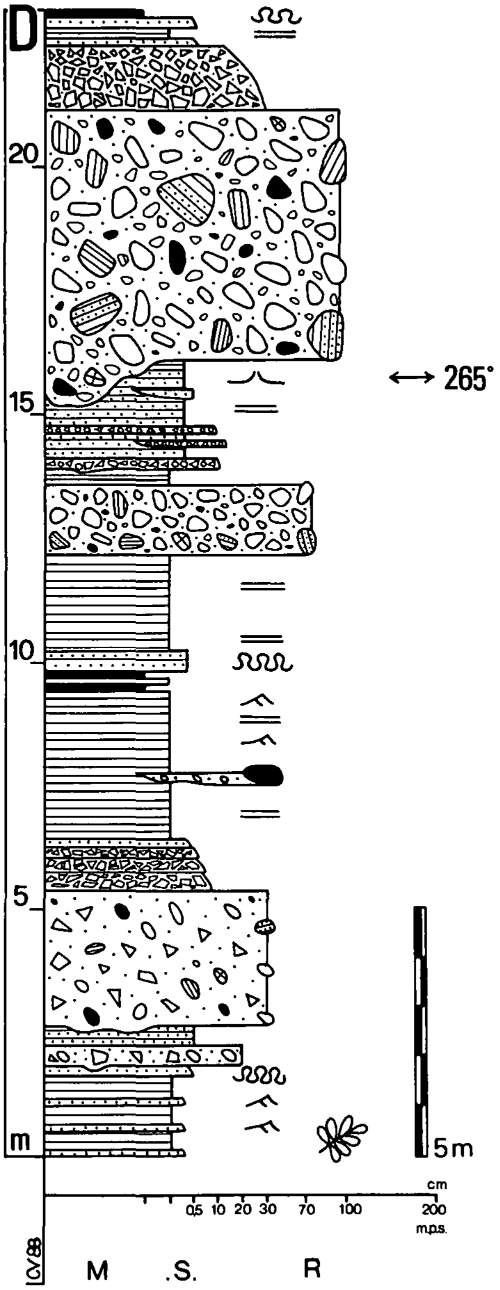
## DELLACHER ALM

C



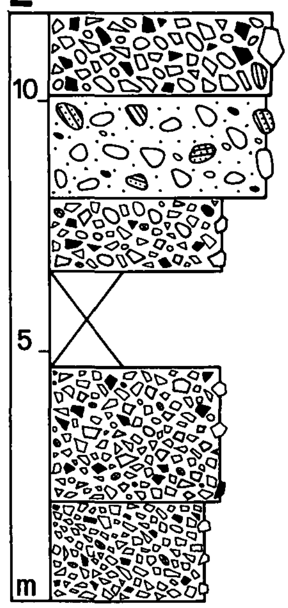

## DELLACHER ALM N

D



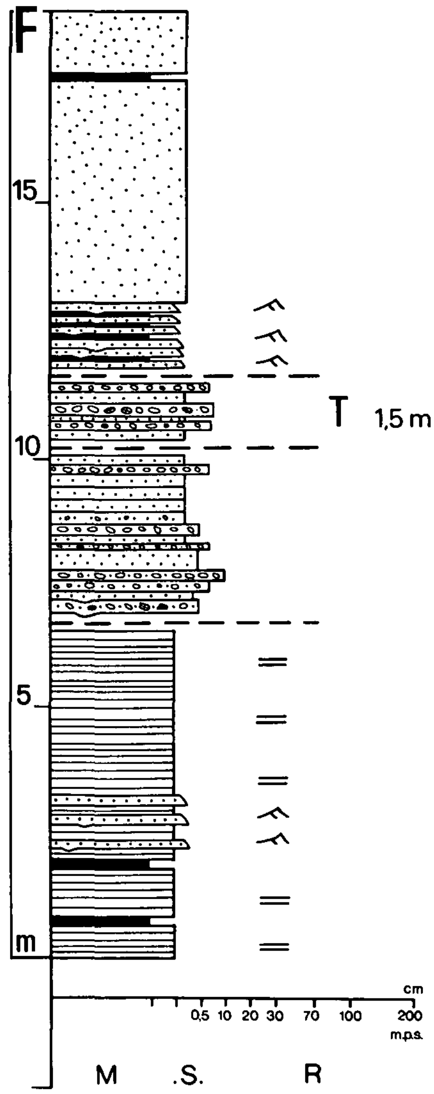

## C.ra VALBERTAD BASSA

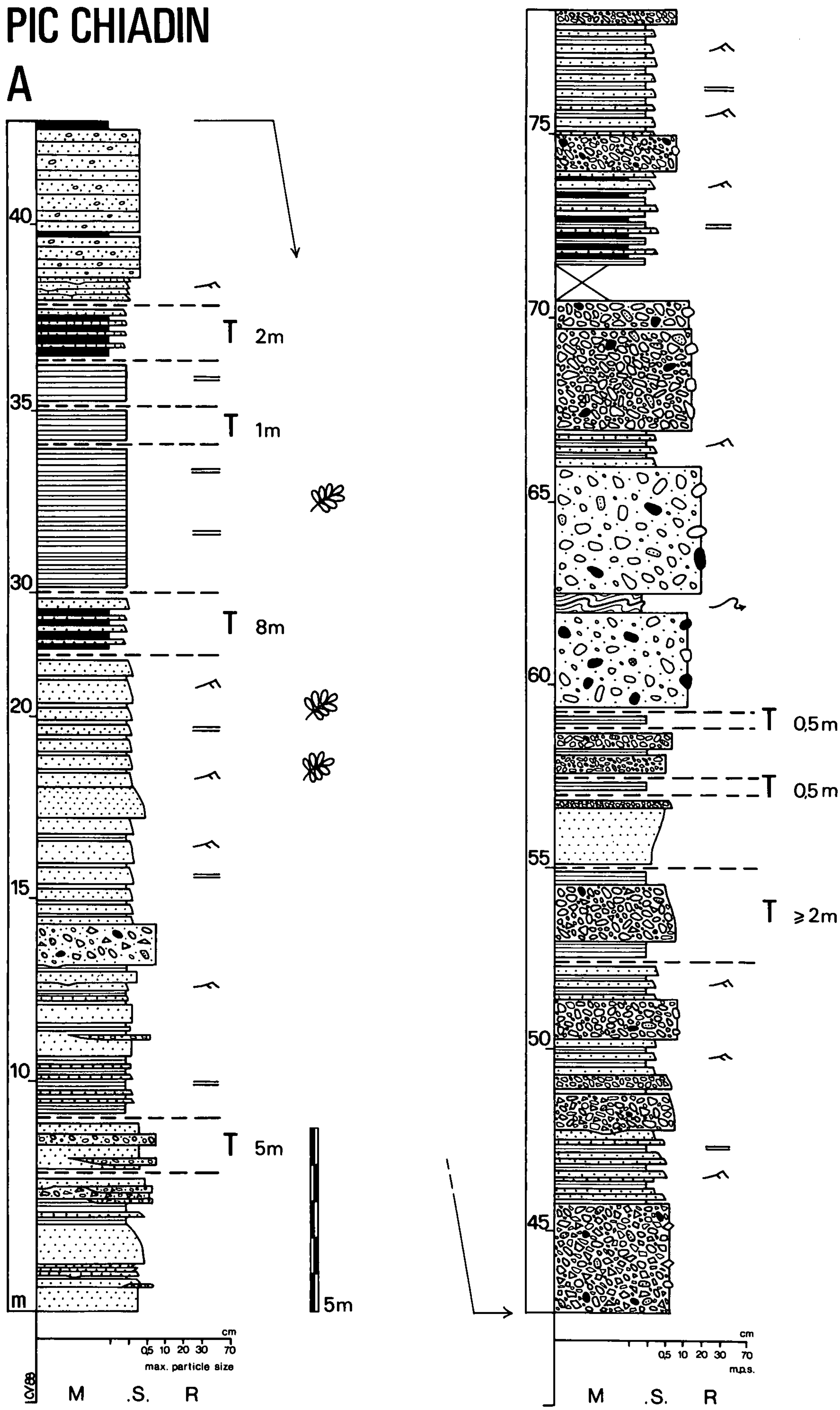
E




## UNTERBUCH. ALM

F




PIC CHIADIN
A
m
10
15
20
30
35
40
45
50
55
60
65
70
75
T 5m
T 8m
T 1m
T 2m
T ≥2m
T 0,5m
T 0,5m
5m
cm
0,5 10 20 30 70
max. particle size
m.p.s.
M .S. R
LCV/88

The Flysch deposits were greatly involved in the Hercynian orogeny responsible of the numerous tectonic slices and embricate thrust sheets (C. CANTELLI et al., 1965, 1968; G. B. VAI, 1979; C. SPALLETTA et al., 1982). The alpine deformations rearranged the previous tectonic setting, locally reactivating the Hercynian thrust planes (C. SPALLETTA et al., 1980, 1982).

The difficulties in measuring thick continuous sections along the strongly tectonized Hochwipfel Formation are therefore selfevident.

R. SELLI (1963) was the first to define the Hochwipfel Formation like a Flysch sequence with estimated thickness near 1000 m. The Flysch age is controverse and still debated. The most reliable and recent palaeontological data (H. W. J. v. AMERON et al., 1984) fix a Middle Visean age for the base of the Hochwipfel Formation. F. FRANCAVILLA (1966) suggested a Namurian – Westphalian age. They both base their assumption on plant remnants or palynomorphs, too rare and scattered to support good correlations among measured sections.

Lacking new palaeontological data and considering the stratigraphical setting (C. SPALLETTA & C. VENTURINI, 1989) the age of the Hochwipfel Formation was confined into a generic Visean – Namurian – ?Lower Westphalian interval.

According to the poor fossil content that prevents detailed biostratigraphy and the complicated tectonic setting, we don't propose any correlation among our measured sections. Anyway, we like to stress the basic role our new data play in a palaeogeographic reconstruction.

Aim of this paper is to attempt a new palaeogeographic interpretation of the Flysch stage of the Carnic microplate, mostly on the base of original data collected along six measured sections (figs. 1, 2) across the Central Carnic Alps.

## 2. Lithostratigraphy

The Hochwipfel Formation overlies a carbonatic to radiolaritic sequence of Devonian to Dinantian age and is laterally interfingered with and covered by the volcanoclastites and volcanites of the Dimon Formation.

According to C. SPALLETTA et al. (1980) the Hochwipfel Formation can be subdivided into three clastic members (torbiditi fini [arenarie, siltiti e argilliti]; brecce e olistostromi calcarei; olistostromi silicoclastici canalizzati „brecce e brecciole a liditi"), capped by an acid to intermediate volcanic sequence. Here we describe the clastic deposits only, subdivided into four lithofacies. The first three nearly correspond to the members reported by C. SPALLETTA et al. (1980). The last one mainly corresponds to a conglomeratic lithofacies that we first introduce, the presence of which allows new palaeogeographic suggestions.

1) Arenaceous to pelitic turbiditic sequence: It represents the main lithology of the Formation. The coarser well bedded strata show 5 to 30 cm thickness and exhibit fining upwards trends, erosive base with rare groove marks. In the arenites the composition of the lithic fragments ranges from filladic to gneissic elements to acid volcanites and abundant radiolarian chert clasts (F. CAPORALETTI & R. PELLIZZER, 1967; C. SPALLETTA et al., 1980). Scattered shale and sandstone lithics with composition similar to the Hochwipfel Formation itself are present. Some rare fragments of fresh, basic volcanics are to be noticed too in the basal bed of the sequence. The arenites composition is partly similar to that of lithofacies 4. This analogy may be connected with the presence of a distal and a proximal source area, as suggested for lithofacies 4 (see Discussion).
2) Limestone breccias: They mainly represent basal intercalations within the Hochwipfel Formation. They were mostly classified as olistostromes by C. SPALLETTA et al. (1980). The main clastic components are carbonatic and correspond to the Devono-Dinantian limestones, mainly pelagic, broken along submarine extensional faults and slid down into the subsiding basin. The thickness of these horizons range from 0.2–0.3 to 3 m and they are recognizable as originally continuous over at least 6 km (C. CANTELLI et al., 1982).
3) Silicatic breccias: They are 0.3 to 4 m thick levels scattered inside the first half of the turbiditic sequence. The breccia levels are interlayered with the turbiditic fine deposits in sequences 1 to 30 m thick. The 99 % of the clasts are black and light grey radiolarian chert. Rare carbonatic clasts are present. The average size of the chert clasts ranges from 0.5 to 2 cm. Clasts are always sharply angular and matrix is poor. This kind of deposits frequently exhibits an erosive basal surface. Normal gradation occurs in the breccia levels, according to turbiditic depositional processes. For this kind of breccias the data support a seismic origin driven by extensional submarine faults that broke the Silurian – Devonian – Dinantian radiolaritic sequences during the early development of the flysch stage in the carnic area (G. B. VAI, 1976; C. SPALLETTA et al., 1980).
4) Silicatic pebbly mudstones (a), conglomerates (b) and massive sandstones (c): The pebbly mudstones (a) always occur in 1–3 m thick episodes interfingered with the turbiditic sequence. No internal organization is present. Clast dimensions vary from site to site. The average size is from 4 to 12 cm; the maximum size may reach 35 cm. Their composition is strictly siliceous (radiolarian chert) with some scattered pelitic boul-

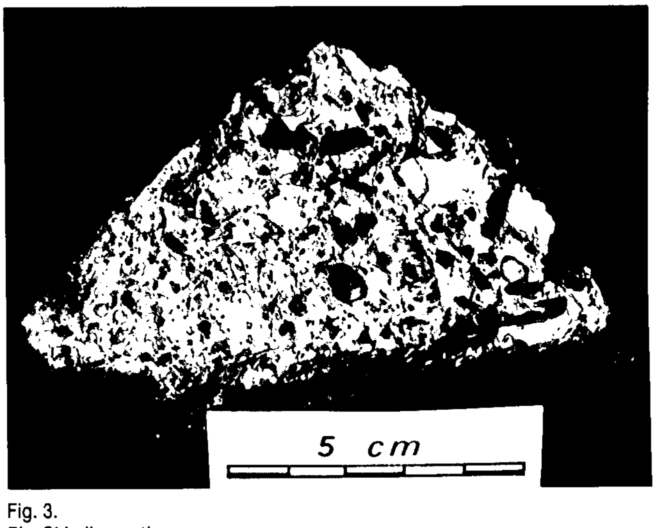



Fig. 3.
Pic Chiadin section.
Lithofacies 4(b). Clasts, mainly radiolarian chert, show manifest roundness.

Fig. 4.
Casera Plotta section.
Second ruditic episode, formed by a basal level with scanty matrix and no internal organization grading into a turbiditic bed with plane lamination. Clasts (mainly radiolarian chert) are mostly angular in the lower portion and rounded in the upper one.

ders (silurian graptolithic black shales), rare shallow marine limestones (Visean [M. MAMBRINI, 1975]), arenaceous pebbles and boulders and scanty basic volcanic clasts. It is to be noticed the high roundness of all the clasts.

On the other hand, the conglomerates (b) are clast supported and show no large size clasts like the pebbly mudstones, but the sorting is low. Internal organization is commonly lacking. Clast composition is quite similar to the former (fig. 3). The most frequent clast shape is tabular (3:2) with perfectly rounded edges. Besides the abundant radiolarian chert pebbles, rare rounded quartz with high sphericity are present.

Rare, sometimes thick, massive sandstone beds (c), interpreted as grain flow, are connected with both the above described lithotypes. Usually these facies are interbedded with turbiditic sandstones and pelites.

Sometimes, on the field, the ruditic facies (3 and 4) are not well distinguishable one from the other. The main lithotypes are often mixed together and it is possible to recognize intermediate facies (3–4a and 3–4b types are common, 4a–b less frequent) (figs. 4, 5). In some cases, normal gradation is present in this kind of deposits. However, there is no doubt that facies 4a is quite separable from the „Brecce e brecciole a liditi“ (radiolarian chert breccias) Auctorum, that correspond to our facies 3 (fig. 2).

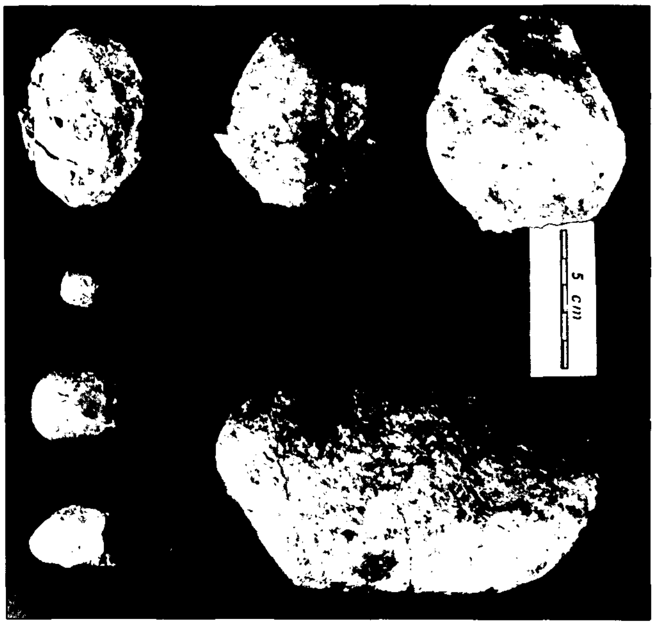



Fig. 6.
Seven radiolarian chert clasts (lydite) collected along the Pic Chiadin section clearly showing high roundness. In some cases (top row) sphericity is good, too. They testify subaerial reworking.

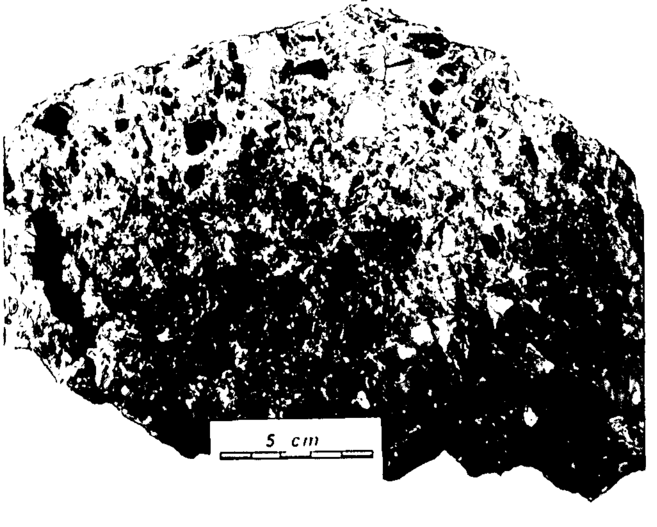



Fig. 5.
Casera Plotta section.
Sample representing the mixture of lithofacies 3 and 4.
Note the presence of both angular and rounded radiolarian chert clasts.

## 3. Discussion

On the base of the new field data it is possible to suggest some palaeoenvironmental and palaeogeographic tentative interpretations.

Before introducing them we like to point out the following remarks.

a) The Hochwipfel extrabasinal sources could have been located in the Northern area, according to the migration of the orogenic rising front (G. B. VAI et al., 1984).

Southern provenances cannot a priori be excluded but they seem genetically unlikely.

b) The well rounded radiolaritic pebbles cannot have been reworked from older conglomeratic units. Radiolarian chert rounded clasts are lacking in the pre-Namurian sequences of the surrounding areas (Carnic Alps, Nötsch, Karawanche, Murau, Grauwacken-Zone, Graz) (F. EBNER et al., 1981).

c) The radiolarian chert clasts (lydite) of facies 4 testify provenance from a near, emerged sourced area, according to the use of the lyditic fragments as palaeogeographic tool proposed by C. SPALLETTA (1982).

Short distance stream transport may produce rounded edges maintaining tabular shape in this kind of clasts (fig. 6) (Ph. H. KUENEN, 1956; E. S. SNEED & R. L. FOLK, 1958) in addition to possible shoreline reworking.

d) The Graptolithic shale cobbles and the scattered limestone clasts also testify subaerial reworking in a near source area.

The exposed remarks and the analysis of the previously described lithofacies allow us to better sketch out the geological framework of the synorogenic Hercynian basin of the Carnic Alps.

Since Upper Devonian to Dinantian p. p. the zone was affected by a widespread extensional regime (G. B. VAI, 1976; C. SPALLETTA et al., 1980). Consequently, the first deposits of the Hochwipfel Formation stored up in the deepest part of the subsiding basin.

May be during this time some local basic volcanic activity developed with thin basalt levels, early episodes similar to the later volcanic sequence of the Dimon Formation.

At this point, it is likely to suppose that during the Upper Visean part of the Carnic basin itself underwent a fast rising. The inferred stratigraphy of the rising blocks was the following: Silurian Graptolithic shales, Silurian to Dinantian p. p. radiolarian chert and shales, capped by arenites of the early stage of the Hochwipfel Formation and thin basic volcanics.

Textural features in lithofacies 4 suggest its source area was located in "deltaic" environments which frequently provided the near deep basin with debris and grain flow deposits. It seems likely to postulate an active tectonic responsible for the instability of these "deltaic" fronts.

Considering the age and the nature of the scanty limestone clasts found within lithofacies 4, narrow biostromal facies can be inferred growing laterally to deltaic bodies. The frequent plant remains scattered all inside the Hochwipfel Formation might have their source not so far as before considered. Deltaic plains might offer the necessary ground to the vegetation.

Till now there are no possibilities to estimate the time length of the deltaic activity. At present no evidences of Lower Carboniferous deltaic bodies can be recognized in the outcrop of the Palaeocarnic Chain. Presumably they and the probably related small, narrow emerged areas were mostly eroded during the early Late-Hercynian stage and stored up in the Bombaso Formation that is rich in radiolarian chert rounded clasts (C. VENTURINI, 1988).

Before considering the variability of provenances of the Hochwipfel sediments, we must discuss the F. CAPORALETTI & R. PELLIZZER (1967) petrographic analysis, the only available about the Hochwipfel arenites. The Authors interpreted them as high quartz content sediments (sublithoarenites). They obtained this result (based on the optical analysis of 25 samples, randomly collected in the arenitic portion of the Hochwipfel Formation) mainly because they compounded the radiolarian chert granules as quartz, in order to define the sediment maturity.

According to provenance analysis, however, we must consider the radiolaritic granules of the Hochwipfel Formation as rock fragments (G. G. ZUFFA, 1980).

With the aim of unravelling the provenance of the Hochwipfel arenites we re-plotted the F. CAPORALETTI & R. PELLIZZER (1967, tab. II) data accordingly, obtaining a substantial increase of lithic content versus quartz amount (fig. 7).

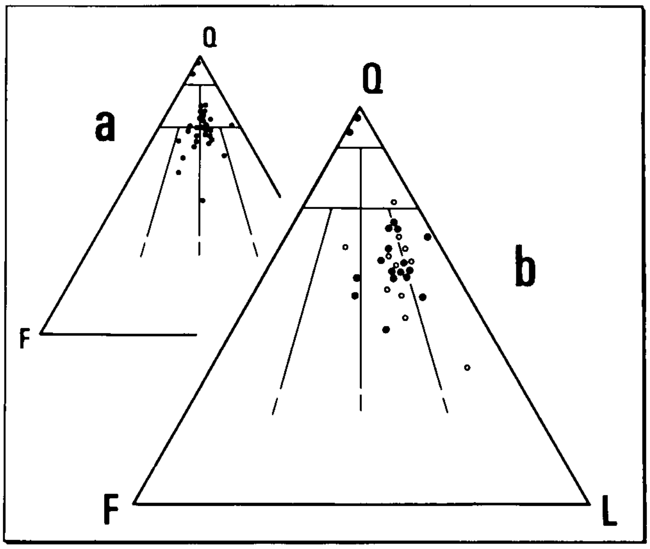



Fig. 7.
Composition analysis of the Hochwipfel arenites.
a = QFL diagram from F. CAPORALETTI & R. PELLIZZER (1967); b = QFL diagram obtained from the F. CAPORALETTI & R. PELLIZZER (1967) data (tab. II) plotting the radiolarian chert granules as lithic and splitting the samples according to grain size.
Maximum grain size: black spots from 0.3 to 0.5 mm, white spots from 0.6 to 1.0 mm.

Moreover, the petrographic data obtained by our review have been discriminated into two groups, according to grain-size, in order to compare homogeneous samples. Over 0.5 mm (maximum grain-size) dispersion is clearly evident. It is to remark that the petrographic analysis of F. CAPORALETTI & R. PELLIZZER (1967, tab. II) allow us to utilize the P. GAZZI-W. R. DICKINSON (1966–1970) method. Both the compositional dispersion connected to grain size (R. V. INGERSOLL et al., 1984) and the P. GAZZI-W. R. DICKINSON method are discussed in G. G. ZUFFA (1985).

Petrographical analysis and sedimentological evidences thus testify a large contribute from a non metamorphic, not far located area.

Otherwise, a distal source of sediments providing metamorphic quartz, zircon granules and filladic fragments (F. CAPORALETTI & R. PELLIZZER, 1967) is always present.

We conclude stressing the Hochwipfel alimentation in the Carnic domain can be derived from three main sources (fig. 8):

SNEED, E. D. & FOLK, R. L.: Pebbles in the lower Colorado River, Texas: a study in particle morphogenesis. – Jour. Geol., **66**, 2, 114–150, Chicago 1958.

SPALLETTA, C.: Brecce e conglomerati a liditi come indicatori paleogeografici del Carbonifero inferiore. – In: L. CARMIGNANI et al. (eds.): Guida alla geologia del Paleozoico sardo, Guide geol. reg. S. G. I., 197–201, Pisa 1982.

SPALLETTA, C., VAI, G. B. & VENTURINI, C.: Il Flysch ercinico nella geologia dei Monti Paularo e Dimon (Alpi Carniche). – Mem. Soc. Geol. It., **20** (1979), 243–265, Roma 1980.

SPALLETTA, C., VAI, G. B. & VENTURINI, C.: La Catena Paleocarnica. – In: A. CASTELLARIN & G. B. VAI (eds.): Guida alla geologia del Sudalpino centro-orientale, Guide geol. reg. S. G. I., 281–292, Bologna 1982.

SPALLETTA, C. & VENTURINI, C.: Stratigraphic correlation form (SCF) of the Palaeozoic sequence in the Carnic Alps (Geotraverse B). – Vol Spec. S. G. I., IGCP Project No. 5, 1989 (in press).

VAI, G. B.: Stratigrafia e paleogeografia ercinica nelle Alpi. – Mem. Soc. Geol. It., **13** (1974), 7–37, Pisa 1976.

VAI, G. B.: Una palinspastica permiana della Catena Paleocarnica. – Rend. Soc. Geol. It., **1** (1978), 29–30, Roma 1979.

VAI, G. B.: Tracing the Hercynian structural zones across Neo-Europa: an introduction. – Mem. Soc. Geol. It., **20**, 39–45, Roma 1980.

VAI, G. B., BORIANI, A., RIVALENTI, G. & SASSI, F. P.: Catena ercinica e Paleozoico nelle Alpi Meridionali. – In: Cento anni di geologia italiana. – Vol. giub. 1° Centenario S. G. I., 133–154, Bologna 1984.

VAI, G. B. & COCOZZA, T.: Tentative schematic zonation of the Hercynian Chain in Italy. – Bull. Soc. geol. France, **8**, 1, 95–114, Paris 1986.

VENTURINI, C.: Bombaso Formation: the basal clastic unit of the late orogenic Hercynian sequence in the Carnic Alps. – In: F. P. SASSI (ed.): Newsletter IGCP Project No. 5, **7**, 1988 (in press).

ZUFFA, G. G.: Optical analyses of arenites: influence of methodology in compositional results. – In: G. G. ZUFFA (ed.), Provenance of arenites, NATO ASE Series, Ser. C: Mathematical and Physical Sciences, **148**, 165–189, Dordrecht – Boston – Lancaster (D. Reidel Publ. Company) 1985.

ZUFFA, G. G.: Hybrid arenites: their composition and classification. – Jour. Sed. Petrology, **50**, 21–29, Tulsa 1980.

Manuskript bei der Schriftleitung eingelangt am 25. Juni 1988.

Zeitschrift/Journal: Jahrbuch der Geologischen Bundesanstalt

Jahr/Year: 1988

Band/Volume: 131

Autor(en)/Author(s): Spaletta C., Venturini Corrado

Artikel/Article: Conglomeratic Sequences in the Hochwipfel Formation: A New Palaeographic Hypothesis on the Hercynian Flysch Stage of the Carnic Alps 637-647