

REEF-BASIN DISTANCE IN THE DEVONIAN OF THE CARNIC ALPS¹

by

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(3 figures)

RESUME.- Un complexe récifal dévotionien du centre des Alpes Carniques est discuté du point de vue de ses microfaciès. Le complexe montre des transitions entre faciès pélagiques, récifaux et intertidaux qui sont, de manière inattendue, proches l'un de l'autre.

ABSTRACT.- A Devonian reef complex in the central Carnic alps is discussed with respect to its microfacies. The complex shows transitions between pelagic, reef and intertidal facies that are unusually close to each other.

1.- INTRODUCTION

If one wants to obtain information about a paleozoic reef and its position toward its basin, difficulties due to the tectonic situation or the quality of outcrops are often crossed.

The area covered in this paper is situated in the Carnic alps at the border between the Austrian state of Kärnten and the Italian province Friule (fig. 1). This massif including a reef complex in the central Carnic alps has many advantages over other reef areas. It is the massif of the Kellerwand-Hohe Warte. The advantages are as follows :

- a) The outcrop is three-dimensional (6 km wide, 1300 m high).
- b) The fold tectonics are of very low grade.
- c) Lateral movement distances of subordinate nappes are small.
- d) The stratigraphic sequences can be observed throughout the whole wall complex.
- e) There are intertidal and pelagic sediments of the same age.

The only major disadvantage is the poor accessibility of the area. It is only possible by alpinistic methods.

2.- TECTONICS

To understand the position of the different facies it is necessary to discuss the tectonic history in the area.

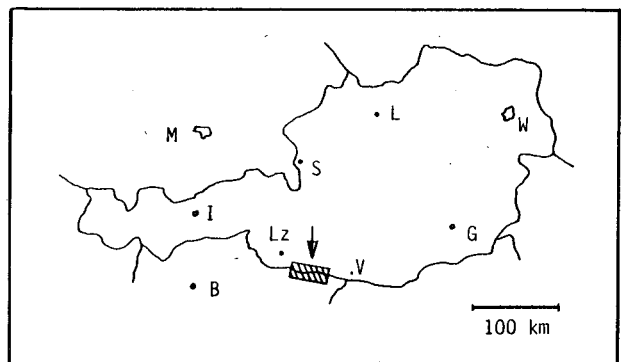


Fig. 1.- The arrow shoes the studied area at the border between Kärnten (Austria) and Friule (Italy).

M: Munich; W: Vienna; L: Linz; S: Salzburg; I: Innsbruck; Lz: Lienz; V: Villach; G: Graz; B: Bozen

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The actual situation of the Carnic alps was caused by variscic and later alpidic movement (Schönlaub, 1979, 1985). v. Gaertner (1931) and Heritsch (1936) recognized nappe tectonics in the Carnic alps. Nine nappes can be distinguished. There exist rudiments of earlier fold tectonics. Additional to the nappe tectonics late alpidic fractures and overthrusting came into play. The time relationships of the tectonic events are very difficult to determine because of alpidic nappe movements recognizable in the overlying sediments of the neighbouring areas (Schönlaub, 1985). Early authors discuss variscic nappe movements (v. Gaertner, 1931). Frascari, Vai & Zanferrari (1979) see the central Kellerwand area overthrust as a total complex at Permian-Triassic boundary, but without effecting the primary variscic emplacement.

The vergency of nappe overthrusting and the folds is to the north. The outcrops show subordinate nappes of one nappe system originally located 30 to 40 km to the south. The entire Kellerwand area is situated in the so called Cellon-Kellerwand-nappe which is divided into three subordinate nappes.

The lower subordinate nappe in a high pelagic facies is known as the Rauchkofel-nappe, the middle subordinate nappe is the Cellon-nappe with a transitional facies from reef to off-shore, while the upper with reef and near-shore facies is called the Kellerwand-nappe.

3.- PRELIMINARY STUDIES

Bandel (1969, 1972) and Pohler (1982) took profiles at the outermost western mountain of the massif, the Seewarte. Limestones can be found from the Lochkovian up to Frasnian.

At the outermost eastern mountain of the massif, the Cellon was investigated by Bandel (1972) in several parts. In the lower Devonian he concluded off-shore facies. In the Frasnian a high pelagic facies is discernable. In the northern section of Cellon there exists a fold that shows interlocking from transition and pelagic facies in the lower Devonian, also recognized by v. Gaertner (1931).

Schönlaub & Flajs (1975) made a reconnaissance survey along the Koban-Prunner route in the north wall of Hohe Warte, however, no samples were taken.

The distance between Cellon and Seewarte is about 6 km. At Seewarte the microfacies is well understood, while at Cellon only in several parts. It is difficult to obtain information and samples from the middle part of the Kellerwände, since the walls are very steep and more than 1000 m high.

Samples can only be taken by climbing or abseiling down the walls. Work often must be done while suspended on ropes. The first microfacial explorations were concluded by Kreutzer (1985). In 1984 the first detailed geological map of the Eiskar-Kellerwand-area was worked out (Kreutzer & Schönlaub, 1984; Kreutzer, 1986). Based on this work samples were taken along several profiles along the north walls of Cellon, Kellerwände and Hohe Warte.

4.- MICROFACIES

4.1.- THE KELLERWAND-NAPPE

4.1.1.- The Seewarte profile

The Kellerwand-nappe is 400-1000 m overthrust upon the Cellon-nappe. In this complex Bandel (1969) showed in the Seewarte profile crinoidal facies of the Lochkovian with costellate shells of brachiopods, algae and coated components in a sparitical matrix. These grainstones indicate a high energetic, well-lighted and oxygen rich environment.

In the Pragian, crinoidal sediments with *Karpinska conjugula* were also deposited and overgrown by reef horizons containing corals and stromatopores.

The Emsian includes *Karpinska consuelo* and begins with the Hercynellenkalk, a sediment showing a restricted lagoon with pellets, much bitumen and a highly differentiated gastropodal fauna. Further bryozoans, bivalves and algae indicating a high oxygen environment can be found. In the upper Emsian the facies develops into intertidal characteristics. Laminites interbedded by algae and dolomites were deposited.

The Eifelian shows loferites with birdeyes also deposited in an intertidal facies.

In the Givetian Amphipora-limestone with brachiopods (*Stringocephalus burtini*) show a back-reef sedimentation in flat subtidal facies interlocking with birdseye limestones of the intertidal facies.

In the Frasnian reef organisms with stromatopores and corals appear more frequently. The water becomes deeper and in the lower Carboniferous the open sea transgresses over the area. Limestones with goniatites are deposited.

4.1.2.- The Hohe Warte profile

In the north wall of Hohe Warte two profiles were sampled. They begin with Lochkovian crinoidal limestones, similar to the layers at Seewarte of the same age but showing more reef fossils. The Pragian is again represented by a crinoidal facies.

In the Emsian the Hercynellenkalk is not as thick as at Seewarte, rather it thins away in a easterly direction. Laminites of the upper Emsian also indicate an intertidal facies.

These laminites are overlain by Eifelian grainstones with echinodermal fragments, dasycladacean algae, gastropods and coated grains. Boring algae micritized much of the components. In the Upper Eifelian loferites with birdseyes occur often.

The Givetian shows amphipores with *Stringocephalus burtini*. At the summit reef organisms are found.

4.1.3.- The upper Kellerwand profile

The profile in the upper Kellerwand begins at the rim of the Eiskar glacier with Eifelian grainstones containing coated grains, echinodermal fragments, corals, bivalves and amphipores.

In the Givetian crinoidal limestones with few dasycladacean algae were deposited. They are overlain by a thick biohermal complex showing the climax of reef development in the area.

In the Lower Frasnian reef deposits continue with *Scruttonia julli* indicating clearly Frasnian (Küster, 1987).

The next higher stratigraphical unit is a thin layer with birdseyes, followed by breccias with imbricate structure, and at last a brachiopodal limestone can be distinguished. Conodonts showed in all layers a Famennian age.

4.2.- THE CELLON NAPPE

4.2.1.- The lower Kellerwand profile

The lower Kellerwand below the Eiskar is occupied by rock sequences belonging to the Cellon-surbordinate-nappe. The profile begins with Lochkovian layers showing a pelagic fauna with tentaculites, orthocerans, trilobites and a fine grained ground mass. The Pragian is represented by yellow platy dolomites and shows tentaculites and pellets like the Lochkovian in calcium rich areas.

In the Lower Emsian fine graded bedding pelletal grainstones, often wackestones with tentaculites, represent a slope sedimentation. In Upper Emsian reef development takes place. Banked Coral and stromatopore layers alternate with platy parts separated with a fine grained ground mass.

In the Eifelian typical back reef sediments, including coated grains and coated fossil components, indicate the continuation of regression. Patch reefs can often be separated in this complex.

4.2.2.- The Cellon profile

The well known profile of the avalanche groove at Cellon begins with the Upper Ordovician and reaches into the Frasnian. The Silurian has been often described (Flügel, H. 1965; Flügel, H., Jaeger, Schönlaub & Vai, 1977; Schönlaub, 1979; Schönlaub 1985). Bandel (1972) worked out the microfacies in the Devonian where it was possible for him to take samples. According to Bandel and recent investigations, deeper shallow water sediments, containing wackestones with radiolarians and calcispheres, tentaculites, trilobites and cephalopods, are often interlaced by fine graded embankments coming from a swell lying in the reef direction. Sometimes fragments of reef fossils can be found. In the Frasnian the area sank, and red cephalopodal limestones were deposited at Cellon.

4.3.- THE RAUCHKOFEL-NAPPE

The Frasnian sediments at Cellon are very similar to the high pelagic thin limestone deposits of the entire Devonian in the Rauchkofel-nappe. The Rauchkofel-limestones interlock with the limestones of Cellon profile in the north fold at Cellon. The Devonian of Cellon- and the Kellerwand-nappe is ten times as thick as the Devonian of the Rauchkofel-nappe.

5.- CONCLUSION

On the north-west wall of lower Kellerwand a fold is exposed, already mentioned by Frech (1894). It is a fold at the front of the Kellerwand-surbordinate-nappe. Following the walls in the direction of the Hohe Warte (west) one sees sediments of the Kellerwand-nappe and following these in the direction of Cellon (east) sediments of the Cellon-nappe of the same age. A change from intertidal to high pelagic facies can be worked out from the west to east (by facial change in profiles) as well as from south to north (by facial change in subordinate nappes). Looking from the north towards the area the following can be concluded (fig. 2).

In the Lochkovian, reef development begins at the Hohe Warte-Seewarte area. In the Emsian it precedes towards the central Kellerwand. At the same time intertidal sediments accumulate at Seewarte. Throughout the Upper Devonian the reef regresses toward Seewarte. Only in the outermost north-east the limestones remain pelagic throughout the Devonian. In the Viséan, Flysch transgresses over the entire area.

It is remarkable that during the whole Devonian a very limited area, such as the Kellerwand-Hohe

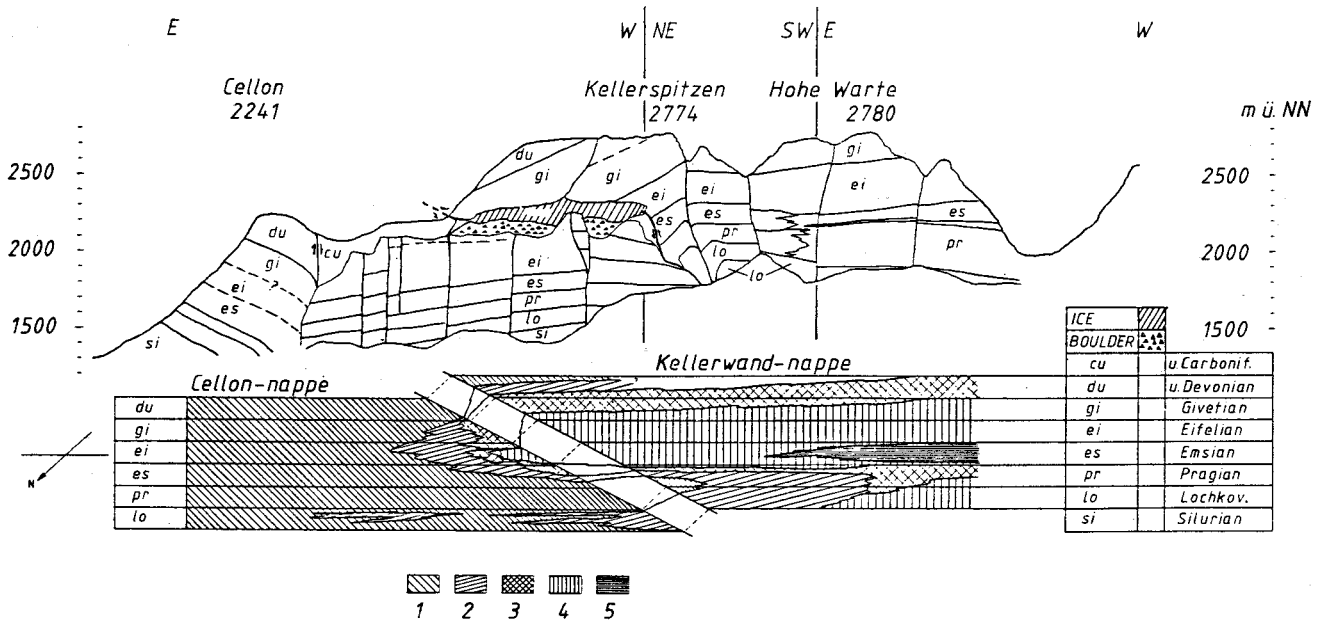


Fig. 2.- View from the north of the Kellerwand-Hohe Warte-area. Below, the dislocation of facies in the Devonian is shown : At the East the lower Cellon-nappe, at the West the upper Kellerwand-nappe
 1: pelagic facies; 2: slope deposits; 3: reef buildups; 4: back-reef-sediments; 5: intertidal sediments

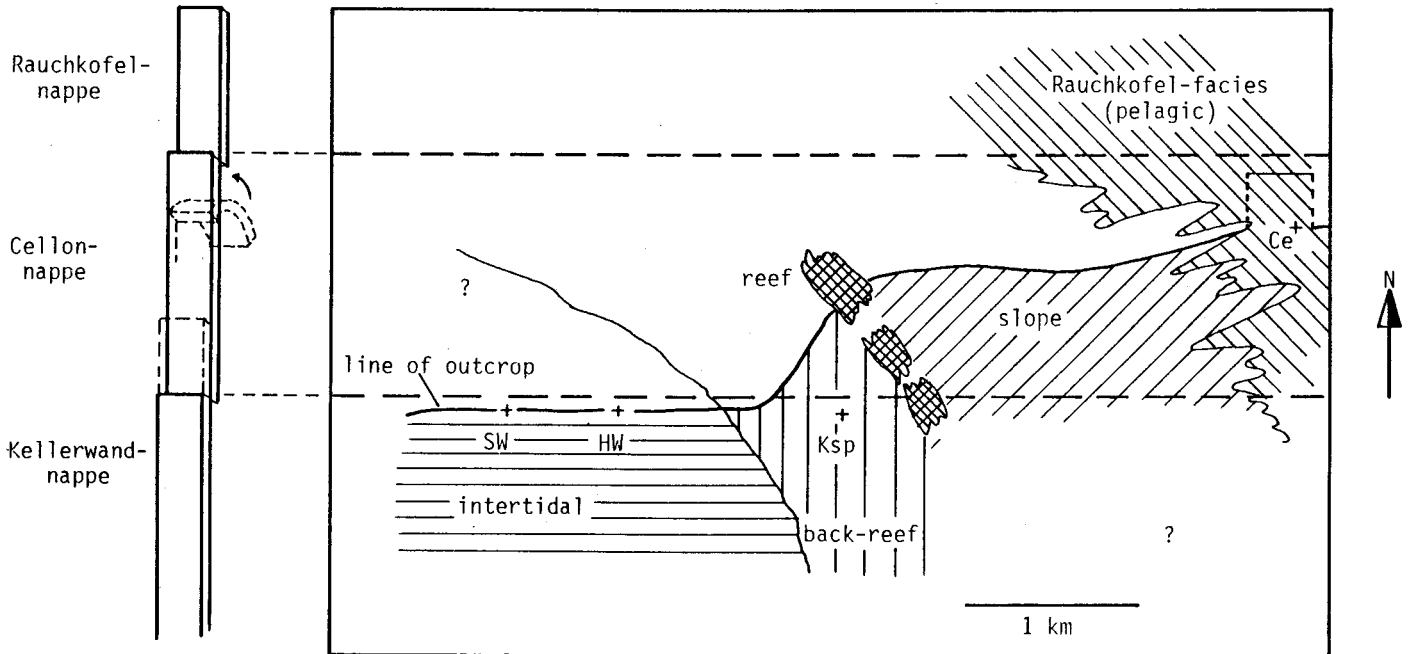


Fig. 3.- Paleogeographic map of the Kellerwand-Hohe Warte-area in upper Emsian.
 SW: Seewarte; HW: Hohe Warte; Ksp: Kellerspitzen; Ce: Cellon

Warte complex, represents a stable development in limestone facies.

6.- PALEOGEOGRAPHIE

Replacing the Cellon-fold and the Kellerwand-nappe to their supposed paleogeographic position the following can be stated for the Upper Emsian (fig. 3):

In the south-west deposition of intertidal sediments took place. The Kellerwand represents an interrupted reef belt with forereef sediments on its slope.

In the north-east there is a basin with red coloured cephalopodal limestones with 120 m thickness. The shallow water deposits in the Kellerwand area reaches over 1000 m thickness.

The mean distance between the reef belt to the pelagic deposition area is only about 3000 m. This

distance is very short compared to distances discussed by other authors concerning other similar fossil limestone complexes. Therefore the Kellerwand area is a typical example for an area of distinct transition from unusually close shallow water and pelagic facies.

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