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Discovery of fossils in the Adula nappe, new stratigraphic data and tectonic consequences (Central Alps)

par

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Résumé.–CAVARGNA-SANI M., EPARD J.-L. & MASSON H., 2010. Découverte de fossiles dans la nappe de l'Adula, nouvelles données stratigraphiques et conséquences tectoniques (Alpes centrales). *Bulletin de la Société vaudoise des Sciences naturelles* 92.2: 77-84.

Des fossiles de crinoïdes ont été découverts dans les roches très métamorphiques de la nappe de l'Adula, près du Plattenberg (pt. 3041), sur la crête entre le Tessin et les Grisons. La préservation de fossiles dans des roches aussi fortement métamorphisées sous haute pression (faciès éclogite) est exceptionnelle. Ils se trouvent dans une formation de brèches à éléments dolomitiques qui avait été confondue jusqu'ici avec le Trias. Nous la nommons la Brèche du Plattenberg. Les crinoïdes montrent que cette brèche s'est formée en milieu marin de haute énergie. Près de sa base, des intercalations discontinues d'une roche rougeâtre riche en mica et oxydes de fer sont interprétées comme du Sidérolitique, démontrant qu'une émersion avec érosion continentale a précédé le dépôt de la brèche. Par analogie avec des situations semblables dans d'autres parties des Alpes, nous suggérons un âge Dogger (Jurassique moyen), dans un contexte tectonique d'extension lié à l'ouverture océanique de la Téthys.

Cette brèche repose sur une formation dolomitique triasique semblable au Trias de plusieurs autres unités penniques inférieures. L'absence d'affinités avec le Trias Briançonnais trouve toute son importance au vu de la découverte récente d'un élément triasique Briançonnais sous le front de l'Adula. Cet élément et les formations paléozoïques à jurassiques qui l'accompagnent (nappe de Luzzone-Terri) doivent donc avoir une origine ultra-Adula; autrement dit ils doivent s'enraciner au sud et être passés par-dessus l'Adula, pendant la subduction génératrice du métamorphisme de haute pression. Ils ont ensuite été rattrapés par la nappe de l'Adula lors de son exhumation.

Mots clés: Adula, Pennique, Alpes centrales, fossiles, métamorphisme HP.

Abstract.–CAVARGNA-SANI M., EPARD J.-L. & MASSON H., 2010. Discovery of fossils in the Adula nappe, new stratigraphic data and tectonic consequences (Central Alps). *Bulletin de la Société vaudoise des Sciences naturelles* 92.2: 77-84.

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Crinoid plates have been found in the Mesozoic sediments of the highly metamorphic (eclogite facies) Adula nappe. They occur in a dolomitic breccia formation that had previously been confused with the Triassic. We name it the *Plattenberg Breccia* and we suggest a Middle Jurassic age.
This breccia overlies a Triassic dolomitic formation similar to the Triassic of several other Lower Penninic units. The absence of affinity with the Triassic of the Briançonnais domain is important with respect to the recent discovery of a Briançonnais Triassic element below the front of the Adula nappe. Consequently this element must have an ultra-Adula origin and was transported over the Adula during its subduction.

Keywords: Adula, Penninic, Central Alps, fossils, HP metamorphism.

Introduction

The Adula nappe is a large tectonic unit of the eastern Central Alps, mainly made of highly metamorphic Paleozoic (and older?) basement rocks (figure 1; e.g. Jenny *et al.* 1923, Frischknecht *et al.* 1923, Löw 1987, Berger *et al.* 2007 and references therein, Nagel 2008, Liati *et al.* 2009, Herwartz *et al.* in press). During the Alpine tectonic cycle this nappe was submitted to a high pressure metamorphism under eclogite facies conditions. A Mesozoic (and younger?) cover penetrates deep into this basement as bands and discontinuous relics of highly metamorphic sediments. Little is known about these rocks that mainly consist of dolomite and calcschists or micaschists (often called Bündnerschiefer) and are classically ascribed to the Triassic and to the Lias (Jenny *et al.* 1923, Egli 1966, Thüring 1990, Wyss & Isler 2007).

We report here the first discovery of fossils in these metasediments together with other stratigraphic observations at the Plattenberg (pt. 3041; 2 km S of the front of the nappe), taking advantage of the excellent quality of the outcrops. The Plattenberg area has been mapped by Egli (1966) and its complex folds have been illustrated by Jenny *et al.* (1923, p. 39-41).

Stratigraphy of the Adula sedimentary cover at the Plattenberg

The stratigraphic succession is the following, from basement upwards (figure 2):

1. The Garenstock augengneiss forms the top of the basement in this area (Kopp *in* Jenny *et al.* 1923, Egli 1966). It often contains brown carbonate nodules of mm size, particularly frequent in its upper part. It also contains a few trails of amphibolite boudins in the core of which eclogite is locally preserved.

2. This gneiss is overlain with a sharp contact by a thin layer of white quartzite, similar to the quartzite that commonly forms the base of the Triassic in many parts of the Penninic Alps.

3. This quartzite is overlain by a thicker alternation of white and grey-bluish dolomites, similar to the Triassic of several Lower Penninic units. The base of this dolomitic formation consists in a 1 m thick brownish to yellow level where a dolo-micaschist passes gradually upwards to pure dolomite with thin micaschist intercalations.

4. These dolomites are overlain with a sharp contact by a coarse detrital formation mainly made of dolomitic breccias (figure 3). The dolomite clasts are reworked from the Triassic

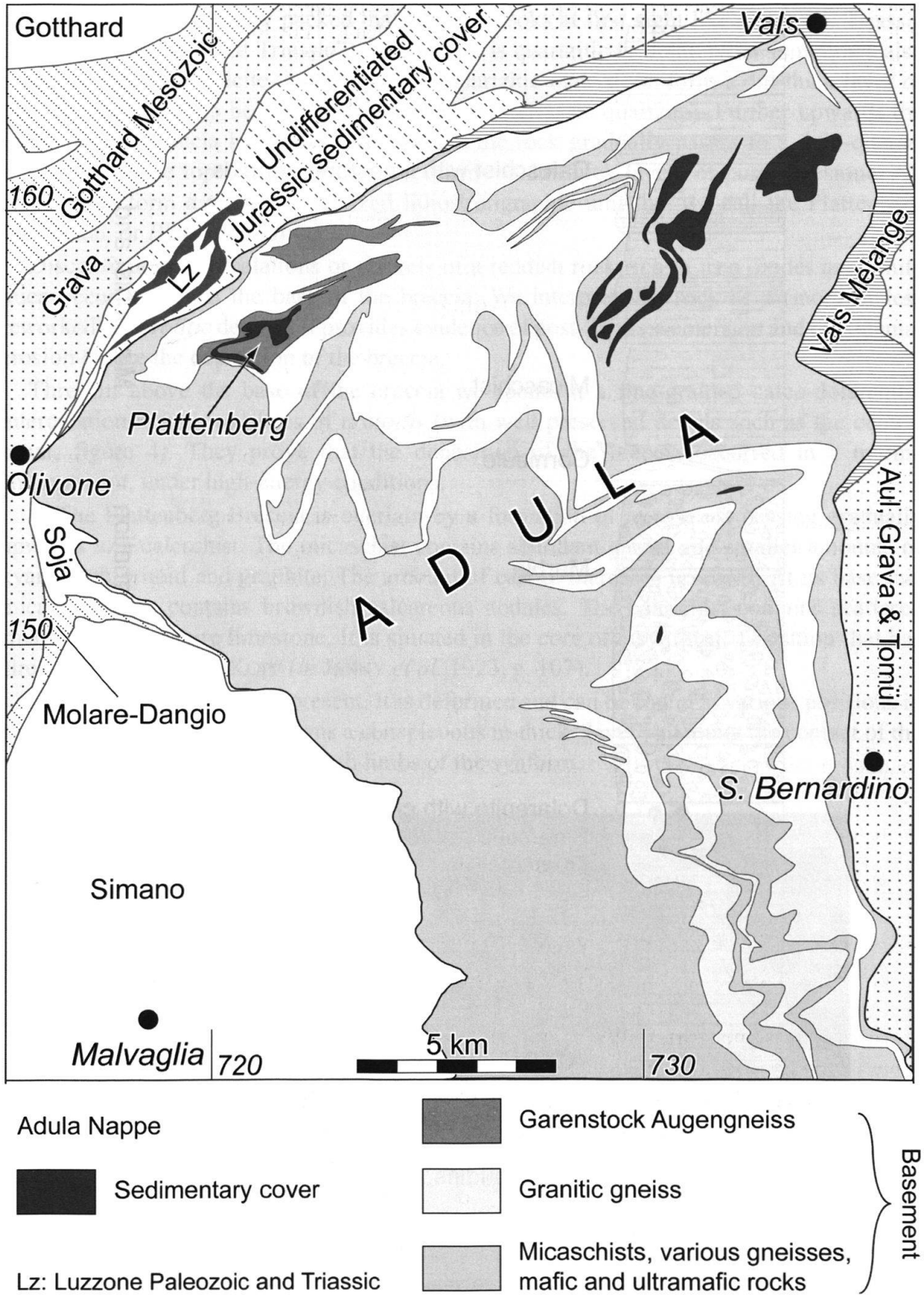

Figure 1.–Geological map of the northern Adula nappe.
Carte géologique de la partie nord de la nappe de l'Adula.

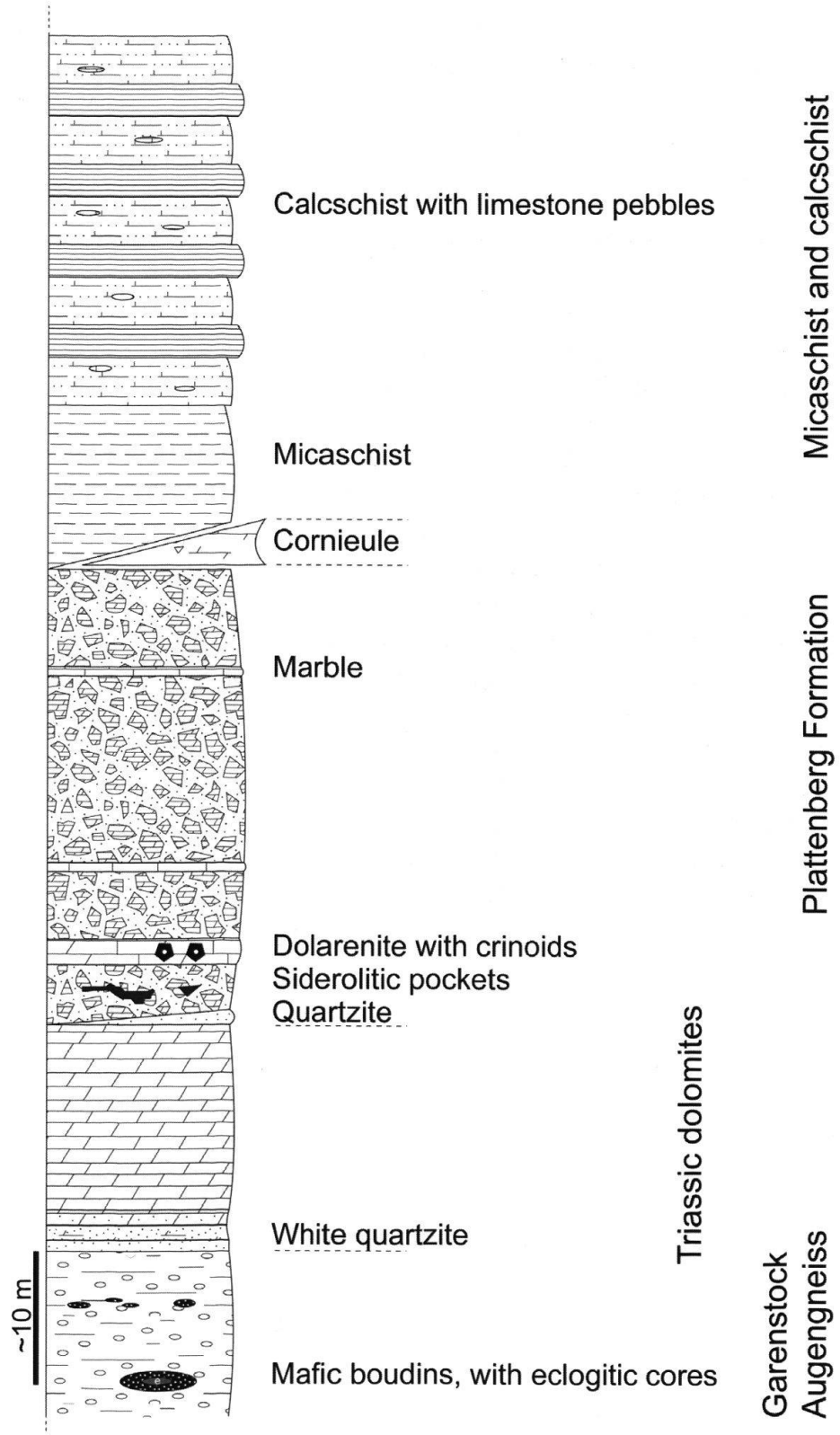

Figure 2.– Synthetic stratigraphic column of the lithologies observed in the Plattenberg area.
Colonne stratigraphique synthétique des lithologies observées dans la région du Plattenberg.

and they can be so closely packed that the rock looks at first sight like a genuine Triassic dolomite ("reconstituted Triassic"). The matrix is quartzitic to dolarenitic, sometimes also containing mica or calcite. At the base the quartzitic matrix can form a dm-thick layer of pure quartzite (not to be confused with the basal Triassic quartzite). Further upwards the matrix of the breccia becomes dominant and the rock gradually passes to a dolo-quartz-arenite. Near the top it may contain a few cm- to dm-thick layers of pure limestone. All these rocks form a well-characterized lithostratigraphic unit that we call the Plattenberg Formation, or *Plattenberg Breccia*.

Discontinuous intercalations or pockets of a reddish rock rich in iron oxides and white mica occur in and at the base of the breccia. We interpret this rock as a (more or less reworked) *siderolitic* deposit. It provides evidence of post-Triassic emersion and continental erosion before the deposition of the breccia.

Three m above the base of the breccia we found in a fine-grained calco-dolarenitic intercalation numerous plates of *crinoids* (with well preserved details such as the central canal; figure 4). They prove that the deposition of the breccia occurred in a marine environment, under high-energy conditions.

5. The Plattenberg Breccia is overlain by a formation of micaschist passing gradually upwards to a calcschist. The micaschist contains abundant garnet and smaller amounts of kyanite, chloritoid and graphite. The amount of calcite increases upwards. At its base this micaschist also contains brownish calcareous nodules. The calcschist contains scattered small pebbles of pure limestone. It is situated in the core of a synform, a position that has already been noted by KOPP (*in* JENNY *et al.* 1923, p. 107).

Cornieule (rauhwacke) is present. It is deformed and can be found at various positions in the stratigraphic column. It forms a conspicuous m-thick "layer" all along the contact of the micaschist upon the breccia in both limbs of the synform.

Figure 3.–The Plattenberg Breccia: dolomite pebbles in a dolo-quartzarenitic matrix.
Brèche du Plattenberg: éléments de dolomie dans une matrice de dolo-quartzarénite.

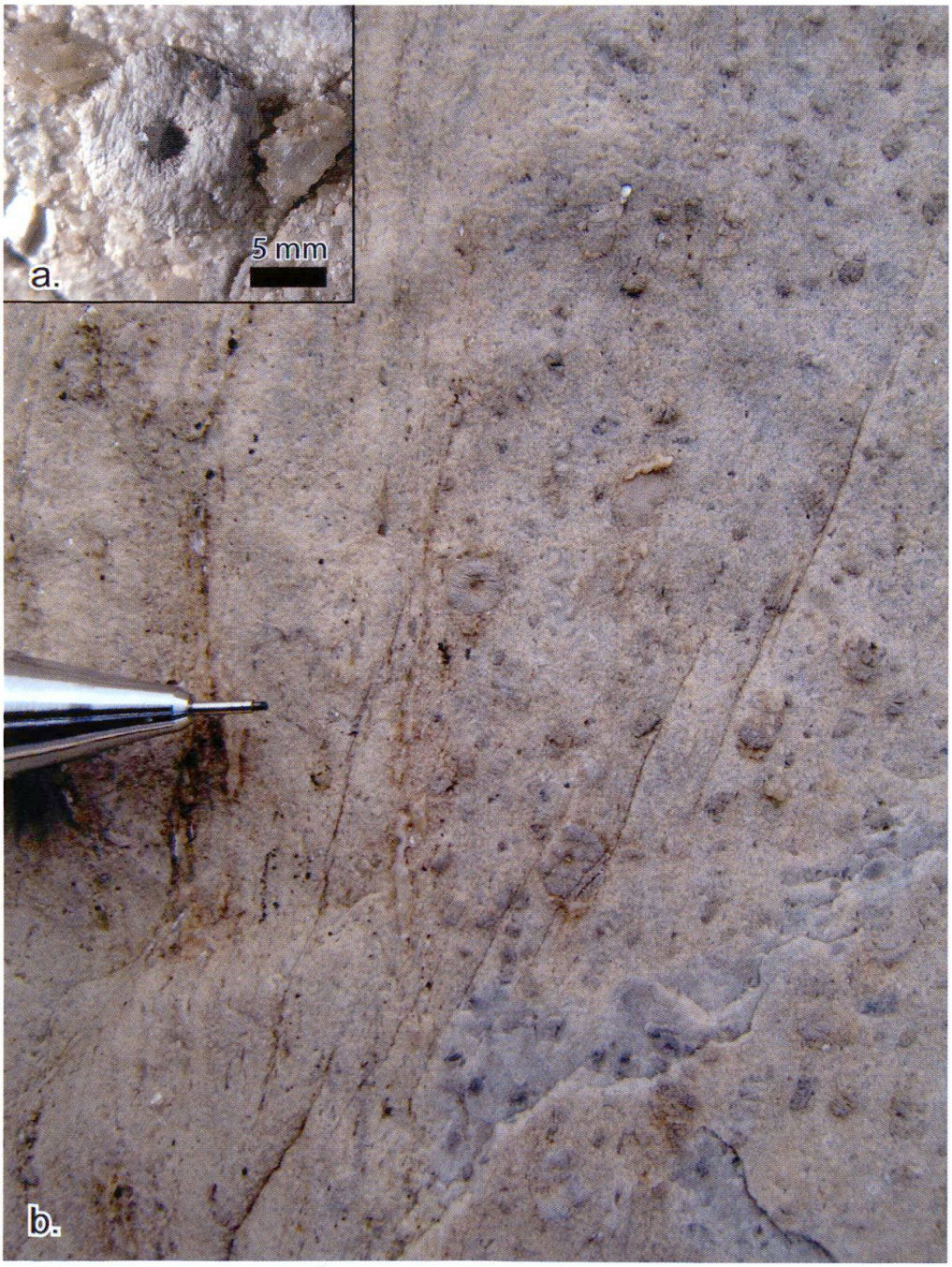

Figure 4.– Crinoid plates in a calco-dolarenitic intercalation in the Plattenberg Breccia. Note the good preservation of the pentagonal shape and of the central canal. 4a.- Detail. 4b.- General view.
Articles de crinoïdes dans une intercalation calco-dolarénitique dans la Brèche du Plattenberg. Notez la bonne préservation de la forme pentagonale et du canal central. 4a.- Détail. 4b.- Vue générale.

Discussion and conclusions

A. The Adula nappe has its own sedimentary cover (autochthonous with respect to the basement), composed of several well-characterized stratigraphic formations.

B. The Plattenberg Triassic sequence has no affinity with the Briançonnais Triassic. In particular the very typical St-Triphon Formation, which characterizes the base of the Briançonnais carbonate series (e.g. Baud & Mégard-Galli 1975), is totally absent. On the other hand the white and grey-bluish Plattenberg dolomites display striking similarities with the Triassic of several Lower Penninic nappes: Simano (Bianconi 1971), Soja s.str. (Galster *et al.* 2010) and Monte Leone (Carrupt 2003).

C. This has important consequences for nappe tectonics, with respect to the recent discovery of a Briançonnais Triassic element below the front of the Adula nappe (i.e. in the Luzzone-Terri nappe, Galster *et al.* 2010). Consequently the Luzzone-Terri unit must have an ultra-Adula origin: it originates south of the Adula and was transported over it before being eventually overtaken by its front. A reasonable scenario is that the passage of the Luzzone-Terri nappe occurred during the Adula subduction.

D. The Plattenberg Breccia is erosive and transgressive. Its basal contact upon the Triassic certainly represents a large stratigraphic gap, underlined by reworked continental deposits. Comparisons with similar situations in other parts of the Alps suggest a Middle Jurassic age in a context of extensional tectonics related to the opening of the Alpine Tethys.

E. The preservation of fossils in such high grade metamorphic rocks is remarkable. This should be an encouragement for Alpine geologists to search for fossils in other eclogite facies metamorphic formations.

F. The interpretation of the upper micaschist-calcschist unit is more uncertain, because of the intercalation of a continuous level of cornieule along its base. The cornieule is formed by hydraulic fracturing of dolomite under high fluid pressure and can be injected into stratigraphic or tectonic discontinuities at various levels (Masson 1972, Milovsky *et al.* 2003). A large stratigraphic gap is possible, and even a tectonic contact can not be excluded.

G. These results open new perspectives for the geological study of the Adula (and similar highly metamorphic nappes) based on detailed stratigraphic analysis.

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