Neotethys derived obducted ophiolite nappes in the Eastern Alps: information from radiolarite pebbles of the Gosau Group

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INTRODUCTION

Since the dating of the Cretaceous eclogites of the Austroalpine unit in the early 90ths of the last century (THÖNi & JAGOUTZ 1992), it was obvious that in the recent Eastern Alps at least two crustal scale subduction zones were active. The most prominent of these subduction zones is Late Cretaceous to Tertiary in age and can be traced throughout the Alpine orogene by the oceanic suture zone defined by the Penninic nappes (Fig. 1). On the other hand Jurassic and Cretaceous subduction processes, which are related to the closure of the Neotethys ocean and indicated by the structural and metamorphic imprint of the Austroalpine unit, are not fully understood and still under discussion (GAWLICK et al. 1999, SCHWEIGL & NEUBAUER 1997, NEUBAUER et al. 2000, SCHMID et al. 2004).

Important reasons for the badly known plate tectonic arrangement during the closure of the Neotethys ocean are 1) the missing of a continuous oceanic suture zone and 2) the overprinting Late Cretaceous and Tertiary tectonic structures. In general remnants of the former Neotethys oceanic realm are scarce in the Eastern Alps and most of the information comes from the tiny Meliata klippen in the eastern part of the Northern Calcareous Alps and from redeposited detritus, which is characteristic in the Late Jurassic and Cretaceous sediments of the Austroalpine unit (FAUPL & WAGREICH 2000). This detritus is represented by serpentinites, basic metavolcanics, Triassic and Jurassic radiolarites and carbonatic rocks.

In this poster we present new data collected from the Cretaceous sediments of the Lower Gosau Group from Pfennigbach (Austria/Lower Austria). In addition to other findings (see poster of SCHUSTER et al. at this conference) these data suggest similarities of the Jurassic to Early Cretaceous history of the eastern part of the Eastern Alps to the situation in the Dinarides. They give additional indications for the presence of obducted ophiolite nappes and melange on the Late Jurassic-Early Cretaceous Austroalpine margin as proposed by MANDL (2000).

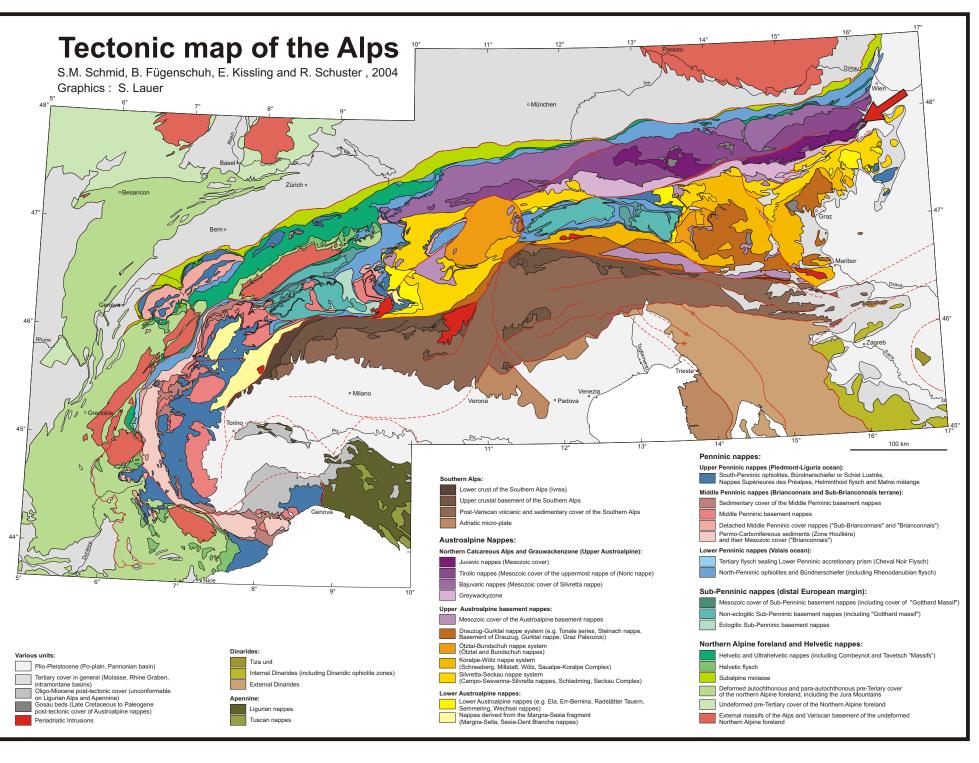


Fig. 1: Tectonic map of the Alps after SCHMID et al. (2004). Sediments of the Gosau Group are present on top of the Bajuvaric and Tirolic nappes within the Northern Calcareous Alps and on top of the Gurktal Nappe System. The sample locality in the area of Puchberg-Neue Welt ist shown by the red arrow.

GEOLOGICAL BACKGROUND

The Gosau Group in the Eastern Alps comprises synorogenic sediments of the eo-Alpine tectonometamorphic event. These sediments are Upper Cretaceous to Eocene in age. They consist of clastic material from surrounding Austroalpine units and a minor amount of exotic input.

According to WAGREICH & FAUPL (1994) the Gosau Group of the Northern Calcareous Alps is composed of two subunits: The Lower Gosau Subgroup is characterised by alluvial fan deposits passing into a shallowmarine succession with a broad variety of facies. It is ranging from Turonian to Santonian/Campanian, and only in a few places up to the Maastrichtian. The Upper Gosau Subgroup comprises deep-water deposits of Campanian to Eocene age.

The sample material presented in this study was collected from the Lower Gosau Group of the locality Grünbach-Neue Welt (Austria/Lower Austria) (Fig. 2A). In this area several outcrops of the Gosau Group are distributed over more than 100 km². Their successions (Fig. 2B) start with breccias derived from directly underlying Triassic rocks. Above reddish conglomerates containing the exotic material occur. They are overlain by a coal bearing series of shallow marine, fluviatile and limnic sediments, marine sandstones ("Orbitoidensandstein") and marls ("Inoceramenmergel"). As the coal-bearing series is Campanian in age a Santonian age of the reddish conglomerates is proposed (GRUBER et al. 1992).

The pebble spectrum and the frequency of the exotic material in the reddish conglomerates are not similar in the individual outcrops. Those containing amphibolites, basic volcanics, low grade metapelites and radiolarites are known from several localities in the western part of the outcrop area only (GRUBER et al. 1992).

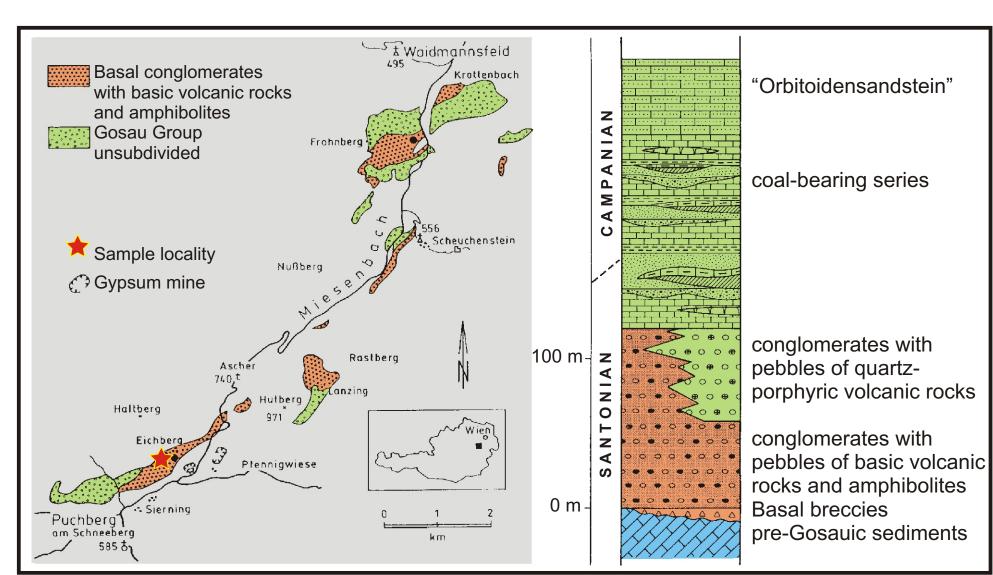


Fig 2: Scatch map showing the distribution of Gosau Group sediments in the area of Miesenbach and Pfennigbach (Lower Austria7 Austria). Shown is (A) the sample locality and (B) a simplified stratigraphic column after GRUBER et al. (1992).

SAMPLE LOCALITY

The locality for the samples discussed in here is at Eichberg, about 2 km NE of Puchberg am Schneeberg (WGS83 E 015°55'24" / N 47°48'00"). Pebbles have been collected along the forrest road which starts behind the buildings of the gypsum mine and runs upwards in direction to the Northwest. Several small outcrops are only present in c. 660 m altitude.

PETROGRAPHY

In the outcrops badly sorted conglomerates with a reddish matrix are visible. The content of exotic material reaches up to 30%, the components are well rounded and up to 30 cm in diameter. Along the road the pebble spectrum is variable. Even light greyish shallow water carbonates are dominating the frequence of diverse carbonatic rocks, radiolarites, metaquartzite, phyllites, volcanic rocks and amphibolites is variable. During this study pebbles of radiolarites and limestones have been investigated.

Based on investigations on thin sections the following material could be identified as components in the conglomerates (Fig. 3.):

- Triassic and Jurassic radiolarite (sample A4655) (**Fig. 3A**)
- Tempestite from the Upper Werfen Formation (Lower Triassic) (A4652) (**Fig. 3B**)
- Middle Triassic reef limestones (A4653/3) (**Fig. 3C**)
- Coated components of "Dachsteinkalk" (Nor) and "Plassenkalk" (Late Jurassic) (A4653) (Fig. 3D)
- Jurassic hemipelagic biomicrites (A4655) (Fig. 3E)
- Late Liassic spiculite (Dürrnberg Formation?) (A4655) (**Fig. 3F**)
- Altered basic subvolcanic and basic plutonic rocks (RS20/01) (Fig. 3G)
- Altered basic volcanic rocks (RS07/01)(Fig. 3H)

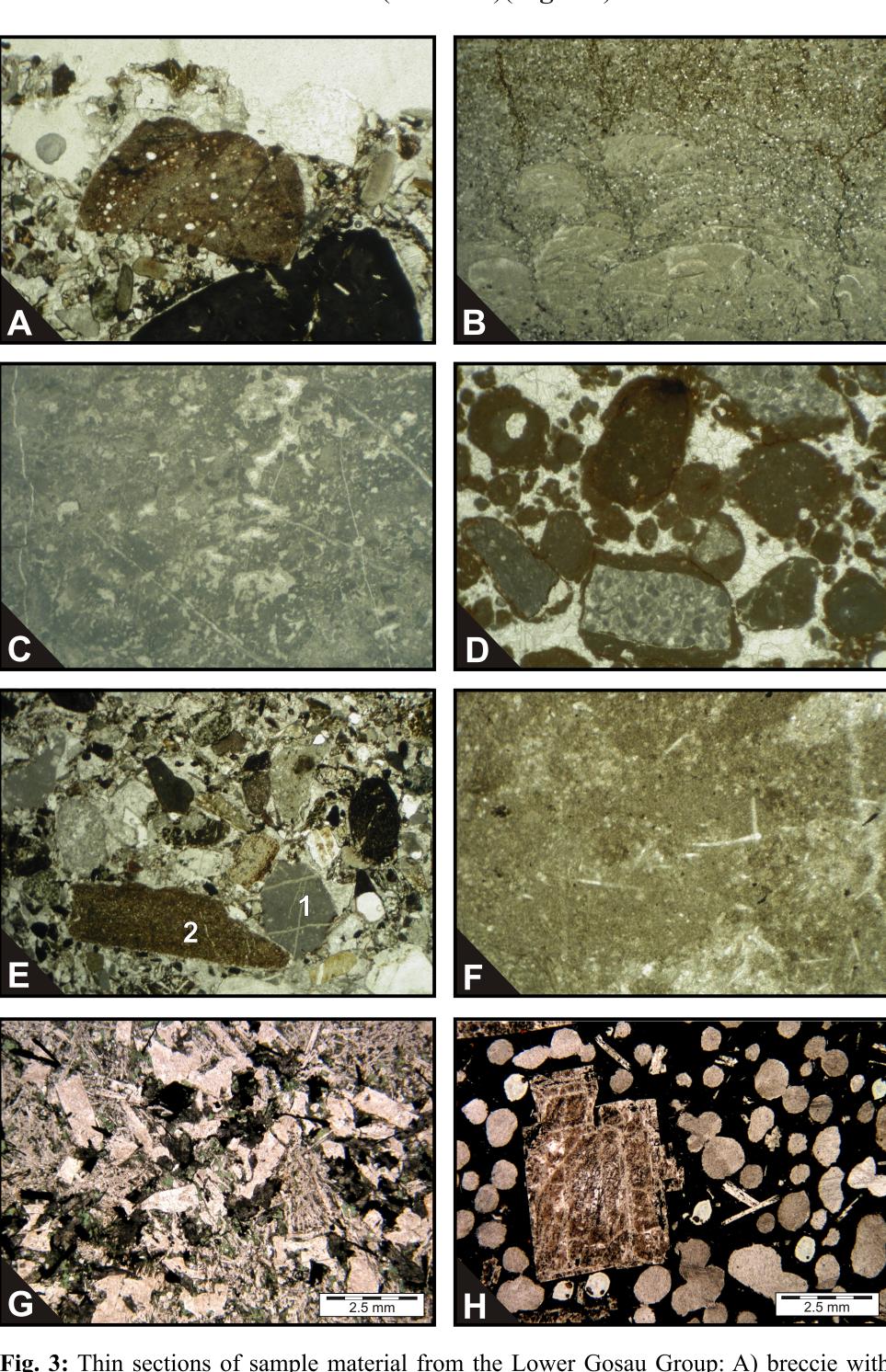


Fig. 3: Thin sections of sample material from the Lower Gosau Group: A) breccie with components of Middle-Triassic radiolarite (sample A4655), B) tempestite from the upper Werfen Formation (sample A4652), C) Middle Triassic reef limestone (sample A4653/3), D) coated components of limestones from the Dachstein- and Plassen Formation (sample A4653/1) E) breccie with components of Triassic radiolarite (1) and Jurassic hemipelagic biomicrite (2) (sample A4655), F) late Liassic spiculite, Dürrnberg Formation? (Sample A4655), G) altered microgabbro (sample RS20/01), H) altered basalt (sample RS07/01).

RESULTS FROM RADIOLARITES

1. Radiolarite samples RS8/01 and RS9/01 were greyish to blackish in colour. Pebble size was only up to 1.5 cm and therefore they were dissolved together. The result is a mixed fauna which gives the following age information (**Fig. 4**):

Late-Anisian to Early-Ladin (Fassan): Sarla anisica KOZUR & MOSTLER; Pentactinocarpus sp.; Triassocampe cf. eruca SUGIYAMA; Yeharaia cf. transita KOZUR & MOSTLER.

Langobardian to Early Carnian (Cordevol): Capnuchosphaera? sp.; Muelleritortis sp., Pterospongus priscus KOZUR & MOSTLER; Scutispongus parvifoliatus KOZUR & MOSTLER; Triassospongosphaera sp.; Pseudostylospaera cf. Nazarovi (KOZUR & MOSTLER); Poulpos cf. phasmatodes De WEVER; Triassocampe cf. nova YAO.

Rhaethian: Triactoma cf. Zlambachense (KOZUR & MOSTLER).

2. Blackish radiolarite pebble RS10/01 (**Fig. 5**):

Middle Jurassic (Late-Bathon to Callov): Gongylothorax aff. favosus DUMITRICA; Tricolocapsa undulata (HEITZER); Williriedellum cf. Dierschei (SUZUKI & GAWLICK); Williriedellum glomerulus (CHIARI, MARCUCCI & PRELA).

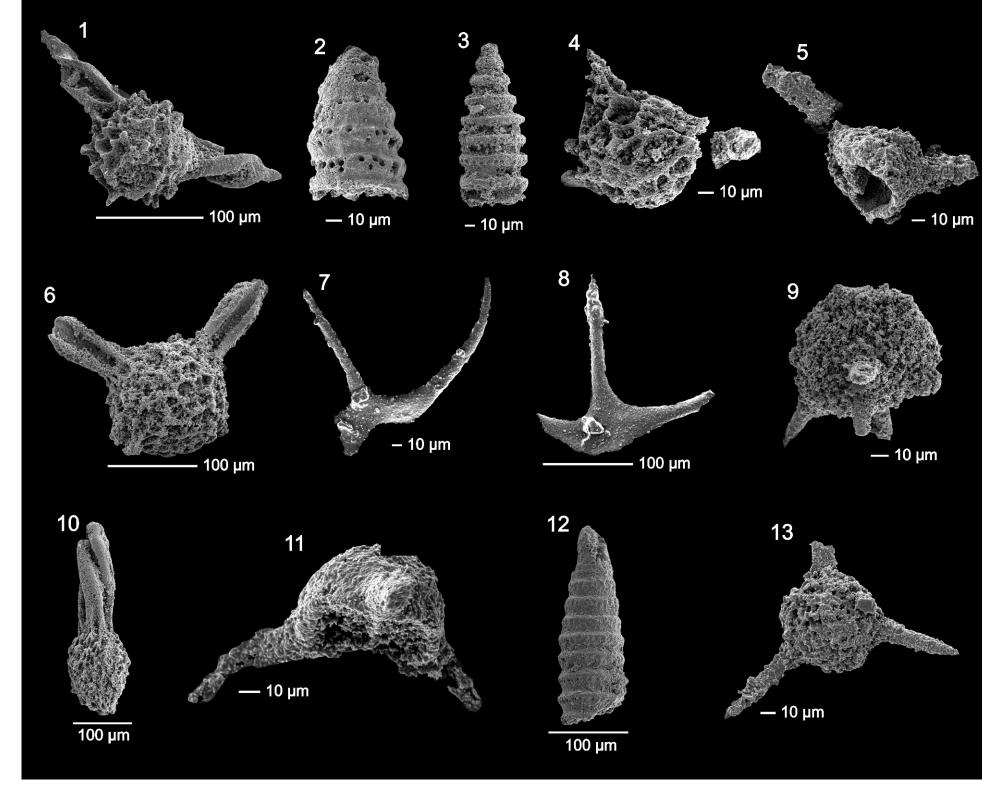


Fig. 7: Sample RS8/01 and RS9/01. Three pebbles of blackish to greyish coloured radiolarite, pebbles size 1.5-2.0 cm in diameter:

- 1. Sarla anisica Kozur & Mostler
- 2. Triassocampe cf. eruca Sugiyama
- 3. Yeharaia cf. transita Kozur & Mostler
- 4. Pentactinocarpus sp. 5. Capnuchosphaera? sp.
- 6. Muelleritortis sp.
- 8. Scutispongus parvifoliatus Kozur & Mostler
- 9. Triassospongosphaera sp. 10. Pseudostylospaera cf. nazarovi (Kozur & Mostler)
- 11. Poulpos cf. phasmatodes De Wever 12. Triassocampe cf. nova Yao

13. *Triactoma* cf. *zlambachense* (Kozur & Mostler)

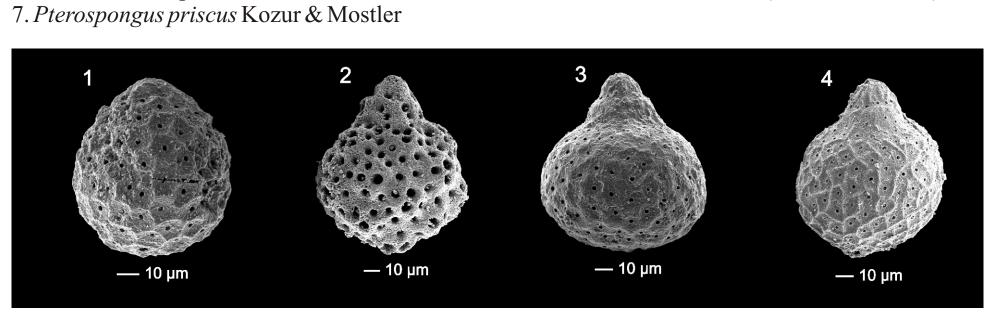


Fig. 8: Sample RS10/01 Pebble of black coloured radiolarite, size of pebble c. 2.5 cm in diameter:

- 1. Gongylothorax aff. favosus Dumitrica
- 2. *Tricolocapsa undulata* (Heitzer)
- 3. Williriedellum cf. dierschei (Suzuki & Gawlick)
- 4. Williriedellum glomerulus (Chiari, Marcucci & Prela)

DISCUSSION

1. Significance of the observed detritic material:

Late-Anisian to Early-Ladin radiolarites can be expected on the distal shelf of the Austroalpine unit towards the Neotethys (Meliata-Hallstatt) ocean. Their formation was promoted by the minor carbonate production rates on the Austroalpine shelf at this time. In the Ladinian (Late-Danian) micrites from the growing Wetterstein carbonate platforms were transported into the oceanic basin and radiolarites can only be expected in the distal oceanic areas (GAWLICK et al. 2007). The same is true for Rhaetian times when the Dachsteinkalk carbonate platforms were growing.

In the Middle Jurassic the carbonate platforms on the Austroalpine unit were drowned and radiolarites were deposited in the Neotethys ocean, but also in large parts of the Austroalpine and Penninic realm.

For this reason the Middle Triassic and Rhaetian radiolarites are of special interest, because they indicate fragments of the Neotethys realm in the source area of the investigated localities. Based on the CAI, the Triassic radiolarites experienced a thermal overprint which is lacking in the Jurassic radiolarites.

2. Relation to the other exotic material within the conglomerates

According to GRUBER et al. (1992) the volcanic pebbles are alkalibasalts ploting into the field of within-plate basalts in most of the discrimination diagrams. Based on the association with serpentinites they argue for a formation in a passive continental margin setting or within a thinned continental crust. In such a setting tholeiitic and alkalibasaltic volcanic rocks are produced during initial rifting. With respect to the formation of the Neotethys (Meliata-Hallstatt) ocean the volcanic rocks might be Late Permian to Middle Triassic in age. However, no geochronological age data exist. The occurrence of fine-grained alkaliamphibole in the ground mass of some of the metabasalts argues that these rocks experienced a pressure-dominated metamorphic event in a subduction zone.

The amphibolites are subject of recent studies (see poster of SCHUSTER at al. this conference). They show remarkable differences to all known amphibolites of the Austroalpine unit but might represent amphibolites from a metamorphic sole of an ophiolite nappe.

Several of the observed lithologies do not occur within the Austroalpine nappes, except as detrital input within the Late Jurassic to Cretaceous sediments. Most probably they were direved from the Neotethys oceanic realm (serpentinites, amphibolites, Middle and Late Triassic radiolarites) or at least from the surrounding shelf areas (basic metavolcanics, Anisian radiolarites).

3. Indications for the evolution of the southern Austroalpine margin

The question arises from where, when and how material from the Neotethys oceanic realm was transported into the Gosau basin. With respect to the highly variable pebble spectra even within small outcrop areas a nearby and heterogeneous hinterland can be expected. This interpretation seems to be contradicted by the fact that the pebbles of radiolarites, amphibolites and basic volcanic rocks are well rounded. However, these bebbles might have been components of a clastic rock in the source area. Such a clastic rock series might have been an ophiolitic melange.

Possible sources for material from the Neotethys oceanic realm are the Meliata klippen a few kilometres to the south of Pfennigbach, the Permian evaporitic sediments of the "Haselgebirge" which contains basic metavolcanics and serpentinites and Late-Jurassic to Early Cretaceous sediments with detrital material from the oceanic realm. However, the investigated material shows remarkable differences to the units mentioned above (GRUBER et al. 1992; MANDL & ONDREJICKOVA 1993). On the other hand similar material in a position on top of the Austroalpine nappes, which has been eroded completely later on, would be a possible source.

In the Dinarides the Dinaric ophiolite zone and the underlying melange occupies such a tectonic position. Several lithologies which occur in these nappes and which are not common in the Austroalpine nappes have been observed within the Gosau sediments. The Dinaric ophiolite zone and the melange were formed during Jurassic intraoceanic subduction and subsequent obduction onto the eastern margin of the Apulian plate, and these obduction processes might have reached into the recent Eastern Alps. As material derived from the Neotethys oceanic realm is widespread in the Austroalpine Late Jurassic to Cretaceous sediments and as no relics of ophiolitic nappes are known in the proposed tectonic position, these nappes must have been eroded completely, most probable still in Cretaceous times.

CONCLUSIONS

The data from the investigated sedimentary rocks in combination with information from magmatic (GRUBER et al. 1992) and metamorphic rocks give additional arguments for the existence of a Neotethys derived ophiolite nappe and/or melange in the eastern part of the Eastern Alps in Late Jurassic Early Cretaceous times. This nappe and/or melange has been situated in a high structural position on top of the Juvavic nappe system (MANDL 2000). This situation might have been very similar to the recent situation in the Dinarides. Still in the Cretaceous this nappe has been eroded and its detritus can be found in the Cretaceous sediments of the Austroalpine unit.

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