Metamorphic detritus in the Cretaceous Gosau Group (Eastern Alps)

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INTRODUCTION

The Gosau Group in the Eastern Alps comprises synorogenic sediments of the eo-Alpine tectonometamorphic event, which derived from the Austroalpine unit and from the Meliata-Hallstatt zone. These sediments are Upper Cretaceous to Eocene in age. They consist of clastic material from surrounding units and a minor amount of exotic input. This study was performed to get information on the metamorphic hinterland and on the first arrival of eo-Alpine metamorphic detritus within the sedimentary successions.

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 shallow-marine 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. Within the Gosau Group of the Northern Calcareous Alps coarse-grained clastic sediments, suitable for pebble analyses occur within the conglomerate facies of the alluvial fan deposits and the shallow marine facies of the lower subgroup as well as within mass flow layers of the slope facies from the upper subgroup.

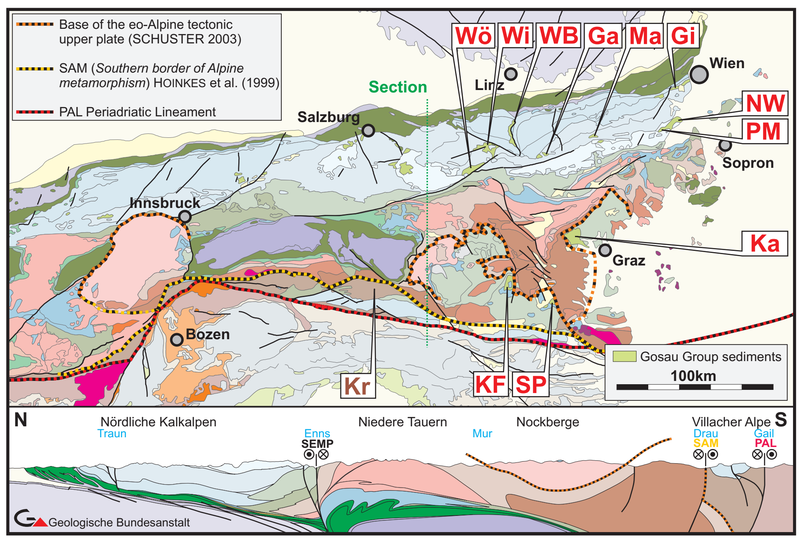


Fig. 1: Tectonic map of the Eastern Alps. Sediments of the Gosau Group are present within the Northern Calcareous Alps and on top of the Gurktal Nappe Systems and the nappe system of the Graz Palaeozoic. Localities refered in the text: Wö…Wörschach, Wi…Windischgarsten, WB…Weyerer Bögen, Ga…Gams, Ma...Mariazell, Gi…Gieshübel, PM…Pfenningbach/Miesenbach, NW…Neue Welt, SP...St. Paul, KF...Krappfeld, Kr…Kreuzeckgruppe.

EXOTIC MATERIAL AND GEOCHRONOLOGICAL DATA

Within the Gosau Group of the Northern Calcareous Alps coarse grained clastic sediments, suitable for pebble analyses occur in the conglomerate facies of the basal alluvial fan deposites, the shallow marine facies and within mass flow layers of the slope facies.

Exotic material within the fluvial fan and shallow whater facies of the Lower Gosau Group

The most frequent exotic material are polycrystalline quartz pebbles and pebbles of quartzporphyric volcanic rocks (Fig. 6A). They are present in all investigated occurrences (e.g. Gosau, Wörschach, Windischgarsten, Gams, Mariazell, Gieshübel, Miesenbach, Pfenningbach and Neue Welt) (Fig. 1). The polycrystalline quartz pebbles represent former quartz rods within low-grade metamorphic rocks, whereas the quartzporphyric volcanic rocks are equivalents to the Lower Permian quartzporphyric volcanism of the Southern and Eastern Alps. Except these kinds of exotics rarely pebbles of greenschists have been found. Sandstones of the Lower Gosau Group are poor in detrital mica.

Conglomerates containing radiolarites, basic volcanic rocks (Fig. 6B,C), serpentinite fragments, low-grade metapelitic rocks and garnet-bearing amphibolites (Fig. 6D) occur at the localities Miesenbach and Pfenningbach (GRUBER et al. 1992) (Fig. 2). The volcanic rocks are highly altered. However, they show pseudomorphs after phenocrysts of plagioclase, pyroxene and olivine, within a fine-grained matrix with an ophitic to subophitic texture. Vacuoles are filled up by calcite, zeolites, quartz and chlorite. Most of the volcanic rocks correspond to alkalibasalts and andesites (GRUBER et al. 1992). The amphibolites show medium-grade mineral assemblages of garnet + hornblende + plagioclase + titanite + ilmenite. Typical are fine-grained symplectitic rims around the garnet crystals. However, they do not represent former eclogites! Ar-Ar hornblende ages measured on garnet-bearing amphibolites yielded 174 ± 5 Ma (RS14/01) and 189 ± 6 Ma (RS16/01) (Fig. 3).

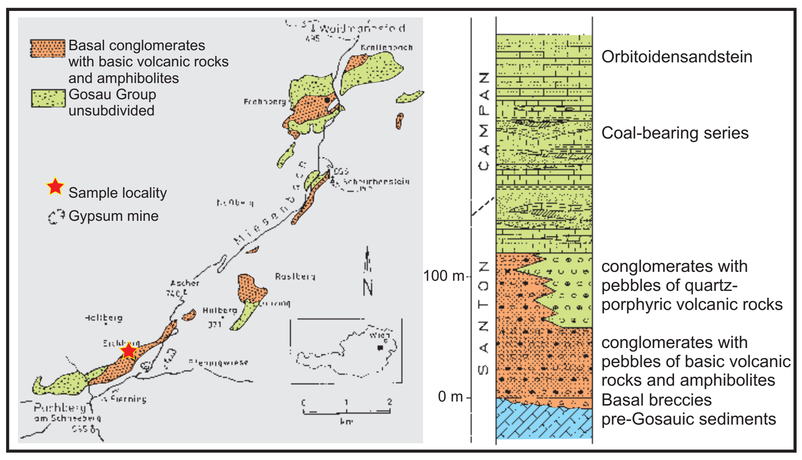


Fig 2: Scatch map showing the distribution of Gosau Group sediments in the area of Miesenbach and Pfenningbach (Lower Austria). Shown is the sample locality and a simplified stratigraphic column after GRUBER et al. (1992).

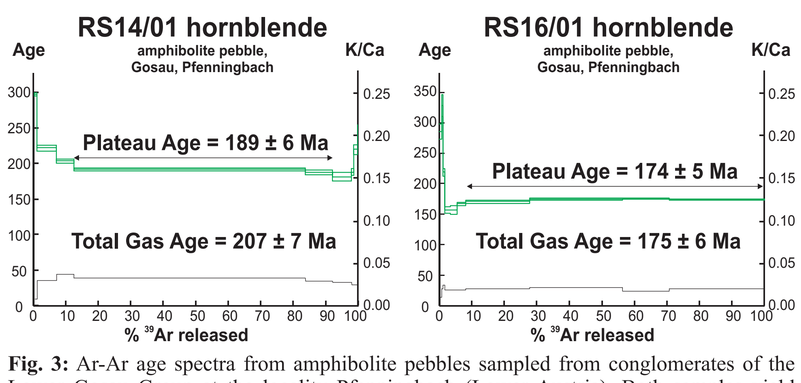


Fig. 3: Ar-Ar age spectra from amphibolite pebbles sampled from conglomerates of the Lower Gosau Group at the locality Pfenningbach (Lower Austria). Both samples yield Jurassic age values. If these ages are geological meaningful they indicate a medium-grade Jurassic imprint of the metabasic rocks.

Exotic material within mass flow layers in the Upper Gosau Group

Also in the Upper Gosau Subgroup low-grade and medium-grade crystalline pebbles are scarce. However, in the Maastrichtian-Danian Brunnbach Formation (Weyerer Bögen, Upper Austria) they occur in several localities (Fig. 4). They comprise biotite-rich orthogneisses, garnet-bearing micaschists (Fig. 6E, F, G), albite-muscovite-chlorite schists, garnet-bearing quartzites, quartzphyllites, and graphitic phyllites.

Based on the microstructures the metamorphic rocks show a polyphase metamorphic evolution: During a first tectonometamorphic imprint garnet was formed during at least upper greenschist conditions and during deformation with a simple shear component. A younger overprint caused a static recrystallisation of various intensities. In some samples a mineral assemblage of chlorite + muscovite + albite + quartz formed, indicating temperatures of 300-400 °C. In some of the pebbles the younger event is the only visible metamorphic imprint.

K-Ar muscovite ages from micaschist pebbles are in the range of 240 ± 11 Ma to 252 ± 12 Ma FAUPL & THÖNI (1981). Remeasurements of the same sample material by the Ar-Ar method yielded ages of 233 ± 2 Ma (303/8), 242 ± 2 Ma (303/8), 259 ± 3 Ma (303/9), 264 ± 2 Ma (303/9), 301 ± 2 Ma (339/5) and 245 ± 2 Ma (347/3) (FRANK et al. 1998) (Fig. 5). Additional measurements from the locality Funkelalm/Admonter Höhe prove this data: Ar-Ar muscovite ages yield 260 ± 4 Ma (Fu1), 280 ± 3 Ma (Fu2) and 334 ± 3 Ma (Fu3), the corresponding Rb-Sr biotite ages are 210 ± 2 Ma (Fu1) and 314 ± 3 Ma (Fu3) (Fig. 7).

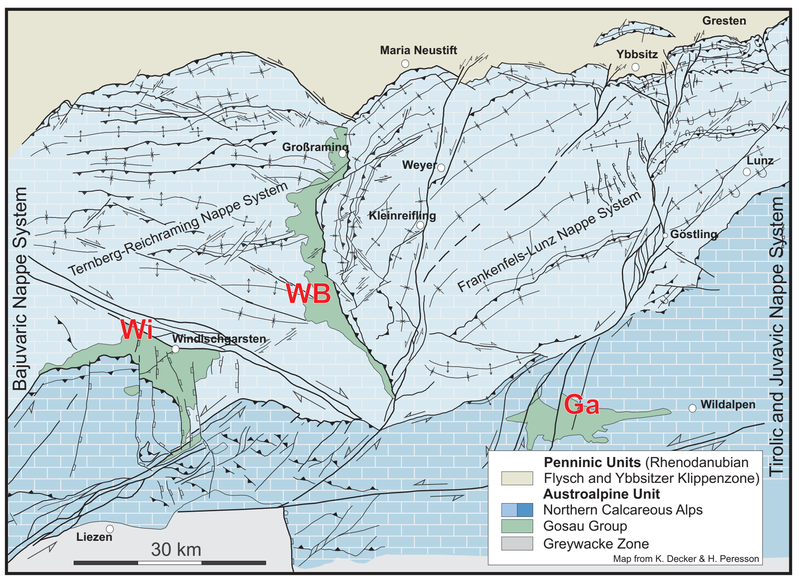


Fig. 4: Tectonic map of the Northern Calcareous Alps in the vincinity of the Gosau Group localities of the Weyerer Bögen, Wörschach and Gams (Lower Austria/ Upper Austria) (map from Kurt DECKER and Herwig PERESSON).

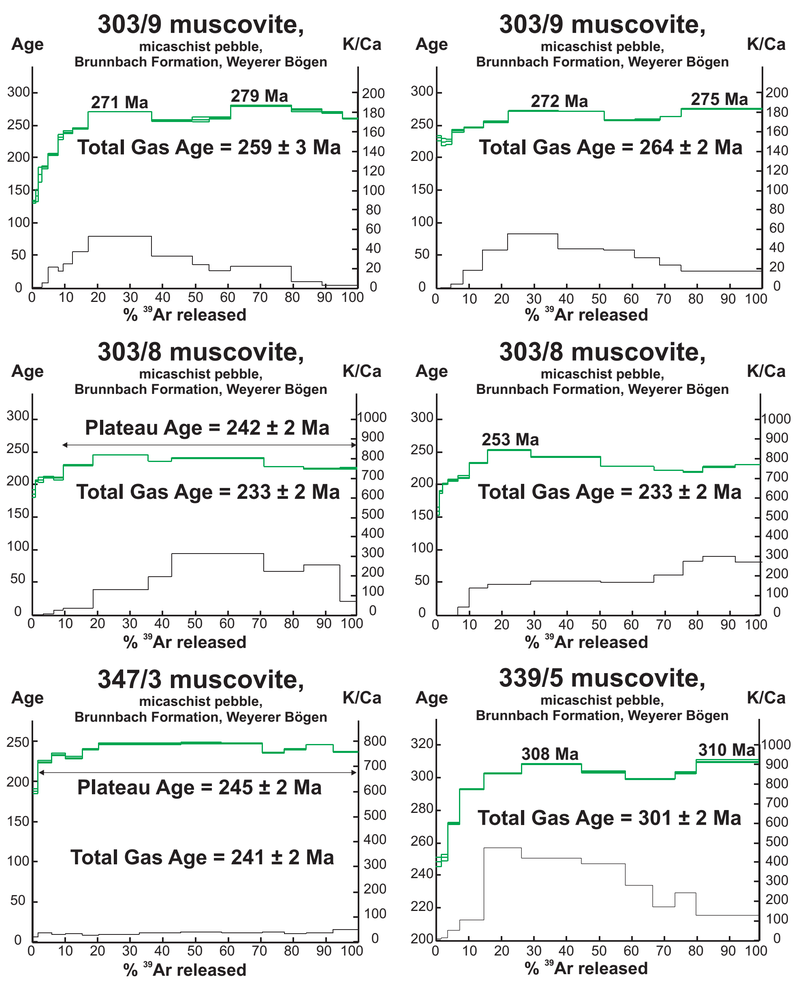


Fig. 5: Ar-Ar age spectra from low-grade and medium-grade metamorphic pebbles sampled from the Brunnbach Formation of the Upper Gosau Group at the locality Weyerer Bögen (Upper Austria). According to these age data, the pebbles exhibit a Variscan and/or Permotriassic metamorphic imprint (FRANK et al. 1998).

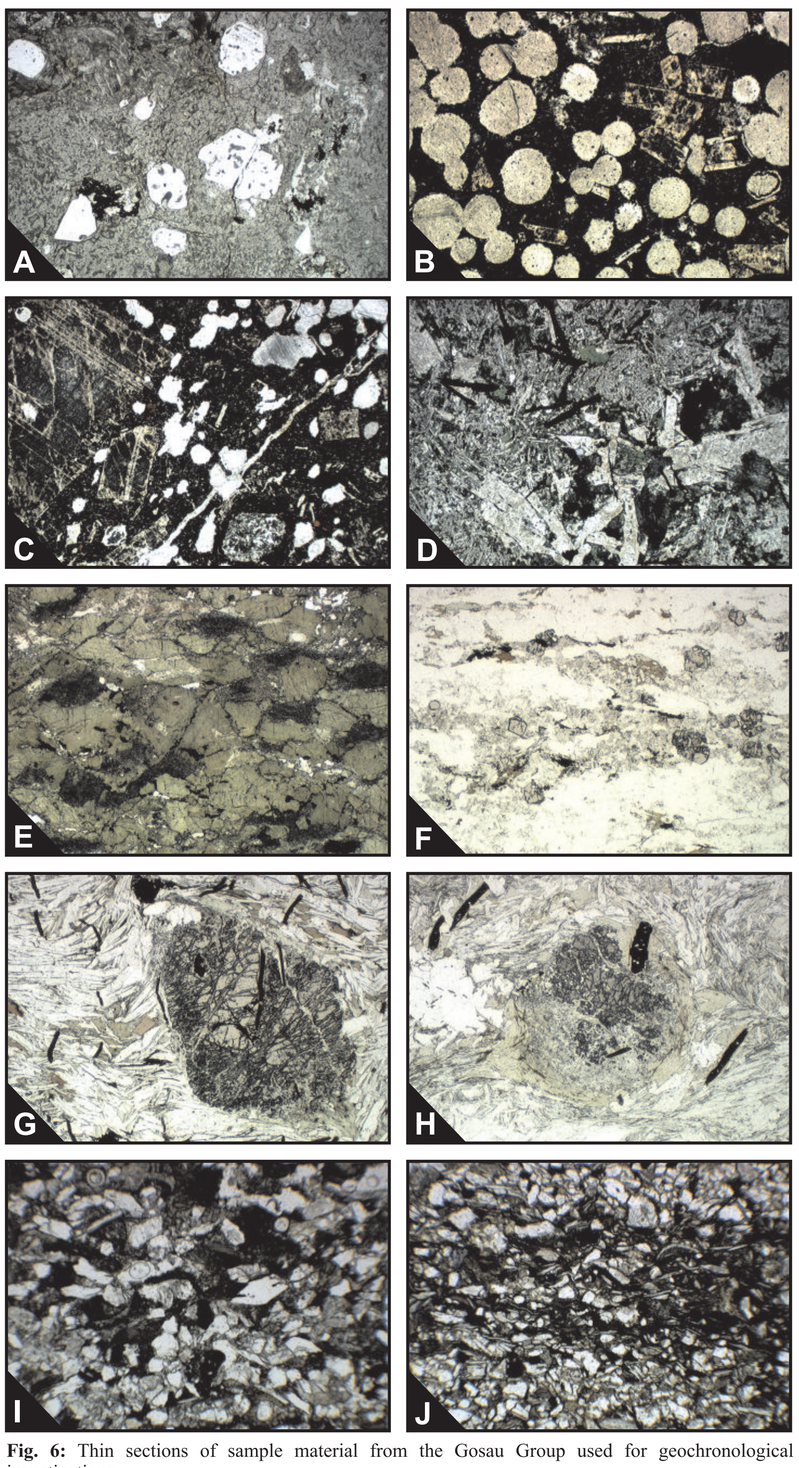
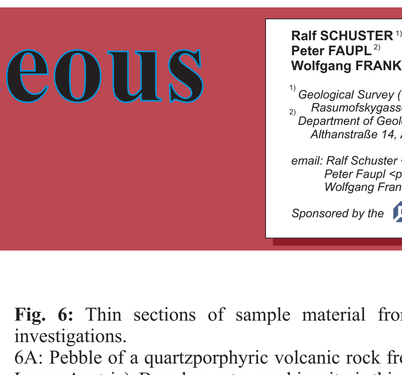
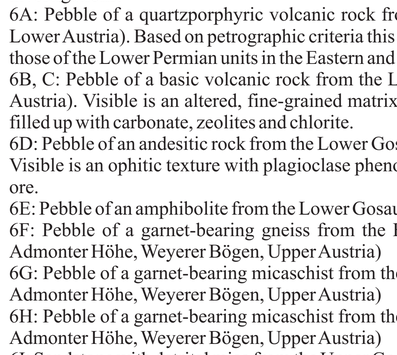
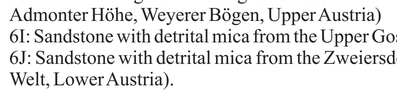


Fig. 6: Thin sections of sample material from the Gosau Group used for geochronological investigations.







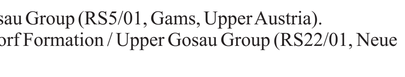


Fig. 7: Ar-Ar and Rb-Sr ages on muscovite and biotite from medium-grade metamorphic pebbles sampled from the Brunnbach Formation of the Upper Gosau Group at the locality Admonter Höhe (Weyerer Bögen, Upper Austria). These data are in the same range as those of Fig. 5. They also indicate a Variscan and/or a Permotriassic metamorphic imprint of the pebble material. However, the fact that the Ar-Ar muscovite ages are older than the biotite Rb-Sr ages, is an additional argument for the interpretation given above.

Sandstones with detrital mica from the Upper Gosau Group

In the Maastrichtian and Paleogene successions of the Upper Gosau Group sandstones rich in detrital white mica occur in several localities. One sample was collected from the Zwieselalm Formation (Maastrichtian-Palaeozene) in the Gosau Group of Gams (Styria). This carbonate-rich sandstone is intercalated with marl layers and breccias. The latter contain components up to 70 cm in size. Black coloured graphitic schists, most probably derived from the Veitsch Nappe of the Greywacky Zone occur frequently as exotic clasts. The multi-grain Ar-Ar analyses of the detrital muscovite yielded 99 ± 2 Ma (RS5/01). A second sample from the Palaeogen Zweiersdorf Formation (Neue Welt, Lower Austria) is rich in detrital mica. The Ar-Ar age of the muscovite is 122 ± 5 Ma (RS22/01) (Fig. 8).

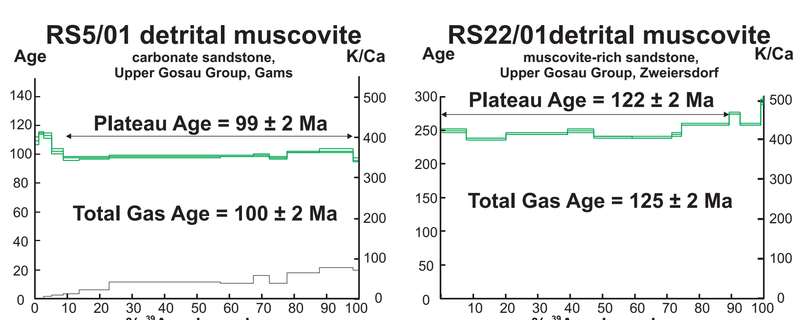


Fig. 8: Multi-grain Ar-Ar ages of detrital muscovites from sandstones of the Upper Gosau Group. Sample RS5/01 was sampled from the Zwieselalm Formation (Gams, Styria), sample RS22/01 represents a mica-rich sandstone from the Zweiersdorf Formation (Neue Welt, Lower Austria).

CONCLUSIONS

The presented data give the following information on the metamorphic hinterland of the Gosau Group sediments:

- During the sedimentation of the Lower Gosau Group the exotic material was derived from an area composed of low-grade metamorphic rocks and Lower Permian transgressional series with quartzporphyric volcanic rocks. Influx of basic volcanic rocks, serpentinites and chromspinel in the Gosau of Pfenningbach and Miesenbach indicates a second very local exotic hinterland. The latter may represent klippen of the Meliata-Hallstatt Zone on top of the Northern Calcareous Alps. As the amphibolites described above occur in the same type of conglomerates, these metamorphic rocks may have been part of this klippen, too.
- At the time when the Upper Gosau Group was deposited the hinterland described above was still active. Only locally upper greenschist facial and/or amphibolite facial metamorphic Austroalpine units with granitic intrusions where present at the surface. Geochronological age data prove a Variscan and/or Permotriassic metamorphic imprint of these units. Units with similar characteristics are still preserved in the area to the south of the Northern Calcareous Alps. E.g. the Strieden Complex (Kreuzeck mountains, Carinthia) (Fig.1) contains petrographically similar garnet-bearing micaschists which yield the same age information (SCHUSTER et al., 2001).
- Eo-Alpine metamorphic rocks formed the surface at least since uppermost Cretaceous times. The widespread occurrence of sandstones rich in detrital mica indicate tectonic processes, which caused the exhumation and uplift of eo-Alpine metamorphic rocks in large parts of the Eastern Alps.

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