the Northern Calcareous Alps (Gosau Group, Austria). - (In: Piller, W.E. & Rasser, M.W. (Eds.): Paleogene of the Eastern Alps), Österr. Akad. Wiss., Schriftenr. Erdwiss. Komm., **14**: 57-75, Wien.

Wagreich, M., Kollmann, H.A., Summesberger, H., Egger, H., Sanders, D., Hobiger, G., Mohamed, O. & Priewalder, H. (2009): Stratigraphie der Gosau-Gruppe von Gams bei Hieflau (Oberkreide-Paläogen, Österreich). - Arbeitstagung '09. Geologische Bundesanstalt: 81-105, Wien.

Transfer zones, fold-fault relations and their influence on syntectonic sedimentation: inferences from analogue modelling

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The geometry of structures and sediments in Late Cretaceous Muttekopf Gosau basin (Tyrol, Austria) is consistent with deformation by fault propagation folding and strike-slip faulting. Sedimentation was syn-tectonic as documented by on- and offlap structures which form progressive growth unconformities (Ortner 2001, Ford et. al. 1997). Field data show a significant change in strike of the bedding planes across the growth unconformities, which could be indicative of synchronous strike-slip faulting and folding. Series of small-scale normal faults and steep thrusts can be related to progressive rotation of fold limbs during trishear-type fault-propagation folding. The dextral tear fault divides the area in a western part with a single anticline - syncline pair showing a large wavelength and an eastern part, with several folds and smaller wavelength. The growth unconformities connect to the tear fault, a direct relation can be assumed.

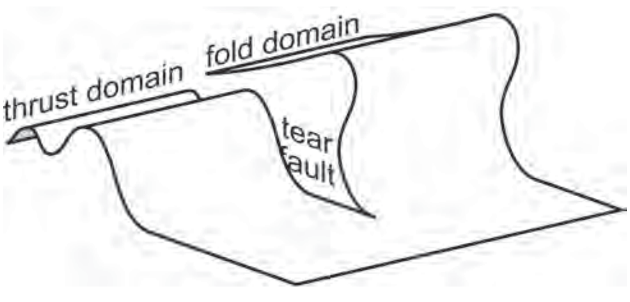

Fig. 1: Illustration of the translation of the field situation to the analogue model.

Analogue modelling has been used to infer the kinematic boundary conditions favourable for the development of tear faults and to decipher deviations from the expected stratal patterns related to fold growth, which can be attributed to tear fault activity.
We used sand for the experiments representing brittle rheological domains. Additionally, the affect of pre-existing basement structures has been implemented by introducing an initially present offset between the independently moving ramps.
The growth of an antiform was simulated by pulling the sediments, which had been added step by step to model growth strata, over two ramps becoming steeper to the with slope angles from 15 to 60 degrees. These experiments aim at investigating the influence of fold growth- and sedimentation rates on the resulting sediment geometries and structures.

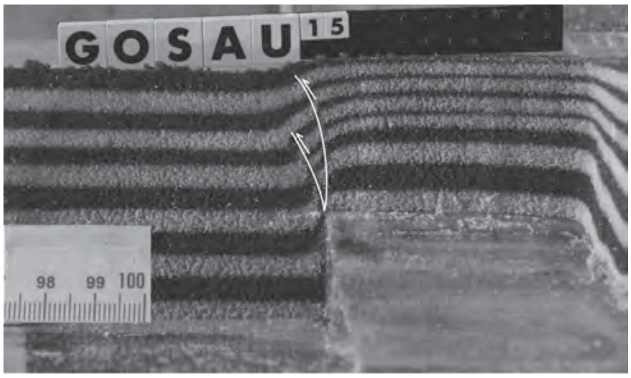

Fig. 2: Crosscut perpendicular to the tear fault within the analogue model showing two steep thrusts.

Results show, when rotative overlap is generated on the faster moving ramp, the slower side is controlled by onlap structures. A constant growth of the structure ends in a constant onlap, whereas constant sedimentation results in offlap structures. Modelling results and observations in the field are comparable. There, rotative overlap on the eastern and constant onlap on the western part of the main tear fault can be described. Furthermore the analogue model reproduced some of the characteristics close to the tear fault within the field. Forced thrusts represent the steep thrusts and moreover the change of strike close to the fault zone could have been clearly reproduced.

Ortner, H. (2001): Growing folds and sedimentation of the Gosau Group, Muttekopf, Northern Calcareous Alps, Austria. - Int. J. Earth Sciences, **90**: 727-739.

Ford, M., Williams, E.A., Artoni, A., Verges, J. & Hardy, S. (1997): Progressive evolution of a fault-related fold pair from growth strata geometries, Sant Llorens de Morunys, SE Pyrenees. - J. Struct. Geol., **19**: 413-441.

Zr and Ti-bearing accessory minerals from metacarbonates of the central Ötztal Complex (North-Tyrol, Austria): geochronological, thermobarometric and textural constraints on the pre-Variscan and Variscan *P-T* evolution

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Within the central part of the Ötztal-Stubai Complex (ÖSC) metacarbonates occur intercalated between various metamorphic rocks such as amphibolites, eclogites, and orthogneisses. The carbonatic rocks are characterised by two mineral assemblages who represent two different metamorphic events. (1) forsterite + (Cr-) spinel + diopside + geikielite + calcite + dolomite ± phlogopite ± wollastonite ± Ti-clinohumite which represents a contact metamorphic assemblage and (2) garnet + omphacite + rutile + calcite + dolomite ± phlogopite ± clinozoisite which represents an eclogite-facies assemblage. The complex polymetamorphic history of these rocks is also reflected in the occurrence of rare accessory minerals. In addition to the common Ti-phases such as titanite and rutile also geikielite and rare Zr-bearing phases such as baddeleyite and zirconolite occur. In one sample (B4) scheelite was found at the rims of titanite. Titanites in the eclogite-facies assemblage often show a distinctive chemical zoning with cores showing high REE (La, Ce, Nd) and HFSE (Zr, Ta) contents while the rims are depleted in REE and show highly enriched Al and F contents. The cores thought to represent a pre-Variscan contact metamorphic event which is consistent with the higher REE and HFSE contents due to the mobility of these elements during metasomatic processes. The rims have grown as a result of the eclogite-facies overprint during the early Variscan metamorphic event. In addition, rutile occurs in both assemblages (1) and (2). In the contact metamorphic samples (1) rutile is present as a narrow rim around geikielite forming due to the model- reaction geikielite + CO_2 <--> rutile + magnesite which takes place with increasing pressures. This indicates that carbonates which mostly contain mineral assemblage (1) have also undergone a *P*-accentuated metamorphic stage. For both titanite and rutile, Zr-geothermometry was applied according to Tomkins et al. (2007), and Hayden et al. (2008). Rutile inclusions in eclogitic garnets yielded temperatures between 676-757 °C at 2 GPa, while matrix rutile shows temperatures ranging from 708 to 749 °C. The Zr-in-titanite thermometer yielded 600-720 °C for the cores and 680-800 °C for the rims. The temperatures obtained by rutile and titanite are in good agreement with results calculated by THERMOCALC v. 3.21 and the data set of Holland & Powell (1998). Zirconolite and baddeleyite occur only in a few samples of the contact metamorphic carbonates (PT9, PT166, PT179). Purtscheller & Tessadri (1985) observed in one sample baddeleyite being replaced by zirconolite according to model-reaction baddeleyite + 2geikielite + 3calcite + CO_2 <--> zirconolite + 2dolomite. This indicates according to Tropper et al. (2007) growth during an increase in XCO_2. Samples which contain the eclogitic-facies mineral assemblage show zircon as the only Zr phase. Therefore SiO_2 saturation is required to form zircon. This leads to the assumption that XCO_2 and $aSiO_2$ increased from the pre-Variscan contact metamorphic event to the Variscan high-pressure stage due to an influx of a SiO_2-rich fluid. Electron-microprobe dating of zirconolite yields two cluster of ages (1): ages between 402-491 Ma which represent the pre-Variscan contact metamorphic event and (2): slightly younger ages between 366-399 Ma which can be attributed to the Variscan high-pressure stage.

Hayden, L.A., Watson, E.B. & Wark, D.A (2008): A thermobarometer for sphene (titanite). - Contrib. Mineral. Petrol., **155**: 529-540, Berlin.

Holland, T.J.B. & Powell, R. (1998): An internally-consistent thermodynamic dataset for phases of petrological interest. - J. Metamorphic Geol., **16**: 309-344, Oxford.

Purtscheller, F. & Tessadri, R. (1985): Zirconolite and baddeleyite from metacarbonates of the Oetztal-Stubai complex (northern Tyrol, Austria). - Mineralogical Magazine, **49**: 523-529, London.

Tomkins, A., Powell, R. & Ellis, J. (2007): The pressure dependence of the zirconium-in-rutile thermometer. - J. Metamorphic Geol., **25**: 703-713, Oxford.

Tropper, P., Harlov, D., Krenn, E., Finger, F., Rhede, D. & Bernhard, F. (2007): Zr-bearing minerals as indicators for the polymetamorphic evolution of the eastern, lower Austroalpine nappes (Stubenberg Granite contact aureole, Styria, Eastern Alps, Austria). - Lithos, **95**: 72-86, Amsterdam.

The metamorphic evolution of metacarbonates from the central Ötztal Complex (Pollestal, North-Tyrol, Austria): mineralogical evidence for episodes of contact metamorphism and high-*P* metamorphism

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In the central part of the Ötztal Complex (Pollestal) dolomitic metacarbonates occur as small lenses intercalated between metabasic and granitic rocks. Based on petrography and textural evidence, two different groups of carbonates can be distinguished which probably represent two separate metamorphic events: (1) the assemblage forsterite + (Cr-)spinel + diopside + geikielite + calcite + dolomite ± phlogopite ± wollastonite ± Ti-clinohumite is interpreted to represent a pre-Variscan contact metamorphic assemblage and (2) the assemblage garnet + omphacite + rutile + calcite + dolomite ± phlogopite ± clinozoisite represents the Variscan eclogite-facies assemblage. Additionally rare accessory minerals such as baddeleyite and zirconolite occur in mineral assemblage (1), similar to rocks from the Bergell-, Adamello- and Stubenberg-contact aureoles. Wollastonite occurs in small calcsilicate lenses and is surrounded by a rim of diopside. According to the T-XCO_2 phase relations in the contact metamorphic marbles wollastonite formed by reducing XCO_2 or increasing temperatures. The presence of olivine at temperatures of 550-600 °C (Tropper et al. 2003) requires the existence of a very H_2O-rich fluid which is in agreement with the formation of wollastonite by reducing XCO_2. T-XCO_2 calculations with the program THERMOCALC v. 3.21 and the data set of Holland & Powell (1998) using the reaction 3dolomite + diopside <-> 2forsterite + 4calcite + $2CO_2$ yielded low $XCO_2 < 0.15$. Zoned chromite/chrome-spinel occurs with maximum Cr_2O_3 contents of 36.57 wt.% (core) and shows orientated exsolution lamellae of ilmenite along the (111) crystallographic direction in the cores. The zoning then changes to Mg-Al-spinel (65-68 wt.% Al_2O_3, 24-26 wt.% MgO) at the rim which is according to Mogessie et al. (1988) a result of increasing metamorphism. Olivine-spinel geothermometry calculated with THERMOCALC v. 3.21