basin. In terms of preservation, a southern subunit with exclusively thick Kreuzgraben Conglomerate can be distinguished from a northern subunit with only fragments of Conglomerate and a well exposed section of mainly marls of the Nierental Formation. Both subunits are separated by an east-trending dextral strike-slip fault. The Kreuzgraben Conglomerate of the southern subunit represents a thick-bedded terrestrial fluvial conglomerate with well rounded components. Upper portions of the Kreuzgraben Fm. also contain fluvial, cross-bedded sandstones indicating paleo-transport to west and up to 8 m thick mudstone intercalated with tempestitic sandstone layers. The Kreuzgraben Fm. comprises mainly Triassic - Jurassic limestone and dolomite clasts of nearby origin within the Central Northern Calcareous Alps and minor, sand-sized ophiolitic detritus in sandstones. The origin of the ophiolitic detritus is disputed and could have its origin in the very rare ophiolite boulders occurring within the tectonic mélange of the Permian to Lower Triassic Haselgebirge Formation.

The northern subunit includes fragments of red Kreuzgraben Conglomerate likely overlain by a ca. 60-80 m thick marly succession of the Nierental Formation and a grayish limestone representing a new lithostratigraphic formation. Discovery of undetermined ammonites within marls indicate that major portions of the succession belong to the Late Cretaceous. The northern subunit indicates rapid deepening of the depositional realm during Late Cretaceous.

On the map-scale, we could recognize gently WNW plunging upright folds predating deposition of the Gaisberg Gosau. Structures within the Gaisberg Gosau well monitor basin inversion during several stages. All these structures are likely younger than Middle Eocene (youngest sedimentary infill of the Gaisberg-Reichenhall Gosau). Main structures include: Ca. W plunging folds and reverse faults formed during N-S shortening, dextral strike-slip fault separating the northern and southern subunits, and sinistral strike-slip faults.

Pliocene to Pleistocene faulting at the transition between Alps and Pannonian Basin: Constraints from dating fault activity by the ^{26}Al/^{10}Be burial age method

Wagner, T.[1], Fritz, H.[1], Stüwe, K.[1] & Fabel, D.[2]

[1] Institute of Earth Sciences, Karl-Franzens University, Universitätsplatz 2, 8010 Graz, Austria;
[2] Department of Geographical and Earth Sciences, University of Glasgow, G12 8QQ, Scotland, UK

For the geodynamic interpretation of the Alpine-Carpathian-Pannonian realm, the Pliocene to Pleistocene tectonic evolution at the transition between the Eastern Alps and the Pannonian Basin poses a series of open questions: (1) What is the significance of the fault pattern that evolved during latest orogenic evolution? The general Lower- to Middle Miocene fault pattern accommodated much of the Eastern Alpine eastward extrusion and is fairly well known. However, some of these major faults are found to be still active at kinematics typical for Middle Miocene times (e.g., Bus et al. 2009), although it has been suggested that the stress regime at the orogen-basin transition changed substantially during the Miocene. (2) Why are there apparently no structures related to basin inversion at the Alpine - Pannonian transition as found elsewhere in the central Pannonian Basin? General consensus holds that roll back and retreat of the Carpathian Slab steered extensional tectonics in the Miocene, but ceased around Late Miocene. This resulted in inversion of the Pannonian Basin (Horvath & Cloetingh 1996). The observed surface uplift at the western termination of the Pannonian Basin, i.e. the Styrian Basin is commonly associated with this process. (3) What is the interpretation of ~ 10 km vertical steps of the Moho at the transition between Eastern Alps and the Pannonian Basin as revealed by seismic experiments? Brückl et al. (2010) identified a triple junction between European, Adriatic and Pannonian / Tisza plates west of the SE corner of the study area. Hence, the question arises whether the simple picture of Miocene extension by extrusion between Adriatic and European plates and renewed Pliocene compression induced by cease of the Carpathian slab pull has to be modified.

Lineament analysis and fault plane solution data in the transition between Alpine orogen and Pannonian Basin shows that a kinematically coherent and seismically inactive block can be defined in this region. This block - here called the „Styrian Block“ - is delineated by the Mur-Mürz Fault System in the north, the Pöls-Lavanttal Fault System in the west and the Periadriatic Fault System in the south and includes both the eastern most part of the Alps and the westernmost part of the Pannonian Basin. Fault analysis shows that the young stress field within this block appears to be extensional in W-E direction. An 1.56±1.11 Ma age of fault activity is constraint by burial age data of quartz rich sediments entrapped within a fault using the nuclide pair ^{26}Al and ^{10}Be. Here we interpret the post-Miocene fault pattern as result of north-south convergence between European and Adriatic plates and displacement partitioning along margins of coherent crustal fragments. The Styrian Block is part of the Pannonian fragment. Strike-slip displacement resolved along margins of this coherent block, especially along the northern Mur-Mürz Fault System. Here the European plate acts as a rigid backstop along which N-S plate motion trajectories are deflected into eastward flow, thereby releasing strike slip displacement. The Styrian Block is continuously extending since Early to Middle Miocene and it experiences uplift since about the Miocene-Pliocene boundary. We explain this by two interfering processes: (1) The weak Pannonian fragment is underthrusted from north and southwest by European and Adriatic plates and (2) decreasing extension rates towards east. While the eastern Pannonian Basin experiences W-E convergence since the cease of Carpathian subduction, the Styrian Block is still extending eastwards. This scenario reflects a multiplate interference system and highlights the complex interplay of plate motion and its consequences to topography and landforming processes.

Brückl, E., Behm, M., Decker, K., Grad, M., Guterch, A., Keller, G.R. & Thybo, H. (2010): Crustal structure and active tectonics in the Eastern Alps. - Tectonics, **29**: TC2011. doi:10.1029/2009TC002491.

Bus, Z., Grenerczy, G., Toth, L. & Monus, P. (2009): Active crustal deformation in two seismogenic zones of the Pannonian region - GPS versus seismological observations. - Tectonophysics, **474**: 343-352.

Horvath, F. & Cloetingh, S. (1996): Stress-induced late-stage subsidence anomalies in the Pannonian basin. - Tectonophysics, **266**: 287-300.

The Lurbach system (Central Styrian Karst - Semriach, Austria) - a complex (but) instructive karst aquifer to evaluate predictive modelling capabilities of rainfall - runoff approaches

Wagner, T.[1], Mayaud, C.[1], Benischke, R.[2] & Birk, S.[1]

[1] Institut für Erdwissenschaften, Karl-Franzens Universität Graz, Heinrichstraße 26, A-8010 Graz;
[2] Joanneum Research GmbH., Institut für WasserRessourcenManagment, Elisabethstr.16, A-8010 Graz

Predicting the hydrodynamic behavior of alpine spring catchments under changing environmental conditions is highly relevant in Austria and elsewhere, regarding drinking water supply, flood predictions and construction works (e.g., tunnels). Especially the effects of climatic changes are of growing concern. Appropriate hydrogeological tools able to capture the system responses outside calibration ranges are required. On the one hand, process-based distributive models might suffer from the lack of information about the spatial variability of hydraulic and geometric aquifer properties. Thus, the model calibration is expected to be ambiguous, suggesting high prediction uncertainty. On the other hand, global models use a group of parameters to reproduce from a given input function the observed system responses. These models are able to cope with the scarcity of input data but often do not adequately account for the physics of flow. Thus, process-oriented global (grey-box) approaches appear to be preferable, in particular, if conditions change beyond those considered by the model calibration.

Keeping these limitations in mind, the predictive capabilities of various global and distributive modeling approaches are tested using a well known and understood field site: The Lurbach system. Located in the Central Styrian Karst (Highland of Graz), the system serves as ideal test site for the evaluation of model performance and prediction uncertainties. Ample hydrogeological as well as speleological data are available (Behrens et al. 1992) and a profound understanding of the whole karst aquifer is established. The system behaves very differently as recharge conditions change. It is decoupled at low rates where the two springs (Hammerbach and Schmelzbach) act individually, but flow from one system to the other occurs at higher flow rates. Further, it seems that the proportion of flow in the conduit and matrix system changes with recharge as well. At extreme flood conditions a single conduit (the Lurgrotte cave) acts as the main flow path. Thus, this site provides an ideal framework to test models under strongly changing boundary conditions and aquifer characteristics. Limits in prediction-making capabilities and their uncertainties are addressed from synergies of the two model approaches (grey-box versus distributive) using differential split-sample tests of this complex aquifer system. The lessons learned will serve as a basis for other field sites where predictions outside the calibration ranges are needed.

Behrens, H., Benischke, R., Bricelj, M., Harum, T., Käss, W., Kosi, G., Leditzky, H., Leibundgut, C., Maloszewski, P., Maurin, V., Raijner, V., Rank, D., Reichert, B., Stadler, H., Stichler, W., Trimborn, P. & Zojer, H. (1992): Investigations with Natural and Artificial Tracers in the Karst Aquifer of the Lurbach System (Peggau-Tanneben-Semriach, Austria). - Steir. Beitr. z. Hydrogeologie, **43**: 9-158, Graz.

Geophysical prospection of subsurface monuments in a highly noisy environment

Walach, G.K. & Scholger, R.

Department of Applied Geological Sciences and Geophysics, Chair of Geophysics, University of Leoben, Peter Tunner Str. 25, A-8700 Leoben

The investigated area in Semlach near Knappenberg (Carinthia) was a Roman iron production site between the 1st and the 4th century A.D. Due to the long period of industrial utilization, a considerable number of relics (walls, melting furnaces, slag heaps, etc.) have been preserved in the subsurface. The delimitation of such monuments by means of geophysical prospection is based on contrasts in their petrophysical parameters compared with the natural soil or under laying rock. In general, relics of iron production processes with a high magnetic susceptibility can be identified with relative ease in a magnetic survey, e.g., by high (dipole) anomalies. The variations of the total magnetic field exceed 2000 nT for huge slag heaps and reach up to 500 nT for smelting furnaces. Contrastingly, minor decreases of about 250 nT, may give evidence for buried walls.

Recent archaeological excavations on the site Semlach yielded remains of a large building, which is assumed to be a roman depository. For the prediction of the further extension of the external walls, a combination of different geophysical methods was applied. A magnetic survey with an extension of 34x45 m and a grid of 0.5x0.5 m was executed using GEM proton precession magnetometers. The apparent conductivity and the inphase response of the soil were measured with a Geonics EM38 electromagnetic instrument. Additionally, the resistivity method (geoelectric mapping and multielectrode geoelectrics) and the self potential method (SP) were applied on selected profiles crossing the excavation area.

The new results from the site Semlach yielded several zones of relative minima of the magnetic field over the suspected areas, which were indicative of walls. However, the interpretation was complicated by a highly noisy background, which was caused by deposits of slag from