is often displaced by approximately NE-SW-striking and even younger NW-SE-oriented high-angle faults of limited displacement. The youngest movements are comparable with the lateral tectonic extrusion. This is also kinematically in a good correlation with data obtained from outcrops in Slovenia. In Oligocene extensive magmatism occurred, followed by dextral strike slip movements and major rotations. Lateral motions since the Turonian formed a mega-imbricate zone between the Dinarides (and Southern Alps) and the Eastern Alps contemporaneous with the movements of the Drau Range and the Transdanubian Range towards the east, to their present position.

With financial support of the FFG-Project 810082/9814 in cooperation with the STW Klagenfurt AG - Geschäftsfeld Wasser.

Late Triassic mass-flow deposits in hemipelagic „Slovenian Trough"-like sediments in the Karavank Mountains (Austria) triggered by Late Triassic strike-slip movements

Missoni, S.[1], Gawlick, H.-J.[1], Dumitrica, P.[2], Krystyn, L.[3] & Lein, R.[4]

[1]University of Leoben, Department for Applied Geosciences and Geophysics: Prospection and Applied Sedimentology, Peter-Tunner-Str. 5, A-8700 Leoben; [2]Dennigkofenweg 33, CH-3073 Guemligen; [3]University of Vienna, Department of Palaeontolgy; [4]University of Vienna, Center for Earth Sciences, Althanstr. 14, A-1090 Vienna, Austria; s.missoni@daad-alumni.de; hans-juergen.gawlick@mu-leoben.at, Paulian.Dumitrica@unil.ch, leopold.krystyn@univie.ac.at, richard.lein@univie.ac.at

The polyphase tectonic evolution along the eastern Periadriatic Lineament in the Karavank Mountains has formed an imbricate, which is located between the Maria-Elend Sattel and the Rosenbach Alm and consist of Late Triassic to Middle/Late Jurassic hemipelagic dolomites to cherty limestones, similar to the sedimentary sequence know from the Slovenian Trough south of the Julian Alps.

Two laterally differing sequences are developed in the study area: The eastern sequence is characterized by ?Carnian dolomites discontinuously overlain by bioturbated, turbiditic Late Norian radiolarian-rich limestones and Rhaetian to Jurassic argillo-calcareous bioturbated, turbiditic wackestones. The western sequence is composed of Carnian dolomites, followed by a ~200 m thick succession of Early to Middle Norian cherty dolomites (= Baca dolomite in the Slovenian Trough), and is overlain by thin bedded limestones with chert-lenses of late Middle to Late Norian in age, with interbedded polymict mass-flow deposits in the upper part.

In the newly formed late Middle to Late Norian basin hemipelagic limestones of allochthonous origin occur in the interbedded Sevatian mass-flows. These resedimented breccia components consist only of different hemipelagic grey limestones and are dated by means of conodonts and radiolarians as Early to Middle Norian. The radiolarians and conodonts from the components of these polymict Late Triassic mass-flow deposits indicate clearly a mixture of Early to Late Norian components. We conclude that the breccia components derived from a palaeogeographically different source area with a complete Early to Late Norian hemipelagic carbonate succession without dolomites, which is not exposed in the studied area or in the Slovenian trough. The matrix of the mass-flows as well the directly overlying sediments is dated by means of conodonts and radiolarians as Sevatian. Upsection (Rhaetian to Middle Jurassic) a several 100 m thick, partly restricted hemipelagic sequence is deposited, which displays since the Late Norian the topography of a relatively deep marine pelagic depositional environment. The sequence in the western part, with radiolarian-rich turbidites and low bioturbation displayed a thinning and fining-upward trend due to the decrease in sediment supply as the Late Norian relief became burried. These sediments (Frauenkogel Formation, Hahnkogel Formation, Kahlkogel Formation) occur in both sequences (= different Late Triassic imbricates) and seal the Late Alaunian to Sevatian tectonic movements. The predominantly matrix-supported clast layers are interpreted as debris-flow deposits triggered by local(?) iterative tectonic pulses rather than by sea-level changes due to the late Middle to early Late Norian lasting breccia formation and mass movements.

Our results point out, that simple extensional tectonics with creation of asymmetric basins cannot explain the observed component composition of these mass-flows. In asymmetric extensional basins we expect breccia components similar to those of the underlying sedimentary succession (e.g. with Baca dolomite components). Our results show in contrast, the derivation of the breccia components from a palaeogeographically different source area. Thus we explain this imbricate in the Karavanks as a result of complex Late Triassic strike-slip movements by forming transtensional asymmetric basins.

With financial support of the FFG-Project 810082/9814 in cooperation with the STW Klagenfurt AG - Geschäftsfeld Wasser.

Austrian Tunnel Structures: Concrete Damage by Thaumasite Form of sulphate attack (TSA)

Mittermayr, F.[1], Klammer, D.[1], Bauer, C.[2], Dietzel, M.[1], Köhler, S.[1] & Leis, A.[3]

[1]Institute of Applied Geosciences, Graz University of Technology, Rechbauerstraße 12, Graz, Austria; [2]Institute of Earth Sciences, Department of Mineralogy and Petrology, Universitätsplatz 2, 8010 Graz, Austria; [3]Institute of Water Resources Management, Joanneum Research, Elisabethstrasse 16/11, 8010 Graz, Austria; f.mittermayr@tugraz.at, dietmar.klammer@tugraz.at, christoph.bauer@uni-graz.at, martin.dietzel@tugraz.at, koehler@tugraz.at, albrecht.leis@joanneum.at

Over the past years concrete deterioration by sulphate attack has been repeatedly reported from several tunnel structures (e.g. Iden & Hagelia 2003). Whereas the formation of thaumasite seems to be a guiding process in contrary to the formation of ettringite and gypsum. Using sulphate-resisting Portland cements (SRPC) with low C_3A content ettringite can be significantly reduced. Nevertheless thaumasite even appears in concretes with negligible availability of Al by consuming C-S-H phases and therefore resulting in a significant decrease of the concrete stability (Bellmann & Stark 2007). Processes that lead to the formation of thaumasite have not yet been entirely understood. To gain new insights in the TSA case studies including the application of stable isotopes ($^{34}S/^{32}S$, $^{13}C/^{12}C$ and $^{18}O/^{16}O$) are carried out at Austrian railroad and highway tunnels.

In the Bosruck railroad tunnel shotcrete pieces were falling down causing safety issues for the highly frequented tunnel. The interlayer between the sooty brick wall lining and the shotcrete shows intense sulphate attack. Investigations by XRD revealed that the damaged horizon is composed mainly of thaumasite with small amounts of calcite, gypsum, and ettringite. The analysed local ground water is enriched in sulphate (> 6 mM SO_4^{2-}) due to the dissolution of local marine evaporites. The sulphate minerals of the damaged horizon and local evaporites comprise $\delta^{34}S_{CD}$ values from 14.8 to 22.2 and from 15 to 27‰ (Spötl & Pak 1996), respectively. Thus, the sulphate minerals from the damaged horizons indicate sulphate from local ground water. Soot relicts as a potential source of sulphur can be ruled out as the respective analysed $\delta^{34}S_{CD}$ values are between 3.4 and 4.1‰.

At the Tauern highway tunnel a second tube is currently under