Archäometallurgische Untersuchungen an frühbronzezeitlichen Kupferschlacken vom Kiechlberg (Tirol)

KRISMER, M.[1], TÖCHTERLE, U.[2], TROPPER, P.[1], GOLDENBERG, G.[2] & VAVTAR, F.[1]

[1] Universität Innsbruck, Institut für Mineralogie and Petrographie, Innrain 52f, A-6020 Innsbruck;
[2] Universität Innsbruck, Institut für Archäologien, Langer Weg 11, A-6020 Innsbruck

Im Zuge der Ausgrabungen des Instituts für Archäologien der Universität Innsbruck am Kiechlberg bei Thaur nordwestlich von Innsbruck wurden in den letzten Jahren eine ganze Reihe von Metallfunden und Verhüttungsprodukten geborgen, die zeitlich vom Neolithikum bis in die Frühbronzezeit datieren. Neben Fertigprodukten (Messer, Dolche, Pfrieme, etc.) wurden auch Roherze, pyrometallurgische Schlacken und Gusskuchen/Rohkupfer gefunden, die die Verhüttung von Kupfererzen im Siedlungsbereich belegen.

Die pyrometallurgischen Kupferschlacken setzten sich hauptsächlich aus SiO_2, Fe_3O_4, CaO, MgO, ZnO, Al_2O_3 und untergeordnet K_2O und P_2O_5 zusammen. Die Schlacken bestehen hauptsächlich aus Olivin, Klinopyroxen, Åkermanit, Spinel, glasiger Schmelze. Einschlüsse von texturell komplex verwachsenen Cu-Fe-S Sulfiden und metallische Einschlüsse im chemischen System Cu-Sb-As-Ag sind in allen Schlacken zu beobachten.

Die Rohkupferstücke vom Kiechlberg setzen sich primär aus Kupfer-Dendriten (2-4 Gew.% Sb) und einer intermetallischen Cu-Sb Verbindung zusammen (18-20 Gew.% Sb). Die Kupferdendriten zeigen eine leichte kontinuierliche Kern-Rand Zonierung, mit hoher Cu-Konzentration im Kern sowie geringster Cu-Konzentration im Randbereich (99-94 Gew.% Cu), welche auf eine rasche Abkühlung entlang des Liquidus hin zum Eutektischem Punkt im vereinfachten Cu-Sb System hinweist. Die Cu-Sb Verbindung zeigt ungefähr eine eutektische Zusammensetzung. Neben den Hauptelementen Cu und Sb enthält das System noch einige Gewichtsprozent an As, Ag, Zn und S. Solvus-Thermometrie und fO_2-fS_2 Partialdruckabschätzungen ergaben Mindesttemperature von 1100 °C sowie logfO_2 Partialdrucke zwischen -15 and -9 und logfS_2 Partialdrucke zwischen -6 and -4. Diese relativ reduzierenden fO_2 Bedingungen weisen bereits auf technologisch verfeinerte Verhüttungstechniken in der Frühbronzezeit hin.

Preliminary results of microfacies analysis of Hallstatt Limestones on selected outcrops in Driencany Karst area, Slovakia

KRONOME, K.

Faculty of Natural Sciences of Comenius University Bratislava, Department of Geology and Paleontology, Mlynska dolina, 842 15 Bratislava 4, Slovakia;
kronomek@fns.uniba.sk

The Driencany Karst is situated in the Western Carpathians, in the wider vicinity of the village Slizke in the Revucka vrchovina Mts., in the southern part of the Slovenske rudohorie Mts. The Driencany Krast belongs to Inner Western Carpathians tectonic unit and it is built by complexes of the Silica Nappe.

The present study is mainly focused on the investigations of the Upper Triassic Hallstatt Limestones. Hallstatt Limestones extend on the both sides of the Kamenny jarok gorge between the villages Hostisovce and Slizke. In the northern part they extend to the southern margin of the Drienocka pustatina area, where they pass into the underlying Tisovec limestone. They are overlain by andesitic volcanoclastics. Hallstatt Limestones are exposed on the surface in small areas near Budikovany and Driencany villages.

Limestones were studied at five outcrops by methods of microfacies analysis. These localities are: 1,2) Kamenny jarok gorge (outcrops A, B), 3) Drienocka pustatina and 4,5) Budikovany village (two outcrops in its vicinity).

On the basis of conodonts (GAAL 1982) the limestones on the locality Drienocka pustatina area are upper Tuvalian to lower Norian in age; limestones on the locality Kamenny jarok gorge (A) sedimented in Alaunian up to lower Sevatian and limestones of the locality Kamenny jarok gorge (B) are of lower to middle Sevatian age. Limestones on the locality Budikovany shows lower Sevatian age (KOZUR & MOCK 1974).

Limestones on the locality Drienocka pustatina area are pink to gray and fine-grained, almost microsparitic packestone/grainstones with peloids, echinoderms, agglutinated foraminiferas and thin-shelled bivalvias. They can form lumachella beds in some positions.

On the locality Kamenny jarok (A) are light gray, fine-grained limestones present. In the upper parts they are represented by pinkish crinoidal limestone. Their microfacies is mostly grainstone with echinoderms, thin-shelled bivalvias and agglutinated foraminiferas. In the uppermost part of the outcrop the microfacies of the limestones is changing into wackestones to mudstones with radiolarians, osteocrinoids and filaments. Limestones on this outcrop belongs probably to younger Tisovec Limestones gentle changing to the Hallstatt Limestones. This presumption is recently subject of study.

Limestones on the locality Kamenny jarok (B) are light-gray bedded fine grained limestone with gray cherts and lumachellas. They are wackestones with radiolarians and very abundant spicules of calcificied silicic sponges. These beds alternates with cocquina layers. In the uppermost part of the section bioclastic packestones with echinoderms and agglutinated foraminiferas are present. The Triassic part of the outcrop terminates with erosive surface of the Hallstatt Limestones and transgression of Egerian breccias of the Budikovany beds.

The limestones on the locality Budikovany are light gray, pinkish gray fine-grained with dark lithoclasts. In the upper parts of the section bedded gray limestones with red nodules and cherts are present. They are almost bioclastic packestones with radiolarians, echinodermatas, sponge spicules and filaments. The second outcrop on this locality is situated in light gray fine grained limestones - wackestones with radiolarians and silicisponge spicules. The

Triassic part of the section ends with limestones sometimes with cherts and is overlain by Egerian breccias.

This work was supported by the Slovak Research and Development Agency with the contract No. APVV-0280-07, SK-AT-0005-08 and VEGA 1/0388/10.

GAAL, L. (1982): Stratigrafia a facialne vztahy triasovych vapencov silickeho prikrovu v driencanskom krase. - Geologicke prace, 77, Geologicky ustav Dionyza Stura: 29- 48, Bratislava.

KOZUR, H. & MOCK, R. (1974): Zwei neue Conodonten-Arten aus der Trias des Slowakischen Karstes. - Casopis pro mineralogii a geologii, **19** (2): 135-139, Praha.

The GSSP for the base of the Jurassic is in the Northern Calcareous Alps (Kuhjoch section; Karwendel Mountains, Tyrol, Austria)

KRYSTYN, L.[1], VON HILLEBRANDT, A.[2] & RICHOZ, S.[3]

[1] University of Vienna, Department of Paleontology, Althanstrasse 14, 1090 Vienna, Austria; leopold.krystyn@univie.ac.at;
[2] Institut für Angewandte Geowissenschaften, Technische Universität, Ernst-Reuter-Platz 1, 10587 Berlin, Germany; hil10632@mailbox.tu-berlin.de;
[3] Commission for the Palaeontological and Stratigraphical Research of Austria (CPSA) Austrian Academy of Sciences c/o Institute of Earth Sciences, University of Graz, Heinrichstr. 8010 Graz, Austria; Sylvain.Richoz@uni-graz.at

The Kuhjoch section near Hinterriss (Tyrol, Austria) was ratified in April 2010 as GSSP for the base of the Hettangian Stage and, as such, the base of the Jurassic System.

Sedimentary successions across the Triassic/Jurassic boundary which are expanded and highly fossiliferous in the Northern Calcareous Alps are restricted to the so-called Eiberg Basin, a Rhaetian intraplatform depression, that can be traced over 200 km from the Salzkammergut (Kendlbachgraben, Upper Austria) in the east to the Lahnewiesgraben valley (northwest of Garmisch-Partenkirchen, Bavaria) in the west. Flanked by carbonate platforms to the north and south, this continuously subsiding basin reached 150-200 m water depth in late Rhaetian time and was, therefore, less affected by the end-Triassic sea level drop which led to widespread and longer-lasting emersion of the surrounding shallow water areas. Instead, marine conditions prevailed in the basin across the system boundary, though a distinct and abrupt lithological change from basinal carbonates of the Koessen Fm. (Eiberg Mb.) to marls and clayey sediments of the lower Kendlbach Fm. (Tiefengraben Mb.), which is interpreted as a result of this sea level fall. This drastic change in lithology was interpreted during the last decade as the T-J boundary because it coincides with the disappearance of typical Triassic fossils such as ammonoids and conodonts. New studies demonstrate, however, that the lower metres of the Tiefengraben Mb. (=„Rhaetische Grenzmergel“ sensu FABRICIUS 1960 - including also the reddish Schattwald Beds) still yield a Triassic micro- and nannoflora and that the earlier cessation of Triassic macrofauna may be an effect of detoriating environmental conditions. With a thickness of more than 20 m, the Karwendel Syncline exposes the most expanded Triassic-Jurassic boundary succession within the Eiberg basin as well as worldwide. The well-exposed section displays a high and continuous sedimentation rate with a constant facies trend across the boundary level. It contains well preserved and frequent fossils and an abundant microflora allowing a cross-correlation with the continental realm.

The exact level is 5.80 m above the top of the Koessen Formation and corresponds to the FO of the ammonite *Psiloceras spelae tyrolicum* HILLEBRANDT & KRYSTYN. This taxon relates to the group of *Psiloceras tilmanni* that is considerably older than other Northwest European psiloceratids (i.e. *Psiloceras erugatum*, *Psiloceras planorbis*) and is comparable with the oldest *Psiloceras* in North America (Muller Canyon, Nevada, USA) but is much better preserved (aragontic shell, whorl section and complete suture line). The ammonite event correlates to the FO of *Cerebropollenites thiergartii*, a widely distributed palynomorph and Early Jurassic marker in continental successions. Additional boundary events are the FO of the aragonitic foraminifer *Praegubkinella turgescens* and of the ostracod *Cytherelloidea buisensis* 60 cm below the proposed stratotype point and the disappearance of the ostracod *Eucytherura sagitta* immediately above the point. The $\delta^{13}C_{org}$ record shows an initial strong negative excursion near the boundary between the Koessen and Kendlbach Formations that may be worldwide correlatable. The Triassic/Jurassic bioevent lies shortly above this negative peak. The stratotype point coincides with a shift to more positive $\delta^{13}C_{org}$ values**.**

Fluid assisted Cataclastic Deformation in quartzitic rocks (Portizuelo Antiform, Luarca, NW Spain)

LANER, R. & GRASEMANN, B.

University of Vienna, Department for Geodynamics and Sedimentology, Althanstrasse 14, A-1090 Vienna

The outcrop at the Portizuelo Beach in Western Asturias presents an antiformal bulge of the transition zone between siliciclastic and marine sediments. The core of the antiform comprises of pure, rigid and resistive quartzitic rocks, severly damaged by brittle deformation and cataclasis. Two large transform faults with a particular thrust component can be found in the hinge area. They are clearly in charge of the damage of the surrounding rocks. The faults accommodate the main part of the deformation, but also sub-parallel cataclastic bands show evidence for lateral movement. Originating from the fault planes, fluidized cataclasites pervade the rock mass, leading to further fracturing. Obviously the fracturing ceases with increasing distance from the transform faults. The fluidized material tends to use preexisting planes, such as bed interfaces, joints or veins for its intrusion. Additionally the fluids are responsible for the cementation of the cataclastic zones, generated during incremental strike slip deformation.