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Mn^{2+}-allanite and rare Co-Ni-As sulfides from the Veitsch Mn deposit (Styria)

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Several carbonate-hosted Fe and Mn ore deposits occur within the upper Austroalpine Grewywacke Zone. The Mn deposit of Veitsch at the Kaskogel and north of the Friedelkogel consists of lense-shaped carbonate bodies of ca. 1.5 m in length which are thought to have formed as sedimentary or submarine hydrothermal Mn-deposits. The manganese silicates described from this deposit are: tephroite, pyroxmangite, spessartine, Mn-chlorite, Mn-humite and friedellite. Sulfides such as sphalerite, galena, chalcopyrite and Co-Ni sulfides also occur.
During this investigation in several samples an unusual REE-Mn-(V)-bearing allanite mineral was found. The allanite occurs in a veinlet with the mineral assemblage REE-Mn-allanite + tephroite + spessartine + Mn-chlorite + rhodochrosite + kutnahorite + serpentine. The REE varies between 1.5 and 1.8 a.p.f.u., and Mn ranges from 1.2 to 1.5 a.p.f.u. In one sample elevated V contents of 1.3-7 wt.% V_2O_3 were observed. The BSE images and chemical analysis reveal a complex zoning of the mineral with increasing Fe_2O_3, MnO and decreasing Al_2O_3 and CaO towards the rim, whereas the REE are unzoned except for V-bearing areas. Charge balance considerations and site assignments indicate that the fraction of Mn^{3+} is very low (<0.2 a.p.f.u.). With such low Mn^{3+} the mineral is a REE-Mn^{2+}allanite [$CaREE(Mn^{2+})(Al,Fe^{3+})2Si_3O_{12}(OH)$], with some androsite [$MnREE(Mn^{2+})(R^{3+})2Si_3O_{12}(OH)$], dissakisite [$CaREEMgAl_2Si_3O_{12}(OH)$], but little or no allanite [$CaREE(Fe^{2+})Al_2Si_3O_{12}(OH)$] component. The elevated F contents of 0.14 to 0.23 a.p.f.u. indicate that a khristovite component [$CaREEMgMn^{2+}AlSi_3O_{11}(F,OH)(OH)$] may also be present.
The complex accompanying sulfide assemblage contains chalcopyrite, pyrite, bornite, digenite, sphalerite, Co-pentlandite and rare Co-Ni sulfides such as linnaeite, carrolite and three so far unidentified Co-As sulfides.

Postglacial denudation and sedimentation in an inner-alpine headwater catchment (Gradenmoos Basin, Schober Mountains, Austrian Alps)

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Knickpoints in alpine stream profiles frequently refer to different lithologic and tectonic units of a catchment, to damming effects through large rockfall deposits, or to the impact of Pleistocene glaciations. As a consequence of glacial overdeepening, various sedimentary sinks developed in alpine drainage basins effectively interrupting postglacial sediment fluxes. In recent times these sinks have been filled up to different degrees with sediments from various sources. The sedimentary record and volumes of sediment storage within these (semi-) closed systems are of great value for the reconstruction of postglacial landscape evolution.
This study investigates the glacially overdeepened Gradenmoos basin an alpine lake mire with adjacent floodplain deposits and surrounding hillslope storage landforms (1920 m; 4.1 km2) - the most pronounced sink in the Gradenbach catchment (32.5 km2, Schober Mountains, Hohe Tauern, Austria). The basin has been filled up with sediments delivered by mainly fluvial processes, debris flows, as well as rockfall and avalanche activity, it is deglaciated since Egesen times and it archives a continuous postglacial stratigraphy. Following the approach of denudation-accumulation-systems, most reliable data on denudation and sedimentation are obtained (1) if sediment output of a system can be neglected for an established period of time, (2) if - due to spatial scale - sediment storage can be assessed with a high level of accuracy, (3) if the onset of sedimentation and the amount of initially stored sediments are known, and (4) if sediment contributing areas can be clearly delimited. All aspects are fulfilled to a high degree within the studied basin.
Sediment storage in and surrounding the basin was quantified using geophysical methods, core-drillings, as well as GIS and 3D-modelling whereas postglacial sedimentation was reconstructed by means of radiocarbon dating and palynological analyses. Subject to variable subsurface conditions (e.g., grain sizes, bulk densities, and water contents) multiple geophysical methods were applied to detect sediment thicknesses. 2D DC resistivity surveying was used most extensively as it delivered most detailed and realistic subsurface models with only low residual errors in the fine-grained and water-saturated central and distal part of the basin. With a lower data density,

ground penetrating radar and refraction seismic profiling provided sediment thicknesses underneath the adjacent debris cone and talus slope deposits. Basin stratigraphy is derived from the sediment cores and comprises a basal layer of till underneath lake sediments, a sandy matrix with several oxidised layers, and layers of peat towards the surface. As bedrock was reached several times, the core-drillings further enabled to calibrate resistivity models.
On the base of bedrock outcrops gathered by terrestrial laserscanning (TLS) and bedrock depths derived from geophysical prospection and core-drilling, the shape of the bedrock basin was interpolated using exact spline algorithms. Sediment volumes were calculated by subtracting the interpolated ?DEM bedrock? from the TLS-based ?DEM surface?. Since single landform volumes can be clearly assigned to different sediment delivering areas, site-specific rates of denudation and rockwall retreat are differentiated and related to (a wide range of) published values. Based on an integrated analysis of surface, subsurface and temporal data a model of postglacial basin sedimentation is finally proposed and discussed in a paraglacial context.
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Modelling of lateral fold growth and fold linkage: comparison with examples from the Zagros Mountains (Kurdistan, NE Iraq)

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We use a finite element model to investigate the lateral fold growth and fold linkage of two initially isolated fold segments. The separation distance between the fold hinge lines controls the linkage mode of the folds: 1) “Linear-linkage” yields a sub-cylindrical fold with a saddle at the location where the two initial folds linked. 2) “Oblique-linkage” produces a curved fold resembling a Type II refold structure. 3) “Oblique-no-linkage” results in two curved folds with fold axes plunging in opposite directions. 4) “Linear-no-linkage” yields a fold train of two separate sub-cylindrical folds with fold axes plunging in opposite directions. The transition from linkage to no-linkage occurs when the fold separation between the initially isolated folds is slightly larger than one half of the low-amplitude fold wavelength.
The model results were compared with natural example of lateral fold linkage from the Zagros fold-and-thrust belt in the Kurdistan Region of Iraq. In this area the folds are not associated with major thrust faults and shortening of the Paleozoic to Cenozoic passive margin sediments of the Arabian plate occurred mainly by detachment folding. We investigated the progressive evolution of the drainage patterns along the growing anticlines, which directly reflects the amplification and lateral growth. The geomorphological studies of fold trains demonstrate that these anticlines have not developed from single sub-cylindrical embryonic folds but they have merged from different fold segments that joined laterally during fold amplification. Linkage points are marked by geomorphological saddle points which are structurally the lowermost points of antiforms and points of principal curvatures with opposite sign. Linkage points can significantly influence the migration of mineral-rich fluids and hydrocarbons and are therefore of great economic importance.