Fault sealing by isochemical cataclastic grain size reduction in arkosic sands: an example from the Eisenstadt-Sopron Basin, Austria

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Deformation bands and cataclastic faults may significantly reduce porosity and permeability in reservoir sediments. This study presents microstructural as well as bulk and mineral chemical investigations of such structures in uncemented, friable arkosic sands of Miocene age (Vienna Basin, Austria). The observed microstructures indicate grain size reduction by grain flaking in deformation bands with small offsets (0.5-8 cm), and increasing intragranular fracturing and clast disaggregation with larger displacements (10-60 cm) in cataclastic fault zones. At small displacements, increasing amounts of phyllosilicate grains (<20 μm) in the matrix can be detected. Detailed microstructural and mineral chemical analyses reveal that the phyllosilicates are released from disaggregating sericitised albite clasts. Both cataclasis of quartz grains and enrichment of phyllosilicates by mechanical expulsion from plagioclase result in grain size reduction within the fault rocks. The measured reduction in porosity of up to 40 % is associated with a permeability reduction, reflected in the retention of iron-oxide rich fluids along the deformation bands and fault zones. The observations indicate that these deformation bands and cataclastic faults formed at very shallow burial depths in unconsolidated sediments, and that fault sealing occurred in the absence of chemical alteration of the fault rocks. Such localized zones of low permeability are not recognized in seismic data due to their small displacement, but might create fluid barriers significantly reducing the connectivity of a reservoir.

The role of transhumance in the Inner Alps at the time of the Alpine Iceman

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Transhumance and alpine summer farming are traditional practices that play a great role in shaping the mountain landscape in the Alps, forcing the lowering of the timberline and causing the expansion of the grasslands. However, it has not yet been clarified when, and for what reasons, these subsistence strategies first developed. During the studies on the Alpine Iceman (3300-3100 cal BC) palynological analyses, performed in the vicinity of his discovery site, indicated a possible local pasture activity starting 1000 years before the Iceman time. This led to the idea that the Iceman himself was possibly involved in the practice of transhumance. In order to scrutinize this hypothesis a multidisciplinary palaeoenvironmental and archaeological study has been developed. The analyses focus on several sites located along the traditional transhumance route that goes from the Vinschgau valley floor (Italy) up to the Ötztal pastures (Austria) crossing the main alpine ridge. This paper presents the results of the combined archaeological, palynological and fire history analyses performed on the Schwarzboden peat bog, one of the study sites located in the high altitude of the Vinschgau.

Ice thickness measurements with ground penetrating radar for a volume inventory of Austrian glaciers

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The ice volume stored in mountain glaciers determines the current and future glacier runoff and thus the contribution of these glaciers to sea level rise. More than 50 Austrian glaciers were surveyed with low frequency ground penetrating radar between 1998 and 2009 (SPAN et al. 2005, FISCHER et al. 2007). The pulsed radar system is based on the sensor of NAROD & CLARKE (1994) and operates at a central frequency of 4.5 to 6 MHz depending on the antenna length used. The resistively loaded dipole antennas (WU & KING 1965, ROSE & VICKERS 1974) have a half length of 10 to 20 m and are operated ground based. The low frequencies allow a penetration depth of more than 300 m even if melt water is present. The maximum ice thickness was measured on Pasterzenkees in Glocknergruppe with more than 300 m.

The GPR data covers more than 40 % of the Austrian glacier area. The data include most glaciers surveyed with seismic methods in the 1970s and 1980s (e.g., ARIC & BRÜCKL 1987) and earlier. Together with the topographic data from Austrian glacier inventory 1998 (LAMBRECHT & KUHN 2007), a world- wide unique glacier volume inventory is compiled for Austria.

The volume was calculated from the ice thickness data by manually constructing the contour lines of elevation of the subsurface topography (FISCHER 2009). This method includes additional information as the slope of the rocks near the glacier and the position of the crevasse zones, but does not include ice dynamical modelling as done by BRÜCKL (1970), and BINDER et al. (2009).

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Homogenization of 50 years of mass balance data at Hintereisferner, Austria

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The annually measured direct mass balance data of Hintereisferner was homogenized and analyzed with respect to climate and glacier changes. The spatial distribution of specific mass balance in the first decade of measurements was changed based on the measured data and according to the current methods and the concepts of modern mass balance analysis on Hintereisferner. This and the homogenization of the glacier area resulted in a better agreement with the results of the geodetic method.
The homogenized spatial distribution of the specific mass balance data was further analyzed with the aim to separate the influence of climate change from the effect of glacier changes. Therefore, the mass balance at three sub areas was compared to the total mass balance and to summer temperatures and winter precipitation measured at the nearby climate station in Vent. The mass balance at high elevations is determined by winter precipitation, the mass balance at low elevations by summer temperatures. Between 1953 and 2003, the surface of the glacier tongue lowered by 160 m. This resulted in a temperature increase of about 1 °C at the surface 2003 compared to the surface 1953 with the same temperature measured in Vent. The potential incoming solar radiation during the summer is reduced due to increased shading as a result of higher elevation differences between the glacier surface and the surrounding mountains. Comparing the effect of these two factors, the impact of the topographic temperature change on mass balance is much higher than the impact of decreased incoming radiation. At higher elevations, the effect of topographic changes is small compared to changes in the mean surface albedo.
The comparison of summer temperatures and precipitation measured in Vent to the specific mass balance showed that extremes in temperatures and precipitation do not coincide with extreme values of mass balance. Mean summer temperatures and mass balance are not directly coupled, since the occurrence of snow and ice melt and the extent of a temporal snow cover play important roles. Those are determined by the chronological sequence and duration of local weather conditions. The results of the degree-day method show that the increased glacier melt in the last decade is caused by an increase of positive degree day sums and a decrease of summer snow fall events.
All glacier related climate proxies as hydrological and direct mass balance as well as length measurements show the same trends, but differ in magnitude and in the processes and time scales comprised in the proxy. The comparison of the hydrological balance of the Rofenache basin to the direct mass balance data showed that Hintereisferner is not representative for all glaciers in the basin.

The not-so-simple effects of boundary conditions on models of simple shear

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Analogue modeling of geological structures, such as the behavior of inclusions in a matrix or folding instabilities commonly employs a linear simple shear or general shear rig. In theory, a homogeneous plane strain flow is prescribed at the boundaries of such deformation rigs, but, in practice, the resulting internal deformation of the analogue material (commonly paraffin wax or silicone putties) often strongly deviates from the intended homogeneous strain field. This can easily lead to misinterpretation of such analogue experiments. We present a numerical finite element approach to quantify the influence of imperfect simple shear boundary conditions on the internal deformation of a homogeneous viscous analogue material. The results (Fig. 1) demonstrate that imperfect circumferential boundary conditions in the simp-