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Architectural analysis and chronology of an Alpine alluvial fan using 3D ground penetrating radar investigation and quantitative outcrop analysis

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Alluvial fans represent sediment sinks directly at the outlet of the source area in mountain landscapes. They contain multiple information on short-term as well as on long-term changes of sediment supply and of environmental parameters like climate and vegetation. However, most studies on alluvial fans are restricted to selective surface analysis and almost no studies exist which aim to clear the subsurface geometry of an alluvial fan in total. Our study is embedded in the *SedyMONT* research program within the *TOPO-EUROPE* framework and aims to clarify the subsurface structure of an alluvial fan by a time-controlled 3D architectural model.

The Illgraben fan is located in the Central Alps of Switzerland within the Rhone valley and covers an area of about 6.5 km^2. Currently construction works for a highway cuts through the fan exposing its deposits (mainly gravel and diamicton) up to 15 m depth and therefore offers the unique opportunity to link ground penetrating radar (GPR) investigations with quantitative outcrop analysis. GPR measurements on the Illgraben fan have been carried out at two different scales: (i) a fan-wide scale with about 80 km radar sections forming a half spiderweb pattern to identify the fundamental architecture of the fan (using 100 MHz and 40 MHz antenna), and (ii) four orthogonal grids of about 50 m x 100 m for detailed architectural analysis (using a 200 MHz antenna). Penetration depth was up to 15 m for high and low frequency antennas. The radargrams were processed, georeferenced and transferred into a 3D-modeling software (GOCAD®) to map radar facies units. By means of quantitative sedimentological analyses and precisely scaled photo panels we could translate radar facies pattern into sedimentary facies, and interpret reflectors and their properties in terms of sedimentary units. These geobodies can be characterized in terms of volume, shape, geometrical key parameters, their spatial distribution, as well as internal sedimentary structures in order to identify depositional processes.

Preliminary results show distinct horizons (‘palaeosurfaces’) indicating fan-wide depositional starvation and minimized sediment supply. Furthermore, between these horizons the Illgraben fan is built up by multi-storey and multilateral architectural elements of different type and at characteristic scales which can be attributed to specific depositional processes (e.g. debris flows, channel fills, levees). At small-scale a heterogeneous and complex stacking pattern of geobody interfaces was observed, showing a distinct multi-fold hierarchy of mainly concave, convex and horizontal structures. First ^{14}C AMS ages from the central part of the alluvial fan (ca. 10 m depth) indicate high sedimentation rates during the past 2000 years. We found no control of natural spectral gamma-ray radiation by lithofacies units. Hence variations must indicate changes in the source areas and/or climate-controlled weathering conditions in the drainage basin (ca. 9.5 km^2).