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Mechanisms of rock slope failure in conglomerates with variable lithification

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In conglomerates with variable lithification very special failure mechanisms my occur. On January 25th, 2010 at the village of Stein at the river Traun, at about 8 p.m. a 432 m3 large and 1,026 t heavy block was released from a conglomerate face obviously without warning, destroying the family home below. Only two of four inhabitants could be saved out of the debris by means of a spectacular rescue operation through the local fire brigade.
After this event the question arised, if the rock fall could have been foreseen or if such spontaneous incidents are abrupt and unpredictable.
In this paper the conducted studies to reconstruct the processes leading to this event will be presented. These investigations included field mapping, geodetic survey, laserscanning of the rupture face, mineralogical analysis of sinter crust thin sections, inventory of the block dimensions and reconstruction of the collapse kinematics, analysis of the weather data prior to the event and a 2D finite element calculation (Phase2, rocscience) using the geometry of the overhanging conglomerate strata.
In this case, it seems like there was no clear triggering event prior to the wall collapse. Instead, it could be proved by engineering geology mapping, mineralogical analysis of the sinter crusts and numerical modelling, that the back scarp connected with a set of discontinuities started to propagate several years ago already. Also supported by early photographs of the cracks in the brick walls of the endangered house in 1993 and 2006 together with eye wittnesses, it could be shown, that the fracture propagation started tens of years beforehand and the rock topple – rock fall took place after the last rock bond bridges finally were sheared through.

As a result of all field data and the numerical modeling, the causes of the event can be stated as:
• caving in the rock mass of up to 9 m depth at the foot oft he wall;
• the low strength values of the conglomerates; and
• vertical joint sets caused by the geometrical constraints and the low rock strength properties.
As trigger mechanism, the multiple freeze/thaw cycles and therefore the frequent contractions of the separated rock column are also responsible for fracture propagation. In fact, only the “last” freezing event can be identified as trigger, thus meaning that there was no “major” triggering event at all.
The results of the numerical modeling also suggest, that shear cracks must have formed, subsequently generating a distinct crack pattern in the walls of the building.
The results of the analyses of the thin sections of the sinter crusts derived from the back faces of the blocks suggest an increasing depth of the back joint with time and an age of at least 11 years or more. This means that the crack pattern must have been visible years before the event. Therefore it can be stated, that the rock fall of Stein could have been predicted, if the clear signs of damage would have been interpreted correctly and the failure process would have been fully understood.