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Cover-collapse sinkholes of the Franconian Alb / Germany

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Recent events of cover-collapse sinkhole formation, the geomorphological, geological and hydrological conditions of selected sinkholes and the spatial and temporal occurrences of such landforms were studied in the Franconian Alb, a karst area located in southeastern Germany. The Franconian Alb consists of karstified limestones and dolomites of Jurassic Age. It is partly covered by Cretaceous and Miocene deposits and a clayey to loamy overburden. The thickness of the loamy cover ranges from a few decimetres up to ten meters. Sinkholes are widely distributed in the area, to some extent they were formed by cover-collapse processes.
In order to prepare a geohazard map, historical records from different archives (municipalities, counties, water management agencies, governmental archives, newspapers) were used for a compilation of sinkholes which resulted from collapses. The frequency of occurrence of cover-collapse sinkholes differs in areas with agricultural or forestal use. Farmers often backfill these surficial cavities immediately after their formation, before they can be registered officially. Therefore a documentation of such collapse events may be restricted in terms of detailed statistical analyses. Nevertheless seasonal clusters of collapses can be observed.
Recent collapses show close relations to climatic conditions. During winter or spring the majority of collapse events is associated with snow melt or heavy rainfall resulting in an increase of the soil moisture and a decrease of shear strength within the loamy cover. Consequently, loose material overlaying cavities can be washed down, or the sediment itself moves downward. For single events, the antecedent climatic development (precipitation, thickness of snow cover, air temperature, soil temperature) was analysed for identification of the triggering factors. In this context, small-scale surficial karst depressions without outlet (underlain by thick loamy deposits) show an efficient drainage via a few temporary active ponors and connected subsurface pipes. These ponors are affected by frequent morphological changes due to the power of the inflowing water, but mostly they are blocked by loamy material.
Besides the climatic relations, the formation of cover-collapse sinkholes is influenced by human activities. Collapses within soils are often caused by the mechanical stress following/during farming activities.
Selected cover-collapse sinkholes were studied in detail with respect to their geomorphological and geological characteristics in order to document cavities and the subsurface structure of the sinkholes. Additionally, the physical properties (grain size, moisture content, shear strength) of the moving sediments were analysed within the accessible parts of the collapse sinkholes. Only little differences were indicated for still slow-sliding sediments (high water content and low shear strength) and the accumulated collapse material (slightly increased shear strength). In contrast lower moisture contents and an increased shear strength were observed for older fillings of cracks which were not affected by the collapse processes.