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Quantifying and timing of long-term carbonate mobilisation in a limestone aquifer

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Carbonate dissolution during weathering, its intermediate storage by reprecipitation, and/or final export to the sea are major components in the global carbon cycle. The Thuringian Basin in the central part of Germany exposes deposits of the German Triassic Muschelkalk sequence consisting of limestone and dolostone beds. Partial dissolution, oxidation and iron redistribution is obvious in limestones along the slopes of the middle Saale river valley.

These features are most prominent close to a Mid Quaternary valley floor (Elster terrace). They decrease down-section following fractures in homogeneous micritic limestones of the Lower Muschelkalk (Jena Formation), and reach a minimum close to the present groundwater table. It implies a discontinuous vertical migration of the groundwater table close to the valley slopes, spanning >700 ka of valley incision, and a coeval increase of oxidative weathering of sulfides and organic matter in the micritic carbonate. The recharging groundwater carries dissolved and particulate organic matter from the soil into fractures and pores. Microbial community oxidizes the organic material by using O_2 that diffuses in from atmosphere. Due to the dissolved CO_2 the water is undersaturated concerning carbonate minerals. The fissures enlarge by the water dissolving the limestones. The working hypothesis suggests the maximum of carbonate dissolution and descendant export within the vadose zone. Material export is supposed to occur dependant on climatic variations with microbial mediation in both dissolution and transient reprecipitation. Furthermore, the study area has the important advantage that the timing of the 100 m migration of the ground water table has a good age control due to topographic dating of terrace formation.

Key aspects of this study are the quantification of long-term telodiagenetic transformations of the limestones, the timing of the involved processes and the analysis of current carbon fluxes both surface and subsurface. The goal is to deliver basic data for a quantification of carbonate export and carbon dioxide consumption within the Thuringian basin Muschelkalk aquifer during the Late Quaternary.