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Geoarchaeological conclusions through investigating sediments, soils and minerals in karst depressions in Mount Ida, Central Crete

I. Holzhauer (1), C. Siart (1), H.P. Meyer (2), G. Schukraft (1), R. Altherr (2), and B. Eitel (1)

(1) Geographical Institute, University of Heidelberg, Germany, (2) Institute of Mineralogy, University of Heidelberg, Germany

The investigation of sediments, soils and minerals can provide important information for the reconstruction of past landscapes and the human impact on the environment. In this context, sediment-filled karst depressions function as archives as their different sediment structures reflect various superficial conditions and associated man-made changes in the environmental system. The study area, namely the doline of Zominthos, is located at 1200 m a.s.l. in the Ida Mountains in Central Crete and is known for its remnants of a late Minoan settlement complex (Neopalatial Period, ~1600 BC).

Our purpose is to help understand the past human-environmental interactions in the Central Cretan highlands through the use of several sedimentological and mineralogical methods including percussion drilling and subsequent analysis with polarisation microscopy, SEM, EPMA and XRD investigations.

The macroscopic evaluation of the core profiles and the micromorphological studies of thin sections give evidence of colluvial sediments within the doline which are interbedded with fine-grained, graded horizons featuring clearly fluvial textures. They must be considered with regard to intense landuse and deforestation of the surrounding escarpments. The mineralogical investigations show the coincident abundance of well-preserved angular minerals on the one side and heavily weathered minerals on the other side. This leads to the assumption of at least two different generations of minerals that underwent a various history of subaerial exposure. The vast majority of heavy minerals (e.g. carpholites, chloritoid, garnets, spinels) cannot derive from the limestone bedrock and must stem from allochthonous sources. They originate from metamorphic rocks that do not outcrop in the catchment area of Zominthos. However, they must have existed here in former times when klippes provided the concerning minerals for the buildup of the soil cover. Hence, the palaeorelief must have been different with divergent lithology. Considerable amounts of volcanogenic pyroxenes and amphiboles have been found, which can clearly be connected with the Thera eruption of Santorini 1620 BC. They have been found all over the core profiles and thus provide a time marker for the intense man-made geomorphodynamics since the date of the intense ash fallout over Crete. More than 10 up to 15 metres of pedosediments have been deposited in the Zominthos doline in the last 3400 years. Furthermore, large amounts of remarkable and very rare mineral species have been detected within the pedosediments, e.g. ferrocarpholite. The observed light minerals, respectively diverse quartz grains, show varied grain morphologies that indicate fluvial, aeolian as well as tectonic impacts. The clay mineralogy of the limestone residues and the pedosediments was investigated, showing significant amounts of kaolinite within the latter, which can be attributed to strong southern wind regimes that transported the particles from the Sahara into the study area. In contrast, the bedrock lacks completely in this allochthonous aeolian dust component.

In addition, the strong polygenetic nature of the sediment fills has to be stated. The prevalent assumption of an autochthonous thin and clayey residue in karst depressions can not be confirmed. The human impact on this landscape is crucial and plays a major role regarding the composition and genesis of the sedimentary fills.

The application of combined sedimentological and mineralogical investigations for (geo)archaeological purposes is still a quite exceptional approach. As shown by the results, it can deliver important information for the reconstruction of past human-environmental systems, which are encoded in minerals, sediments and soil properties.