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Magnetic Fabrics of volcaniclastic Units of the Messel Maar-Diatreme (Germany)

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Geophysical investigations around the Messel Pit (well known for its fossil-bearing excavations; World Heritage Site since 1995), 25 km south of Frankfurt (Germany), allowed the reconstruction of a subsurface maar structure. A cored drilling project commenced in 2001 proofed the existence of a phreatomagmatically evolved maar-diatreme-volcano. Besides the well known “oil shales”, volcaniclastic material was discovered in a depth between 240 m and 370 m beneath the surface. This study deals with rock magnetic investigations on these volcaniclastic units of the Messel maar-diatreme. Thereby a special attention is paid to its structural characteristics linked to the genetic relation of AMS (anisotropy of magnetic susceptibility) geometry compared to the regional tectonic features.

The volcaniclastic deposits found within the maar diatreme-structure are lapilli tuffs consisting of juvenile components and rock fragments (mostly from the crystalline basement) set in a fine grained matrix, which is composed of highly altered glass shards and/or calcitic cement. The juvenile fragments are highly vesiculary, which are formed by explosive fragmentation of vesiculating magma. Widely varying clast vesicularity reflects complex variation in the relative timing of vesiculation and water-induced fragmentation. The material appears petrographically as unsorted tephra, which is poorly stratified. Measurements of AMS, however, indicate spatial alignment of ferromagnetic grains (magnetic fabric) within the erupted material. These ferrites, strictly bound to the juvenile lapilli, are mainly (titano)magnetites with a low-Ti composition. Measured AMS geometries reveal typical deformation structures with a NW-SE orientated lineation possibly tracing the paleostress field of the Rhinegraben tectonics.