Paleoenvironmental record of loess in southern England – decoding sediment sources and transport pathways by magnetic anisotropy

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Abstract

Considerable research efforts have been attempted to use loess deposits in southern England to unravel late Quaternary past climate fluctuations and wind patterns (e.g., Eden 1980, Stevens et al. 2020). However, this extensive investigation has not included the analysis of the magnetic mineral composition and the alignment of minerals i.e. the magnetic fabric of the sediments, which if successful would significantly improve the understanding of outstanding questions over late Quaternary climate and dust transporting wind-directions. Samples from two distinct sites in southern England were collected: Lowland Point (LP) in eastern Kent and Pegwell Bay (PB) on the Lizard Peninsula of Cornwall. Rock magnetic analyses, such as temperature dependence of the magnetization and susceptibility were conducted to gain insight into the mineral magnetism of the studied units. Alongside the magnetic mineral composition, the analysis of the primary origin of the magnetic fabrics and the potential influence of various post-depositional processes as detected through anisotropy of magnetic susceptibility (AMS) measurements is assessed.

Our findings reveal a comparable magnetic mineral composition at both LP and PB sites, arising from both sedimentary (aeolian) and post-sedimentary sources. Magnetite, with sedimentary and pedogenic origins, was identified as the primary ferrimagnetic contributor. Additionally, maghemite, a product of weathering and/or pedogenic processes, is prevalent. The presence of goethite and superparamagnetic (SP) particles suggests a higher degree of weathering in the source area and/or alternatively pedogenesis in cooler and drier conditions.

The bulk AMS results indicate variations in magnetic foliation between the two sites, generally aligned with the bedding plane. In the PB section, magnetic foliation is more pronounced, implying slightly stronger compaction of dust fall deposits and suggesting a sedimentation environment characterized by lower wind transport energy. Conversely, the LP site's results suggest stronger wind transport energy and a consistent record of stable winds. Furthermore, the presence of a prolate fabric in the frequency-dependent AMS results within the LP and PB section suggests the potential influence of secondary processes, probably caused by vertical alignment of the secondary SP fraction, such as seasonal thawing, cryogenic processes, and the infiltration of precipitation. While the magnetic lineation of bulk AMS is relatively weak, there is a noticeable tendency toward alignment, with flow directions from the SE direction in the PB section (weak winds) and similarly (if a stronger wind) in the lower LP site (or SW direction for a weaker wind assumed). These observations may imply the preservation of paleowind directions during dust transport, with a substantial southerly component, in contrast to earlier studies. The inferred dominant southeasterly wind direction suggests a limited influence of katabatic, westerly or polar northeasterly winds during dust transport, and rather may imply the effect of low-pressure systems passing through the English Channel, to the south of the field area, during that period. This further implies a pronounced local source of material originating from the exposed North Sea and the English Channel shelf and interconnected braided river systems.

References

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