WIDESPREAD OCCURRENCE OF GREIGITE IN THE FINE-GRAINED SEDIMENTS OF LAKE PANNON: IMPLICATIONS FOR ENVIRONMENT AND MAGNETOSTRATIGRAPHY

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Lake Pannon was a large, brackish water lake that occupied the Pannonian Basin during the Late Miocene. Its sedimentary sequence was studied from several aspects, among others for magnetostratigraphy. However magnetic mineralogy experiments were rarely carried out in these studies, magnetite alone was supposed to be the carrier of the natural remanent magnetization (NRM); while mineralogical studies only described framboidal pyrite from the fine-grained sediments.

More recently, magnetic mineralogical experiments carried out in connection with tectonically oriented palaeomagnetic investigations revealed that the principal magnetic mineral was greigite (Fe_3S_4) in these sediments. To follow up this finding, we started a systematic study on the magnetic minerals of fully oriented samples from 34 outcrops and of several specimens from three cores.

First, we measured the NRMs, all samples using stepwise thermal demagnetizations accompanied by susceptibility monitoring during heating to detect phase changes and investigated the consistency of the NRM. Then we identified the magnetic minerals by magnetic methods (acquisition of isothermal remanent magnetization (IRM), stepwise thermal demagnetization of a three-component IRM, hysteresis measurements and tests for distinguishing between greigite and pyrrhotite). The use of classical mineralogical methods were prevented by the extremely low content of magnetic minerals (0.004 to 0.2 mass% for greigite).

The main result of the present experiments is that in the sampled fine-grained sediments the most common magnetic mineral is greigite as was expected from the earlier studies. The localities with greigite (as the magnetic carrier) give consistent palaeomagnetic results both of normal and reversed polarities, as well as a declination deviation from the present north characteristic of the studied area. These together can be taken as proof of the pristine nature of the NRM, which means that the NRM is contemporaneous with the formation of greigite during (preferably early) diagenesis. On the other hand, localities with magnetite often failed to yield palaeomagnetic results. This suggests that the magnetite here is more often a secondary mineral than the original one.

This widespread occurrence of greigite in the fine-grained sediments of Lake Pannon points to oxygen depleted conditions of deposition and early diagenesis, even in the absence of lamination or palaeontological evidence for anoxic-suboxic conditions.

While our results are relevant to the environment of deposition and early diagenesis, the very presence of greigite raises questions as to its usefulness for magnetostratigraphy. In the best case, greigite forms during early diagenesis, i. e. the magnetization is not much younger than the time of deposition. But to demonstrate it, fully oriented samples were needed. The earlier studies from the sediments of the lake, however, were based on cores without azimuthal orientation. Another difficulty is that when greigite and magnetite occur together, their polarities may be opposite. Then either the greigite or the magnetite (or both?) must be of later formation, but it is difficult to decide which.

The results of present study as well as the possibility of neoformation of greigite and other magnetic minerals suggest that the magnetostratigraphic investigations in sediments formed under oxygen depleted conditions must be carried out on fully oriented samples (or at least on samples which are oriented with respect to one another) and should be accompanied by detailed mineral magnetic studies in order to avoid pitfalls in the interpretation.