A new perspective on enhanced chemical weathering during the PETM: Evidence from interstratified Kaolinite-Smectite clay minerals in the Paris Basin

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Résumé

The Paleocene-Eocene Thermal Maximum (PETM) was a short intense warming event lasting approximately 200 000 years. Triggered by a sharp increase in atmospheric CO2 around 56 million years ago, the PETM is often cited as an analogue to current global warming. It has been associated with an accelerated hydrological cycle and a global, yet not systematic, increase in kaolinite content within sediments. This enhanced kaolinite sedimentation has been explained by two main hypotheses: (1) increased chemical weathering, which facilitated kaolinite formation and transport to basins, and (2) the reworking of pre-existing lateritic paleosoils due to a higher frequency of extreme climatic events. The latter hypothesis suggests a lag time between kaolinite formation and sedimentation that exceeds the duration of the PETM. Recently, Walters et al. (2022) proposed an alternative mechanism based on OH-isotope measurements performed on kaolinites found in marine sediments from the North Sea Basin. They suggested that the transformation of smectite to kaolinite in soils from the basin margins could account for the observed sedimentation patterns, aligning with the timescale of the PETM.
In this study, we investigate clay mineralogy of three terrestrial sections in the Paris Basin (Therdonne, Cachan and Maisse), located on the southern edge of the North Sea Basin, using X-Ray Diffraction (XRD) of the 2 μm fraction and transmission and scanning electron microscopy (TEM and SEM). The three studied sections are tied to the PETM interval thanks to δ13Corg and palynological data.

Our results show the development of interstratified kaolinite-smectite (KS) within two of the three sections. More precisely, an evolutive sequence from smectite-rich KS in calcretes towards kaolinite-rich KS in pseudogley and finally kaolinite, is evidenced in the Cachan

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borehole. These results are the first observation of the transformation of smectite to kaolinite within PETM sediments and confirm the hypothesis of Walters et al. (2022). The transformation of smectite to kaolinite in soils reflects tropical conditions in the Paris Basin and provides a new perspective explaining worldwide enhanced kaolinite sedimentation in relation to an accelerated hydrological cycle during the PETM.
Walters et al. (2022) : https://doi.org/10.1038/s41467-022-35545-2

Mots-Clés: Interstratified Kaolinite, Smectite, PETM, Paris Basin