

Thermally altered early Silurian cyanobacterial mats: Biomarkers and ^{15}N isotopic signatures

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Morphologically preserved cyanobacterial mats are rare in the fossil record due to destructive biological and diagenetic processes. Early Silurian black radiolarian cherts from the Holy Cross Mts. and Sudetes (Poland) contain abundant variously degraded remnants of benthic coccoid cyanobacterial mats. These cherts underwent thermal alteration with various intensity, which influenced the organic matter preservation.

Here we examined the organic matter of these cherts to investigate its origin and maturity. Aliphatic fractions of the extracted organic matter was dominated by n-alkanes in a range of 15 to 36 carbon atoms exhibiting unimodal distribution with a maximum between C_{17} and C_{19} . The most immature cherts still contained hopanoids dominated by 22S-isomers attesting to the relative high maturity of the organic matter. The dominance of hopanoids over steranes and the presence of 7-methyl and 8-methyl alkanes are in agreement with the presumed cyanobacterial origin of the organic matter. In contrast, the more mature sediments did not contain recognizable cyanobacterial biomarkers which are presumably lost during diagenesis. Thus, in spite of good morphological preservation, the biomarker signatures of the Silurian cyanobacteria, due to their thermal maturation, are no longer recognizable.

Nitrogen isotopic signatures of bulk organic matter in the studied cherts vary from -2.2 to +0.1‰ what is consistent with values observed for biological nitrogen fixation. Although it is known that diagenesis and bacterial degradation may alter the nitrogen isotopic composition, the rather low $\delta^{15}\text{N}$ values from the studied cherts seem to reflect isotopic N signals not considerably changed by maturity and degradation.

Fingerprinting of a thin secondary mineral film on DU

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Depleted uranium (DU), a by-product in the production of nuclear fuel, is used for military purposes in projectiles for attacking armoured vehicles. Concerns about the ecological consequences following the use of DU as ammunition in wars in Iraq and in the former Yugoslavia have received much public attention. The long-term effect on groundwater and drinking water as a result of dispersed DU projectiles in soil is far from understood. In this study, the weathering of DU in conditions representing agricultural soil, rich in calcium and phosphate, was studied in laboratory experiments. Surface alteration products were identified by infrared spectroscopy (IR) and time-resolved laser-induced spectroscopy (TRLFS).

Discs of DU, 0.5 mm in thickness and 25 mm in diameter, obtained from a British pristine military tank shell were used in our experiments. One sample was placed in a solution containing $2.5 \cdot 10^{-3}$ M $\text{Ca}(\text{NO}_3)_2$ and $1.05 \cdot 10^{-3}$ M $(\text{NH}_4)_3\text{PO}_4$. After a contact time of 360 days the sample was taken out of the solution. IR- and TRLFS measurements were made on the surface of the sample, immediately after rinsing with deionised water and drying. The spectra obtained were compared with those of natural uranium minerals, formed under oxidising weathering conditions, provided by the Mineral Collection of the TU Bergakademie Freiberg. Comparison of the IR-spectra from the DU surface with those of the reference minerals revealed that the newly formed secondary mineral on DU is a uranium (VI) phosphate. Further identification of the respective uranium phosphate mineral was not possible with IR. However, a comparison between the TRLFS spectra of the newly formed unknown uranium phase on the DU disc with well-known TRLFS spectra of uranium reference compounds clearly showed the presence of meta-autunite. The hypothesis established in [1] was confirmed based on much better spectra with regard to signal-to-noise ratio and reproducibility. Agreement between TRLFS spectra from altered DU and the fingerprints was obtained not only in the position of the peak-maxima, but also in the life time of the fluorescence signals. TRLFS clearly shows the presence of a very thin layer of the newly formed uranium phosphate mineral on the DU disc, which is formed from the metallic uranium and the calcium phosphate solution, an alteration process that may well occur in agricultural soil.

References

- [1] Baumann, N. *et al.* (2006) *Sci. Total Environ.* **366**, 905-909.