Supporting Information

Soil organic matter and phosphate sorption on natural and synthetic Fe oxides under in situ conditions

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Fig. S1 X-ray diffraction patterns for synthetic Fe oxides from a Fe redox bar (orange line) with dominant goethite peaks (Gt) and natural Fe oxides from a Mn redox bar (red line) after field installation. The PVC material without mineral coatings (black line) contained sharp peaks, which are present in all samples and highlighted with black arrows.
**Fig. S2** Images from a pre-field installed Mn and Fe oxide reference (a and b) and images from post-field installed Mn and Fe oxide sample (c and d) with the hyperspectral images (e to h), respectively. A detailed view of the oxide coatings from two regions of interest (ROI area highlighted with black square) reveal similar spectral data for natural Fe oxides (ROI #28) and synthetic Fe oxides (ROI #10) and indicate similar chemical properties. The separated regions of the principle component analysis (PCA) are shown for the first three principal components displayed as RGB bands and PCA biplot (PC1/PC2) of the spectral z-scores extracted from the ROIs (i).
Fig. S3 Representative NanoSIMS images of the Mn bar material before and after field installation indicating the distribution of $^{16}\text{O}^-$ (a and e), $^{56}\text{Fe}^{16}\text{O}^-$ (b and f), $^{12}\text{C}^{14}\text{N}^-$ (c and g), and $^{31}\text{P}^{16}\text{O}_2^-$ (d and h) counts per pixel, respectively. Please note the change of the color scales according to the different concentration of $^{56}\text{Fe}^{16}\text{O}$, $^{12}\text{C}^{14}\text{N}$ and $^{31}\text{P}^{16}\text{O}_2$ before and after field installation. White boundaries highlight regions of interests (ROIs) defined by the $^{56}\text{Fe}^{16}\text{O}^-$ signal for the natural Fe oxides formed along the Mn redox bar (e – h). Due to the low $^{56}\text{Fe}^{16}\text{O}^-$ count intensity of the Mn oxide coating, ROIs were defined by the $^{16}\text{O}^-$ signal (a – d) to visualize the mineral oxide distribution.
Fig. S4 Representative NanoSIMS images of the Fe bar material before and after field installation indicating the distribution of $^{56}\text{Fe}^{16}\text{O}^-$ (a and d), $^{12}\text{C}^{14}\text{N}^-$ (b and e), and $^{31}\text{P}^{16}\text{O}_2^-$ (c and f) counts per pixel, respectively. White boundaries in each image define regions of interests (ROIs) defined by the $^{56}\text{Fe}^{16}\text{O}^-$ signal and represents **synthetic Fe oxide** distribution before and after field installation.
**Fig. S5** Comparison of computed ion ratios for $^{56}\text{Fe}^{16}\text{O}^- / ^{12}\text{C}^{14}\text{N}^-$ (a) and $^{56}\text{Fe}^{16}\text{O}^- / ^{31}\text{P}^{16}\text{O}_2^-$ (b) within predefined Fe-ROIs derived by the distribution of $^{56}\text{Fe}^{16}\text{O}^-$ along synthetic Fe oxides from a field-installed Fe redox bar and reference material not in contact with the soil (blank). The boxes encompass the 25th and 75th percentiles, the whiskers extend to the 1st and 99th percentile, the black bar is the mean and the circles indicate outliers. The box integrates all defined ROIs for the field-installed Fe redox bar ($n = 524$) and the reference material ($n = 374$). Please note the logarithmic scale. The lowercase letters indicate significant different mean values derived by a one-way ANOVA. We could not construct ion ratios for the Mn redox bar (natural Fe oxides) because no $^{56}\text{Fe}^{16}\text{O}^-$ was detectable (Fig. S3) at the blank sample not in contact with the soil. This proofs that NanoSIMS analyzed natural Fe oxides formed by the reaction of Fe$^{2+}$ with the soil solution and not due to any impurities during mineral synthesis.