

Spatial complexity of soil organic matter forms at nanometer scales

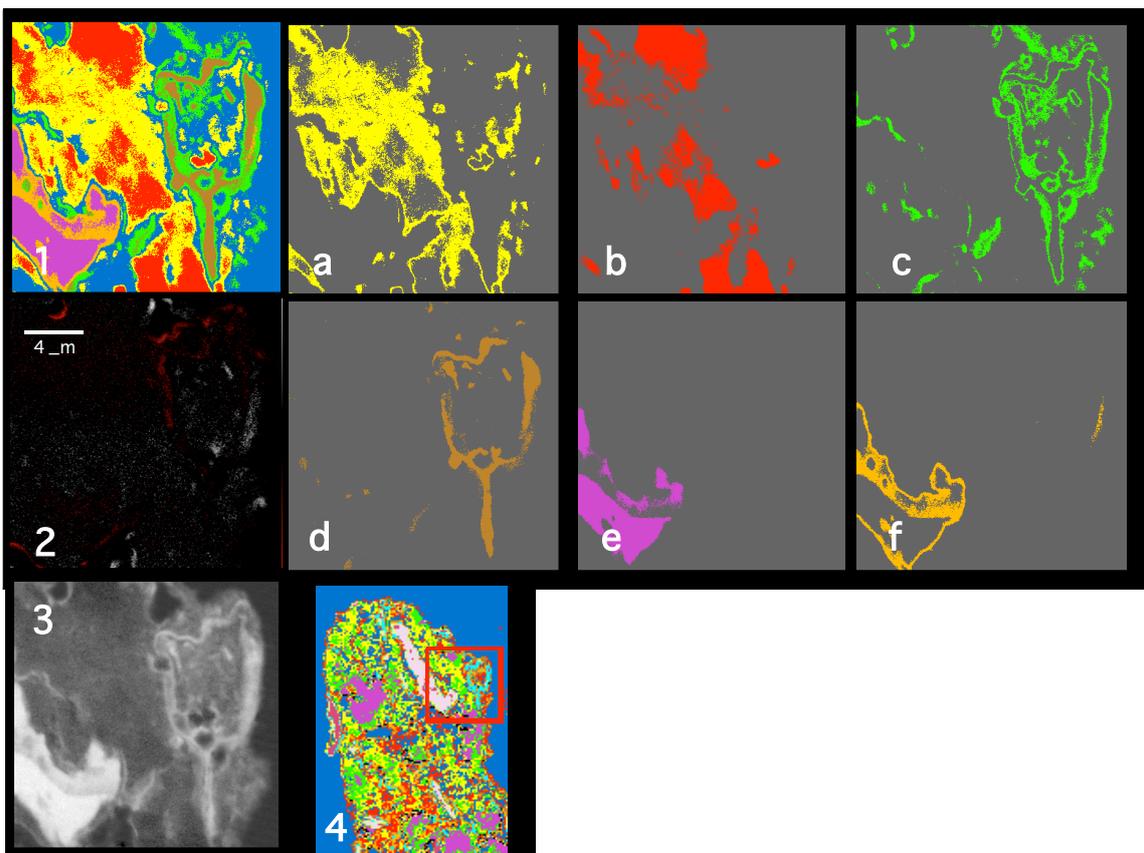
Johannes Lehmann¹, Dawit Solomon¹, James Kinyangi¹, Lena Dathe¹, Sue Wirick²
& Chris Jacobsen²

*¹Department of Crop and Soil Sciences, College of Agriculture and Life Sciences,
Cornell University, Ithaca, NY 14853, USA*

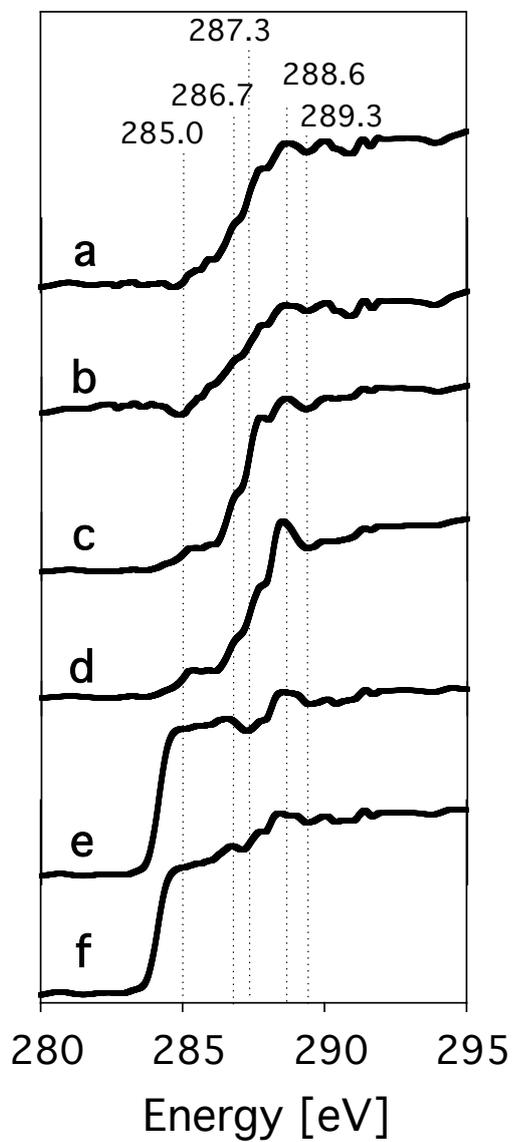
*²Department of Physics and Astronomy, State University of New York at Stony
Brook, Stony Brook, NY 11794, USA*

Online-Only Supplementary Information

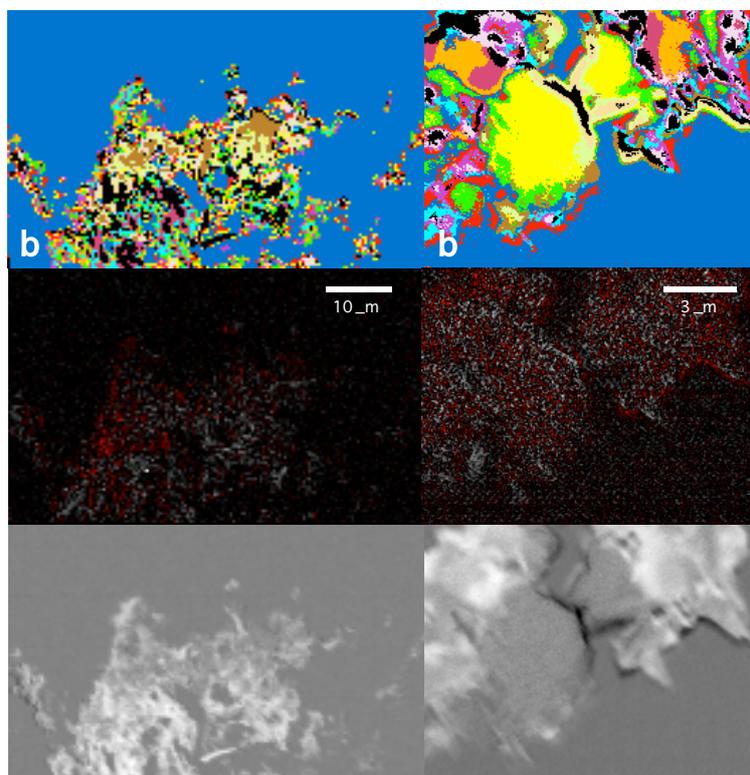
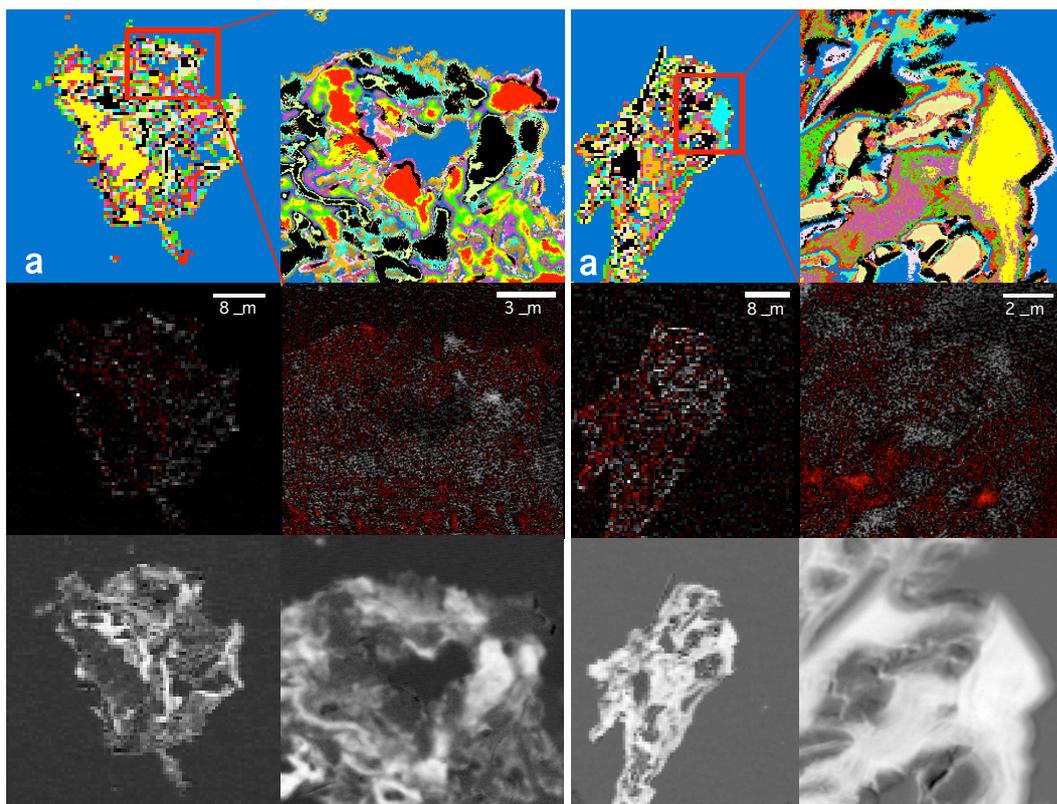
Figures 1-6



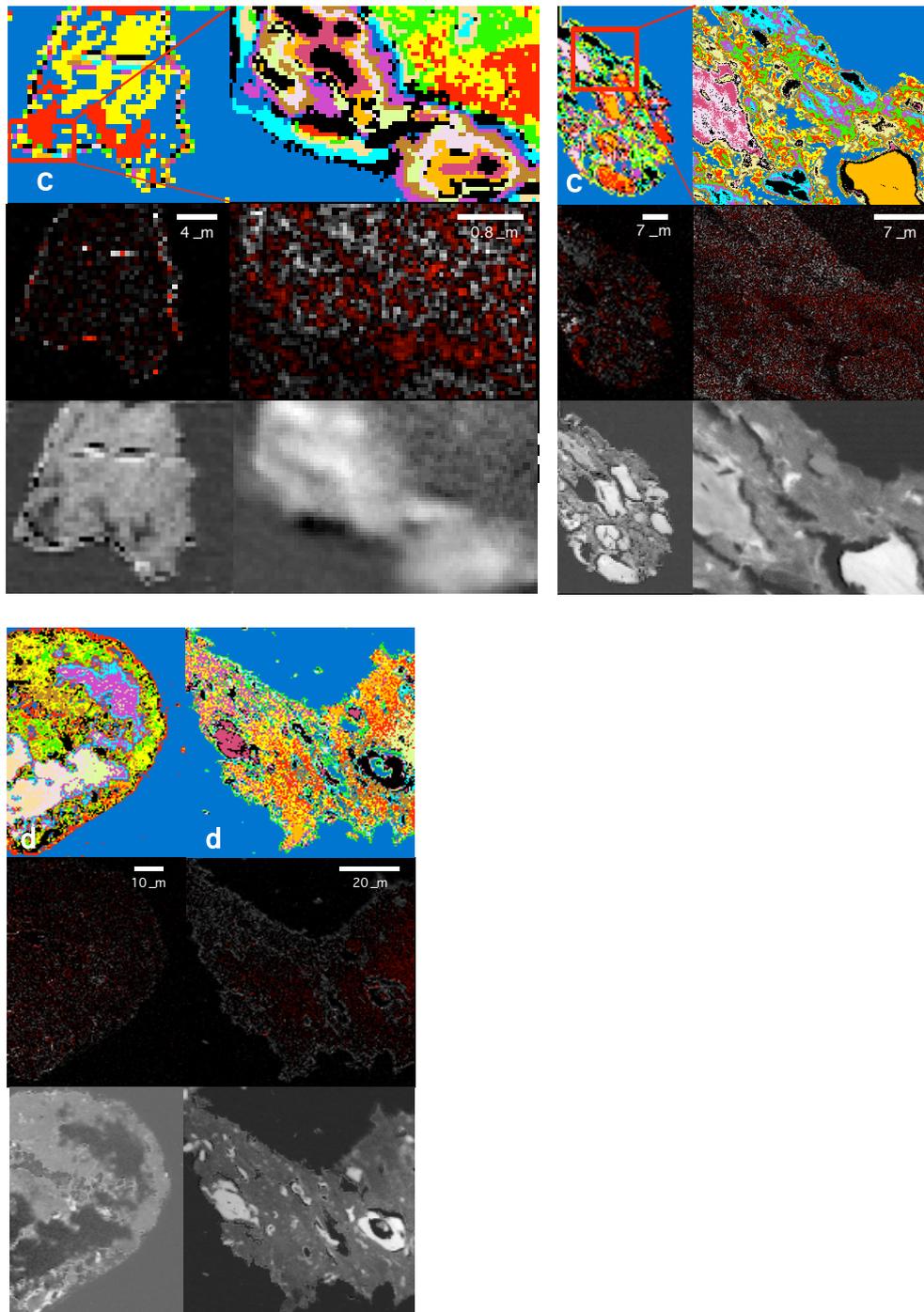
Supplementary Figure 1: Detailed cluster maps from principle component analysis of stacks using C (1s) NEXAFS data (50 nm step size) obtained from a micro-assembly of a soil from Nandi Forest in Kenya. **1**, all clusters. **2**, target maps showing in white the areas which have the spectral properties of the organic matter of total soil organic matter (compare to Fig. 4 in the main manuscript). **3**, carbon difference maps showing total carbon (subtraction of energy region at 280-282 eV from 290-292 eV). **4**, area marked by a red box was measured (from example shown in the main manuscript). **a-f**, clusters refer to corresponding spectra in Supplementary Fig. 2.



Supplementary Figure 2: NEXAFS spectra corresponding to clusters from Supplementary Fig. 1. Spectra are background corrected, normalized and smoothed once.

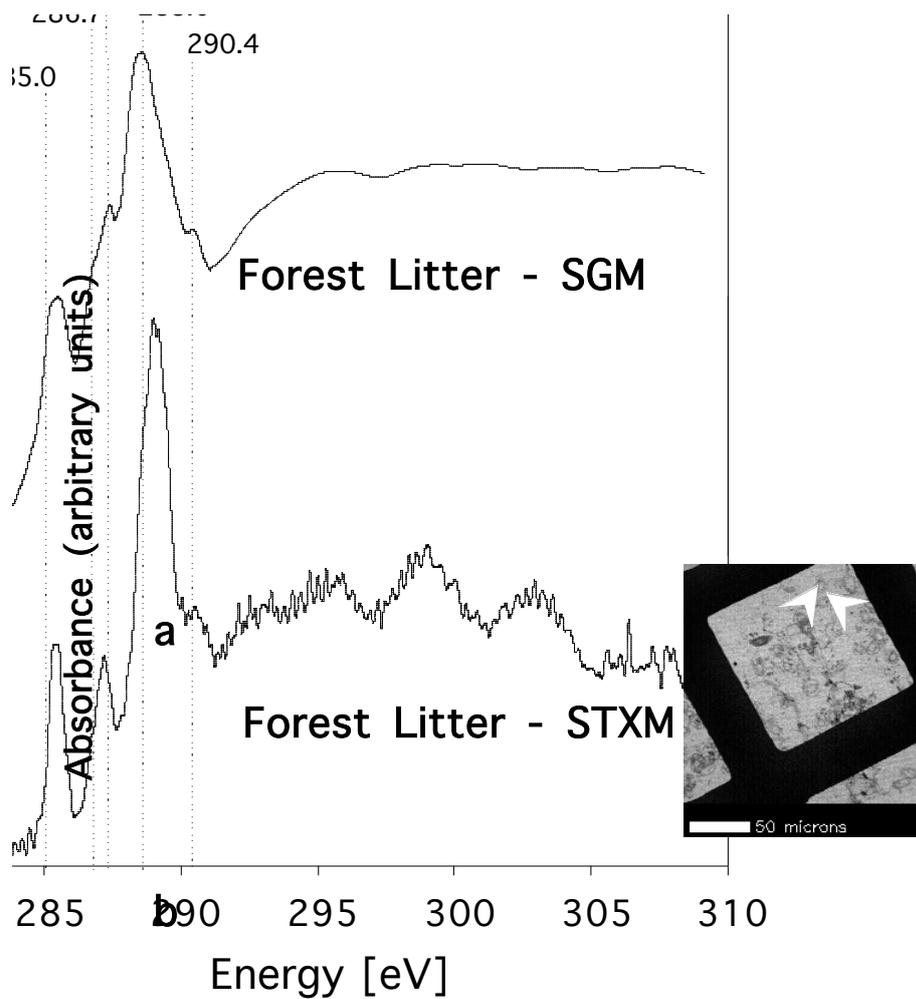


(continued)

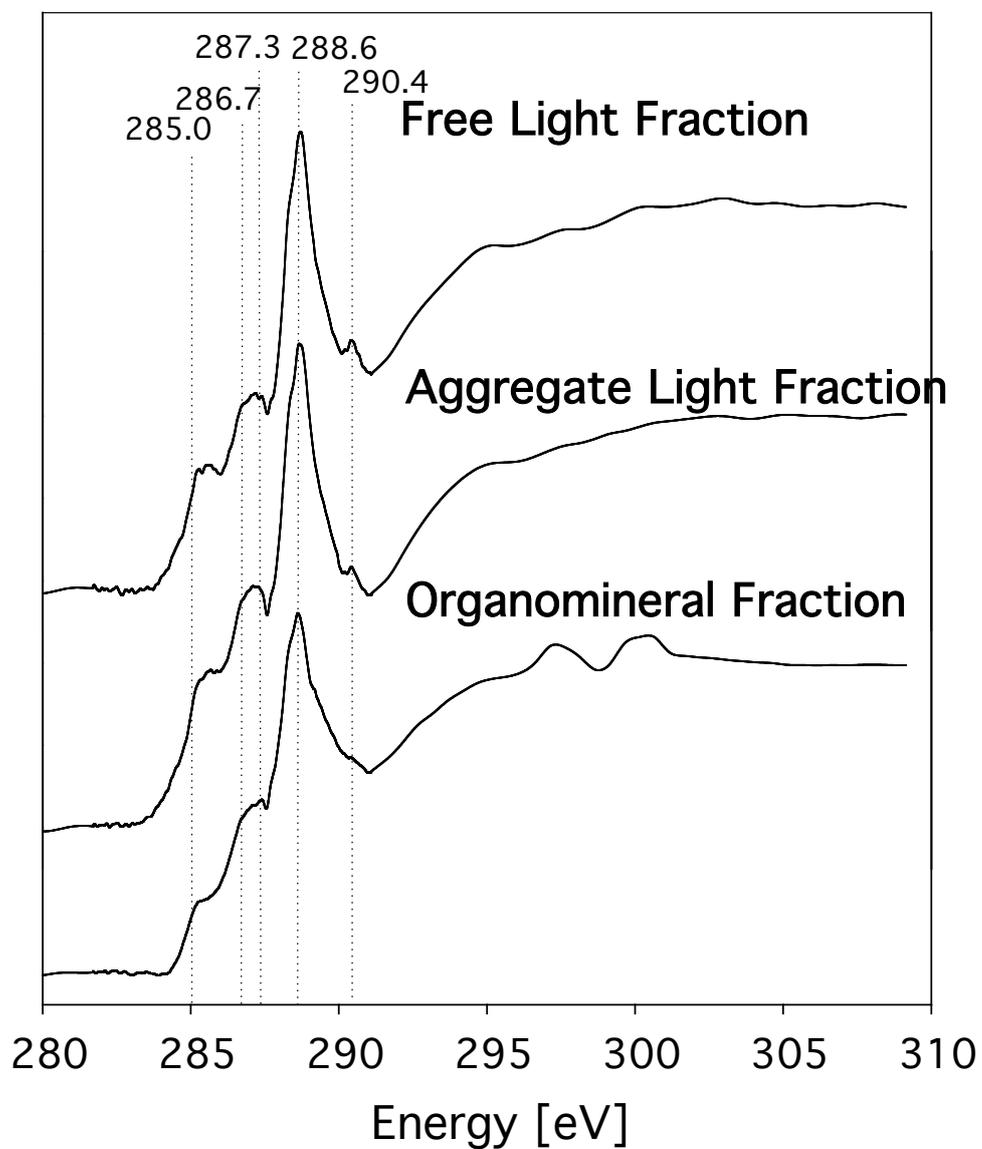


Supplementary Figure 3: Cluster images of NEXAFS data from micro-assemblages obtained from different soils (500 nm step size; with 50 nm resolution on the right for **a-c**); below: target maps showing in white the areas which have the spectral properties of total soil organic matter; below: carbon difference maps showing total carbon (subtraction of energy region at 280-282 eV from 290-292 eV). **a**, Arnot Forest on schist parent material in New York State, USA. **b**,

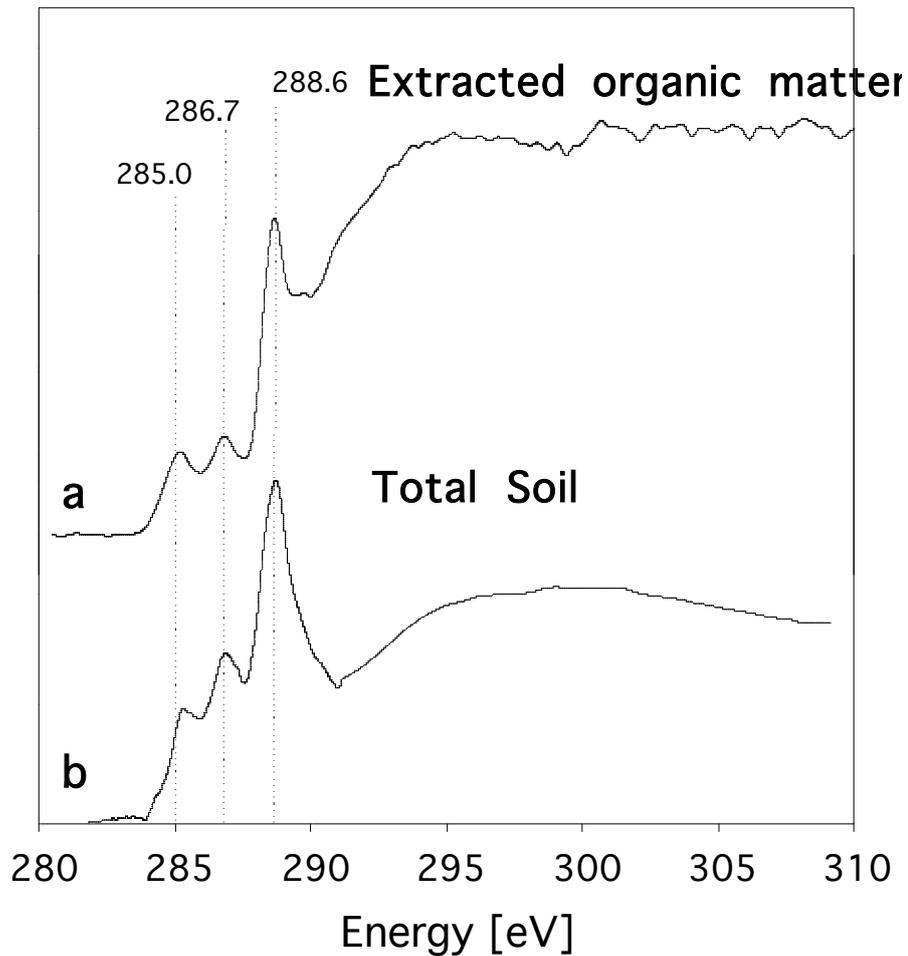
McGowen Forest on glacial till in New York State, USA. **c**, Barro Colorado Island Forest on volcanic facies in Panama. **d**, Embrapa Forest on Tertiary sediments in Central Amazonia, Brazil. Red boxes indicate areas where measurements with greater resolution (50 nm step size) were taken.



Supplementary Figure 4: C (1s) NEXAFS spectra of forest litter from Nandi, Kenya. The spectra were obtained by fluorescence yield at the SGM beamline of the Canadian Light Source, and by transmission at the STXM beamline of Brookhaven National Laboratory of thin-sectioned litter using a cryo-microtome as described for soils. The inset shows the locations of the point spectra taken by STXM, which were then averaged.



Supplementary Figure 5: C (1s) NEXAFS spectra of density fractions from Nandi Forest soil. Description of fractionation procedure in the Methods section.



Supplementary Figure 6. Molecular characterization of total carbon in soil (Nandi Forest soil from Kenya). C (1s) NEXAFS spectra of **a**, extracts of organic matter obtained by transmission (STXM) in comparison to **b**, total soil organic matter determined by total fluorescence yield (SGM).