Survival at the interface of surface input and oligotrophic conditions in the deep biosphere

BEATRIX HEINZE[1], MARTIN TAUBERT[*], NICO JEHMLICH[2], MARTIN VON BERGEN[2], KIRSTEN KÜSEL[1]

[1]Aquatic Geomicrobiology, Institute of Biodiversity, Friedrich Schiller University Jena, Germany (*correspondence: martin.taubert@uni-jena.de)
[2]Helmholtz Centre for Environmental Research – UFZ, Department for Systems Biology, Leipzig, Germany

In shallow subsurface environments both surface-derived organic matter from photosynthesis and biomass from chemolithoautotrophic primary production are available. However, the interplay between autochthonous primary production and biogeochemical cycles and the transfer of fixed carbon to heterotrophic organisms are still unknown. Here, we added ^{13}C-labelled bicarbonate to anoxic groundwater incubations and tracked the carbon flow though the microbial food web after 1, 3 and 6 weeks via metagenomics and metaproteomics analysis. Active autotrophs like *Sulfurimonas* or *Sulfuricella* showed a uniform ^{13}C incorporation of 45% in their peptides. In contrast, for active heterotrophs like *Curvibacter, Caulobacter,* and *Polaromonas* it ranged from 10 to 40%, indicating the uptake of various organic carbon compounds from autotrophic primary production via different catabolic pathways. The production of proteins involved in denitrification, sulphur oxidation, anaerobic oxidation of ammonium, and dissimilatory sulphate reduction point to diverse link to the sulphur and nitrogen cycle. Our isotopic approach reveals that the groundwater microbiome is adapted to utilize a variety of S compounds derived from geogenic origin and N compounds like nitrate and ammonium primarily from surface inputs to drive chemolithoautotrophic primary production and support a complex microbial food web. Maintaining metabolic flexibility seems to be one key for survival at the interface of surface input and the oligotrophic conditions of the deep biosphere.