Anaerobic organic carbon oxidation rates through nitrate and sulfate reduction in littoral sediments

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In order to investigate the contributions of different terminal electron acceptors to anaerobic organic carbon degradation, we determined potential nitrate and sulfate reduction rates in 12 different sediments collected in lacustrine, riverine, estuarine, marine and hypersaline environments from France, the US and the Netherlands. The sediments represent a range in surface water salinity, sediment organic carbon, sulfate and nitrate availabilities and pH. All sediments harbored viable and coexisting populations of nitrate and sulfate reducers, which reduced the added electron acceptors (NO_3^- and SO_4^{2-}) instantaneously. Half of the sediments investigated showed higher potential nitrate reduction rates compared to sulfate reduction rates, up to one order of magnitude. In all sediments, nitrate and sulfate reduction coexisted when the two electron acceptors were added simultaneously, however, sulfate reduction rates tended to decrease due to preferential use of nitrate as an electron acceptor. We also observed sulfate release from two-thirds of the sediments that were supplied with nitrate, suggesting that part of the nitrate reduction was coupled to sulfide oxidation. However, this process could not explain the high nitrate compared to sulfate reduction rates in half of the investigated sediments.

The results of our study show that there is no straightforward correlation between the contributions of nitrate and sulfate reduction rates to organic carbon degradation. Nitrate reduction may lead to faster organic matter degradation than sulfate reduction, with consequence for their role in anoxic decomposition. In addition to a discrepancy between the contribution of nitrate and sulfate reduction to organic carbon oxidation, part of the nitrate reduction might be coupled to sulfide oxidation rather than to carbon oxidation in some sediments. These observations challenge our current understanding and predictive capabilities of the carbon, nitrogen and sulfur biogeochemical cycles.

Development of a new facility for dating old groundwaters and ice cores based on ^{81}Kr measurement

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CNAB has started in 2006 the development of a new facility for dating old groundwaters and ice cores based on the measurement of the cosmogenic radioactive ^{81}Kr, produced by nuclear reactions induced by cosmic rays in atmosphere. With a half-life of 229 kyrs, this isotope is considered as an ideal tracer for dating ancient groundwater or ice core [1,2,3,4]. Due to the very low abundance of ^{81}Kr in groundwater – 1200 atoms/l in modern water – the dating procedure used at CNAB, includes 3 complex steps, each one having required the development of a new apparatus: 1) A vacuum line allowing the extraction and the purification of Kr from 20l of water sample; 2) A mass spectrometer dedicated to the ^{81}Kr isotopic enrichment of the gas samples including a source specially designed for this purpose, two quadrupoles, an electrostatic sector and a magnetic sector; 3) a new instrument based on resonance ionization spectroscopy and time of flight mass spectrometry (RIS-TOF) capable to perform isotopic abundance measurements from samples containing only a few thousands atoms of Kr. All steps are operating and the whole dating procedure is currently in test. This extremely high sensitivity of the new mass spectrometer (RIS-TOF) has been demonstrated by measuring about 2500 atoms of ^{81}Kr extracted from 40mg samples of well documented iron meteorites in order to determine the duration of exposure of these objects to cosmic rays in space.

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