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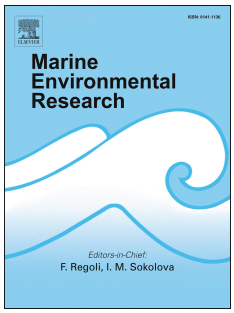

CO_2 leakage from carbon dioxide capture and storage (CCS) systems affects organic matter cycling in surface marine sediments

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CO_2 leakage from carbon dioxide capture and storage (CCS) systems affects organic matter cycling in surface marine sediments

Eugenio Rastelli[1,2], Cinzia Corinaldesi[1], Antonio Dell'Anno[1], Teresa Amaro[2,3], Silvestro Greco[4], Marco Lo Martire[1], Laura Carugati[1], Ana M. Queirós[5], Stephen Widdicombe[5], Roberto Danovaro[1,2*]

[1]Department of Environmental and Life Sciences, Polytechnic University of Marche, Ancona, 60131, Italy
[2]Stazione Zoologica Anton Dohrn, Villa Comunale, Naples, 80121, Italy
[3]Norwegian Institute for Water Research (NIVA), Regional Office Bergen, Bergen, N-5006, Norway
[4]Istituto Superiore per la Ricerca Ambientale, ISPRA, Roma, Italy
[5]Plymouth Marine Laboratory, Prospect Place, Plymouth PL1 3 DH, United Kingdom

[*]*Correspondence to*: Prof. Danovaro Roberto (r.danovaro@univpm.it)

Abstract. Carbon dioxide capture and storage (CCS), involving the injection of CO_2 into the sub-seabed, is being promoted worldwide as a feasible option for reducing the anthropogenic CO_2 emissions into the atmosphere. However, the effects on the marine ecosystems of potential CO_2 leakages originating from these storage sites have only recently received scientific attention, and little information is available on the possible impacts of the resulting CO_2-enriched seawater plumes on the surrounding benthic ecosystem. In the present study, we conducted a 20-weeks mesocosm experiment exposing coastal sediments to CO_2-enriched seawater (at 5000 or 20000 ppm), to test the effects on the microbial enzymatic activities responsible for the decomposition and turnover of the sedimentary organic matter in surface sediments down to 15 cm depth. Our results indicate that the exposure to high-CO_2 concentrations reduced significantly the enzymatic activities in the top 5 cm of sediments, but had no effects on subsurface sediment horizons (from 5 to 15-cm depth). In the surface sediments, both 5000 and 20000 ppm CO_2 treatments determined a progressive decrease over time in the protein degradation (up to 80%). Conversely, the degradation rates of carbohydrates and organic phosphorous remained unaltered in the first 2 weeks, but decreased significantly (up to 50%) in the longer term when exposed at 20000 ppm of CO_2. Such effects were associated with a significant change in the composition of the biopolymeric carbon (due to the accumulation of proteins over time in sediments exposed to high-pCO_2 treatments), and a significant decrease (~20-50% at 5000 and 20000 ppm respectively) in nitrogen regeneration. We conclude that in areas immediately surrounding an active and long-lasting leak of CO_2 from CCS reservoirs, organic matter cycling would be significantly impacted in the surface sediment layers. The evidence of negligible impacts on the deeper sediments should be considered with caution and further investigated simulating the intrusion of CO_2 from a subsurface source, as occurring during real CO_2 leakages from CCS sites.

Keywords*: carbon storage, seawater acidification, CO_2 impact on benthos, remineralization; biogeochemical cycles.*