Compound-specific radiocarbon analysis - Application for dating Antarctic sedimentary records

Sonja Berg[1], Janet Rethemeyer[1], Sandra Jivcov[1]

[1]Institute of Geology and Mineralogy, University of Cologne, Germany sberg0@uni-koeln.de

Information on past climate and ice sheet evolution of Antarctica can be derived from sedimentary records. The quality of these reconstructions, however, depends on good age control of the records under study. One widely applied method of age determination of Late Pleistocene and Holocene (<55000 years) sediment records is radiocarbon analysis. Radiocarbon-based age determination of sediments from Antarctic environments is often carried out on total organic carbon since carbonate fossils are rare in the marine sediments of Antarctica. The dating of this relatively unspecific material, which may include high and variable reservoir effects in this region, can lead to large uncertainties in age models of sediment archives, especially in settings were reworking and re-deposition of old, carbon-bearing sediments occurs.
Compound-specific radiocarbon analysis (CSRA) uses source-specific organic biomarkers, which are purified from sediments using chromatographic method. In previous studies, short-chain fatty acids, which are mainly derived from diatoms in the Antarctic marine environment, have been shown to be promising CSRA targets for improving age determination of Antarctic sediments. In surface sediments from the Ross Sea short-chain fatty acids reflect modern dissolved inorganic carbon (DIC) ages while bulk organic carbon ages are significantly older (Ohkuchi & Eglinton 2008). CSRA on a short-chain (C_{16}) fatty acids has also been successfully applied for Holocene records (Yamane et al. 2014).
CSRA is technically challenging and requires a detailed study of contamination that may be introduced by the numerous steps of sample purification. For the analysis of small samples sizes (<50 µg carbon) the assessment of size and isotopic composition of the process blank is especially important. We present the results of test performed in the radiocarbon laboratory at Cologne University to evaluate our isolation and purification methods using preparative gas chromatography (PC-GC). For our tests, we use different standard materials of known radiocarbon age to identify young/old sources of exogenous carbon and to quantify potential contaminants to provide an appropriate correction for the ^{14}C results of these small sample sizes. We also present first CSRA ages of lipid biomarkers including fatty acids derived from Antarctic sediments. In addition, we compare CSRA results of sediments from different sites to show that this method can improve age assignment of sediment records from Antarctic and Sub-Antarctic environments.

Keywords: Compound-specific radiocarbon analysis, preparative gas chromatography, sediments

References

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