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Ocean circulation and bioproductivity in the Weddell Gyre: Geochemical findings

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Atypical distribution of tracers

The Weddell Gyre is one of the key areas for ocean circulation, and consequently for global climate. Here, deep waters reach the surface, and new production of bottom water brings surface signals at depth. This unusual situation is mirrored in the distribution of naturally occuring radionuclides like Radium isotopes or ^{227}Ac in the water column. Not only tracers for ocean circulation show anomalies here. Tracers of particle flux also indicate atypical processes, reaching from the sea surface to the sediment.

Atypical productivity

Results of an expedition to the Eastern Weddell Gyre (Polarstern Expedition ANT XX/2) now have given a more comprehensive view of the whole Weddell Gyre. Together with measurements of nutrient distribution and other parameters, they reveal that the Weddell Gyre may not only be important in terms of ocean circulation, but it may also represent a site of suprisingly high bioproductivity. Pronounced differences between the Western part of the Gyre and its Eastern part were observed.

Here, we present a comprehensive set of radiotracer data from the Weddell Gyre, together with oxygen and nutrient distribution data. Additionally, data of chlorophyll-a illustrate the vertical distribution of phytoplankton, explaining why satellite measurements lead to an underestimation of productivity in the Weddell Gyre. First results for sediment accumulation rates in the Eastern Weddell Gyre will also be presented.

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Estimating the residence time of a deep brine pool in the Gulf of Mexico

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Continental slope features of the Gulf of Mexico include seep sites associated with buried salt domes. One surface expression of salt dome seepage is the GC233 brine pool at 640-m depth located southwest of the Mississippi River mouth. Understanding fluid flow rates of these seep features are important not only for geochemical mass balances, but will also help better characterize salt dome dissolution rates and physical sculpting of the Gulf seafloor. Salinities measured within the pool surface waters (less than 1-m depth) were 124 psu, which is in sharp contrast to Gulf bottom waters at 35 psu. Brine waters less than 1-m below surface contained ^{222}Rn and ^{226}Ra at secular equilibrium activities of 2300±340 $Bq \cdot m^{-3}$, thus suggesting a nominal diffusive source of ^{222}Rn from pool sediments and a high dissolved Ra component in the brine. Slope bottom waters surrounding the brine pool feature contained ^{222}Rn and ^{226}Ra of about 2.2 $Bq \cdot m^{-3}$.

A 3-m vertical profile of ^{223,224,226,228}Ra across the brine pool - ocean interface was measured using MnO_2-impregnated fiber. Low activities (less than 2 Bq) of the short-lived Ra isotopes were measured. Activity ratios of ^{228}Ra/^{226}Ra ranged from 0.53 to 1.0 within the brine pool. Brine pool residence times calculated from these activity ratios ranged from 1 to 3 years. If the long-term flux into the pool from deeper seepage is approximately equal to the long-term flux out of the pool, a seepage rate can be estimated. We report here preliminary seepage rates of about 1.4 to 3.4 $m^3 \cdot day^{-1}$ as brine leaks onto the continental slope. Sediment push cores collected up and down slope of the brine pool revealed pore water salinities typically equal to 35 psu. Immediately next to the pool we observed pore water salinities greater than 50 psu. This suggests the seep water does not move through the sediments, but it is apparently a spillover feature down the continental slope.