

Final Project Report

Office of Naval Research

Tritium/He-3 and O-18 Measurements During the ACSYS Expedition 1996

Award No. N00014-96-1-0612

April 1, 1996 - March 31, 1999

Peter Schlosser, Principal Investigator

1. Background

We requested half of the funds required for collection, measurement, and interpretation of about 500 tritium/ ^3He and 500 ^{18}O samples in the framework of the Swedish/German ACSYS (Arctic Climate System Study) cruise to the eastern Arctic Ocean in 1996 (the other half was provided by NSF). The work was focused on closing the existing tracer data gap in the eastern part of the Eurasian Basin. Coverage of this part of the Arctic Ocean will provide the link between the tracer distributions observed just north of Fram Strait and in the central Eurasian Basin along about 30°E and the region where shelf waters enter the Transpolar Drift. The data will be used, together with hydrographic and nutrient data, to (1) study the transport of shelf waters into the Arctic halocline, (2) to derive evolution, circulation patterns, and mean residence times of halocline waters in the Transpolar Drift and its interaction with the Beaufort Gyre, (3) to determine the mean ages of the deep and bottom waters found in the eastern Eurasian Basin, and (4) to determine oxygen utilization and primary production rates. Additionally, we plan to use the data for validation of Arctic Ocean circulation models.

2. Sample collection

During year I of the project we prepared sample containers for collection of about 500 tritium, 500 helium isotope, and 800 oxygen isotope samples in the framework of the ACSYS 96 expedition of the German research icebreaker POLARSTERN and participated in the expedition (L-DEO participant: Brenda Ekwurzel). The sampling program was very successful and provided us with an excellent sample set from the eastern Eurasian Basin, as well as from the boundary regime east of the Lomonosov Ridge. The sections sampled for tracers are very close to those projected in our proposal.

3. Measurements

All helium isotope, tritium, and shallow ^{18}O samples have been measured. Only a subset of the deep $\delta^{18}\text{O}$ samples has been measured because of the two gradients in the oxygen isotope distribution in the deep and bottom waters of the Eurasian Basin.

4. Results

Interpretation of the data is still ongoing. However, we already obtained important result: The new ^{18}O data set, if compared to a section collected in 1991, reveals a clear decrease in the freshwater inventory of the upper layers in the Eurasian Basin. Furthermore, the $\delta^{18}\text{O}$ data indicate that the decrease in the freshwater inventory is due to a smaller fraction of river runoff in the surface waters. This observations supports previous hypotheses that there was a shift in the location of the Transpolar Drift toward the Canadian Sector. It will be interesting to determine whether this change in freshwater inventory is accompanied by a change in the mean residence of the near-surface waters.

The second interesting observation is a parcel of water at intermediate depth (ca. 1500 to 2000 meters) in the center of the Amundsen Basin. The tracer characteristics of this water parcel point toward an origin in the Canadian Basin. It is unclear how this water was transferred across the Lomonosov Ridge into the Eurasian Basin. This finding might shed some light on the occurrence and nature of deep eddies in the Arctic Ocean.

5. Publications

Most of the results will be published after completion of the measurements. However, this grant contributed already to publications and oral presentations:

1. Schlosser, P., Kromer, B., Ekwurzel, B., Boenisch, G., McNichol, A., Schneider, R., von Reden, K., Oestlund, H.G., and Swift, J.H., 1997. The first trans-Arctic ^{14}C section: comparison of the mean ages of the deep waters in the Eurasian and Canadian basins of the Arctic Ocean. *Nuclear Instruments and Methods in Physics Research, B*, 123, 431–437.
2. Schlosser, P., Bayer, R., Bönnisch, G., Cooper, L., Ekwurzel, B., Jenkins, W.J., Khatiwala, S., Pfirman, S., and Smethie, W.M., Jr., 1999. Pathways and mean residence times of dissolved pollutants in the ocean derived from transient tracers and stable isotopes. *Science of the Total Environment*, 237/238, 15-30.
3. P. Schlosser, P., B. Ekwurzel, B., S. Khatiwala, S., B. Newton, B. W. Maslowski, W., and S. Pfirman, S., 2000. Tracer studies of the Arctic freshwater budget; Chapter for NATO book 'Freshwater balance of the Arctic Ocean', edited by E.L. Lewis.
4. P. Schlosser, S. Khatiwala, S. Pfirman, B. Ekwurzel, R. Fairbanks, R. Mortlock, R. Bayer, L. Cooper, R. Macdonald. Application of the $\text{H}_2^{18}\text{O}/\text{H}_2^{16}\text{O}$ ratio in studies of the Arctic freshwater balance. AGU meeting, 1998, accepted for oral presentation.

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