Tritium/He-3 results from the PARGO cruise

GOAL

Tritium and its radioactive decay product, He-3, are used as transient tracers to study the pathways of water masses that have recently been in contact with the atmosphere. Additionally, these tracers provide mean residence times and deep water formation rates. The main goal of the PARGO 1993 tritium/He-3 program was to test if high-quality tritium/He-3 samples can be collected during a submarine cruise.

Specifically, we wanted to see if surface stations can be carried out within a reasonable degree of effort. The sampling program was performed in an ad-hoc fashion and supported by ONR through ANWAP (Arctic Nuclear Waste Assessment Program).

RESULTS

Sample collection

During the 1993 PARGO cruise we took about 70 water samples on 10 surface stations (in the Canadian Basin; for geographic positions, see Fig. 1). Accounting for a few samples lost during the gas extraction procedure and during measurement, we obtained 61 data points that we consider as high-quality measurements. In this sense, the PARGO tritium/He-3 program was a full success and
formed the foundation for the SCICEX 96 cruise.

The data fall into three distinct groups (Fig. 2a,b,c) which coincide with the hydrographic regimes observed by James Morison (personal communication). These regimes are created by a front running across the Canadian Basin as depicted in Fig. 1 (regime 1: east of the front, T/He-3 stations 3, 13, 14, 15; regime 2: frontal regime: T/He-3 stations 2 and 10; regime 3: west of the front, T/He-3 stations 1, 8 and 9).

**Preliminary interpretation**

1. There are significantly higher tritium concentrations east of the front (Fig. 2a), qualitatively indicating a higher river-runoff fraction in these waters. The largest tritium gradient is located between about 50 and 100 meters, i.e. close to the depth of the Bering Strait Inflow. This feature indicates that the river-runoff is largely confined to the upper 50 to 75 meters of the water column.

2. The tritium/He-3 ages of the surface waters east of the front group around 3 to 4 years indicating a strong suppression of gas exchange (loss of He-3 produced by tritium decay) through the ice cover (Fig. 2c). This leads to a minimum mean residence time of the surface waters in this regime of 3 years. In contrast, the surface waters west of the front are well ventilated, i.e., they are close to solubility equilibrium with the atmosphere. Their ventilation age, i.e., the time elapsed since the last gas exchange with the atmosphere, is close to zero.

3. Both the delta He-3 (Fig. 2b) and the tritium/He-3 age profiles (Fig. 2c) indicate that the waters east of the front are renewed on longer time scales than those observed west of the front. They seem to be trapped in the Beaufort Gyre, while the waters west of the front seem to be renewed from the shelves at a significantly higher rate. This holds true for
the surface waters, the halocline, and the Atlantic layer.

**Final evaluation**

Final evaluation of the data is presently being carried out in connection with the other data sets collected from the Canadian Basin (e.g., AOS 94; SCICEX 96; SCICEX 97).
Fig. 1: Tritium/He-3 stations occupied during the 1993 PARGO cruise.
Fig. 2a: Depth profiles of tritium for the PARGO stations shown in Fig. 1; blue: regime east of the front; red: regime west of the front; green: frontal zone.
Fig. 2b: Depth profiles of delta He-3 for the PARGO stations shown in Fig. 1; blue: regime east of the front; red: regime west of the front; green: frontal zone.
Fig. 2c: Depth profiles of the tritium/He-3 age for the PARGO stations shown in Fig. 1; blue: regime east of the front; red: regime west of the front; green: frontal zone.