

Formation of high-density water (over 26.8 sigma-t) near the La Perouse Strait (the Soya Strait)

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The Soya Warm Current is the only supplier of saline subtropical water to the Okhotsk Sea. The Soya Warm Water obtains high density values comparative to NPIW (North Pacific Intermediate Water) by winter cooling, due to its high salinity value, and may influence the intermediate water in the Okhotsk Sea, which is considered as a source water of NPIW. However, as the northern half of the La Perouse Strait (the Soya Strait) belongs to Russia and the southern half to Japan, no observations across the strait have been made except in the period before the World War II. The vertical resolution and spatial coverage of these old observations are very limited, and the accuracy of the measurement is also very limited due to instruments used in those days. The Joint Oceanographic Observation Program between the Hokkaido Central Fisheries Experimental Station (HCFES) and the Sakhalin Research Institute of Fisheries and Oceanography (SakNIRO) started in August 1995 in order to deduce the detailed structure of the Soya Warm Current in and near the La Perouse Strait and its seasonal and inter-annual variability. By introducing the observational results of the program, the seasonal variability of the Soya Warm Current Water in the La Perouse Strait and the formation of the dense water (heavier than 26.8 sigma-t) is discussed in this paper.

Distributions of temperature, salinity and sigma-t in the section (S1-line) across the La Perouse Strait observed on 12-14 March, 1996 are shown in Figure 1a through Figure 1d, respectively. Low-density water was found in a shallow domain along the coast of Sakhalin, while high-density water was found on the Hokkaido side. Judging from its high salinity characteristics, the

high-density water found on the Hokkaido side seems to be formed by winter cooling of the Tsushima Warm Water. Takizawa (1982) called this water the forerunner of the Soya Warm Water. According to Watanabe and Wakatsuchi (1998), the forerunner of the Soya Warm Water contributes the formation of Kuril Basin Intermediate Water, which would be one of the source waters of NPIW in the Okhotsk Sea. It was shown that the water of the northern part of the La Perouse Strait flows toward the Japan Sea in early spring.

The distributions of temperature, salinity and sigma-t in the section (S1-line) across the La Perouse Strait observed on August 20-21, 1996 are shown in Figures 2a-2d, respectively. In summer, a sharp thermocline was found just below the depth of 10 m. A halocline was found at the same depth, and the corresponding pycnocline is seen in the sigma-t section (Fig. 2c). The oceanic structure in and below the thermocline was very complicated, and the weak density inversion found below 20 m depth is probably the result of limited resolution or accuracy of the observation. A strong horizontal density gradient was also seen (Fig. 2), except just near Sakhalin, but the gradient is opposite to that observed in March (Fig. 1). The denser water is located on the Sakhalin side and the lighter water on the Hokkaido side. The low-density water on the Hokkaido side has high temperature and high salinity values, which are the typical of the Tsushima Warm Water during summer. The water in the surface layer on the Sakhalin side had low temperature and low salinity values, which characterize the Okhotsk

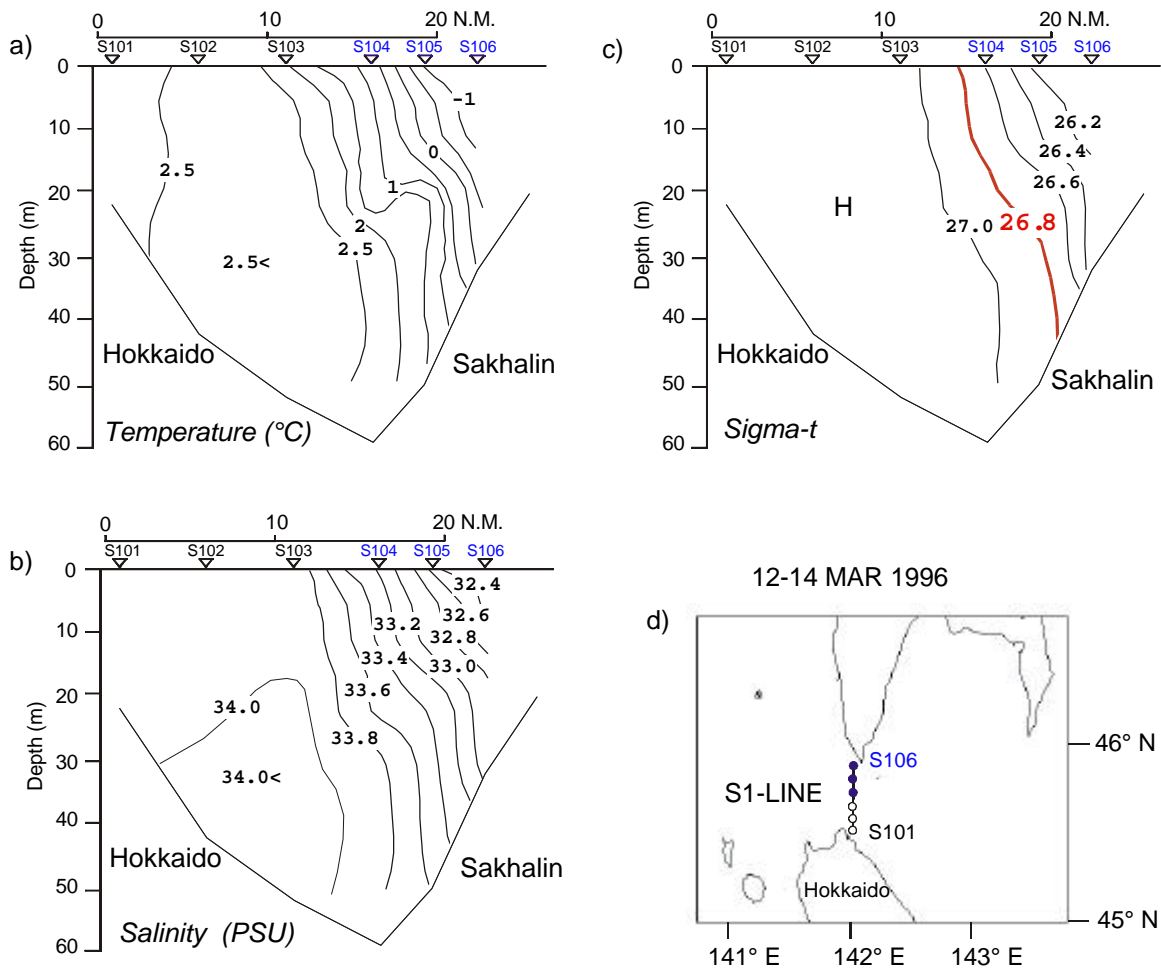


Fig. 1 Distributions of temperature (a), salinity (b) and sigma-t (c) in the section along the S1-line across the La Perouse Strait on 12-14 March 1996. The location of the line and stations are shown in the left-bottom figure (d): solid circles indicate the observation points occupied by Russian vessel, and open circles are those occupied by a Japanese vessel.

Sea Water. The high density water found below the pycnocline on the Sakhalin side has a temperature $<7^{\circ}\text{C}$ and high salinity, of about 34 psu. The density of this water exceeds 26.8 sigma-t, and is similar to that of the forerunner of the Soya Warm Water found in the March section (Fig. 1). Such high salinity water is difficult to find in the Okhotsk Sea, and probably originated in the Japan Sea. Our observations suggest that this heavy water was brought to the near-surface layer by upwelling along the southwest coast of

Sakhalin. It flows into the Okhotsk Sea through the northern part of the strait, and is one of the sources of the Cold Water Belt Water in the Okhotsk Sea.

It should be noted that high-density water flows into the Okhotsk Sea in summer as well. Flow rates of these dense waters must be determined and it would be desirable to clarify its distribution and seasonal variability in the Okhotsk Sea in future projects.

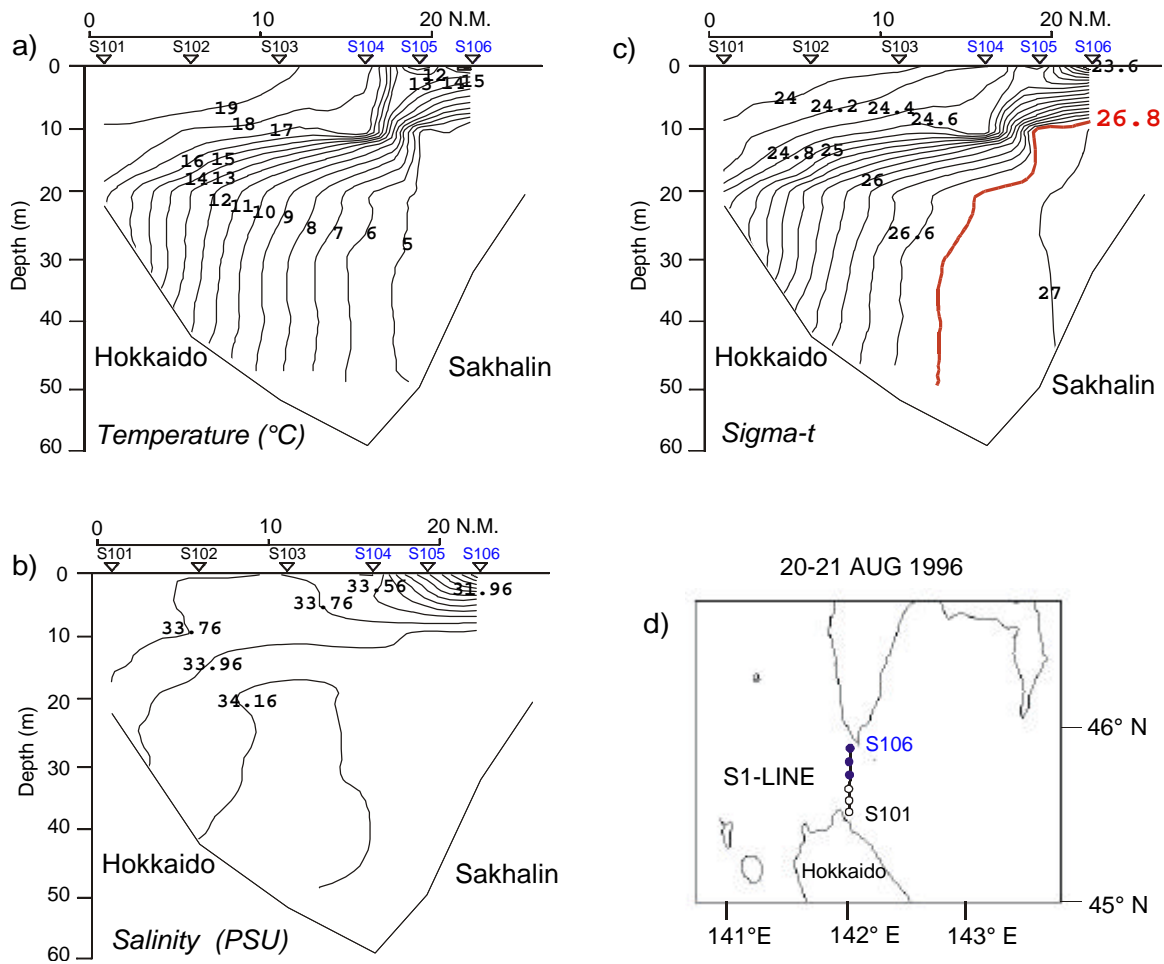


Fig. 2 As in Figure 1 except for 20-21 August 1996.

References

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