The Imaging Of Fine Structure Using Seismic Reflection Method

Speaker : Via Ramadlona

OUTLINE

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REFERENCES

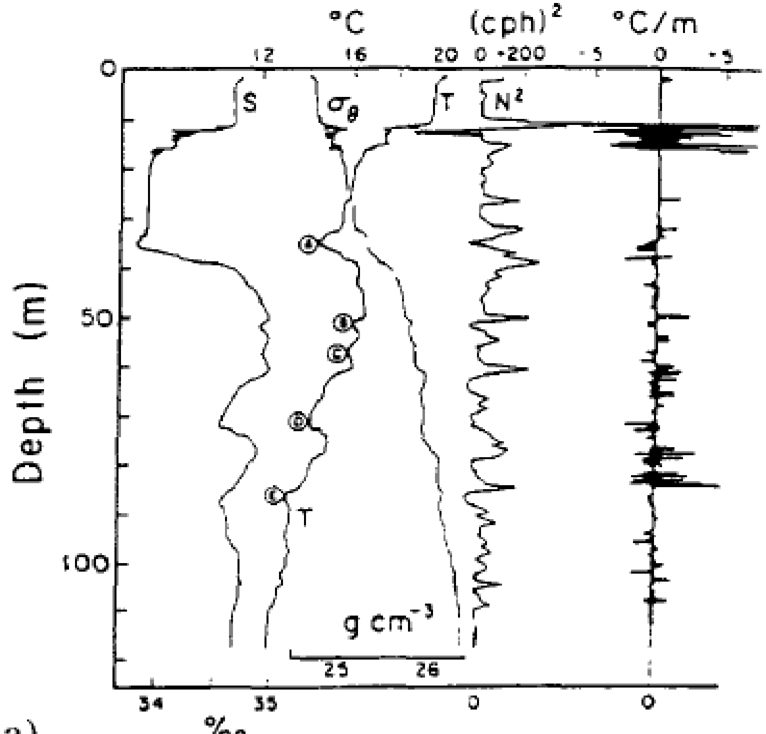
- Nakamura, Y., Noguchi, T., Tsuji, T. *et al*. (2006). Simultaneous seismic reflection and physical oceanographic observations of oceanic fine structure in the Kuroshio extention front. *Geophysical Research Letters* 33, L23605, doi:10.1029/2006GL027437.
- Osborn, T.R. (1998), Finestructure, microstructure, and thin layer, *Oceanography, II* (1), 36-43.
- Tsuji, T., Noguchi, T., Niino, H. Et al. (2005). Two-dimensional mapping of fine stuctures in the Kuroshio Current using seismic reflection data. *Geophysical Research Letters* 32, L14609, doi:10.1029/ 2005GL023095.

INTRODUCTION

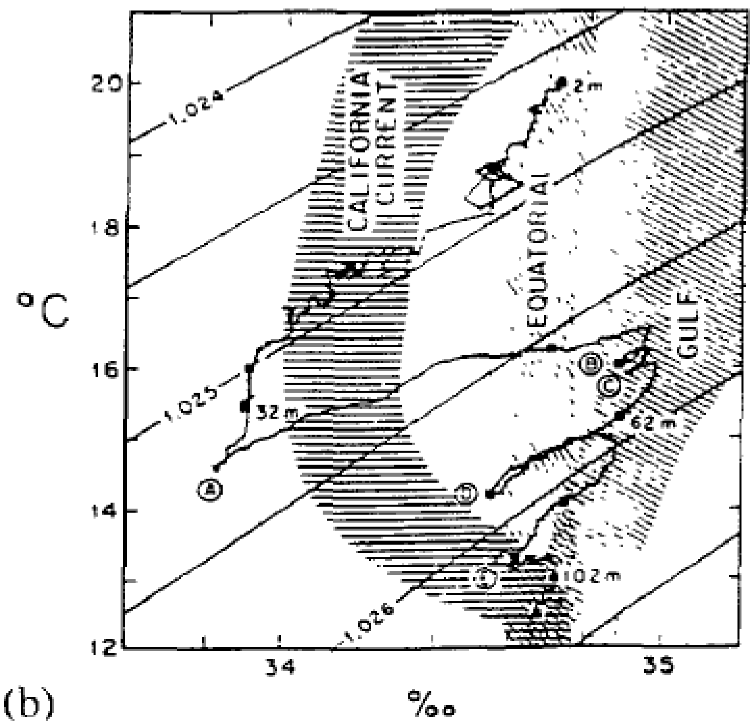
- Oceanic fine structure commonly develops at boundaries between different water masses.
- Understanding fine structure is critical to studies of large-scale thermohaline circulation.
- Physical oceanographers typically investigate fine structure using vertical profiles of temperature and salinity. Because most physical oceanographic measurements are made at discrete locations, the horizontal scale and continuity of fine structure are not well understood. Therefore, 2D and 3D mapping of fine structure is of great interest to the physical oceanographic community and beyond.

ABOUT FINE STRUCTURE

- Finestructure is the label for larger features where the stratification limits the motion to the horizontal plane.
- Signatures of this stirring motion have horizontal scales substantially greater than their vertical scales



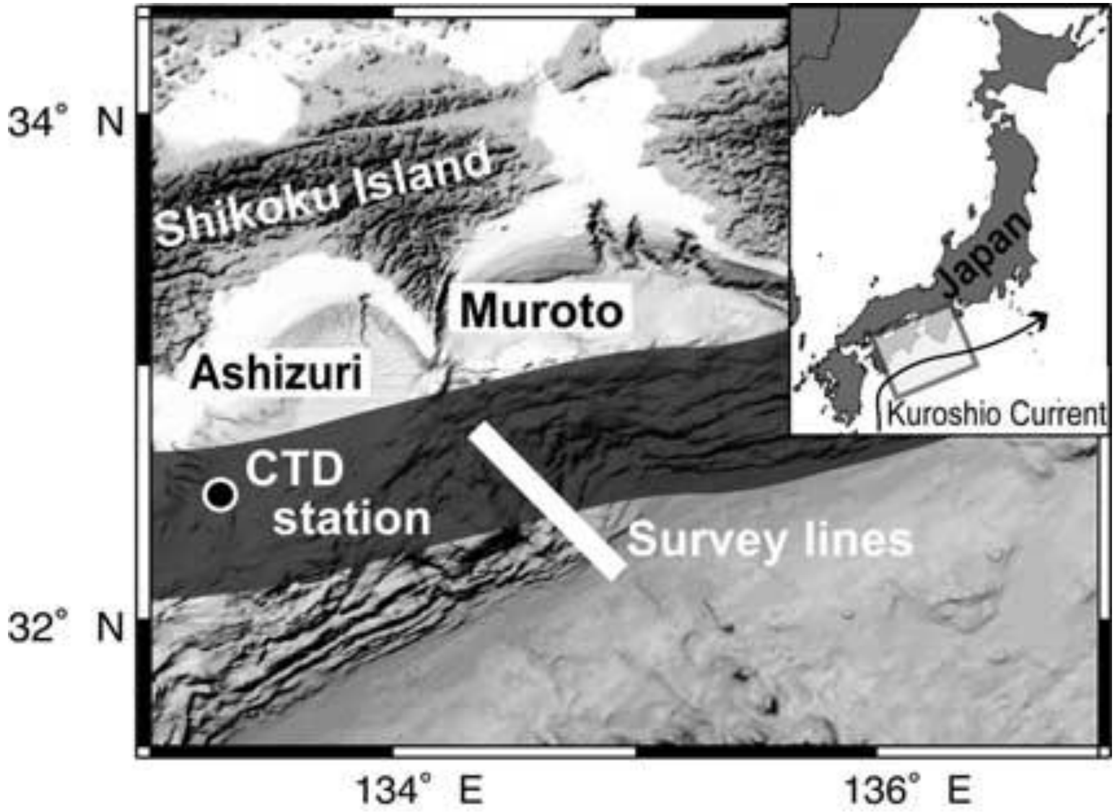
(a)



(b)

DISCUSSION

Bathymetric map of the Nankai Trough area, including Shikoku Island and southwestern Japan.

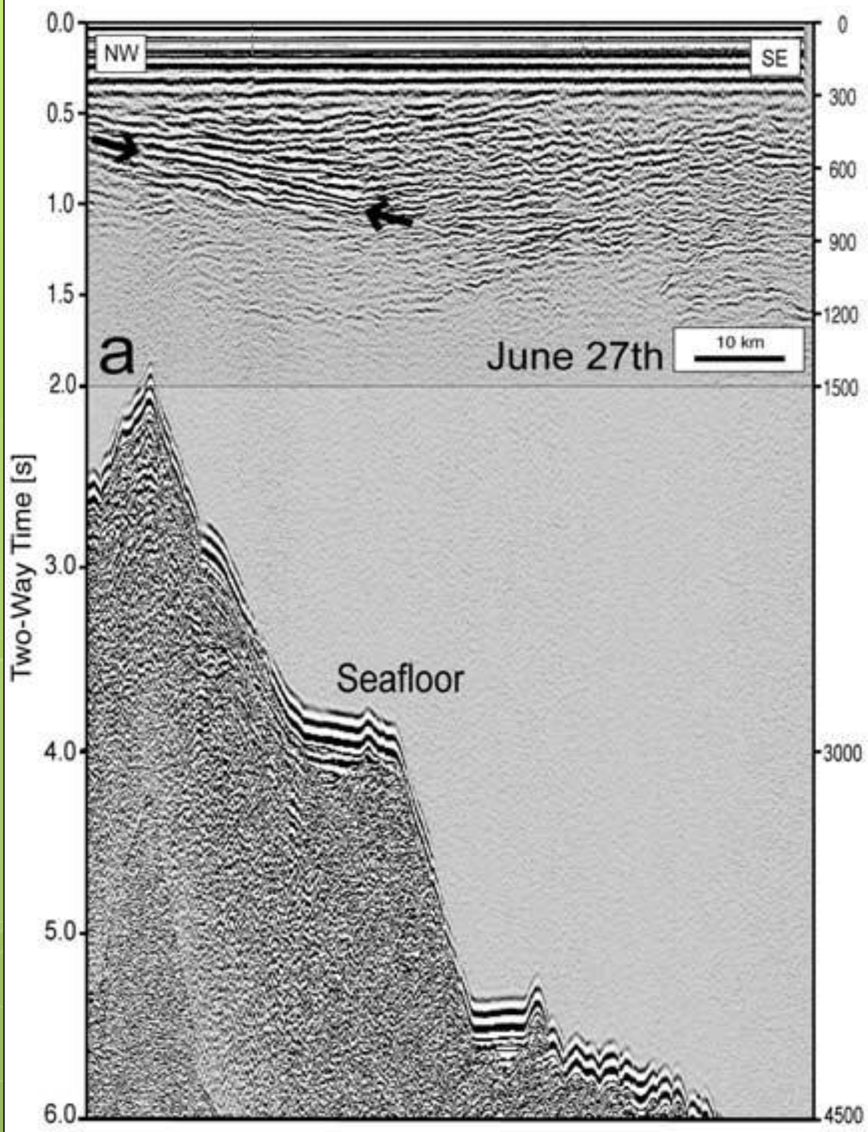


White line
the survey line of seismic reflection.

Solid circle
location of the CTD measurement.

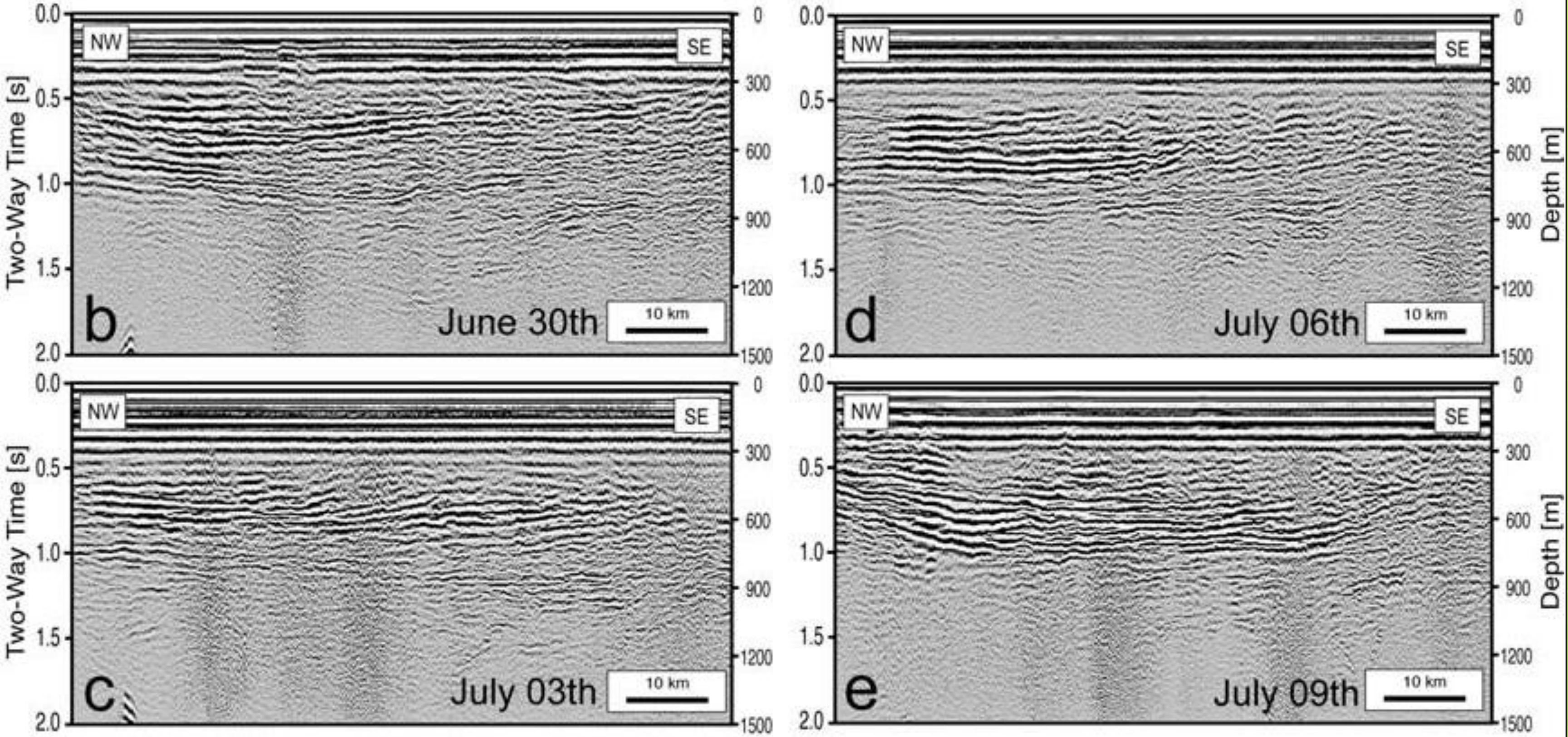
Dark gray
Kuroshio Current axis.

DISCUSSION



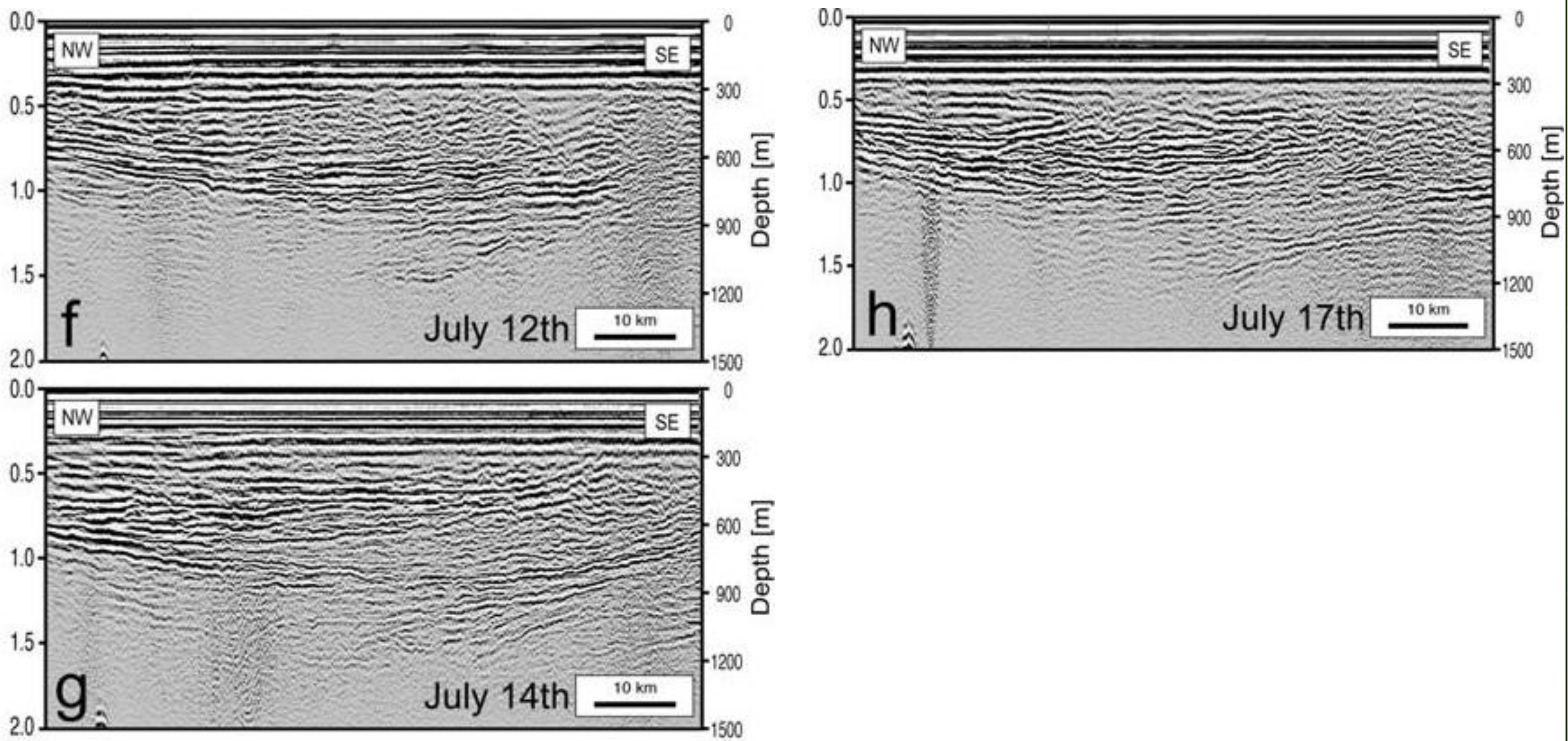
Stacked seismic profiles at 27 June 1999. The seismic profile for two-way travel time of 0–6 s. The black arrows represent the location of the reflection used for calculation of reflection coefficient.

DISCUSSION



Stacked seismic profiles:(b) 30 June, (c) 3 July, (d) 6 July, (e) 9 July 1999. The seismic profile for two-way travel time of 0–2 s.

DISCUSSION



Stacked seismic profiles (f) 12 July, (g) 14 July, and (h) 17 July 1999. the seismic profile for two-way travel time of 0–2 s.

DISCUSSION

The formula to calculate acoustic velocity of seawater [Wilson, 1960]

$$v_P = 1492.9 + 3(T-10) - 6\cdot 10^{-3}(T-10)^2 - 4\cdot 10^{-2}(T-18)^2 + 1.2(S-35) - 10^{-2}(T-18)(S-35) + Z/61,$$

v_p : acoustic velocity (m/s)
T : temperature (°C)
S : salinity (%)
Z : depth (m),

The equation to calculate density of seawater [Fofonoff and Millard, 1983]

$$\rho = \frac{\rho_0}{1 - p/K},$$

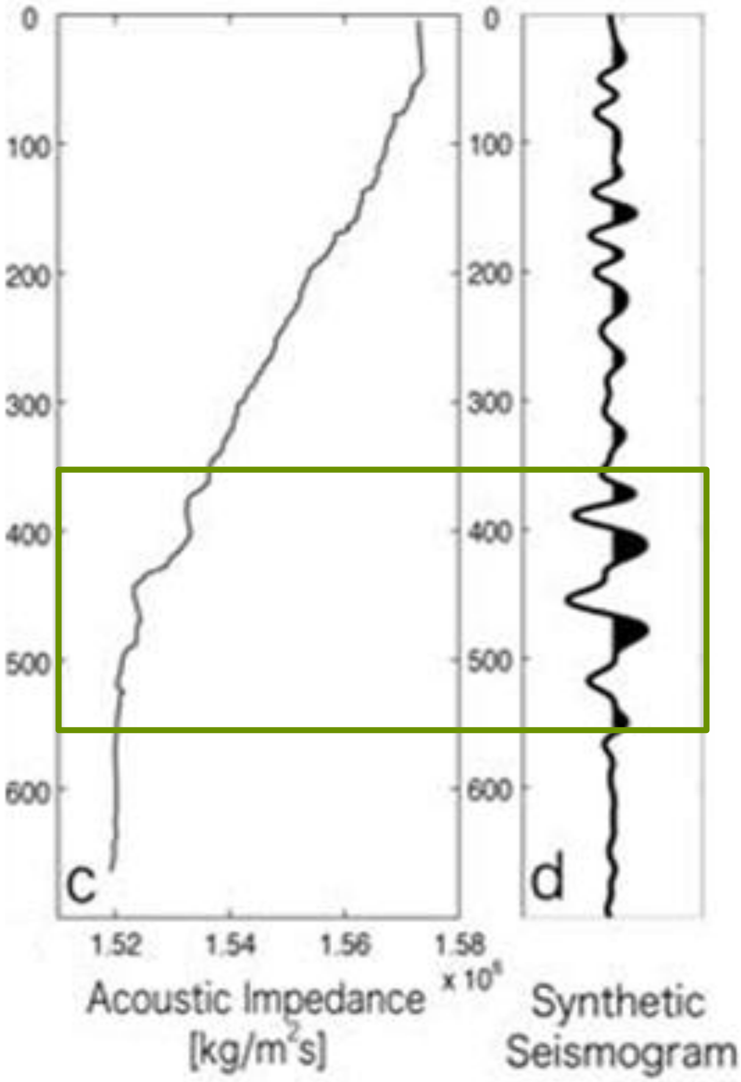
p : pressure
ρ_0 : density under the standard atmospheric pressure
K : bulk modulus of seawater

Depth [dbar]

Temperature [C]

Velocity [m/s]

DISCUSSION

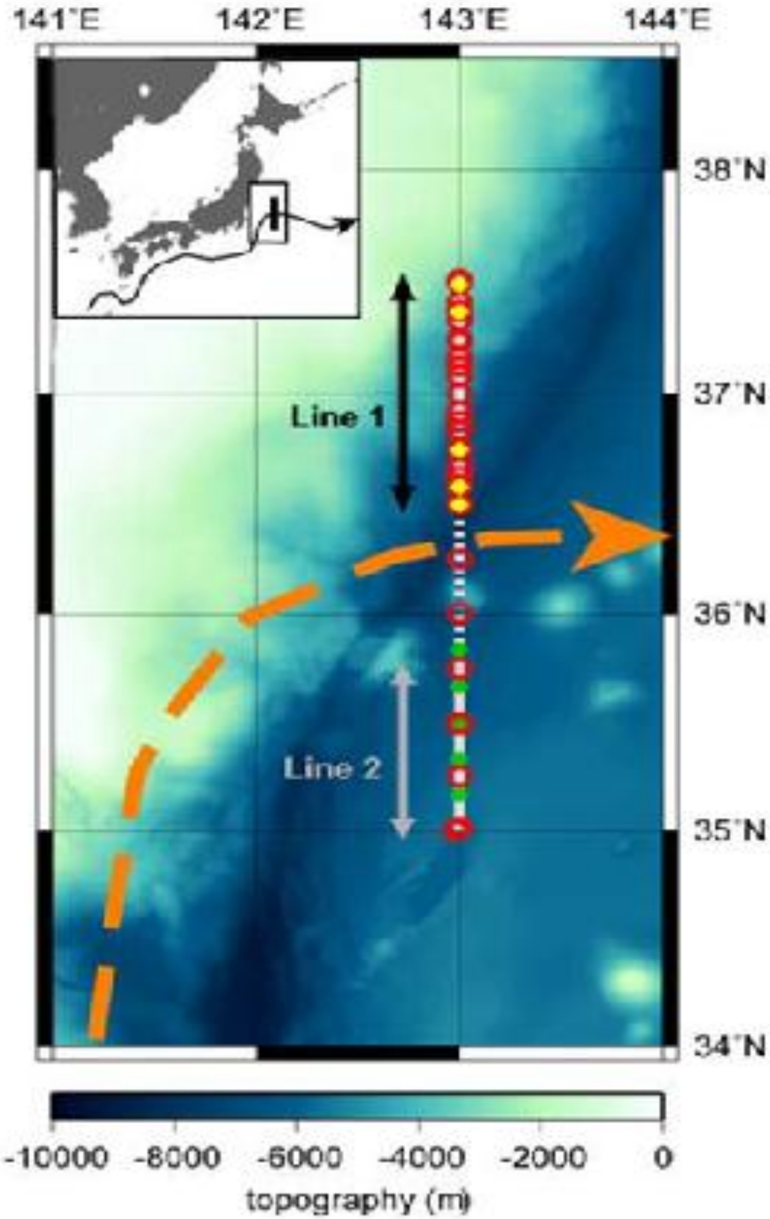


Vertical profiles of :

c) acoustic impedance calculated from acoustic velocity and density

d) synthetic seismogram calculated from acoustic impedance

DISCUSSION



Bathymetric map of the study area

Gray lines
Two seismic reflection lines

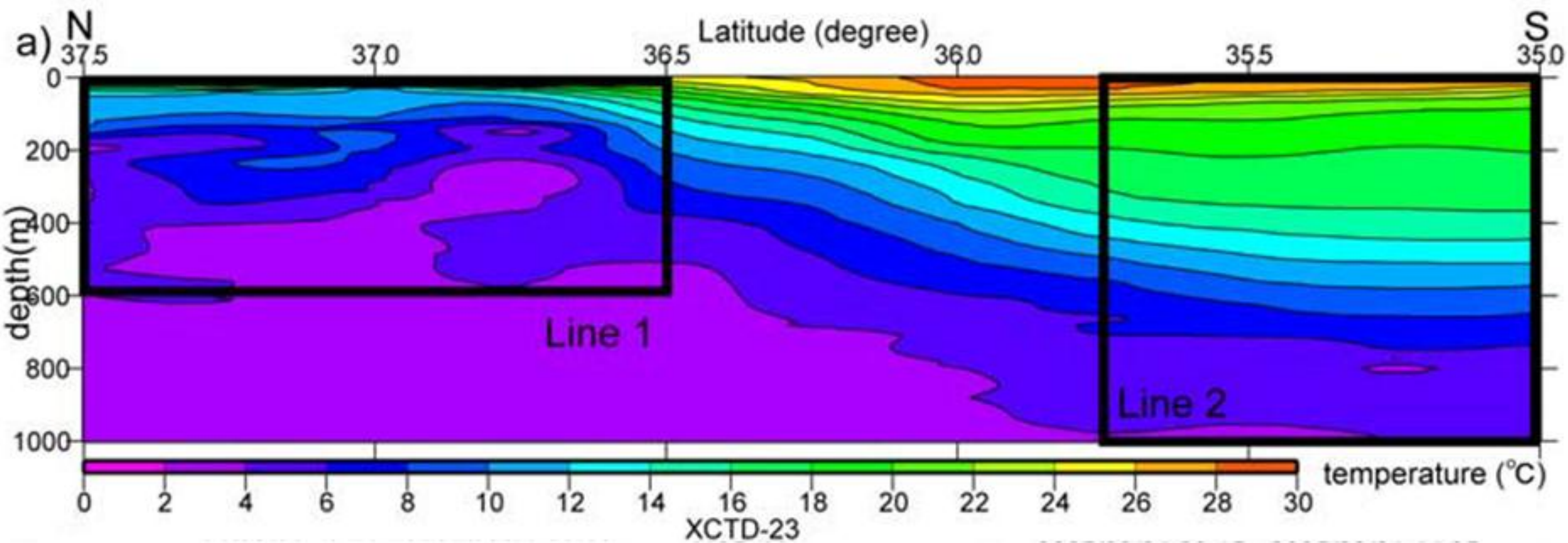
Red open circles
Expendable conductivity-temperature-depth (XCTD)

Green diamonds
Expendable bathythermograph (XBT)

Yellow diamonds
expendable current profiler (XCP)

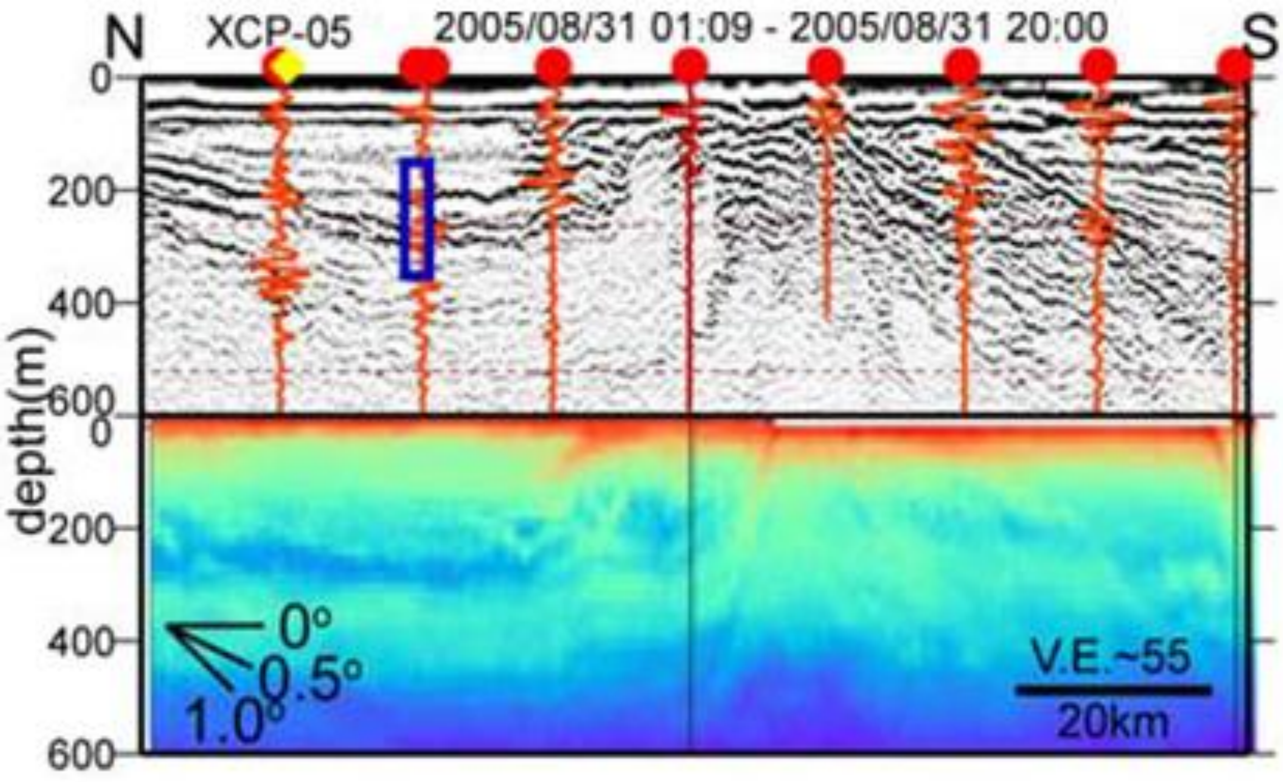
Orange dashed line
The Kuroshio extension front.

DISCUSSION



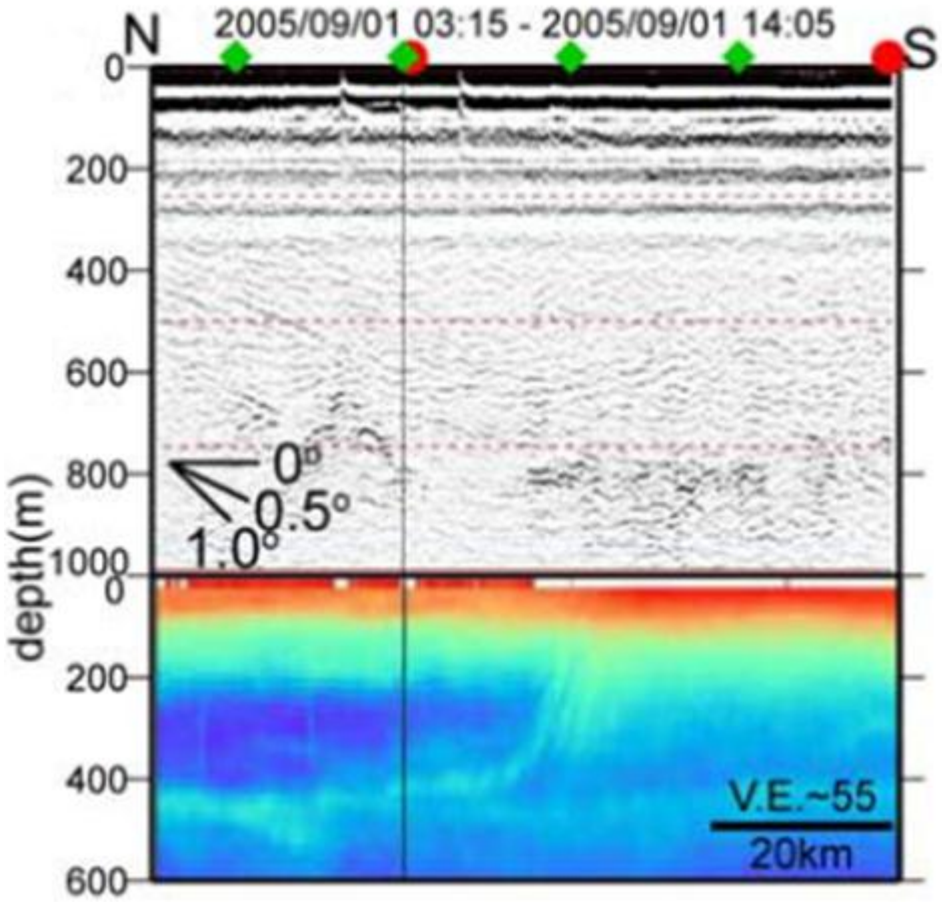
Temperature profile derived from expendable conductivity-temperature-depth (XCTD) measurements.

DISCUSSION



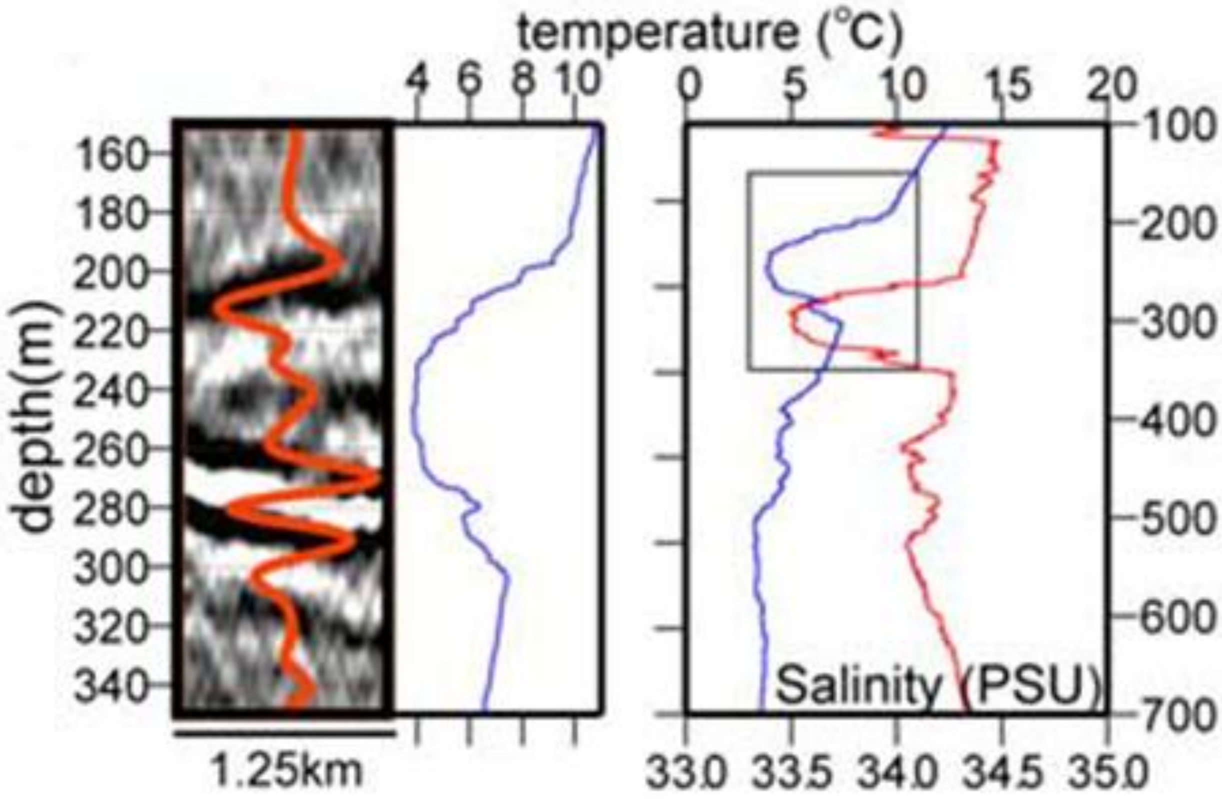
Seismic reflection profile (top) and acoustic Doppler current profile (ADCP) intensity (bottom) for Line 1. Time period of observation is indicated above the seismic profile.

DISCUSSION



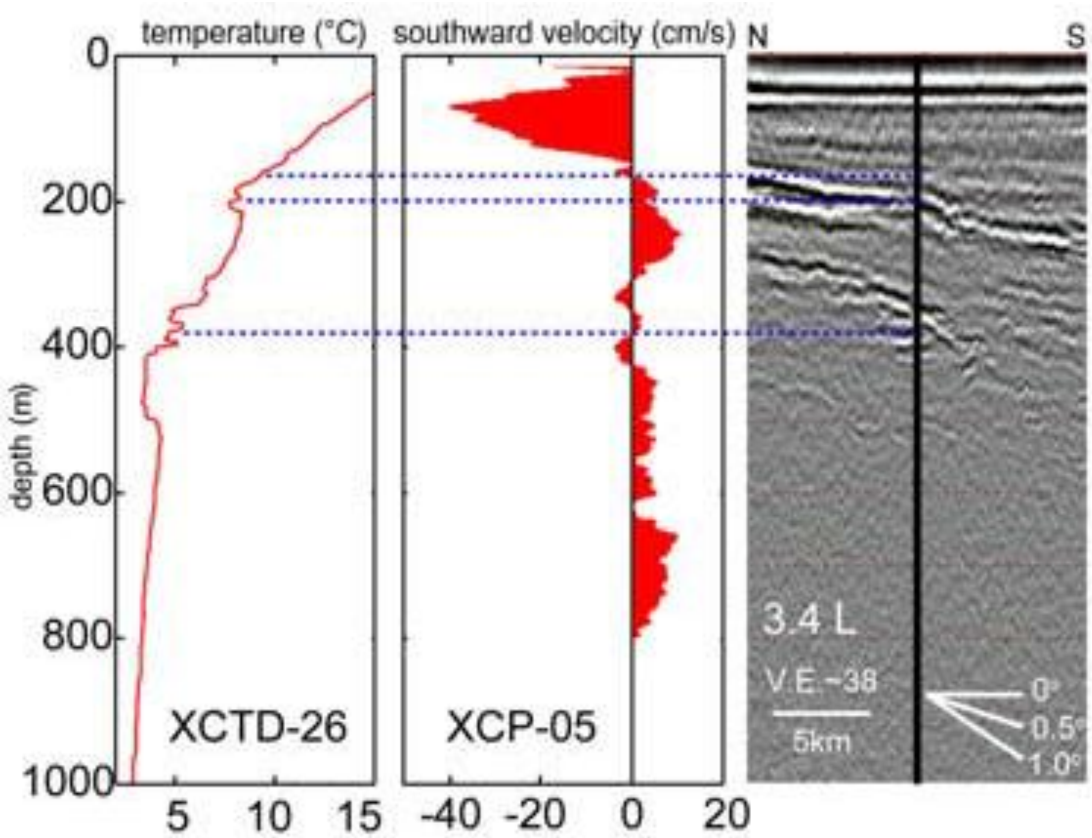
Seismic reflection profile (top) and acoustic Doppler current profile (ADCP) intensity (bottom) for Line 2. Time period of observation is indicated above the seismic profile.

DISCUSSION



Seismic profile overlain by a synthetic seismogram (red line) (left). Temperature (blue) and salinity (red) profiles derived from XCTD measurements (right). Blow-up of temperature data from the black rectangle to the right, which corresponds to the depth range of the seismic reflection profile to the left (middle).

DISCUSSION



Comparison of (left) (XCTD) temperature, (middle) (XCP) southward velocity, and (right) seismic reflection data.

Thin dashed blue horizontal lines indicate abrupt temperature and velocity changes correlative with seismic reflections. Thin black vertical lines on the seismic reflection data indicate locations of the XCTD and XCP.

CONCLUSIONS

- Seismic reflection data have revealed the existence of fine structures in the Kuroshio current.
  - The first study, that fine structures with a horizontal scale of 40 km. The temperature and salinity observed in CTD data from the Kuroshio Current off the Ashizuri peninsula can produce reflection patterns that are similar to the fine structures on seismic profiles acquired off the Muroto peninsula.
  - The second study, seismic reflections between 200 and 800 m deep and apparently dipping southward were investigated and compared with in situ physical oceanographic measurements, and the reflections were confirmed to originate from oceanic fine structure.

CONCLUSIONS

- The seismic reflections were observed at the boundary between two water masses with different thermohaline characteristics, where mixing of the two causes fine structure to develop.
- For the first time, current profiling was conducted simultaneously with MCS data acquisition, and the data indicate that the reflections are situated at the boundary of water flowing in opposite directions, perpendicular to the axis of the front.

THANK YOU FOR YOUR ATTENTION

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