Nitrite in the Japan/East Sea

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Nitrite distributions

Nitrite is an intermediate product of nitrate reduction or ammonium oxidation. Lifetime: 3 to 30 days

Nitrite is created by

(1) oxidation of ammonium by nitrifying bacteria

(2) reduction of nitrate by phytoplankton (euphotic zone)

(3) reduction of nitrate by denitrifying bacteria

Nitrite is removed by

(1) utilization by phytoplankton (euphotic zone)

(2) bacterial oxidation to nitrate

(3) bacterial reduction to ammonium (denitrification process)

Usual nitrite occurrence

1. Euphotic zone: primary nitrite maximum (PNM) at the base of the euphotic zone, coincident with a nitracline (high nitrate gradient). Created mainly by oxidation of ammonium, plus some phytoplankton reduction, and limited phytoplankton uptake due to light limitation

2. Nearly anoxic regions, mainly in the eastern tropical regions, such as in the Pacific. Created by reduction of nitrate by denitrifying bacteria, part of process to complete denitrification (to N_2).

Sediment processes affecting nitrogen; NW Pacific oxic waters

Water column in Japan, Okhotsk and Bering Seas is full of oxygen, so subeuphotic zone nitrite cannot be due to denitrification in the water column.

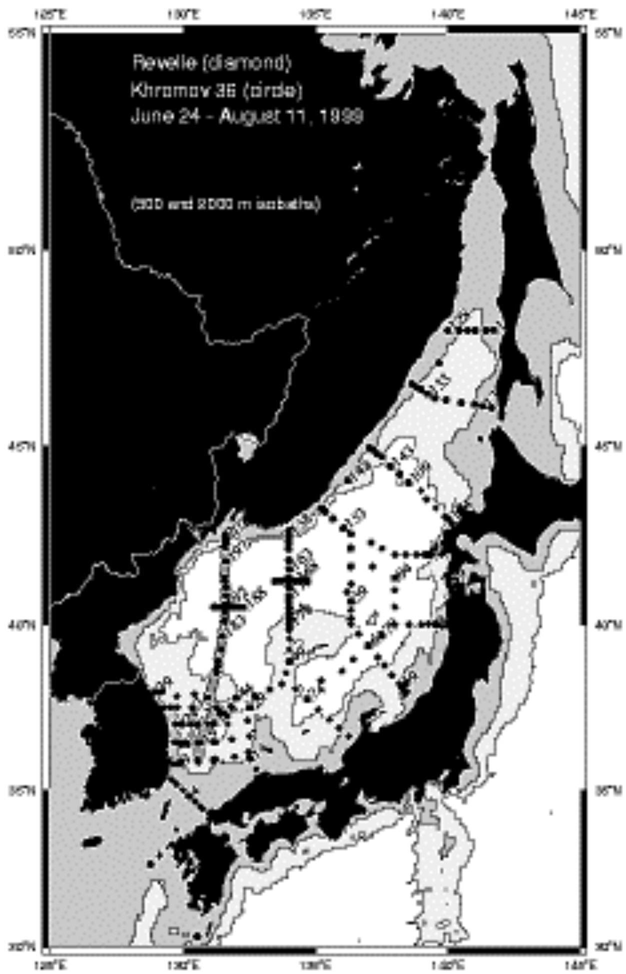
Sediment processes: possibly coupled denitrification and nitrification as suggested by a number of authors. Large-scale effect is of denitrification.

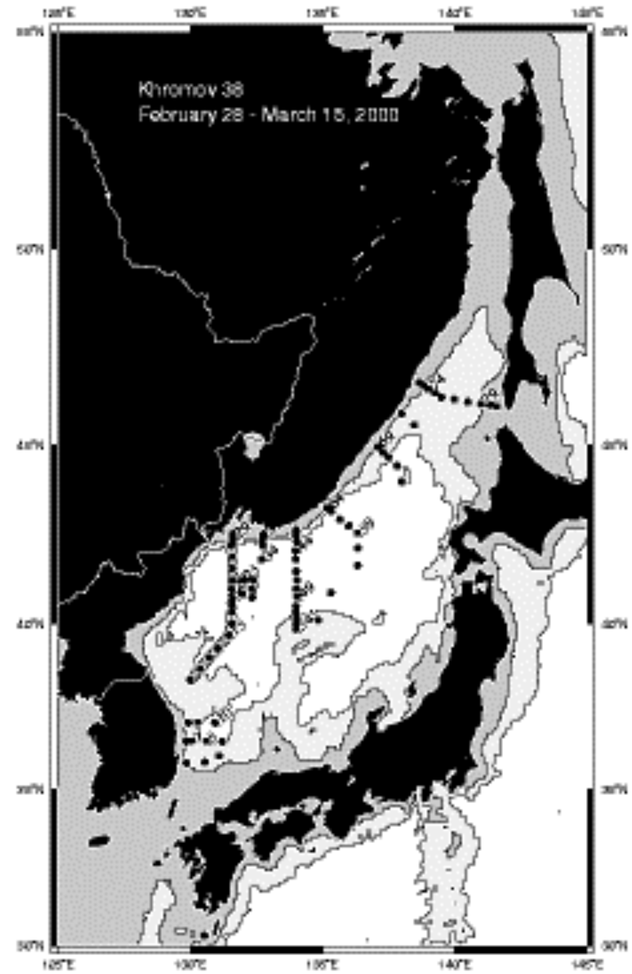
Existence of deep nitrite (in turbid bottom boundary layer): sediment-water interface is wide.

Nitrification (oxidation) could occur in upper interface, producing NO2, using ammonium from decay of organic matter.

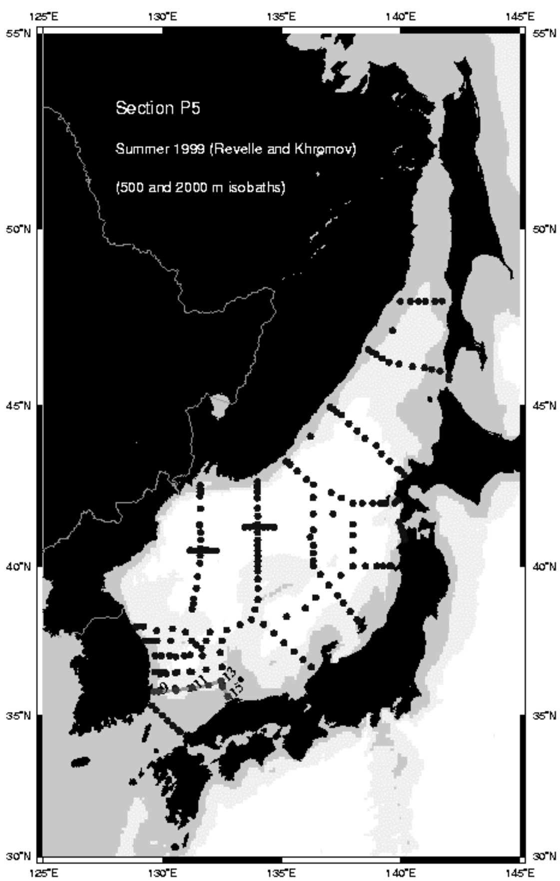
Denitrification (reduction) farther down, net downward flux of NO3 out of water column and into sediments.

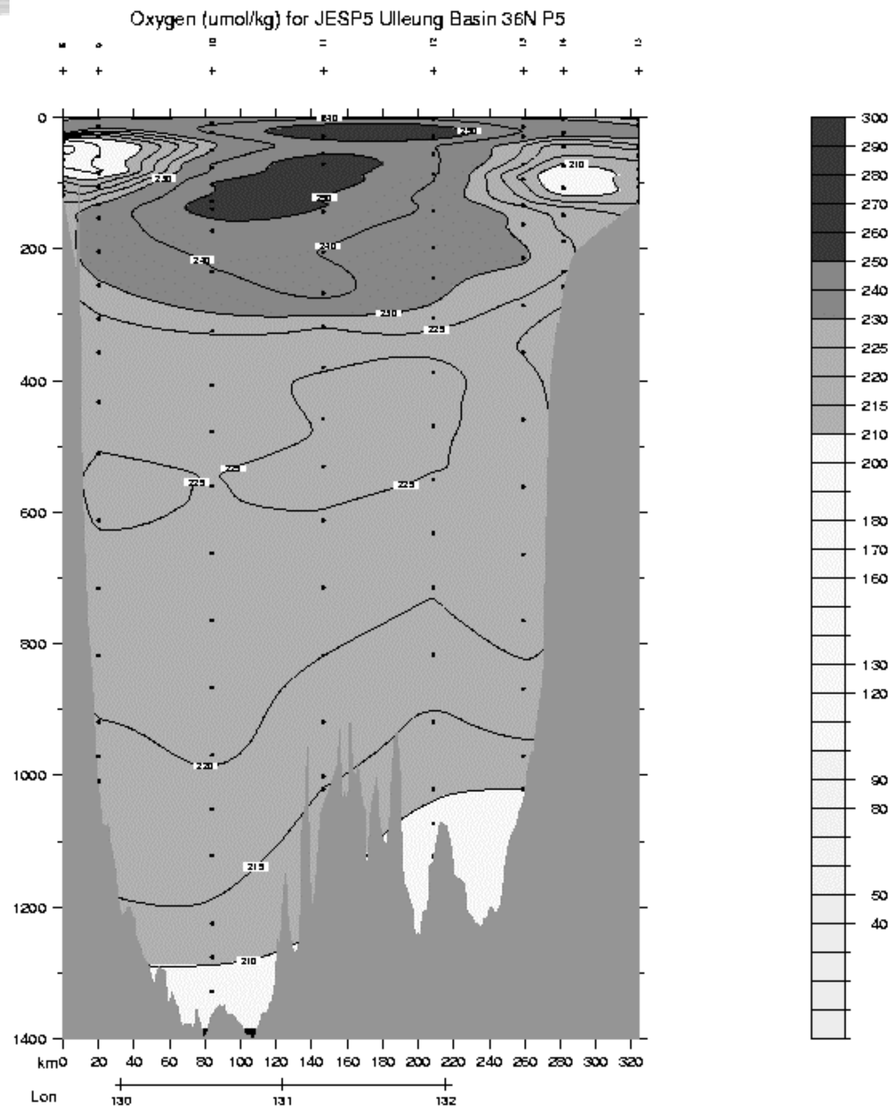
Summer 99 and winter 2000



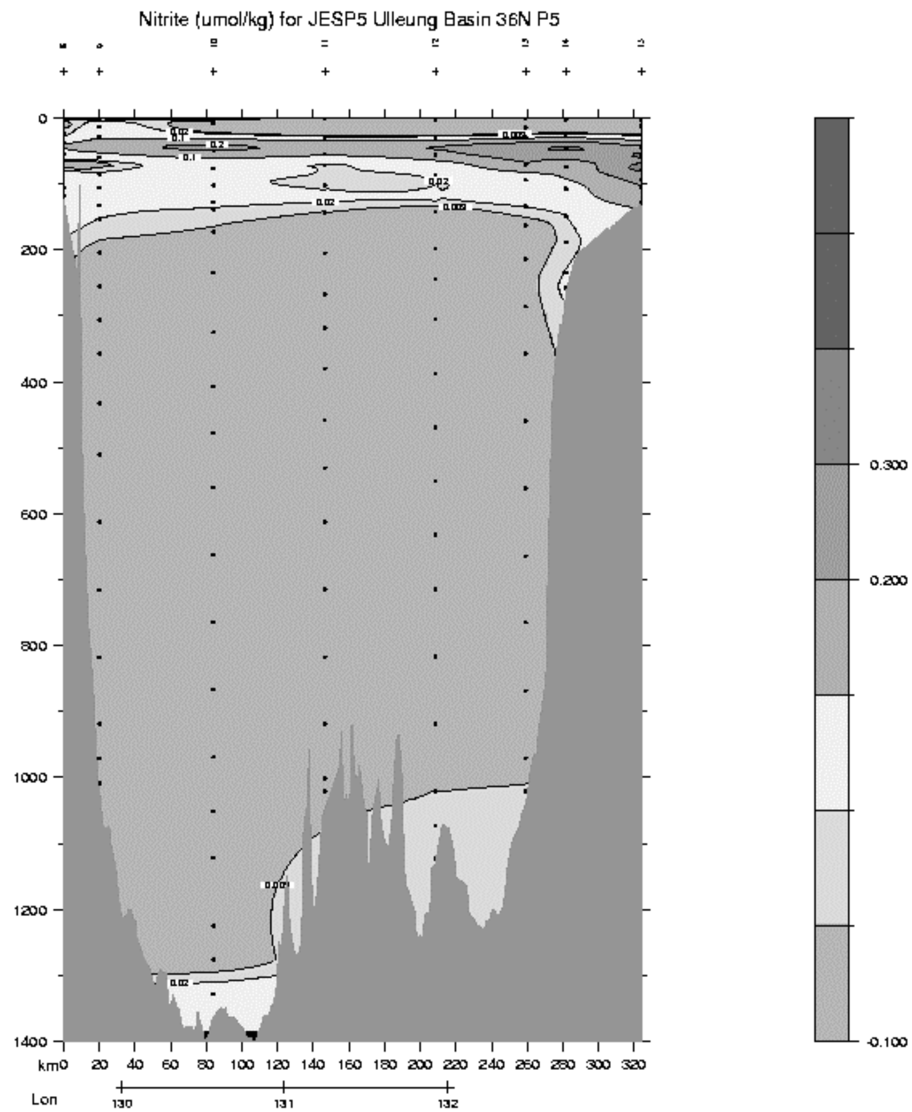


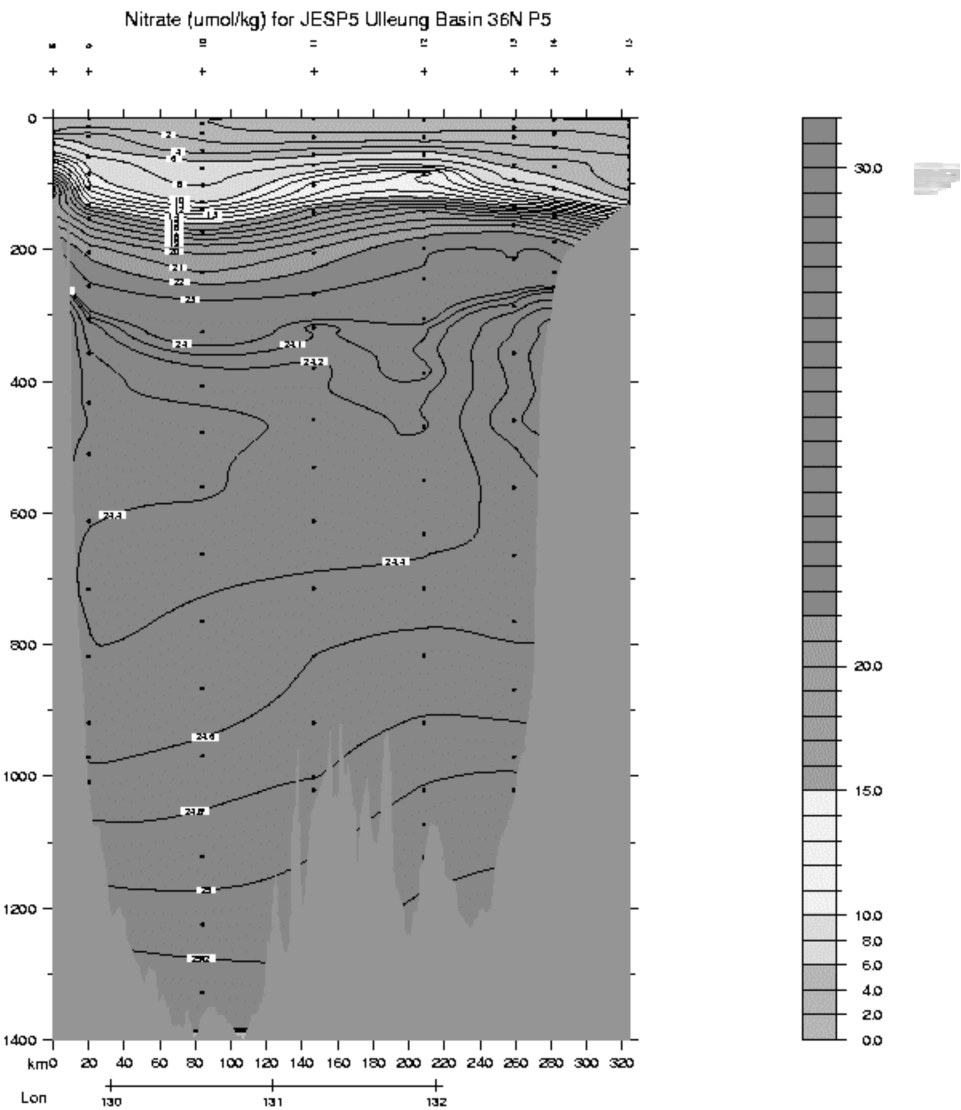
Southernmost Ulleung Basin section: nitrite at bottom



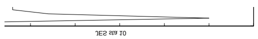


Ulleung Basin, southernmost section

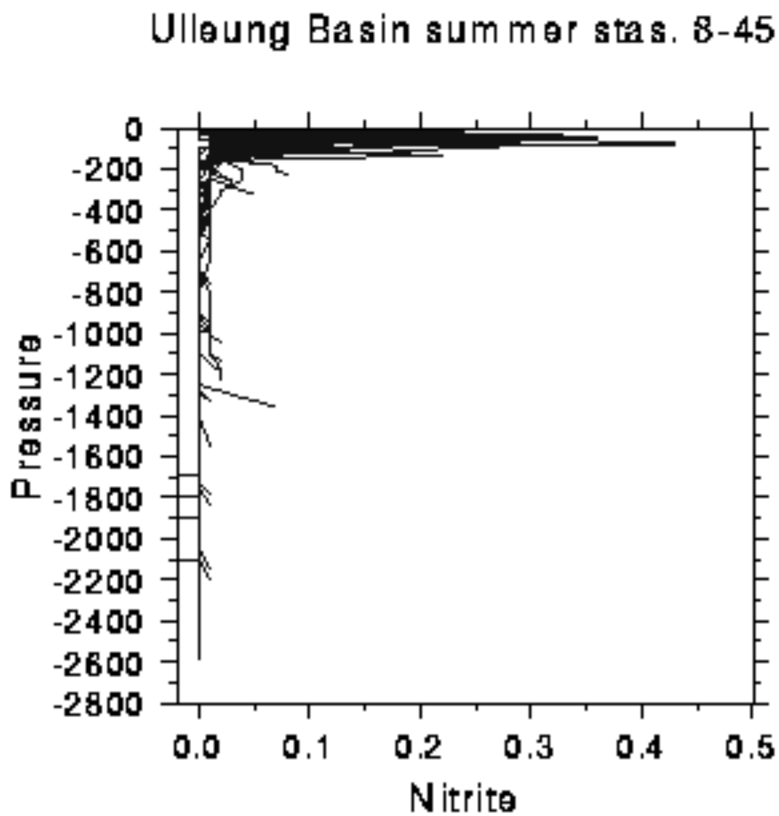




Ulleung Basin: profiles at station 10 (1400 m deep, southern section). Bottom boundary layer: nitrite enhancement, O2 depletion, NO3 depletion, N* suggesting denitrification, high turbidity (water full of sediment)



All profiles of nitrite in the Ulleung Basin



The 0.01 “noise” is the bottom sample on many stations.

It coincides with turbid layer, lowered oxygen, lowered nitrate, lowered alkalinity.

Location of measurable bottom nitrite

"Measurable" is > 0.004 μmol/kg (rounded to 0.01 in these files). Using standard autoanalyzer, colorimetric procedure (Scripps Institution of Oceanography Oceanographic Data Facility). (Much smaller quantities are measured with other specialized techniques.)

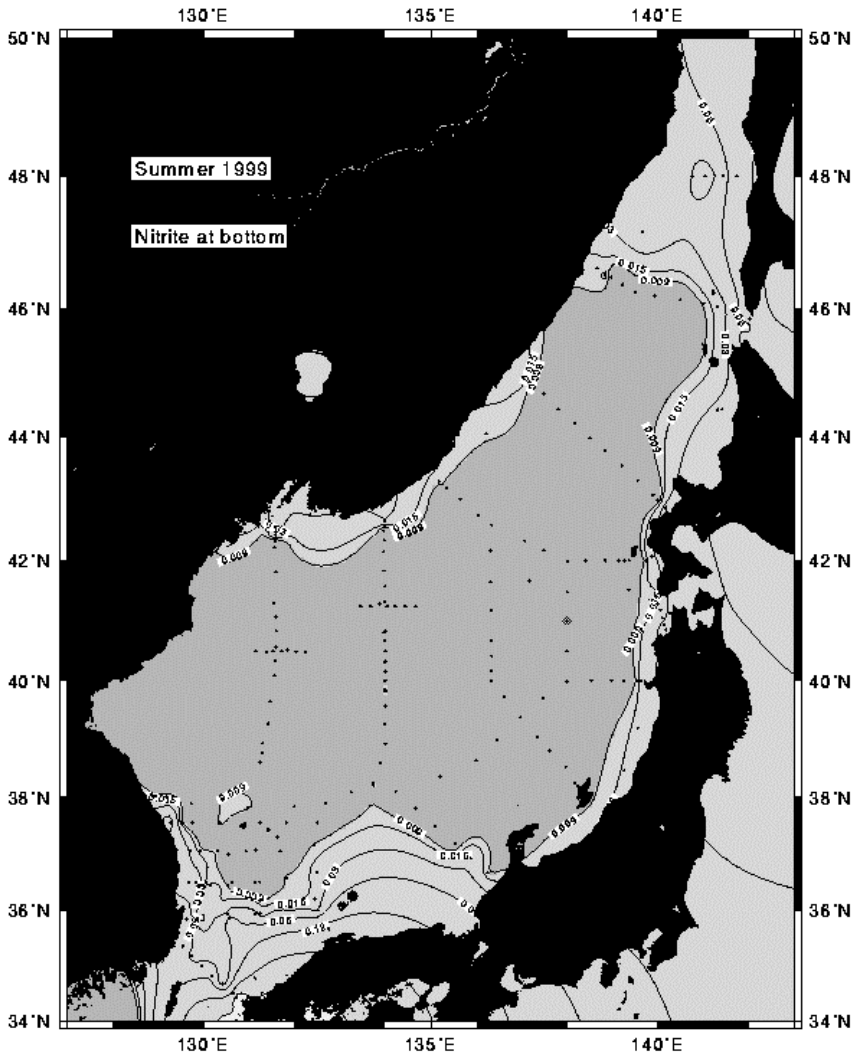
<u>Next overheads</u>: location of bottom nitrite and depth ranges.

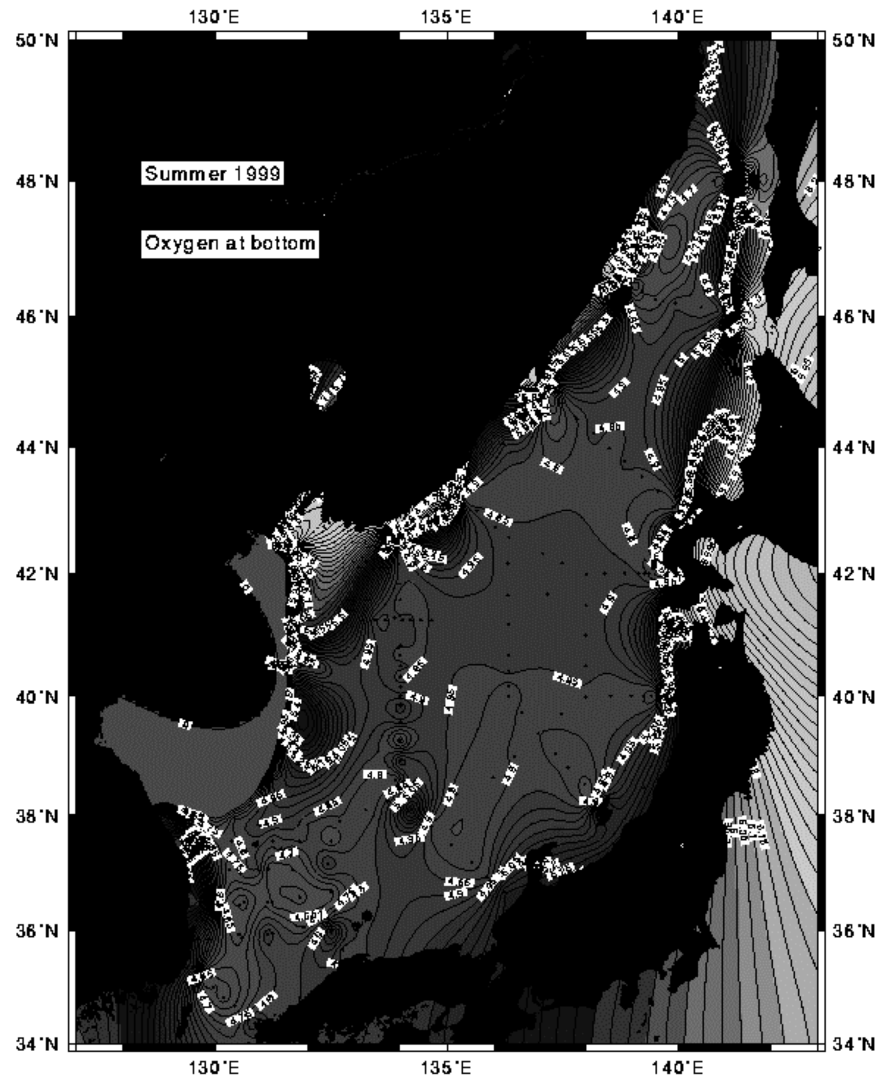
Showing that the Ulleung Basin in particular has measurable bottom nitrite but not in the middle at the deepest stations.

Also the Primorye and Honshu coasts (to 500 or 1000 m)

Extension: look at Okhotsk and Bering Sea nitrite as well.

Bottom nitrite and oxygen





Sediment composition

Overheads showing:

1) high percentage of organic carbon in the sediments in the Ulleung Basin and around the margins - coinciding with occurrence of deep nitrite. High percentages are similar to (greater than) percentages found in Washington coast sediment measurements that showed denitrification (Devol, 1991)

2) schematic of bottom composition near Okishiri, showing fissures, gas hydrates that mix bottom sediments. (Takeuchi et al., 1998)

3) strong currents and eddies extending to bottom might also result in turbidity, extending the sediment processes up into the water column.

Larger-scale effects of sediment denitrification

Denitrification can be recognized using N* (Gruber and Sarmiento, 1997): based on N:P ratio for nitrification and denitrification.

Values greater than zero indicate nitrogen fixation.

Values less than zero indicate denitrification.

Consider N* and the N:P ratio in the Japan/East, Okhotsk and Bering Seas, as well as in the Pacific.

Japan/East Sea

Okhotsk Sea

Bering Sea

Denitrification in Okhotsk Sea is most pronounced.

Denitrification in Japan/East Sea below the shallow pycnocline

Depth

Sigma 0

N*

N*

Pacific-wide N* distribution

Overhead shows N* for the Pacific WOCE sections (Robbins).

Low N* in 2 regions: eastern tropical Pacific (nearly anoxic water column -> denitrification) and NW Pacific (apparently denitrification in the sediments)

NW Pacific has just P14N and P01W in the Bering and Okhotsk Seas. Additional Okhotsk Sea survey, already shown, highlights denitrification effects in Okhotsk Sea in comparison with Bering, which is weaker, but which is often referred to because of Geosecs data.

Summary

Nitrite in the water column just above the bottom, in a turbid bottom boundary layer - characteristic of the Ulleung Basin to about 2200 m and of the Primorye and Honshu coasts to about 500 m.

Signature of denitrification in the East Sea Proper Water. Reduction of oxygen accompanies the stronger denitrification signature and suggests that mid-depth oxygen minimum results from sediment processes, primarily in the Ulleung Basin (e.g. Jahnke and Jackson, 1987).

Okhotsk Sea and Bering Sea also sites of denitrification, especially Okhotsk. Major effect on Pacific-wide nitrogen distribution.