HYDROCHEMICAL STRUCTURE OF BLACK SEA

HYDROGEN SULFIDE

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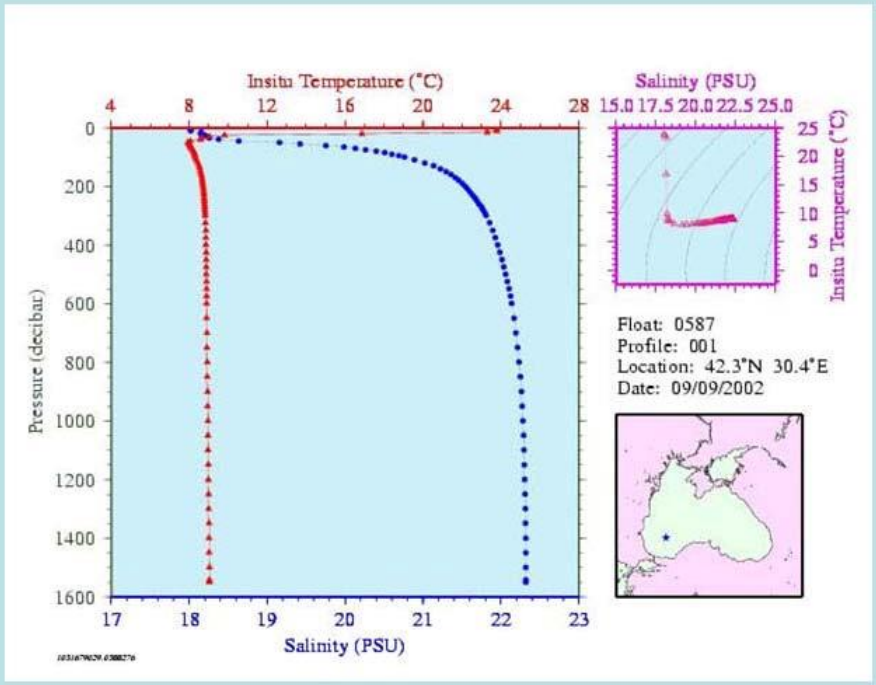
Hydrological structure

The Black Sea is one of the largest enclosed seas in the world

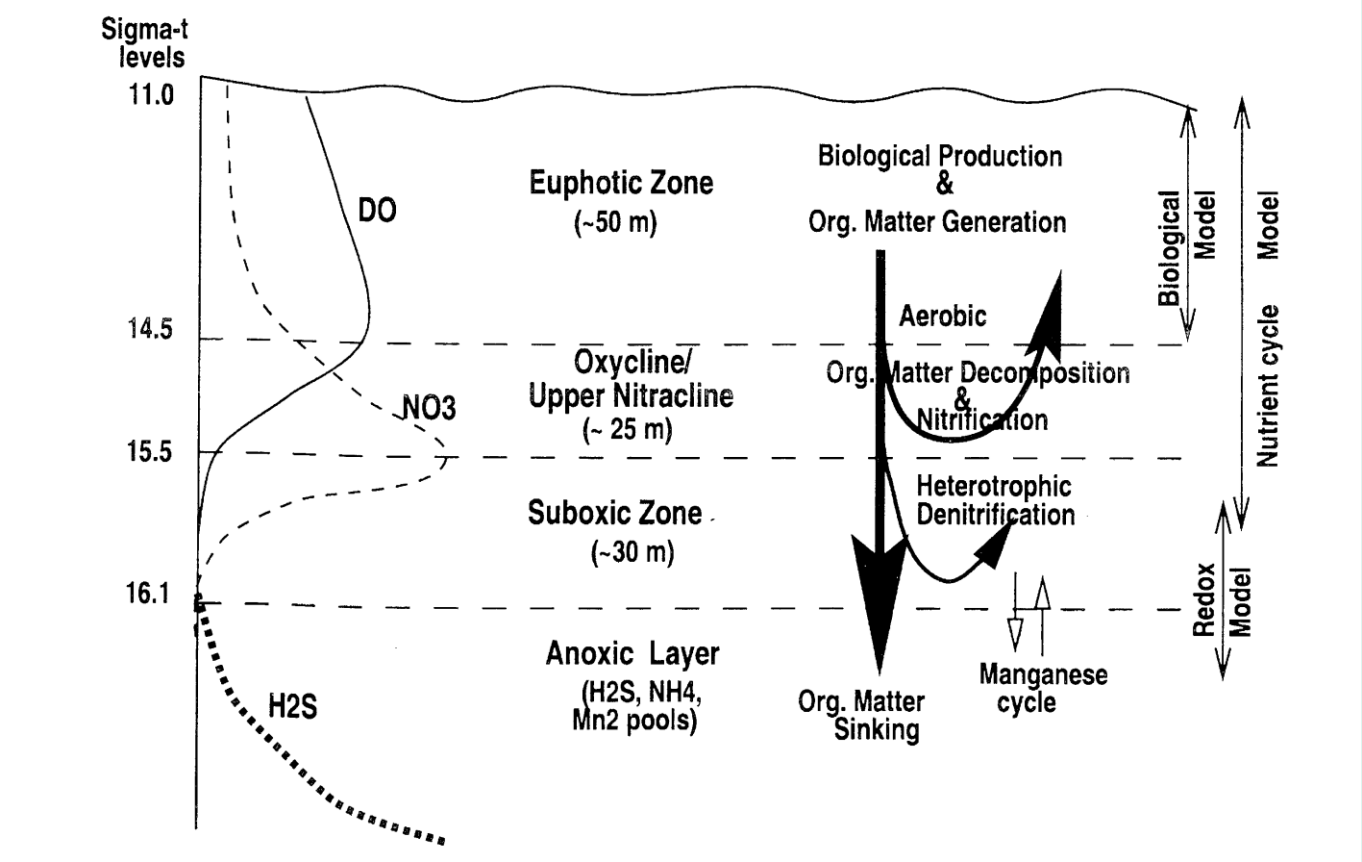


PALACE float measurements at the Black Sea

- Upper Mixed layer
- Termocline
- Cold intermediate layer
- Bottom convective layer

Because of the different salinities and weights, the freshwater and seawater mixing is limited to the uppermost 100-150m. In this depth an pycnocline detaches the surface water from the bottom waters because the mixing between surface waters and bottom water is strongly restricted

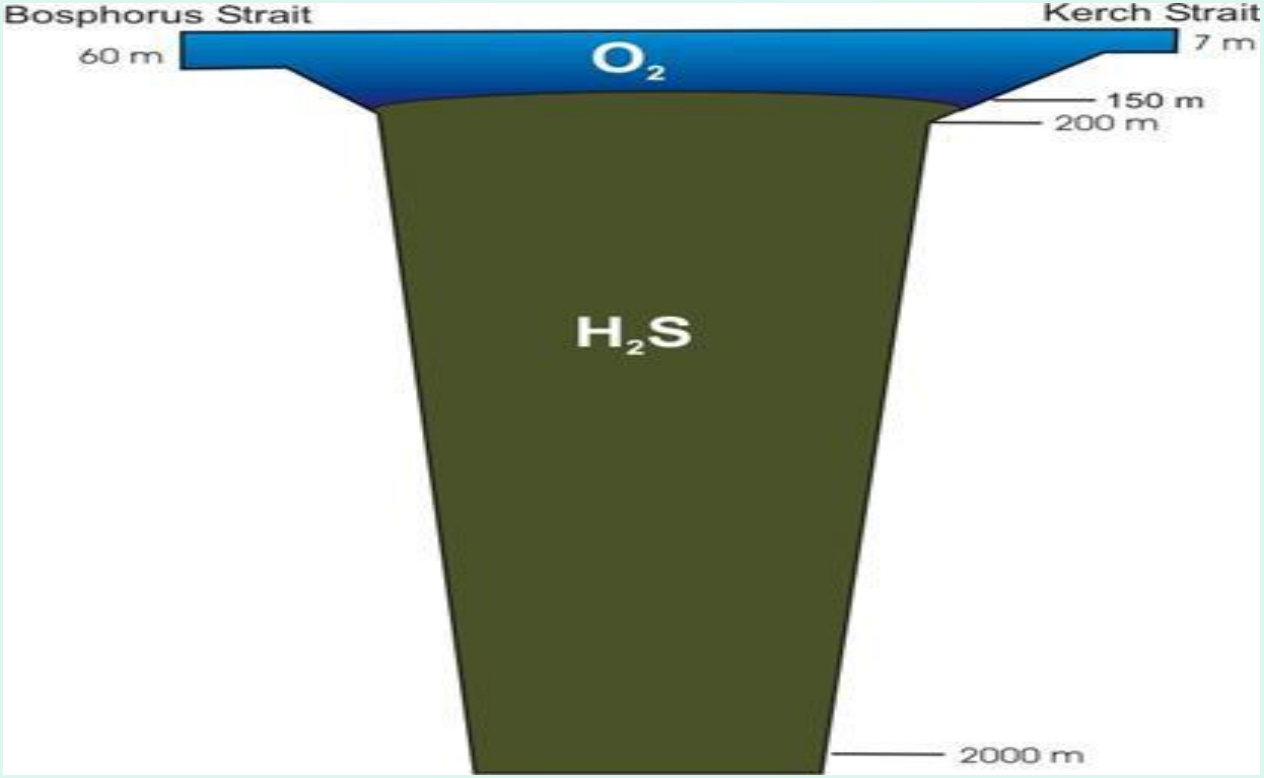
Vertical Black Sea hydrochemical structure



The hydrochemical structure depends on hydrological structure

Oxic-anoxic structure

Stratification – one of the peculiarities of the Black Sea.



The thin upper layer of marine water (up to 150 m) supports the unique biological life in the Black Sea ecosystem. The deeper and more dense water layers are saturated with hydrogen sulfide, that over thousands years, accumulated from destructing organic matter.

Winter mixing in the sea results in the formation of an oxygen-rich Cold intermediate layer (CIL), which is observed at depths of about 60 to 100 m.

Sources

- **H2S Production in the Water Column**

Sulfate-reducing bacteria are key player in anoxic waters. In the first compiled organic carbon budget of the Black Sea, Deuser suggested that at least half of the total particulate carbon that is transported into the anoxic water column is oxidized there by sulfate-reducing bacteria . A maximum in sulfate reduction rates (SRRs) in the water column was usually observed in the upper (200–300m down to 600 m) part of anoxic column and in the layers adjacent to the bottom.

- **Sulfide Production in Deep-Sea Sediments**

Based on measurements by Sorokin, Deuser calculated an average annual sulfide production in Black Sea sediments. Lein and co-authors calculated an average hydrogen sulfide production in the anoxic sediments of the Black Sea

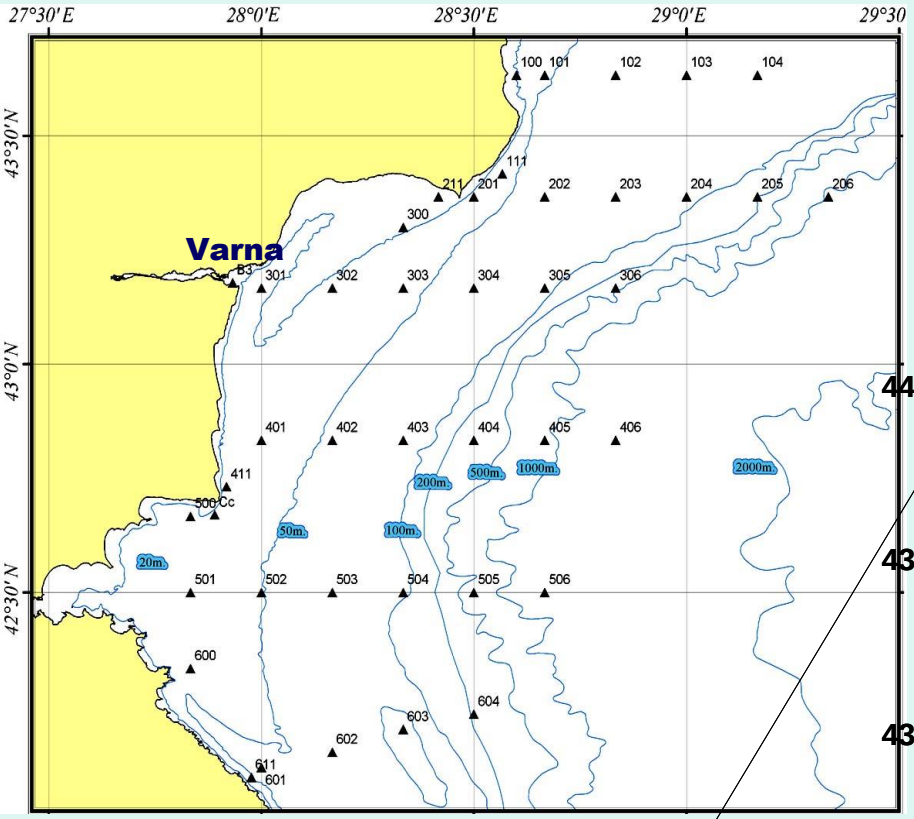
Sources

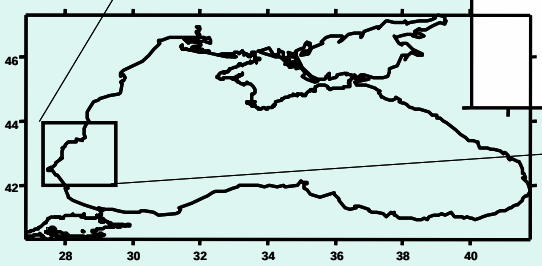
- **The Geological Sources**

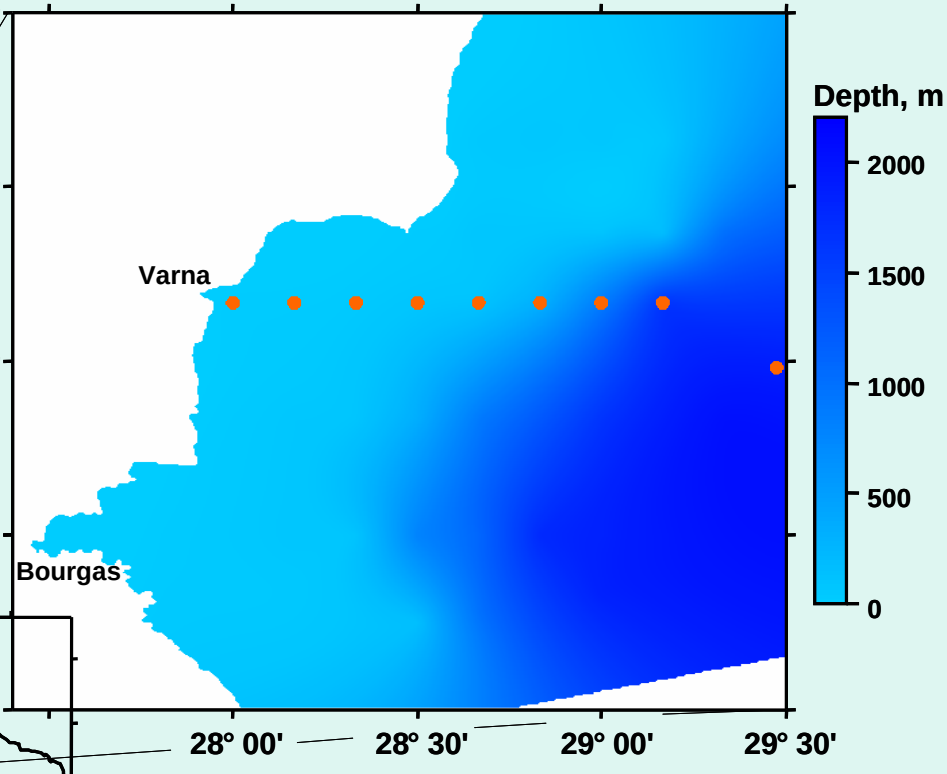
Fractures and mud volcanoes, as well as the destroyed gas-hydrate deposits, which contain the solid phase of H2S. At the same time, from earth shells through the cracks it enter in the sea ground and with hydrothermal waters.

- As a chemically active component H2S from the volcanoes is absorbed by the iron coming from the land and is fixed on the sea bottom in the form of undissolved iron sulfides.

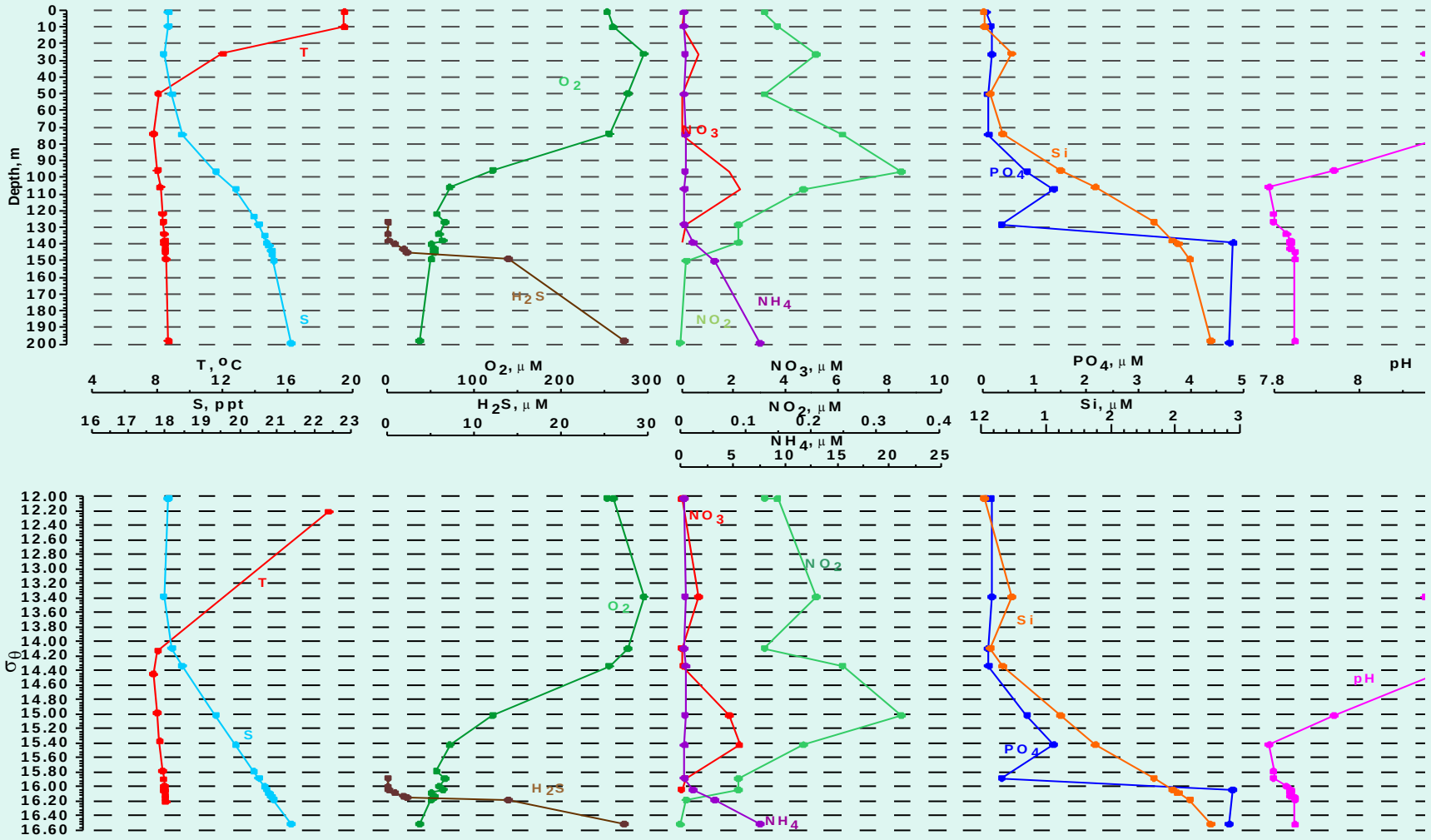
Investigation area in Western part







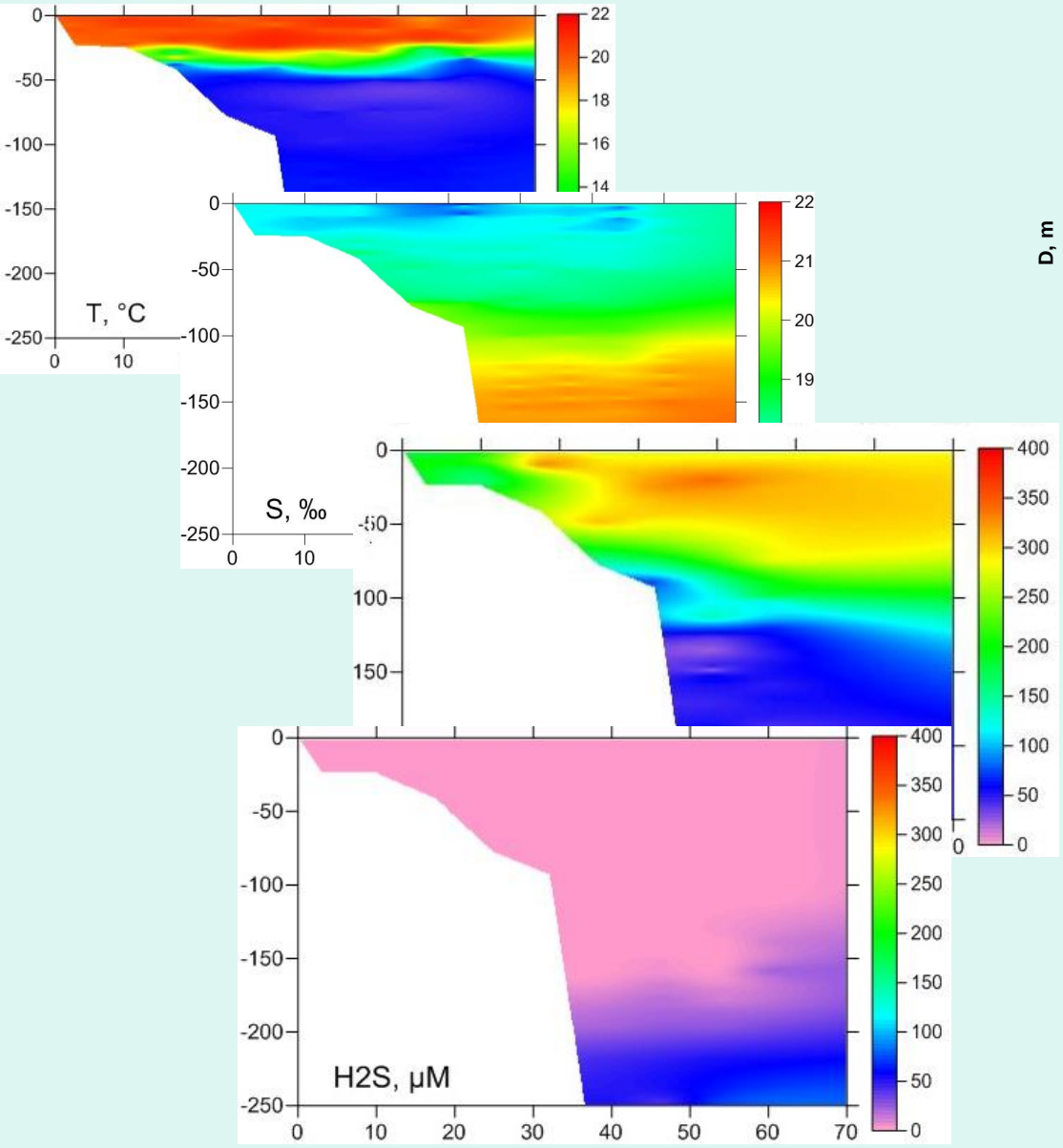
Vertical distribution of O2, pH, H2S and nutrients

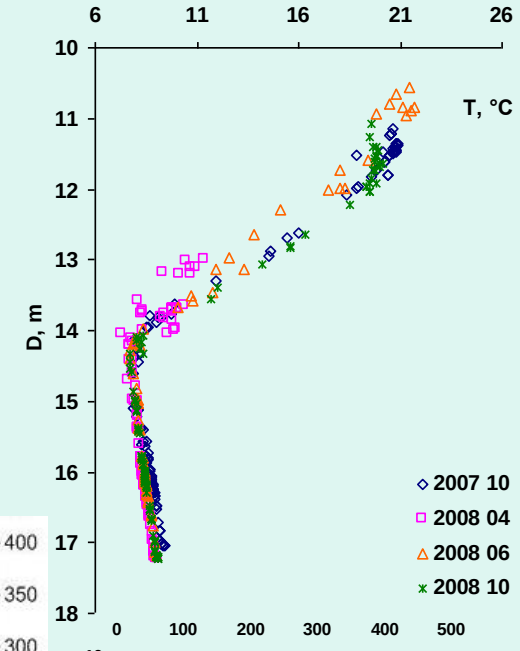


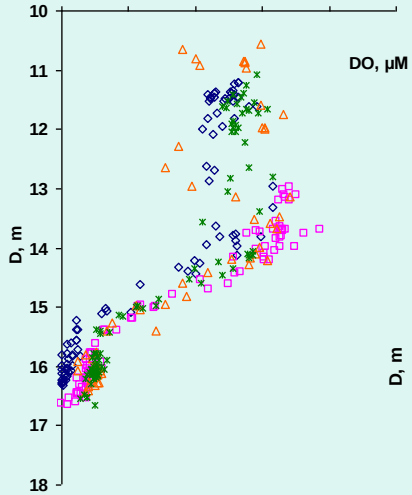
Range

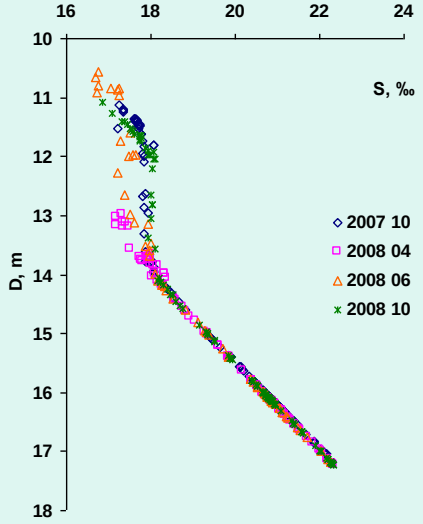
Layer		S ‰	pH	O2 µM/l	OS%	NO3 µM/l	NH4 µM/l	PO4 µM/l
Oxic	min max	15.72 20.22	7.9 8.5	20 405	6 128	0 5.1	0.1 1.0	0.0 0.12
Suboxic	min max	20.67 21.02	7.8 7.9	0 20	0 6	0 0.02	0.9 5.0	0.02 0.04
Anoxic	min max	>21.0 >21.0	7.6 7.8	0 0	0 0	0 0	4.4 18	0.5 6.9

Vertical distribution of hydrochemical parameters

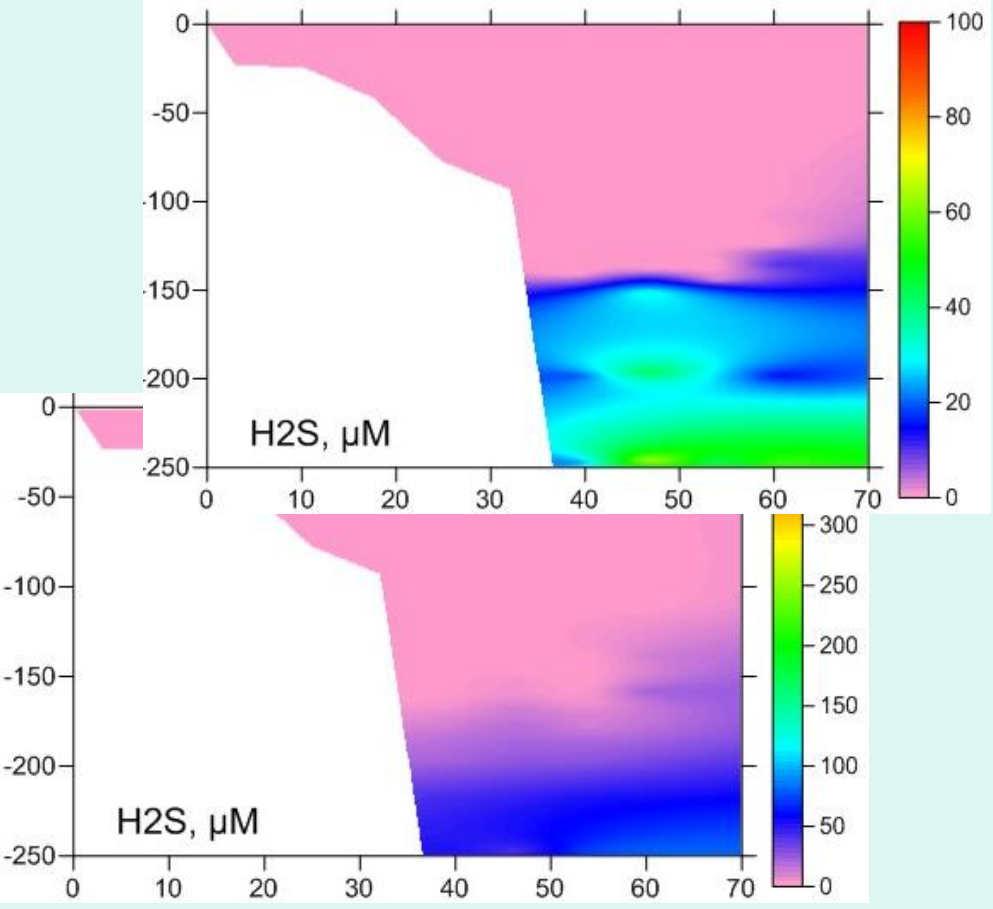


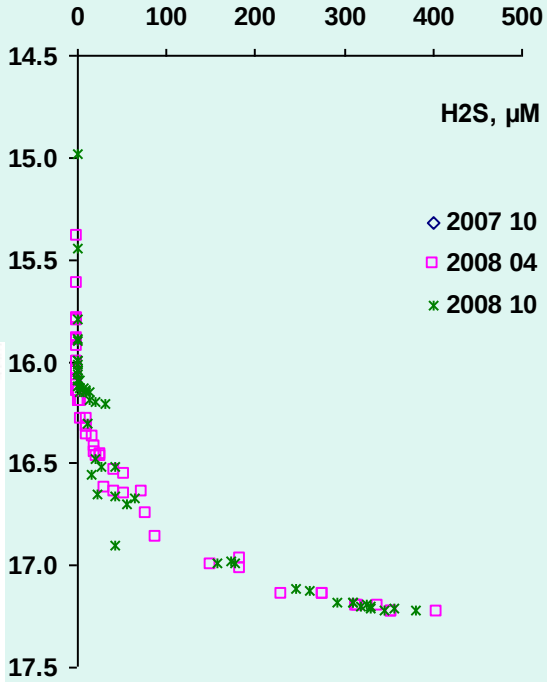


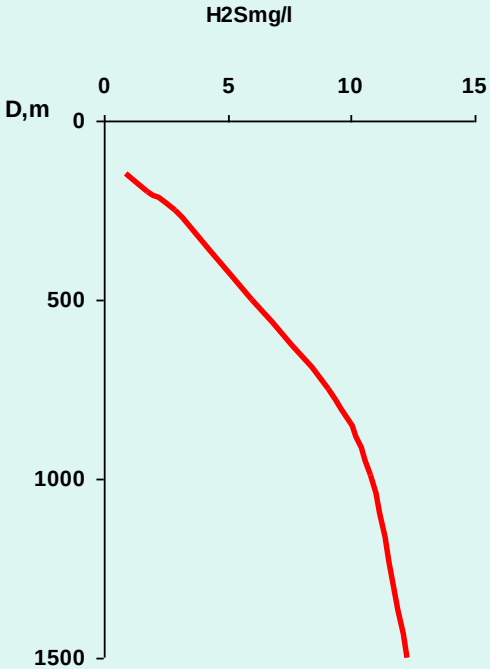




H2S







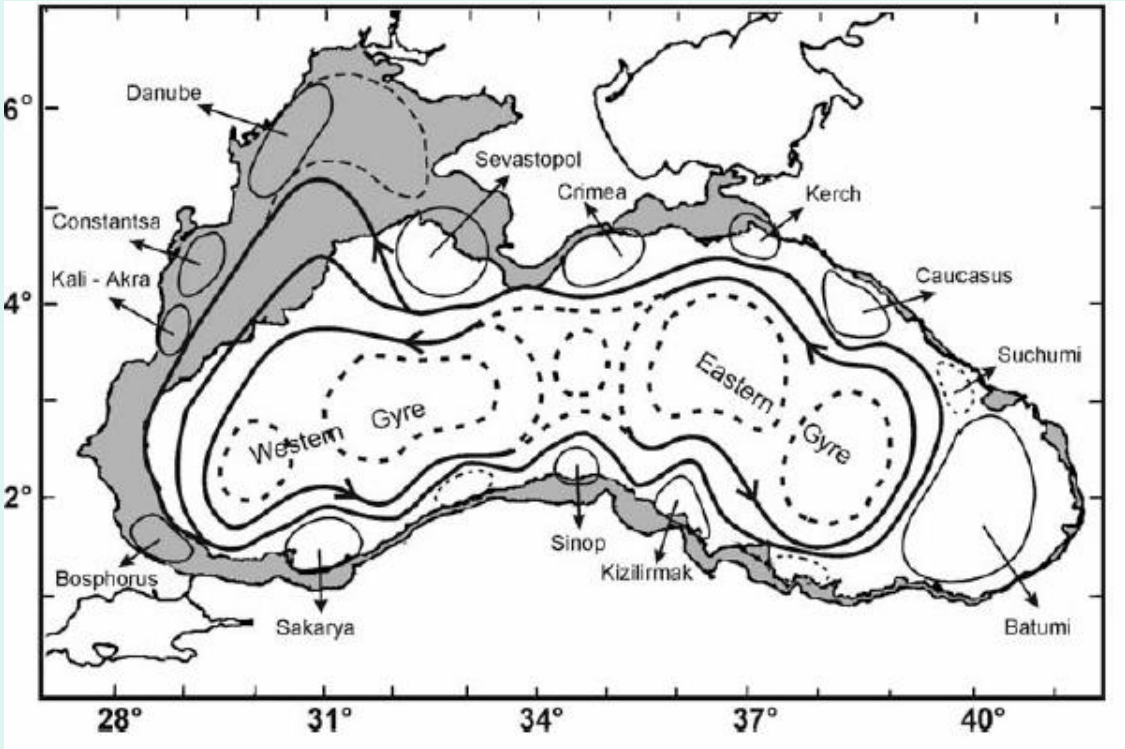
H2S

- The sulfide vertical distribution correlates with vertical distributions of temperature, salinity and density in the Black Sea. the thermohaline structure of the water column controls the vertical distribution of H2S in the basin.

The H2S vertical distribution is quasilinear above 500–600 m. Dissolved sulfide concentration increases gradually with depth. The vertical sulfide gradient at the boundary between the entire anoxic water mass and the bottom convective layer (ca. 1700–1750 m) increases sharply.

- The temperature–salinity relationship in the Black Sea is a result of large-scale external factors such as water and heat balance of the basin.
- In the upper part of the sulfide zone, the correlation between H2S and density $\sigma\theta$ is smaller due to a larger hydrophysical inhomogeneity of the upper 300 m. The location of the upper sulfide boundary and distribution of other chemical parameters are also density-dependent

- In the centers of cyclonic gyres, the location of the H2S upper boundary decreases to 90–110m, whereas at the periphery of the basin and in the centers of anticyclonic gyres it can deepen up to 160–200 m.



Bottom convective layer

- The existence of a homogeneous bottom water mass – Bottom convective layer (BCL) – at water depths below 1740–1800m was first reported, based on detailed CTD profiling, by Murray et al. and since then it has beenintensively studied. Based on the data obtained in 2000–2002 in the Black Sea, the bottom water mass was characterized by the following parameters: temperature = 8.883–8.888ºC, salinity S = 22.330–22.334 and density $\sigma\theta$= 17.233–17.236 kgm–3

RV Akademik cruise - 2014

SHIP DATA

Length: 55m

Width: 9.8m

Displasement: 1150t

Depth molded: 6.8m

Crew – 18

Meeting room – 18m2

EQUIPMENT on deck

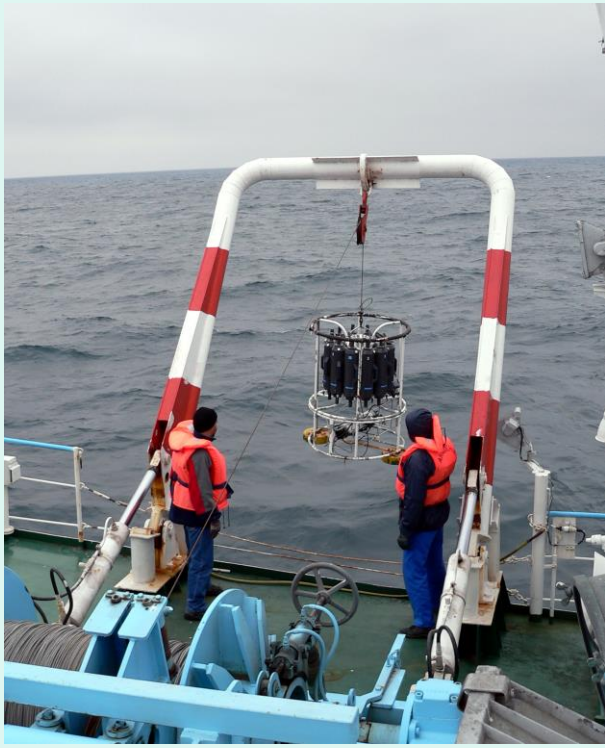
- Side A-Frame – 3t

Side-Winche on A-FRAME (hydraulic driven)-2.5t

- Side-L-Frame – 2t

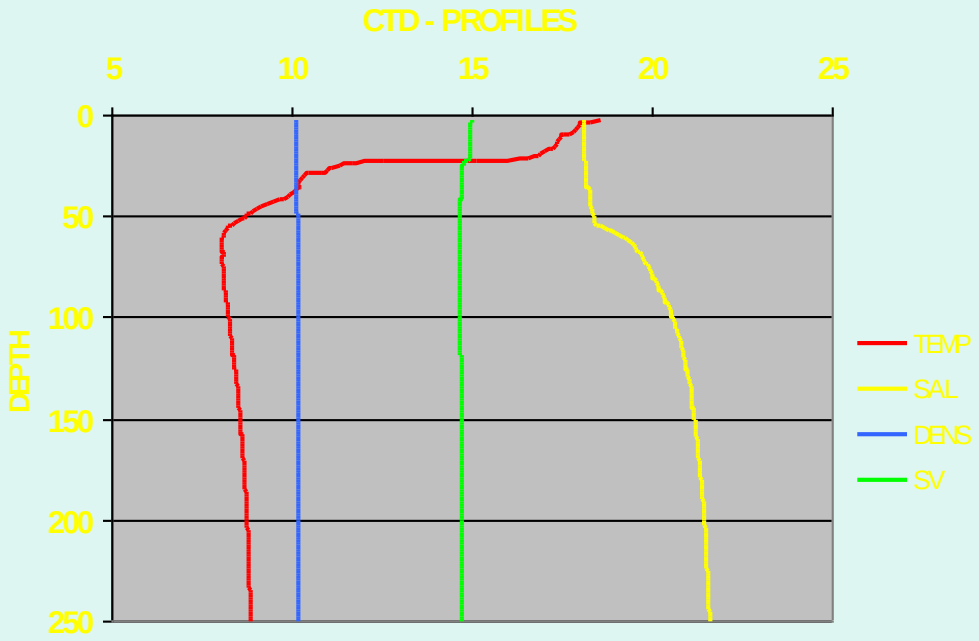
Hydrographic winch on L-Frame - 1.5t

- STERN A-FRAME – 7t
- Cranes (hydravlic driven)



T, S PROFILES

- SBE device
- Carusel with 12 plastic sampling bottles (5l)



LABORATORIES

- Multi use lab – 22m2
- General wet lab – 9m2
- Dry measuring lab – 14m2


VARNA


THANK YOU FOR YOUR ATTENTION!