THE HYDROGRAPHIC CHARACTERISTICS OF THE WATER MASSES IN THE SICILY STRAIT AND THE SURROUNDING REGIONS

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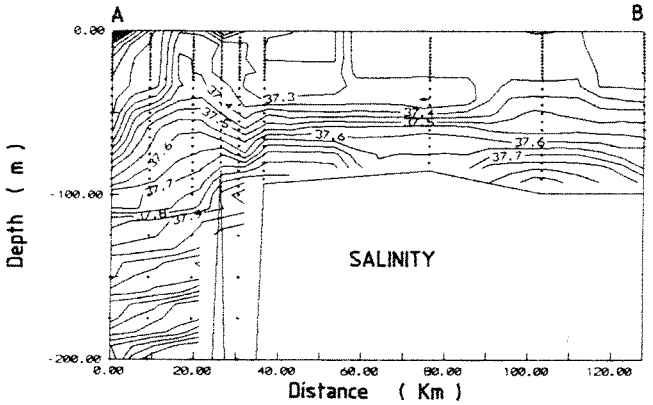
The knowledge of the oceanographic conditions of the central region of the Mediterranean Sea extending between Sicily, Sardinia and the northern African coast is crucial for the comprehension of the whole basin dynamics. This region is surrounded by the three of the major straits and passages within the Mediterranean, all of them exerting a strong control on the water and particle fluxes from one basin to the other. An oceanographic investigation of this area based on periodic hydrographic stations and long-term current meters measurements along all the strait sections, was initiated in the frame of a cooperative effort among French, Spanish and Italian teams working under the sponsorship of IOC and CIESM and with the financial support of the EC (EUROMODEL and GEODYME Projects). In this frame, the hydrographic properties of the Sicily Strait and the surrounding regions were investigated during two oceanographic campaigns carried out in November 1993 and May 1994 by the Stazione Oceanografica of CNR. In this paper we present the results obtained in the two campaigns, that are to be considered preliminary to our future activity in this region.

The Sicily Strait is a two-sills, wide and relatively shallow strait, characterized by a very complicated bottom bathymetry. In agreement with the previous measurements (for all, GRANCINI *et al.*, 1972), in the Sicily Strait we are in the presence of a two-layer system divided by a transition layer. At the surface we find the Modified Atlantic Water (MAW) characterized by low salinity values and deepening as far as about 100 m of depth. All the previous measurements (for all, GRANCINI *et al.*, 1972) indicate that the flow of MAW mostly takes place close to the Tunisian coast. Being prevented to work in this area, we found a salinity minimum close to the Sicilian coast, and a wide region of mixing in the central channel (Figure). We then believe that, due to the presence of the Skerki Bank upstream of the strait, two separate veins of MAW reach the Sicily Strait, each bordering the two sides of it. In both periods, a portion of the MAW was seen to flow into the Tyrrhenian Sea, very close to the western Sicilian coast.

Below about 200 m of depth as far as the bottom, there is the Levantine Intermediate Water (LIW) characterized by high salinity values and flowing westward. At the strait section, the flux of LIW is splitted by the presence of a steep ridge, and most of it flows within the narrow valley (the eastern sill) between the ridge and the Sicilian shelf. In spite of the higher salinity values found on the other side of the ridge, this secondary vein does not seem to play an active role in the following path of the LIW. This can be observed in the hydrographic sections adjacent to the strait, just showing that, once in the western Mediterranean, LIW is conveyed as a unique vein directly toward the Tyrrhenian Sea, where it enters as a strong jet at the bottom of the Sicilian slope. The outflow of this water, with substantially modified characteristics, can be recognized in the central part of the Sicily-Sardinia passage.



The distribution of the MAW in the Sicily Strait during November 1993. A and B indicate the Tunisia and Sicily sides, respectively.

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CONTINUOUS SURVEY OF UPWELLING IN THE STRAITS OF MESSINA

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The presence of deep waters at the surface in the Straits of Messina was detected by VERCELLI and PICOTTI (1926), who considered this phenomenon generated by internal waves. The upwelled waters were found only near the "Sill" (located between Ganzirri and P. Pezzo) which separates the Tyrrhenian basin from the Ionian one. The upwelling occurs intermittently by oscillation of tidal levels between the two seas. In the last ten years, many hydrological studies were performed in this area using traditional methodology (CORTESE and DE DOMINICO, 1990).

During 1992 both continuous surface survey of "traciers parameters" (such as temperature, salinity and nitrate) and survey at hydrological stations were carryed out by researchers of Talassografico Istituto CNR of Messina (CESCON *et al.*, 1993). Full synoptic environmental scenary characterized by high variability in the space-time distribution of chemical and physical parameters was obtained using latter survey strategy (N/O Urania, December 1993).

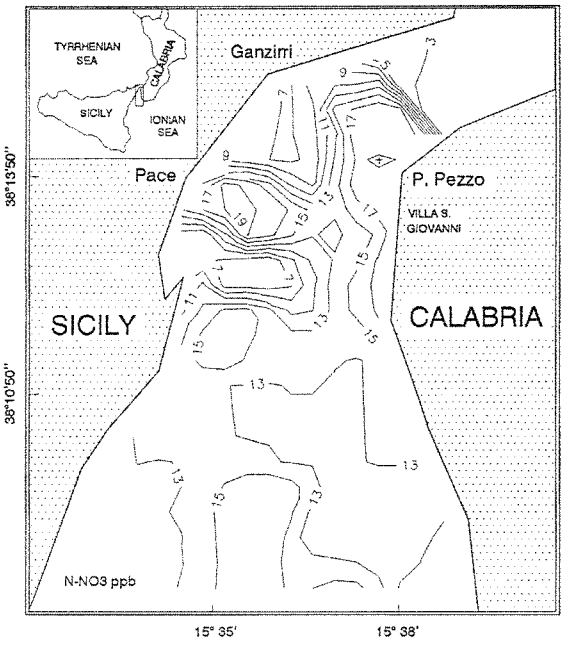
Both techniques of continuous survey of suitable traciers from sailing vessel (following the tidal wave) and 24-hour survey (every hour sampling) at three significant stations were used to investigate upwelling processes. Each continuous survey was made in about three hours around the peaks of maximum and minimum tidal level, in order to seize the quasi-stationary situations following the dynamic phases of flooding and ebbing tide respectively.

Data on surface distribution of tracier parameters evidenced a high positive correlation between nitrate and salinity in upwelled waters. The temperature values of the latter were less than 17°C whereas in the North side of the straits they exceeded 18°C. The figure shows the nitrate surface distribution after the diurnal high tide. The maximum nitrate concentration was detected alongshore both of Sicily (19.0 ppb, Pace) and Calabria (21.2 ppb, P. Pezzo). During the subsequent phase of low tide the upwelling areas are localizated only along the Calabrian coast and southwards (villa S. Giovanni, see figure). However, in all tide stages the minimum nitrate concentration was found in the northern zone of the system. Salinity ranged between 38.15 psu (in the southern zone) and 38.00 psu (in the northern zone) whereas it reached higher values (38.26 psu) in upwelled waters.

Finally, during the high tide, the upwelling is present near the Sill, mainly along the Calabrian and Sicilian coasts. During the reversed phase, the upwelled waters were located between the middle part of the Straits and the nearby Calabrian coast.

The vertical profiles at the hydrological stations, selected by the continuous survey, showed strong upwelling at the Pace station, with 12 hours frequency after low tide phase. This condition was supported by temperature mean values of 16,5°C detected at the bottom of the water column which were lower (15°C) during the upwelling phase. On the other hand at P. Pezzo station upwelling occured mainly after the high tide but even after the reversed tide, in fact in the latter phase lower temperatures were measured already at 30 m depth. The average temperature was close to 16°C at the bottom of water column (50 m) whereas these values decreased to 14°C during the upwelling stage. The Sill station monitored throughout 48 hours (at 6 h intervals during stationary current) showed upwelling phenomena only in the first 12 hours; later, the event decreased later. This phenomenon was due to reduction of tidal levels during the change of spring to neap tide.

In conclusion, the results obtained confirm the peculiar hydrodynamic features of the Straits of Messina even out of the Mediterranean sea. Further deterministic study will be based on a long term monitoring of individuated processes.



Surface distribution of nitrate (12-2-94, high tide)

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