

# 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 "tracers parameters" (such as temperature, salinity and nitrate) and survey at hydrological stations were carried out by researchers of Talassografico Istituto CNR of Messina (CESCON *et al.*, 1993). Full synoptic environmental scenery 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).

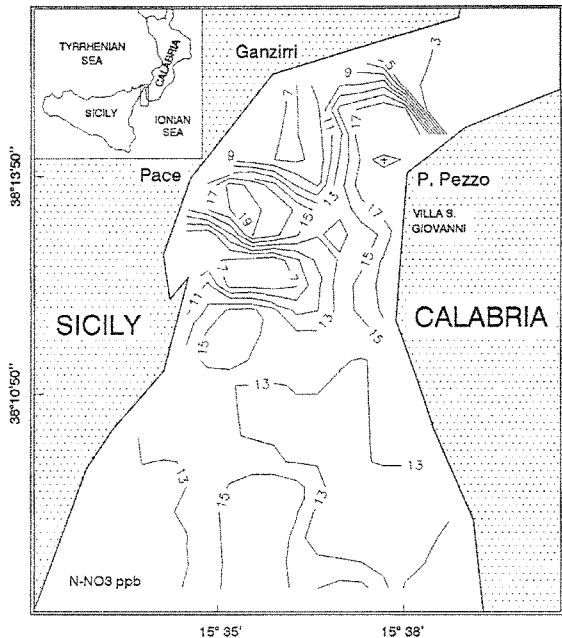
Both techniques of continuous survey of suitable tracers from sailing vessel (following the tidal wave) and 24-hour survey (every hour sampling) at three significant stations were used to investigate upwelling processes. Each continuous survey was made in about three hours around the peaks of maximum 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 tracer 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 localized 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 occurred 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)

## REFERENCES

- CESCON B., AZZARO F., CREAZZO S., DECEMBRINI F. and MAGAZZÙ G., 1993. Processing affecting upwelling and primary productivity of the Strait of Messina. (submitted to *Boll. Geof. Teor. e Appl.*)  
CORTESE G. and DE DOMINICO E., 1990. Same consideration on the Levantine Intermediate Water distribution in the strait of Messina. *Boll. Geof. Teor. e Appl.*, 8 (3): 197-207.  
VERCELLI F. and PICOTTI M., 1926. Crociere per lo studio dei fenomeni dello stretto di Messina. *Comm. Inter. del Mediterraneo, Venezia*, 1-161.