LARGE TEMPERATURE AND SALINITY TRENDS IN THE DEEP TYRRHENIAN AND ORIGIN OF THE TYRRHENIAN DEEP WATER

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Abstract
Large θ-S trends (~+0.016°C.yr^{-1} and ~+0.01 psu.yr^{-1}) recorded with a CTD moored during 8 months at ~3400 m in the southern Tyrrhenian are supported by CTD profiles performed there ~4 years apart and by historical data. Together with relatively large θ-S values, they allow questioning the origin of the Tyrrhenian Deep Water. We hypothesise that deep water formation process might occur in the northern Tyrrhenian.

Key-words: Tyrrhenian Sea, Temperature, Salinity, Deep waters

From June 1999 to February 2000, a few-metre mooring supporting a Seacat SBE16 (T/C accuracy-resolution of 0.01-0.001°C/ 0.001-0.0001 S.m^{-1}) was set at ~3505 dbar, ~25 km North-East of Ustica, as a preliminary survey to the deployment of the GEOSTAR observatory [1]. Both the temperature and salinity time series increased tremendously and almost continuously (fig. 1) by ~0.012°C/8 months and ~0.007psu /8 months. The idea that the 8-month trends reflected a several-year phenomenon is supported first by ship-handled SBE911+ profiles performed there ~4 years apart. The θ/S bottom values were ~12.90°C/~38.46psu (at 3470 dbar) in October 1996 and ~12.95°C/~38.48psu (at 3440 dbar) in September 2000. These isolated values are remarkably aligned with the SBE16 θ/S ones.

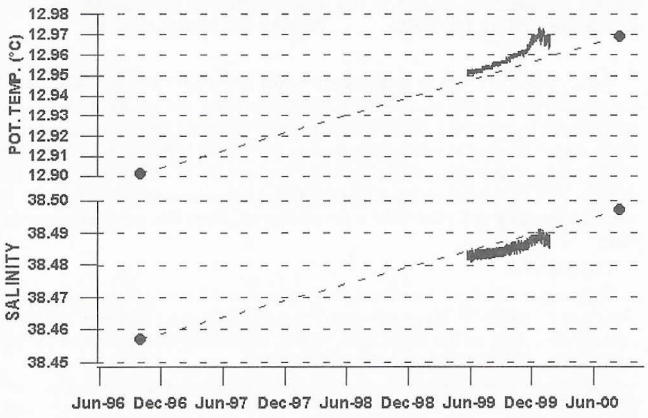

Fig. 1. θ-S time series from SBE16. Black dots: terminal values of 1996/2000 profiles.

Also, annual averages computed from the Medatlas database [2] reveal that the θ-S of the Tyrrhenian deep water (depth >3000m, TdeepW hereafter) increased continuously during the 1909-1990 period, with slopes comparable (few 0.01°C-0.01psu / decade) to those already reported for WMDW (Western Mediterranean Deep Water) in the Algero-Provençal Basin (*e.g.* [3]). Our observations complete the historical data and demonstrate that the θ-S of TDeepW markedly increased during the last decade, with slopes up to ~10 times greater than before (and than for WMDW now). Such dramatic trends put into light the question of the origin of TdeepW which cannot be considered as a mixture of waters having lower trends. Moreover, historical data clearly show that TdeepW has always been warmer (~0.1°C) and saltier (few ~0.01) than the WMDW inflowing from the deepest part of the Sardinia Channel (~2000m). θ-S diagrams show that TdeepW cannot be considered as a mixture of WMDW and waters originated from the Eastern Mediterranean. We hypothesise that TDeepW might be generated by a deep water formation (DWF) process within the Tyrrhenian.

Up to now, it has been demonstrated [4] that, due to strong (and cold, in winter) westerlies blowing through the Bonifacio Strait, the region east of the strait was occupied by a year-round cyclonic gyre, extending at depth and surrounding cold dense waters. Associated processes invoked by [4] are an upwelling that enhances mixing of MAW (Modified Atlantic Water) and LIW (Levantine Intermediate Water) below, making the region a privileged place for vertical exchanges between the different water masses. But, to our knowledge, DWF has never been said to occur there.

We think that the stratification and circulation described by [4] east of the Bonifacio Strait are very similar to what is encountered in the Gulf of Lions where WMDW is formed. We note, as shown by fig. 2, that the deep values of historical θ and S profiles east of the Bonifacio Strait (E9°-12°/N 41°-42°) display a striking continuity with the deepest Tyrrhenian values (depth >2000m), contrary to the profiles representative of the water which comes from the Algerian Basin or from the Eastern Mediterranean (profiles collected in regions E6°-10°/N37°-38° and E12°-14°, N38°-38.5°, resp.). We also note that TdeepW is warmer (+ ~0.1°C) than WMDW, which could be related to LIW east of the Bonifacio Strait being saltier than in the Gulf of Lions. We thus believe that these three features strongly support the hypothesis of DWF east of the Bonifacio Strait.

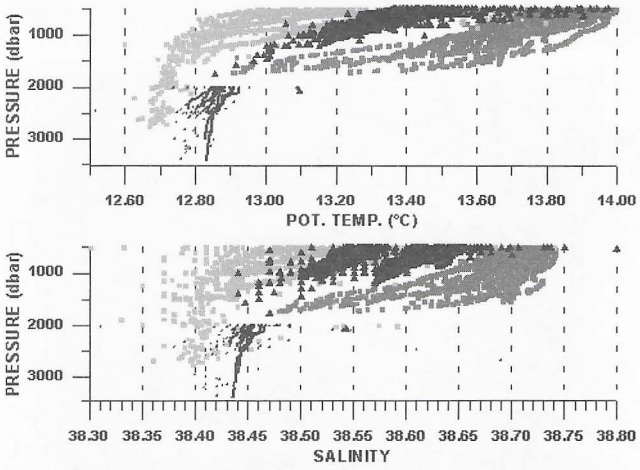

Fig. 2. θ and S profiles in the southeastern Algerian Basin (light grey squares), east of the Bonifacio Strait (black triangles), north Sicily (dark grey squares), and deep profiles (>2000m) in the central Tyrrhenian (thin dots).

References

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