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Along-path evolution of biogeochemical and carbonate system properties in the intermediate water of the Western Mediterranean

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It is well known that in the Mediterranean major oceanic processes may occur, of which the most important example is deep water formation (DWF) that sustains the basin-wide thermohaline circulation cell. This is also the main oceanic mechanism that sustains the physical carbon pump: once carbon dioxide is dissolved in surface water, it can enter into the ocean carbon cycle and be sequestered and transported to different depths and parts of the ocean thanks to the processes of DWF and thermohaline circulation. The deep waters that are formed via DWF have long residence times, thus trapping great parts of the anthropogenic carbon released to the atmosphere.

The most ubiquitous water mass of the Mediterranean Sea is the Intermediate Water (IW). It forms via salinification and densification of the surface waters in the Levantine Basin and in the Cretan Sea. After sinking to its equilibrium depth, the IW spreads throughout the whole Mediterranean Sea. The core of this water mass can be easily identified by its absolute maximum in salinity (and relative maximum in temperature), when looking at vertical profiles of these properties. While flowing back towards the Western Mediterranean (WMED), it tends to gradually lose its characteristics, due to dilution with adjacent water masses, becoming thus less salty and less warm. Not only salinity and temperature change along the IW path across the WMED, but also its biogeochemical and carbonate system properties: these non-conservative properties change also as a consequence of bio-chemical processes.

The aim of this investigation is to understand the evolution of physical (temperature, salinity), biogeochemical (AOU, nutrients and DOM) and carbonate system properties (TA, pH) of the IW along its pathway through the WMED, assessing the role of changes induced by physical mixing of the IW with adjacent water masses and those induced by biological and biochemical processes. To discriminate between the acting processes and assess their relative roles, a mixing analysis has been performed.

Along IW path the increase of AOU with age of the water mass indicates the preponderance of respiration over the production. The most important increase of AOU occurs while the IW enters and circulates within the Tyrrhenian Sea. In all other areas persistent strong hypoxic conditions are maintained with scarce changes. The decrease in TA is consistent with the change in salinity, as expected given the strong linear relationship between these two parameters, while the decrease of pH and the increases of the concentrations of the main inorganic nutrients (+77%, +34 and +26 %, for phosphates, nitrates and silicates, respectively) indicated an active remineralization of organic matter in this water mass. The process of acidification of IW also causes a shift of the carbonate equilibrium, toward more acidic species, and a decrease of the saturation state of calcite and aragonite, indicating a reduction of the oversaturation of these calcium carbonate minerals along IW path. The concomitant increase of the Revelle buffer factor suggest that this water is potentially less efficient to take up atmospheric CO_2 with aging.