EXPORT OF DISSOLVED ORGANIC CARBON TO DEEP WATERS IN WESTERN MEDITERRANEAN

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Abstract

Three deep water types were observed in Western Mediterranean Sea in Spring 2005 [1]. These waters showed different DOC concentrations, in relation to their formation site and their age. The highest DOC values (72-58 μM) found in the new WMDW, characterized by a higher amount of Atlantic water, confirm the relevance of the deep water formation processes in DOC export to the deep layers.

Keywords : Organic Matter, Deep Waters, Western Mediterranean.

Dissolved Organic Carbon (DOC) in the sea represents one of the major reservoir of organic carbon on the Earth [2]. In the past, the role of DOC in deep sea respiration has been underestimated, as demonstrated by Christensen et al. (1989) data on carbon oxidation [3]. They found in Western Mediterranean deep waters (WMDW) values of electronic transport systems (ETS) higher than those measured in the Oceans and proposed that DOC transport, during deep water formation, could rival the sinking particulate flux, in importance for deep-sea metabolism. In general, deep waters of Mediterranean Sea are characterized by higher DOC concentration than Oceans [4,5].

The goal of this work is to study the role of deep water formation in the carbon supply to the deep ecosystem in the Western Mediterranean Sea.

In spring 2005 a layer of newly formed WMDW was found in the bottom of Gulf of Lions, Balearic Sea, Algero-provençal basin and northern Algerian basin [1]. In particular three different water types with different physical and chemical characteristics were evidenced by the θ-S diagrams (figure 1): resident deep water (type A); newly formed, mainly of open sea origin (type B); newly formed, mainly of surface and costal origin (type C) [1]. DOC showed different concentrations in the core of each water type, with the lowest values (42$\pm$3 μM) in type A water, values of about 49$\pm$3 μM in type B water, and the highest values (65$\pm$8 μM) in type C water. Assuming 40 μM as the refractory DOC pool in Mediterranean Sea [4], we can deduce that the amount of semi-labile carbon, available for bacteria, was 39 % of DOC in type C water, 18% in type B water and only the 5% in type A water. Studying DOC spatial variation in the core of each water type, water A and B maintain their DOC concentration in all the transects, whereas DOC in type C water showed values of 72$\pm$4 μM in the Gulf of Lions and the Algero-Provençal basin and of 58$\pm$3 μM in the Balearic Sea and Algerian Basin, with a correspondent reduction of its semi-labile fraction from 44% to 31%. Type C water, which is characterized by a major portion of Atlantic water, was formed probably near to the coast, in a region characterized by high productivity [1]. For this reason a very high amount of DOC (>72 μM) may be exported to the deep layers. Moreover this water was characterized by a very high dissolved oxygen concentration (212 μM) suggesting that little organic matter has been consumed in its core, consequently, the amount of DOC found in this water may give a good estimation of DOC export to depth. The significant DOC spatial variation in the core of type C water may arise from the availability of high amount of semi-labile DOC for bacteria that can be consumed with a short temporal scale. The lowest DOC values found in type A water may be explained by the mineralization of almost all semi-labile DOC exported from the surface. This water in fact is an old resident deep water, as demonstrated by its lower content of DO (196 μM, fig.1). Surprisingly also the newly formed type B water was poorer in DOC than type C water (fig.1). This lower DOC content may be explained by the major contribution of LIW (poor in DOC) to type B water and by its probable formation site in the open ocean [5]. In conclusion, WMDW is an important source of Carbon for deep waters ecosystems, but the mechanism of deep waters formation and the DOC production-accumulation processes, occurring at surface, may affect the quantity and quality of DOC transported to the bottom. As the export of different amounts of semi-labile DOC to the bottom may be vital for deep waters ecosystem, DOC represents an important link between surface processes, deep water formation mechanisms and deep water metabolism.

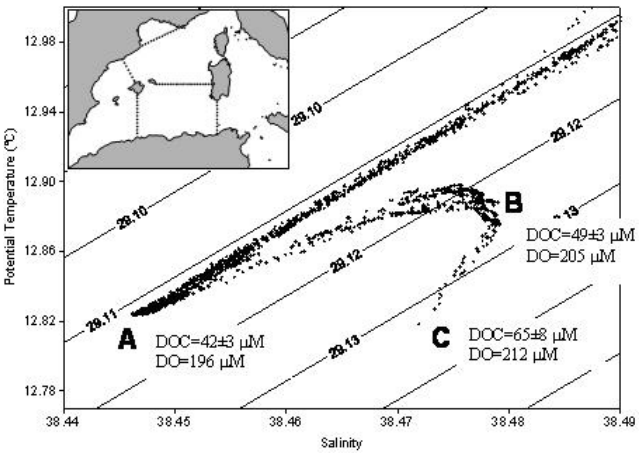

Fig. 1. θ-S diagram for deep layer of a representative section. Dissolved organic carbon (DOC) and dissolved oxygen (DO) mean concentrations, in the core of the different water types, are indicated on the diagram. Study area and sampling stations are indicated in the map on the left.

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