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The Impact of the December 2003 Catastrophic Storm on Near Bottom Particle Fluxes at Canyon Heads in the Gulf of Lions

J. Fabres (1), S. Miserocchi (2), S. Heussner (3), A.M. Calafat (1), D. Zúñiga (1), M. Canals (1), T. Tesi (2), P. Puig (3), A. Palanques (3), X. Durrieu de Madron (4)

(1) GRC Geociències Marines, Universitat de Barcelona, Spain

(2) Istituto Scienze Marine CNR, Sezione di Geologia Marina, Italy

(3) Centre de Formation et de Recherche sur l'Environment Marin, University of Perpignan, France

(4) Institut de Ciències del Mar, CSIC, Spain (joan@geo.ub.es / Fax: +34 934021340 / Phone: +34 934021369)

The role of Gulf the of Lions canyons in the transfer of matter from the shelf to the slope and basin, and the controlling factors of such process, are not fully understood yet. In order to improve our knowledge a set of moorings with sediment traps at 30 m above the sea floor was deployed at 300 m depth in the head of seven of these canyons between November 2003 and May 2004.

With the exception of the lower values recorded in the Aude canyon, the analysis of the sediment trap samples collected during the first sampling period (11/03-02/04) allowed to identify a clear increasing tendency in averaged total mass fluxes from the NE (3 $g \cdot m^{-2} \cdot d^{-1}$ in Planier canyon) towards the SW (25 $g \cdot m^{-2} \cdot d^{-1}$ in Lacaze-Duthier canyon) only broken by. This NE-SW increasing tendency agrees well with the fine sediment dispersion models that predicted a preferential arrival of particles to the SW canyons due to the general southwestward circulation of water over the shelf.

Regarding temporal evolution, the most outstanding feature are the maximum particle fluxes recorded between the 1st and the 7th of December at all monitored canyons. Maximum fluxes reached values of up to 110 $g \cdot m^{-2} \cdot d^{-1}$ in the Lacaze-Duthiers canyon. Those values are up to nine times the average values for the rest of the studied

period. Some other canyons, like Hérault and Petit Rhône in the central Gulf of Lions also recorded increased fluxes (67 and 32 $g{\cdot}m^{-2}{\cdot}d^{-1}$) that are from 3 to 8 times the average fluxes for the rest of the period. Finally, the fluxes recorded in canyon heads to the east of the Rhône River mouth (Planier Canyon) recorded only a faint increase, with maximum values around 6 $g{\cdot}m^{-2}{\cdot}d^{-1}$, representing only twice the average values for the rest of the period. These increased fluxes are concomitant with a major storm that swiped southern France and the Gulf of Lions between 30^{th} November and 4^{th} December. This storm was accompanied by heavy rainfall that extended for more than 48 hours in some areas of the Rhone Valley and by very intense winds over the gulf of Lions during the 3^{rd} December and the night of the 4^{th}. Extended heavy rainfall over an area that had already been receiving abundant precipitations since early autumn caused an important increase in river discharges with peak discharges of the Rhône river above 10000 $m^3{\cdot}s^{-1}$. Increased particle fluxes at canyon heads have been related with the very intense winds or the combination of very intense winds with increased river discharge. Increased river discharge on its own seems not to be sufficient to trigger increased particle fluxes at the heads of the canyons as increased Rhône discharges recorded during the 3^{rd} and 4^{th} week of January and with similar values to those recorded during the December event did not have a clear impact on the total mass fluxes.

Geochemical analysis results highlight the differences between particle fluxes in canyons east and west of the Rhône River mouth already noticed from the analyses of total mass fluxes. While lithogenic, carbonate and organic carbon fraction account for 57%, 37% and 2.4%, respectively, in the Planier Canyon they account for approximately 66%, 31% and 1.4%, respectively, in the southwestern canyons. These differences imply different source areas for the particles transferred through such canyons.

Geochemical analysis results also reveal that particles delivered to the canyon heads during maximum flux periods are poorer in organic matter and richer in calcium carbonate that the ones corresponding to background fluxes. Furthermore, the δ^{13}C values for the first period in the Planier canyon samples are homogenous ranging from –22.25 to –22.805 per mil with almost no temporal variability while in the Lacaze-Duthiers canyon, values range from –22.5 to –23.94 with the lowest value corresponding to the maximum flux recorded during the floods. The lower values recorded in Lacaze Duthiers canyon and, especially, the minimum recorded during the storm, can be regarded as an indication of an enhanced transfer of organic matter of terrestrial origin through the southwestern canyons during exceptional stormy conditions.

The drastic increase in total mass and carbon fluxes during catastrophic flood events implies a significant increase in the amount of carbon transferred from continental watersheds and shallow areas towards the adjacent deep basins. Therefore, if the impact

of flood events would be taken into account, some of the figures involved in global carbon budgets may change significantly even if the recurrence period of such events is in the order of tens to hundreds of years.