

Transport of soil organic matter to the ocean by flood events

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With a warmer climate, the possibility of increased precipitation intensity and variability is projected to increase the risks of extreme events such as floods. In this perspective, many countries located in temperate and tropical zones are highly vulnerable to such extreme events, exposing their coastal areas and their dense population to dramatic human and economic consequences. Continuous paleoflood (floods in the past) records beyond the instrumental period are rare or too short to assess variations in natural flood occurrence related to climate changes. Our results from the Têt watershed (France) and the Gulf of Lions (NW Mediterranean) show that the BIT (Branched and Isoprenoid Tetraether) index, indicator of soil input from land into the ocean, has a potential for tracing flood events occurred in the past and thus for providing paleoflood records on geological scales.

Instrumental records of water discharge are too short and fall within the period of suggested strong human impact on natural conditions (after industrial evolution). Study of paleohydrological responses to past global climate changes can provide valuable information to indicate the potential impact of the present greenhouse global climate change and thereby contribute to the design of strategies for water and risk management. Therefore, a large range of tools and analytical techniques have been developed to extend hydrological data beyond the instrumental period (18th century) on historical and geological scales. However, reconstructions of paleohydrological changes on land are still challenging.

As a new means for estimation of the rel-

ative amounts of fluvial derived terrestrial organic matter (OM) in marine sediments, the BIT index has been introduced by our department. This index is based on a group of specific lipid compounds derived from presumably anaerobic bacteria which are omnipresent in soils and a structurally related "crenarchaeol" predominantly produced by marine planktonic Crenarchaeota (Fig. 1). The BIT index varies between 0 and 1, representing marine and terrestrial organic matter, respectively.

We determined the temporal and spatial distribution patterns of the concentration of soil-derived lipids and the BIT index, by analyzing soils from the Têt watershed (France), suspended particulate matter in water of the Têt River, and sediment trap material and surface sedi-

ments from the Gulf of Lions (NW Mediterranean) into which the Têt and Rhône rivers flow out.

Our studies carried out in the Têt watershed (Southern France) show that variations in concentration of soil-derived lipids are closely related to water and sediment discharges depicting the flood events (Fig. 2). The average BIT value of suspended particles in the Têt River (0.85, terrestrial organic matter) was substantially higher than that of the offshore seawater (<0.01, marine organic matter). Soils from the Têt watershed reveal a heterogeneous distribution pattern of BIT index, varying between 0.2 and 1.0, with an average BIT value of 0.84 ± 0.14 (n=58). The pH of soil is the major factor controlling the Têt soil BIT distribution. Marine surface sediment studies in the Gulf of Lions show that the BIT values are higher along the coast in comparison to offshore values, especially in the Rhône prodelta area (Fig. 3). Applications of the BIT index to marine surface sediments show that values of the BIT index are also much higher along the coast than those from the outer shelf and the continental slope. Consequently, soil organic matter estimates based on the BIT index are higher along the coast, while those from the outer shelf and the continental slope are lower. Remarkably, the spatial distribution pattern of the BIT index is similar to the MODIS (Moderate Resolution Imaging Spectroradiometer) true colour

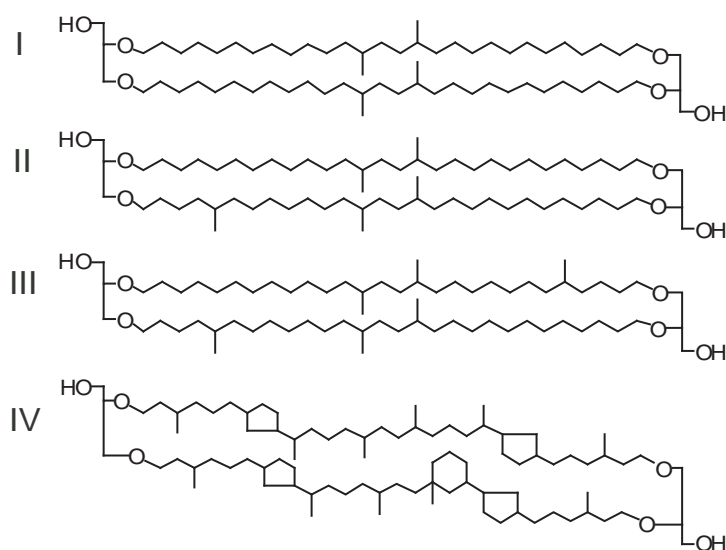


Fig. 1. Chemical structures of the branched glycerol dialkyl glycerol tetraethers (GDGTs) (I to III) and crenarchaeol (IV). The BIT-index is defined as $[I+II+III] / [I+II+III+IV]$.

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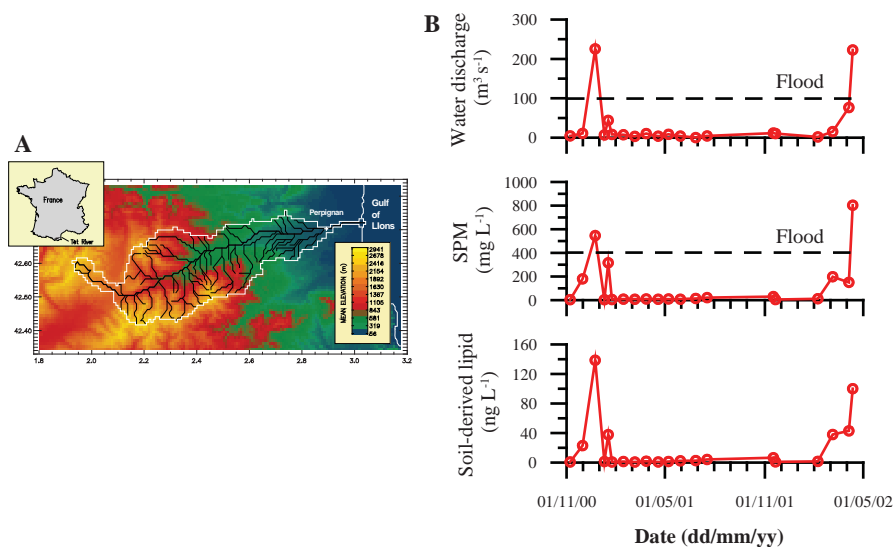


Fig. 2. A. Map of the Têt River catchment area showing the water sampling station (Perpignan) and B) water discharge in $m^3 s^{-1}$, suspended particulate matter (SPM) in $mg L^{-1}$, and sum of soil-derived lipid concentration in $ng L^{-1}$.

image of the Gulf of Lions showing across and along-shelf dispersion of the river plumes during a flood event occurred in December 2003. This suggests that soil organic matter inputs from land to the sea are the main controlling factor of the soil-derived lipid concentrations and the BIT index in this river-dominated continental margin.

Conclusion

Our results from the Têt watershed (France) and the Gulf of Lions (NW Mediterranean) show that soil-derived lipids produced by bacteria are transported from land to the ocean via rivers and the BIT index has potential as a tool to trace paleoflood events.

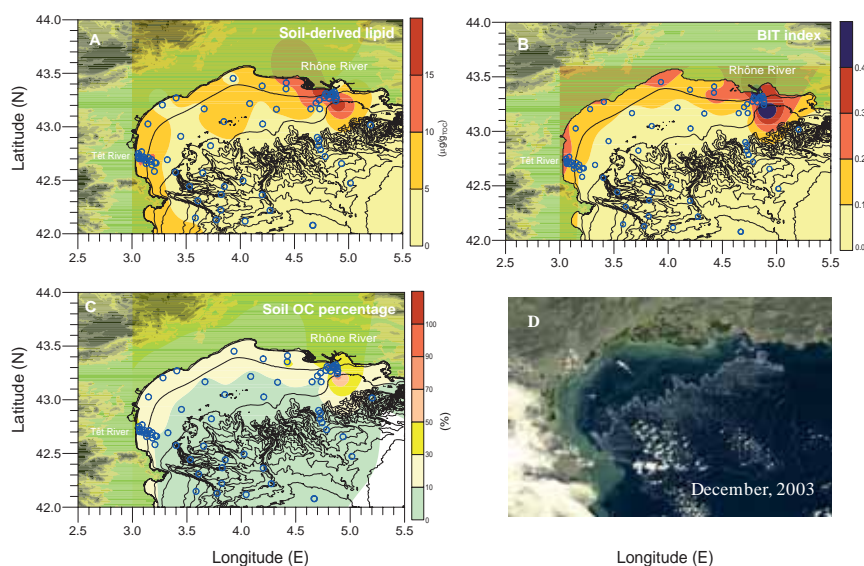


Fig. 3. Spatial distribution patterns of A) the summed soil-derived lipid concentration in $\mu g gTOC^{-1}$, B) BIT values, and C) calculated soil OC percentages using two end-member modelling in the Gulf of Lions, and D) MODIS image of the Gulf of Lions showing across and along-shelf dispersion of the river plumes occurred in December, 2003 (Guillén et al., 2006). Blue circles indicate sample locations.