Influences of tropical monsoon climatology on the delivery and dispersal of organic carbon over the Upper Gulf of Thailand

Bin Wu[1, 2], Xiaodan Wu[2, 3], Xuefa Shi[1, 2]*, Shuqing Qiao[1, 2], Shengfa Liu[1, 2], Limin Hu[1, 2], Jihua Liu[1, 2], Yazhi Bai[1, 2], Aimei Zhu[1, 2], Narumol Kornkanitnan[4], Somkiat Khokiattiwong[4]

[1] Key Laboratory of Marine Sedimentology and Environmental Geology, First Institute of Oceanography, Ministry of Natural Resources, Qingdao 266061, P. R. China.
[2] Laboratory for Marine Geology, Qingdao National Oceanography Laboratory for Marine Science and Technology, Qingdao 266061, P. R. China.
[3] CAS Key Laboratory of Marine Geology and Environment, Institute of Oceanology, Chinese Academy of Sciences, Qingdao 266071, P. R. China.
[4] Marine and Coastal Resources Research and Development Institute, Department of Marine and Coastal Resources, Bangkok 10210, Thailand.

1. Introduction

Organic carbon in fluvial sediment is recognized as an important negative feedback to the rising atmospheric CO_2 during sedimentary deposition in the ocean margins for long timescales. Organic carbon burial in the fluvial-to-marine transition system is therefore highly underscored. Organic carbon cycling in SE Asia is data-sparse and poorly studied, although high sediment yield and organic carbon intensity occur in the tropical region. In this study, we extensively investigated the organic carbon dynamics in the suspended particulate matter and surface sediment in the land-sea continuum by linking the hydrological conditions and sedimentary processes during two contrasting monsoon climate campaigns in the Upper Gulf of Thailand (UGoT) (Fig.1a). The present study aims to evaluate the seasonal shift of monsoon climatology, in terms of precipitation, fluvial discharge, currents and water stratification on the biogeochemical cycling of organic carbon in the tropical coastal system.

2. Materials and Methods

Samples were collected in the UGoT during two alternating monsoon seasons: the NEM period (November 2013, January 2014) and the SWM period (July 2014, September 2014), under the framework of China-Thailand cooperation on marine science. Twenty stations were sampled for total suspended matter (TSM) and surface sediment distributing in 10 transects over the investigated area (Fig.1b) by the Thai colleagues. Sample preparation and chemical analysis (elemental C, N and $\delta^{13}C$ etc.) were carried out at the Key Laboratory of Marine Geology and Metallogeny, MNR, China.

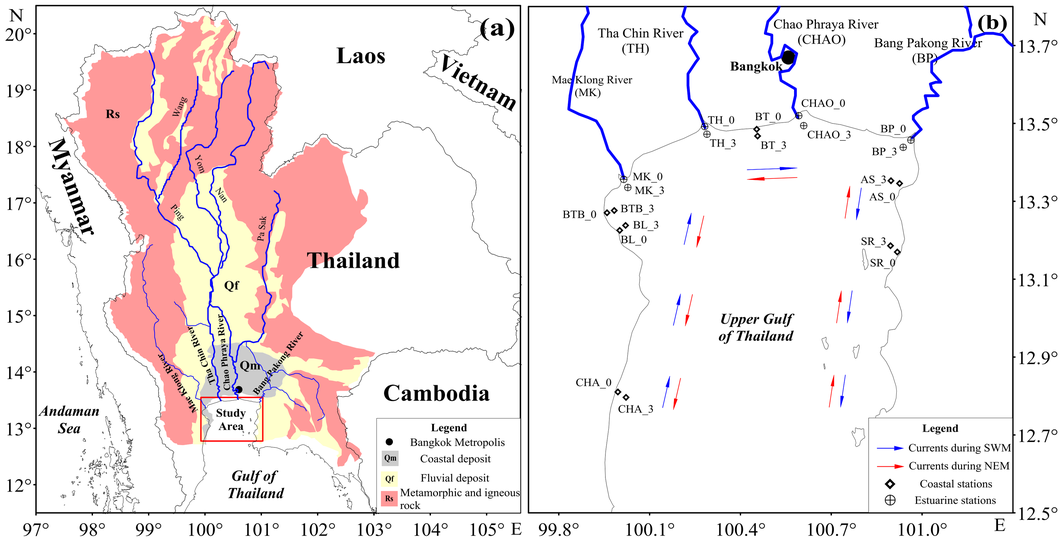

Fig.1 Study area (a) and sampling sites (b)

3. Results and discussion

3.1 The influences of precipitation and river influx on the organic carbon delivery

This study demonstrates that POC is closely correlated with the TSM (Fig.3c), which is generally regulated by the local rainfall (Fig.2). Higher POC is found near the large estuarine section during SWM and the small estuarine section during November 2013 when tropical cyclones impacted (Fig.3a). Land-derived organic matter prevails in the small estuarine and coastal sections, while marine-derived organic matter dominates in the estuarine sections impacted by CHAO and MK (Fig.3d).

TOC however displays less significant seasonal monsoon variations than POC (Fig.3b). It tends to accumulate in the sub-silt fraction of sediments (Fig.3f), which mainly occurs in the small estuarine and eastern coastal sections and is more obviously influenced by marine-derived factors (Fig.3e).

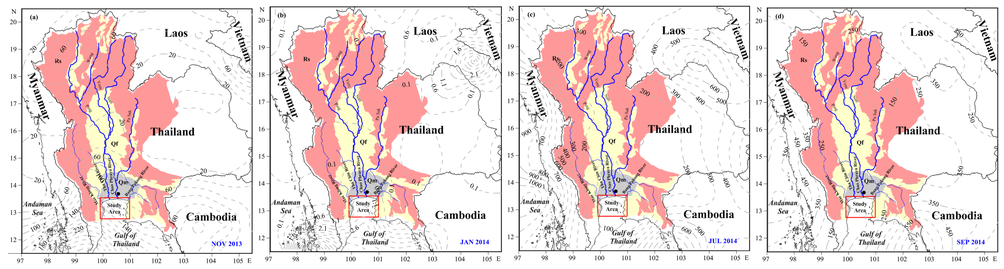

Fig.2 Monthly total precipitation (mm) in Thailand during four sampling campaigns during 2013 and 2014

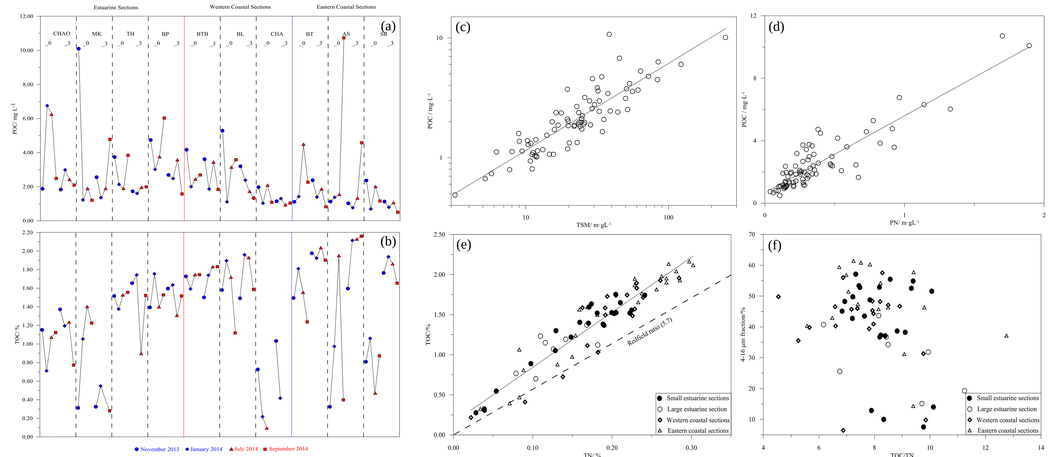

Fig.3 Spatiotemporal variations of (a) POC, (b) TOC, and plots of (c) POC *vs.* TSM, (d) POC *vs.* PN, (e) TOC *vs.* TN and (f) TOC/TN *vs.* 4-16μm

3.2 The influences of currents and stratification on the dispersal and burial of organic carbon

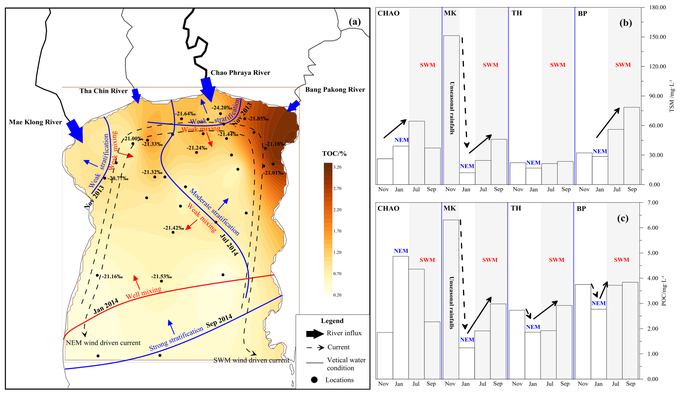

Fig.4 Seasonal shifts of surface current and vertical water stratification associated with the blocking effect of organic carbon, illustrated by the distribution of TOC and $\delta^{13}C$ over the UGoT. Variations of estuarine section of (b) TSM, and (c) POC during the tropical cyclones impacted, NEM and SWM periods. TOC and POC content are the average values for each estuarine section

The seasonal shift of monsoon winds leads to the rainfall heterogeneity in the river basins, resulting in distinctive river export of POC among rivers and seasons (Fig.4b, c). The almost year round water stratification acts as the barrier in retaining OC in the estuaries and their vicinities from dispersal into the lower GoT, as indicated by TOC and $\delta^{13}C$ distribution (Fig.4a). High sedimentation rate further facilitates the OC burial in the estuarine area (Fig.4a).

4. Conclusions

The delivery, dispersal and burial of OC are closely associated with the climate-controlled precipitation, and thus the tropical monsoon climatology under the global warming in particular is an important factor influencing OC in the UGoT.

Note: This study has been published in the journal of *Marine Geology* and details can be seen in Wu et al. (2020) (https://doi.org/10.1016/j.margeo.2020.106209)