In order to answer to these scientific questions, we carried out a study on several benthic foraminiferal species by combining different geochemical signals: elemental ratios (Mg/Ca and B/Ca as proxies for deep-water temperature and carbonate ion concentration, respectively) and stable isotopes (δ¹³C, δ¹⁸O and δ¹¹B as proxies for benthic foraminiferal microhabitats, vital effect and seawater pH, respectively). We selected the studied sites following different sedimentary contexts of good CaCO₃ preservation (Bay of Biscay; Bay of Bengal at water depths above 2500m), CaCO₃ dissolution (Bay of Bengal at water depths below 2500m) and precipitation of authigenic minerals inside the sediment (Mediterranean Sea). By studying modern samples, we documented the vital effect on geochemical signals versus the environmental influence in the Bay of Bengal (Haddam et al., In prep., Fig.1) and in the Bay of Biscay (M. Tribonseau and O. Nguyen-Thuyet Master research courses). By studying fossil specimens, we assessed the evolution of the geochemical signal in the past in the Arabian Sea (Sepulcre et al., to be submitted). We also tested B/Ca and δ¹¹B analysis on modern samples (Fig. 2).

**Comments on figure 1:**

Benthic foraminiferal assemblages (fossil and live-stained) were determined on 6 stations covering 2,140 to 2,608 m of water depths in the Bay of Bengal and from 0 to 10cm depth inside the sediment. Stable isotopes (only results from MONO3 station are presented on Fig. 1) were measured on selected species (*Anomalinooides globulosus*, *Epistominella exigua*, *Fontbotia wuellerstorfi*, *Globobulimina pacifica*, *Hoeglundina elegans*, *Melonis pompiloides*, *Oridorsalis umbonatus*). To summarize (see all results and discussion in Haddam et al., in prep.), the main results are that faunal assemblages are directly controlled by the seasonal monsoon, through the amount and distribution of nutri-
ments and sedimentation processes (inputs of sediments and of detrital organic Carbon) inside the Bay of Bengal. The $\delta^{13}$C measurements allow to determine: i) the microhabitat effect between epifaunal (F. wuellerstorfi) and endoфаunal (O. umbonatus) species and ii) the seasonality in the Carbon inputs, by comparing the opportunistic species E. exigua (epifaunal) with F. wuellerstorfi. The comparison between the $\delta^{18}$O of the different species shows that the vital effect of O. umbonatus is less pronounced than that of F. wuellerstorfi (of about 0.7 and 1.2‰, respectively, average values for all stations). These results are important since F. wuellerstorfi are not always available in paleoceanographic records, and show that O. umbonatus could be used to construct isotopic stratigraphy. Finally, no size effect were observed in the results. The preliminary study of sediment cores from the Bay of Bengal has shown that only few benthic foraminifera specimens are available, preventing the bulk geochemical analysis. However, the microscale analysis for the study of the diageneric effect on the geochemical signals are possible and are planned in the next few months.

Figure 2: a) B/Ca and b) $\delta^{11}$B of modern benthic foraminifera Ammonia aguil from the Bay of Biscay.

Comments on figure 2:
We performed analytical tests on modern benthic foraminifera Ammonia aguil from the Bay of Biscay, in order to assess our preparation protocols and instrumental settings. The B/Ca results are in good agreement with expected values and reproducibility, giving confidence into our analytical methods. Elemental ratio analysis are currently performed on 5 selected species (epifaunal Hyalina balthica and Hoeglundina elegans, shallow infaunal Uvigerina mediterranea and U. peregrina, deep infaunal Globobulimina species) along a transect in the Bay of Biscay (10 stations from 250 to 200m of water depth) during the Master II research course of M. Tribondeau. In order to assess the validity of the calibrations obtained on the modern specimens, fossil samples from marine sediment core SU81-47 (44°53N-3°18W, 3300m) will be studied by M. Tribondeau and by O. Nguyen-Thuyet (Master I research course). In this context, we should not have any diageneric effect and thus we will assess environmental controls. However, some specimens clearly show dissolution (e.g., test fragmentation or perforation): these individuals have been withdrawn for the bulk geochemical analysis but are kept for the microscale analysis, in order to evaluate the dissolution impact on the geochemical signal.

Future of the project:
The collaborations initiated in the framework of the GeoFoBe project have been successful, and we all consider that this work has to continue. Thus, a project will be submitted to the ANR and to the ERC in the future.

Nombre de publications, de communications et de thèses

Master courses:
Nguyen-Thuyet O, Reconstitution des températures des eaux profondes de l’Atlantique à partir de l’analyse géochimique de foraminifères benthiques, Master I research course, 05-06/2015, under the supervision of Sepulcre S. and F. Bassinot.

Tribondeau M., Répartition et géochimie des foraminifères benthiques dans les sédiments du Golfe de Gascogne : vers une meilleure compréhension des trajects des changements climatiques, Master II research course, 02-06/2015, under the supervision of Sepulcre S., Nardelli M. P., and F. Bassinot.

Haddam N., Répartition (assemblages) et géochimie des foraminifères benthiques dans les sédiments du Golfe du Bengale : liens avec les contraintes environnementales (Corg, T°) et la géochimie des eaux interstitielles, Master II research course, 02-06/2013, under the supervision of Sepulcre S., Licari L., and F. Bassinot.

Communications and publications:
Sepulcre S., Vidal L., Bassinot F., and E. Bard, Assessing the stable carbon isotope records of multiple species of benthic foraminifera to reconstruct past changes in deep and pore water composition over the past 450 ka in the Indian Ocean, To be submitted to Paleoceanography.


Sepulcre, S., Etude de la signature géochimique en Bore (B/Ca, $\delta^{11}$B) et Magnésium (Mg/Ca) de foraminifères benthiques actuels et fossiles à différentes échelles d’analyse, Journées Climat et Impact, Orsay, Poster, 19-20/11/12.