Planktic foraminifera ecology in marginal basins

H. Howa, R. Schiebel, T. Kuhnt, S. Retailleau, M. Siccha

La dynamique des populations de foraminifères planctoniques (PF) est suivie pour la première fois de façon saisonnière et pluriannuelle dans un bassin océanique marginal : le Sud-Est du Golfe de Gascogne. L'échantillonnage des populations vivantes par filet à plancton stratifié a été réalisé en simultané avec les mesures des caractéristiques physico-chimiques de la colonne d'eau (température, salinité, O_2, Chlorophylle a, nutriments, pH et turbidité). La quantification des flux de tests de PF, depuis la zone de production de surface jusque dans les fonds océaniques, a été effectuée grâce au déploiement sur 3 ans de pièges à sédiments. Grâce à cette base de données, l'influence continentale (apports fluviatiles, effet de la bathymétrie, hydrodynamique) sur la dynamique des populations de PF et les flux exportés a pu être caractérisée en domaine de marge continentale.

1. Regional and seasonal variability of PF assemblages in the Bay of Biscay: Onshore-offshore effects

PF population dynamics in the south-eastern Bay of Biscay (SE BoB) is analysed along an offshore–onshore transect, sampled nine times in six years. Basically, PF population dynamoics is strongly related to food availability (Fig. 1). Offshore, highest PF abundances are linked to seasonally enhanced primary production, due to spring phytoplankton bloom events [2]. The rapid and localized response of PF underlines the heterogeneity in primary production (patchiness). At a temporal and spatial resolution of 3 hours and approximately 1 km, the PF fluxes vary with a factor of 5 [4]. Through the year, the dominant species, *Globigerina bulloides* and *Neogloboquadrina incompta*, migrate vertically to follow the chlorophyll maximum that shifts from the sea surface (spring) to ~100 m water depth (summer, autumn) [2].
Onshore, PF production may indirectly benefit from nutrients/organic matter supplied to coastal waters by river discharge, for instance from the Adour River, and/or responds to mesoscale upwelling events induced by topography, such as the head of Capbreton Canyon [3]. In addition, under the influence of river plumes, PF population dynamics is negatively affected by seawater turbidity whereas low salinity seems to have no impact on the distribution of PF. In the SE BoB, the indigenous FP population is not related to sea-surface temperature [2,3].

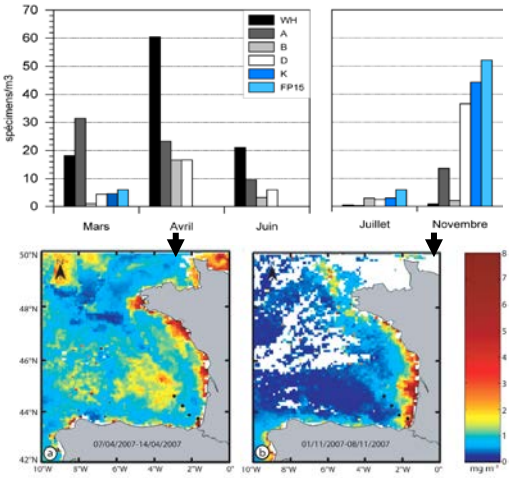

Fig. 1: Standing stocks of living PF; SeaWiFs© satellite image with Chlorophyll-a concentration (mg/m^3): a) in April and b) in November.

2. Flux dynamics of PF tests in the southeastern Bay of Biscay

Fluxes of PF species (tests >150 µm) were analysed for temporal and water depth related dynamics in the SE BoB by means of sediment traps deployed for three years at two offshore stations. Analyses of PF test fluxes and current velocities reveal interfering downward flux and lateral flux, respectively due to (1) seasonal PF production in surface waters, and (2) subsurface hydrology, sediment reworking and particle advection [1]. Major changes in PF fluxes to the deep ocean reflect changes in the seasonal production of PF, and are closely coupled to seasonal changes in trophic conditions at the surface ocean.

At 800 m water depth, PF fluxes show seasonal maxima in spring and minima from late summer to winter. The total mass flux could be quantitatively modified by dilution from laterally advected particles conveyed by intense and sporadic mesoscale hydrologic activity (eddy formation; Fig. 2).

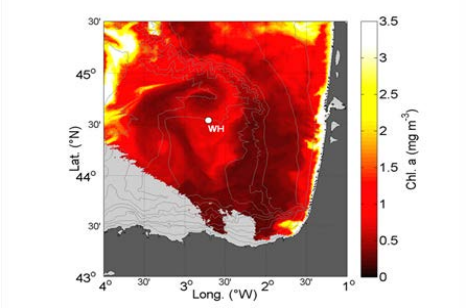

Fig. 2: Satellite image (Aqua MODIS ©) of the SE BoB, showing changing chlorophyll-*a* concentration over an eddy close to Station WH (http://oceancolor.gsfc.nasa.gov/).

At 1700 m water depth, seasonal variability of the PF fluxes is less well pronounced. Sporadic increases in PF test fluxes, which co-occur mainly during winter with an input of benthic foraminifer tests and enhanced ^{210}Pb budgets (^{210}Pb F/P ratios), are indicative of frequent lateral advection. Decoupled mass and PF fluxes between sediment traps at 800 m and 1700 m suggest that stratification of the water column affects particle flux dynamics. Possible energy sources for offshore transport of particles, and consequent lateral advection at depth are hydrological structures such as intermediate nepheloid layers detaching from the shelf-break and upper continental slope. Energy sources for sediment resuspen-sion are tidal energy rays, which reach the shelf edge and upper continental slope of the SE BoB at a low angle (Fig. 3).

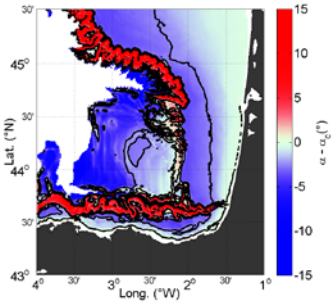

Fig. 3: Angle between sea floor slope (α) and direction of tidal energy rays (α_c) in the SE BoB (provided by SHOM).

Significant lateral transport super-imposed on the downward mass flux need therefore to be considered when assessing production and transport of PF tests to the deep ocean in continental margin regions.

Collaborations

EPOC Bordeaux I (F. Eynaud, S. Schmidt); UBO/IFREMER, Brest (L. Marié); LSCE, Gif /Yvette (E. Michel)

Associated publications

1- Kuhnt T., Howa H., Schmidt S., Marié L., **Schiebel R.**, 2013. Flux dynamics of PF tests at a hemipelagic site of the inner Bay of Biscay (NE Atlantic margin). *Journal of Marine Systems*, 109-110, S169-S181.

2- Retailleau S., Schiebel R., Howa H., 2011. Population dynamics of living PF in the hemipelagic SE BoB. *Marine Micropaleontology.* 80/3, 89-100.

3- Retailleau S., Eynaud F., Mary Y., **Schiebel R., Howa H.**, 2012. Canyon heads and river plumes: how might they influence neritic PF communities in the SE Bay of Biscay? *Journal of Foraminiferal Research*, 42/3, 257-269.

4- Siccha M., Schiebel R., Schmidt S., **Howa H.**, 2012. Short-term and small scale variability in PF test flux in the Bay of Biscay. *Deep-Sea Research I*, 64, 146-156.