

Reconstructing palaeo-circulation: Reading sediment drifts with the aid of IODP information

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Abstract

Concern about the observed changes in climate has resulted in growing research on climate and coupled ocean-atmosphere interactions. This led to numerous studies of the modern and ancient global ocean Thermohaline Circulation (THC), which is closely linked to the earth's climate. Via the upper branch of the THC the surface ocean stores and transports heat and freshwater around the globe. It interacts with the overlying atmosphere through surface fluxes of heat and freshwater. The compensating counterpart is the deep ocean circulation. The surface and the deep circulation are connected via deep-water formation in high latitudes and Southern Ocean upwelling. North Atlantic Deep Water (NADW) formation is the main driving mechanism for the North Atlantic branch of the THC, and Antarctic Bottomwater (AABW) for the Southern Ocean branch. Thus, NADW and AABW production and circulation are of highest importance for the global THC and the global climate.

THC-driven bottom currents and their related deposits, generally termed sediment drifts, gained an increasing amount of attention during the last decades. This is due to the fact that drift deposits contain a record of palaeoenvironmental information about climate development and oceanography, and this archive is hence used to gain knowledge on the palaeoclimatic development of a certain region. Sediment drift refers to larger sediment deposits with an often complex internal architecture, which are generated by persistent currents of thermohaline origin. Transport, erosion and deposition of sedimentary particles are fundamental processes in the benthic boundary layer because they represent the link between oceanographic processes in the water column and the documentation of these processes in the sedimentary record. Sedimentary structures and textures hence constitute archives of the depositional and re-depositional environment and processes. By an inversion of those features into the generating process, the analysis of sedimentary structures can lead to a deciphering of the acting oceanographic conditions and, thus, to a better understanding of the development of both oceanographic currents and the climate in a particular area.

By drilling sediment drifts along the pathways of the THC water masses IODP has provided both direct information on modifications of climate as well as indirect proxies for changes in the oceanic circulation. Using this information in combination with seismic reflection data and numerical simulations we are able to study changes in the circulation of a particular region both chronologically and spatially to provide necessary pieces for understanding the puzzle of climate modifications.