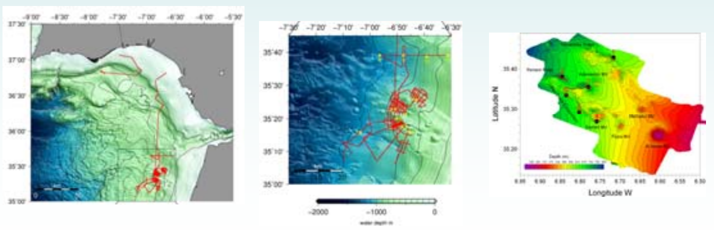
Hydrographic Institute contribution for the COMIC Ghent University cruise on Moroccan and Iberian Margins

Martins, I.; Vitorino J., Instituto Hidrográfico, marina.martins@hidrografico.pt
Vandorpe, T.; Van Rooij D., RCMG, Ghent University

In May/June 2013, the Instituto Hidrográfico (IHPT) joined a multi-disciplinary survey off the NW Moroccan Atlantic Margin, on board of the R/V "Belgica. This cruise (labeled "*COMIC - Comparative study of Plio-Pleistocene contourite drift evolution along the Moroccan and Iberian margins of the Gulf of Cadiz*") focused, among others, on the sedimentary and palaeoceanographic history of the southern Gulf of Cádiz and Moroccan Margin, specifically the region of El Arraiche mud volcano filed (EA MV) and around the Pen Duick escarpment (PDE). This mud volcano field consists of 8 mud volcanoes in water depths between 200m and 700m (Van Rensbergen et al, 2005).



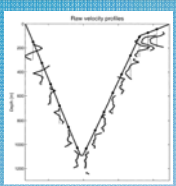
Left and centre: Map of seismic lines (red) and CTD/LADCP stations (yellow stars) acquired at PenDuick region (RV Belgica 2013/16 Cruise report). Right: Detailed bathymetric map of EA MV field (provided by UGhent), with position of CTD/LADCP stations discussed in this paper (with exception of station 7) and along-topography direction at each station location.

IHPT participation aimed not only to extend the data set of physical oceanography measurements available for this area, and by so to contribute to improve our understanding of the processes playing a role there, but also intended to evaluated the add value of including some of the observation methods that IHPT presently uses (LADCP and VMADCP) as contributions to a mission that was not dedicated to the physical oceanography component, in an opportunistic perspective.

The LADCP system used consisted in a 300 kHz broadband RDI ADCP from IHPT, installed in a downward looking configuration and mounted in the lower frame of the R/V "Belgica" Rosette/CTD structure, a Seabird SBE 9 plus CTD probe, equipped with pressure, temperature, conductivity and dissolved oxygen sensors, coupled to a General Oceanic rosette firing system equipped with 12 sampling bottles of 10 litre each. The LADCP was configured to operate with 45 cells of 5m each, an ensemble interval of 2s with 3 pings per ensemble. This configuration allowed to reach 91m of maximum range, a blank distance of 1.76m and 1.64cm/s of standard deviation.

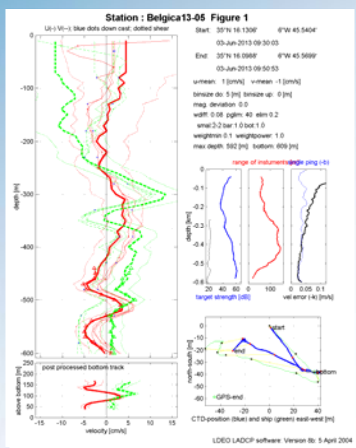
Rosette/CTD/LADCP structure used on the cruise

Data was processed with LDEO LADCP processing software, developed by Martin Visbeck, using the velocity inversion method (Visbeck, 2002; Thurnherr, 2011).

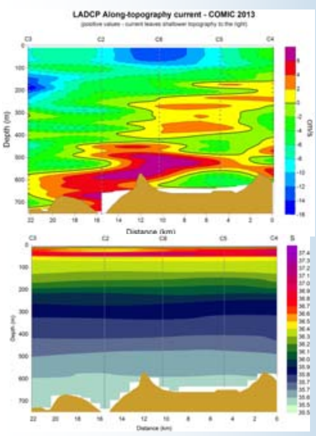


LADCP velocity profiling – an idealized LADCP cast in the depth/time dimension. The solid line represents the CTD depth as a function of time descending from the surface to the bottom and back to the surface. The shorter thick lines are examples of individual ADCP profiles with an unknown CTD velocity removed. The assumption behind the LADCP method is that one can use successive overlaping velocity profiles, which individually cover only a small fraction of the water collumn, to obtain the full ocean depth velocity profile (Visbeck, 2002).

An example of the capacities of the LADCP processing software used is presented in figure on the right, which corresponds to the processing of data collected in station 5. Besides the presentation of the full solutions of velocities with error bars, the processing also provides a comparison with the current solution calculated with the (alternative) shear method, and the bottom-track solution. As an evaluation of the bottom track procedure, the processing also displays a comparison of the ship and instrument drift during cast (bottom-left).



LADCP eastward (red) and northward (green) velocities of COMIC 2013 stations 5.

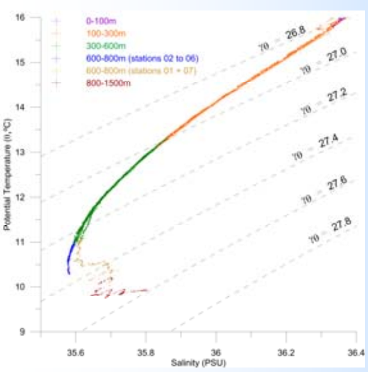


LADCP current (above) and salinity (below) sections along topography of COMIC 2013 stations 4, 5, 6, 2 and 3.

To construct the section, the LADCP current profile measured at each CTD/LADCP station was decomposed in a coordinate system with axis aligned along and across the local topography The along-topography current was taken as positive when flowing in the direction that leaves shallower topography to the right.

The LADCP profile corresponds to an instantaneous image of different processes (e.g subinertial currents, internal tides and waves) with different time and spatial scales, that all add to build the total current profile. Additional observations (e.g currentmeter measurements, repeated CTD casts) are required to evaluate the role of each one of these contributions.

However, the penetration of the AAIW water along the slope that was expressed in the CTD profiles is consistent with the presence of a poleward slope circulation that continues along the PDE flank. So the image build with this data and presented in the along topography section suggests to express in large measure the subinertial flow along the PDE and Renard Ridge area.



θ-S diagram of the COMIC2013/16 CTD stations. The colour indicates the depth range. Two colour options were used to depth range 600-800m to highlight different water mass in the study area. The data collected in the upper 100m is excluded for better identification of intermediate water masses.

With the CTD data collected on the PDE and EA MV field a θ-S diagram was draw that shows evidences of the main water masses affecting this area. Below the levels of influence of North Atlantic Central Water (subtropical component in orange and subpolar component in green), this diagram shows the presence of high salinity Mediterranean Water (MW) in the CTD/LADCP stations located offshore (station 7) and north (station 1) of the EA MV and PD area, which is revealed by the high salinity values that occur at depths below 600m.

The present work shows that it was possible to get important physical oceanography information from a few set of observations conducted during a non-dedicated campaign, in an opportunistic basis. The choice of methods used allow to include these observations in the cruise work program without compromising any of the main objectives while, at the same time, optimises the observation by providing a large range of physical parameters. The data collected in this way revealed to be extremely important to combine with and extend the data collected in dedicated cruises, allowing to increase the understanding of the physical process and to build the "big picture".

Thurnherr, A. M. (2011). *How to Process LADCP Data with the LDEO software (version IX.7)*, 32.

Van Rensbergen, Pieter et al; (2005). The El Arraiche mud volcano field at the Moroccan Atlantic slope, Gulf of Cadiz. *Marine Geology*, 219, 1-17.

Visbeck, M. (2002). Deep velocity profiling using lowered acoustic Doppler current profilers: Bottom track and inverse solutions. *Journal of Atmospheric and Oceanic Technology*, 19; 794-807.

To know the sea so that all may use it