RHUM-RUM Project : Investigating Earth's deep structure around La Réunion from crust to core
Orienting 57 Ocean-Bottom Seismometers (OBS)

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INTRODUCTION

• The Piton de la Fournaise at La Réunion is one of the most active volcanoes on earth. This hotspot is a strong candidate to be underlain by a feeding mantle plume[4]; upwelling material originating from the lower and/or upper mantle.

• RHUM-RUM is designed to investigate the deep structure beneath La Réunion, from crust to core. Main component of the experiment are 57 three-component brad-band OBS, deployed over an area of 1500 x 2000 km² around the La Réunion Island[1] (map).

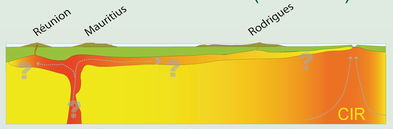
• We analysed particle motions of P-waves and Rayleigh waves with two independent methods[3,7;5,6] to determine the horizontal OBS orientations at the seafloor.

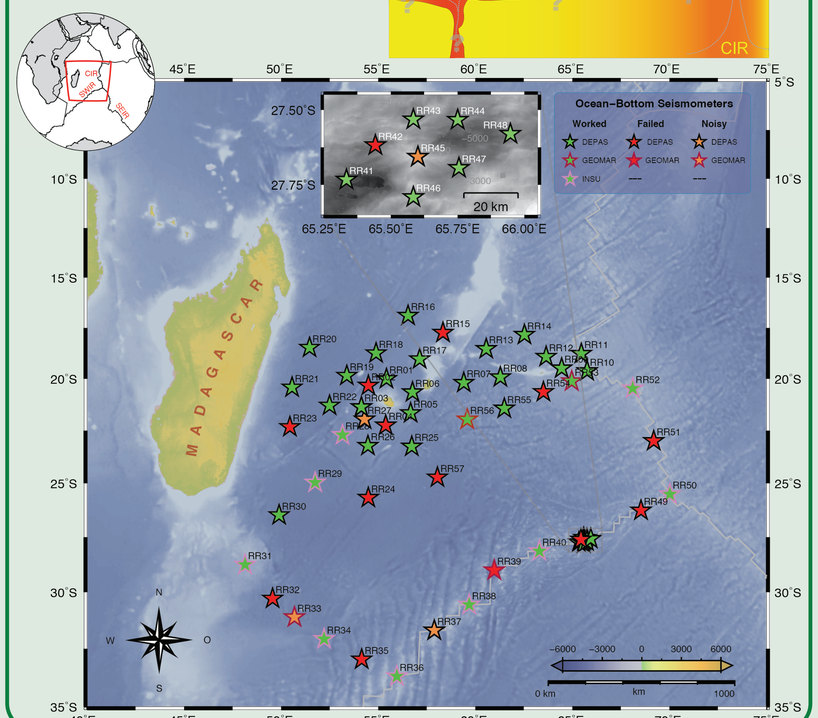
• Several seismic analysis (such as receiver functions and SKS-splitting) rely on correct OBS orientations and it is thus of importance to determine the sensor orientations.

RHUM-RUM (Réunion Hotspot and Upper Mantle - Réunions Unterer Mantel)

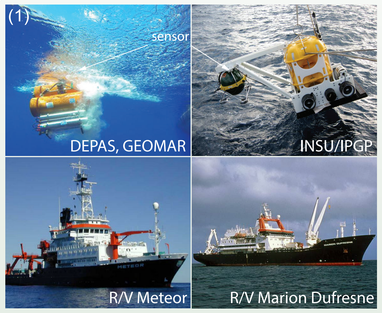
Facts:
- French-German passive seismic experiment
- 57 OBS (44 DEPAS, 4 GEOMAR, 9 INSU/IPGP) and ~40 land stations
- OBS deployment: 13 months

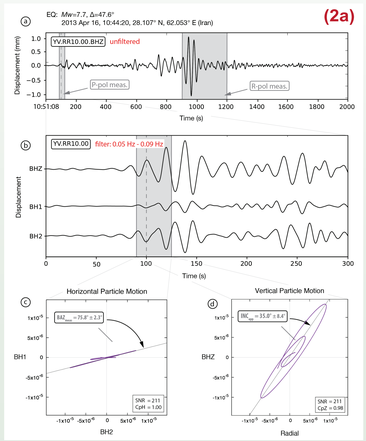
Goals:
- imaging mantle plume – or lack of
- possible links CIR / African Superswell ?
- Objectives PhD-thesis: mapping
  - upper mantle flow (SKS-splitting)
  - crustal & lithos. thickness (rec. func.)

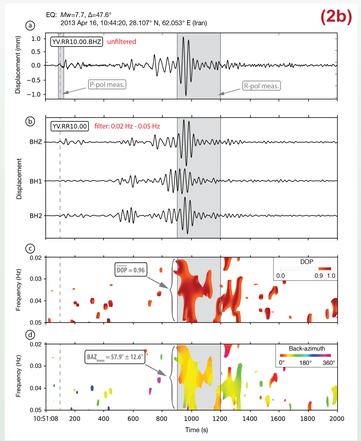


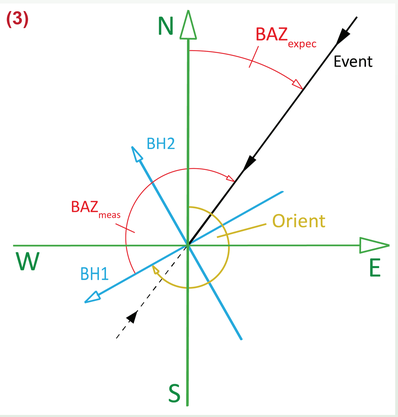


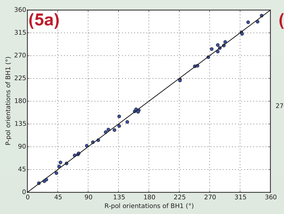
STEP 1 : OBS ORIENTATIONS using P-WAVES and RAYLEIGH WAVES

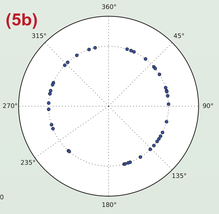


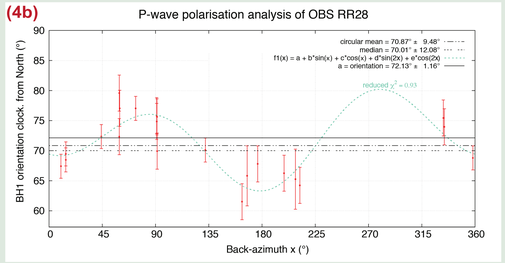


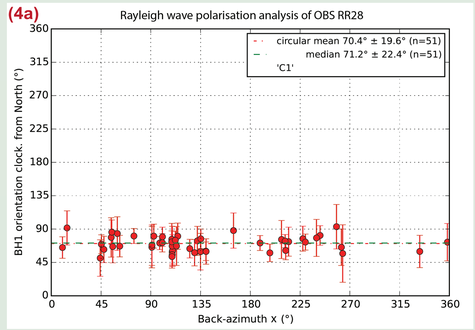












ROUTINE:

(1) : OBS fall freely to the seafloor and are thus not oriented towards North

(2) : back-azimuth (BAZ) of earthquake at the OBS is measured using:
- (a) P-waves (9 filters bands 0.03 - 0.10 Hz) - tool 'P-pol'[3,7]
- (b) Rayleigh waves (filter: 0.02 - 0.05 Hz) - tool: 'polfre'[5,6]

(3) : compare BAZ_{meas} to BAZ_{expec}
BH1 orientation is computed with respect to geographic North

(4) : repeat measurement for all earthquakes, calculate circular mean and median station orientation for:
- (a) Rayleigh waves
- (b) P-waves (back-azimuthal deviation due to upper mantle anisotropy and dipping dis-continuities)

(5) : (a) both methods agree well in orientation values
(b) station orientations are randomly distributed (as expected)

SUMMARY

Results: - oriented 40 (out of 44 working) OBS using two independent techniques:
246 measurements based on 58 earthquakes for P-waves
749 measurements based on 110 earthquakes for Rayleigh waves
- orientation errors (95% confidence interval) average to:
21° for P-waves
16° for Rayleigh waves

Problems: - SNR smaller for OBS than for land stations
- for 17 stations no orientations (13 no data, 4 too noisy - see map)
- DEPAS & GEOMAR OBS: smaller SNR compared to INSU/IPGP due to higher instrument & tilt noise (T>10 s)[8]

Applications: - polarisation, back-azimuth & incidence angle measurements
- orienting OBS (includes data check)
- tracking cyclones[2] and whales

FUNDING & SUPPORT

DFG Deutsche Forschungsgemeinschaft
ANR
Westfälische Wilhelms-Universität Münster
LMU Ludwig-Maximilians-Universität München
universitätbonn
OSU-Réunion
Terres australes et antarctiques françaises
GOETHE UNIVERSITÄT FRANKFURT AM MAIN
IPEV
cnrs INSU Observer & comprendre
Université de La Réunion
EGU Outstanding Student Poster & PICO Contest
AWI Alfred-Wegener-Institut für Polar- und Meeresforschung in der Helmholtz-Gemeinschaft

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