

Supplementary materiel

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MULTI-CHANNEL SEISMIC (MCS) DATA

MCS profiles MOZ1 and MOZ5 were acquired in Feb-Apr 2016 onboard R/V Pourquoi Pas. The profiles were shot at about 150-m shot spacing and recorded on a 4.5-km-long solid streamer with 720 channels at 6.25 m spacing. The sound source was an array of 15 air guns with a total volume of 6500 cubic inches, and source and receiver depths were 17 m and 15 m respectively. The raw seismic data were processed for quality control and geometry with the SolidQC software, developed at IFREMER. Then, MCS data processing was performed using the Geocluster, version 5100 software package from CGG-Veritas. The aim of SolidQC software is to merge and correct navigation data, to generate the seismic profile geometry and along-profile 2D-binning, and to provide a full quality control, standard for all IFREMER seismic acquisition. All the data necessary to SolidQC are included in the shot records as extended header in SEG-D format. The main seismic processing sequence is composed of: geometry, CMP sorting, water column mute, wide band-pass filtering, editing (noisy channels), spiking predictive deconvolution, multiple removal, spherical divergence compensation, Normal Move-Out, time dependant band-pass filter, NMO outside and inside mutes, stack or DMO-stack, post-stack mute and filtering, post-stack 1550 m/s FK Stolt migration, and F-X deconvolution. Finally, the velocity model obtained from the analysis of wide-angle data is used to perform Kichhoff pre-stack time and pre-stack depth migrated sections of the MCS data.

WIDE-ANGLE DATA

MZ1 and MZ7 were shot at about 150-m shot spacing for a coincident wide-angle seismic profile recorded by ocean bottom seismometers (OBSs) positioned at a seafloor spacing of

~12,5 km. Standard processing of the OBS data included OBS internal clock-drift correction; OBS relocation on the seafloor from travel-time picks of water-wave direct arrivals; and band pass-filtering (1-6-48-64Hz). Then a spiking predictive deconvolution was applied to the upward traveling record using the downward traveling wave as signature. Spherical divergence was applied to compensate amplitude decay of the records. Traces were further scaled with a gain proportional to the offset to enhance refracted events. OBS shootings were projected along a large circle to minimize the effects of out-of-plane energy propagation. The zero of each profile was chosen to match with the projection of the first or last OBS of that line. According to this geometry setup, the distance of each OBS and LSS projected in-line was calculated relative to the zero.

The seafloor of the velocity model was then extracted from the bathymetry grid acquired during the MOZ35 experiment, and both OBS depths and seafloor twt from the MCS were compared to the model seafloor. To obtain an accurate thickness of the water layer, the sampling of the seafloor was set to ~0.5 km. We verify that the seafloor depth of the model is consistent with the depths of the OBS and the twt of the seafloor. Where no ship bathymetry was available, the seafloor depth was extracted from the global grid of Sandwell and Smith (2009). Inland, the topography was set upon the coordinates and altitude of the land seismic stations.

FORWARD MODELING

The data were then modeled using an iterative procedure of two-dimensional forward ray tracing

followed by a damped least-squares travel-time inversion from the RAYINVR software (Zelt and Smith, 1992). The wide-angle modeling proceeds in a top-to-down strategy of arrival time fitting of the reflected and refracted phases identified in the sedimentary section. For

each sedimentary sequence we correlate the twt of its base, from the MCS section, with the arrival times of the reflected and refracted phases identified in the OBS data. An iterative procedure of velocity and depth adjustment, with check of the depth-twt conversion against MCS data was then applied. This procedure is applied to all sedimentary layers up to the basement. In the basement we used only the arrival times from the OBS (Fig DR_1) and LSS data set.

Whereas the OBS set recorded direct and inverse sense of energy propagation, allowing to constrain both velocity and topography of the layered medium, LSS records are not reversed. Nevertheless, considering that the large number of in-land records spanning for 100 km to 200 km, the wide-angle LSS record is a powerful datum to evaluate the actual geometry of the crust across the margin.

The final inversion of MZ1 profile included 155002 events and interpreted their respective phase from 38 OBS receivers and 16 LSS. With travel-time uncertainty for each phase automatically calculated based on the trace signal to noise ratio, the final model has a RMS travel time residual of 0.069 s and a chi-square value of 0.591. The model explains the travel-times and phases of 151455 events or 98% of total picks. Pg arrivals represent 43% of total events (with Pg1 5%, Pg2 22%, Pg3 10% and Pg4 6%), and PmP 9% (Table DR_1).

REFERENCES CITED

Zelt C.A. and Ellis R.M., 1988. Practical and efficient ray tracing in two dimensional media for rapid travelttime and amplitude forward modeling, *Can. J. Explo. Geophys.*, 24, 16-31.

Zelt, C.A. and Smith, R.B., 1992. Seismic travel time inversion for 2-D crustal velocity structure, *Geophysical Journal International*, 109, 43-71.

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Fig-SuppMat-MZ1OBS30. Example of the MZ1OBS30 on profile MZ1. The model is constructed from top to bottom using the picking (c), the MCS (e) and the ray tracing (d). Then the evaluation of the model is performed, by a comparison with the predicted time arrivals (b) and record (a). Focus on the crust and mantle at both negative and positive offsets. On a, b, and c, travel-times is reduced by a velocity of 7.0 km/s. In the two boxes, color code used to identify phases.

Table DR_1. MZ1 reflected or refracted phase name, number of explained events, residual mean-square, and normalized chi-squared value for MZ1 profile.

Phase	Index	Npts	Trms (s)	Chi-squared
Pw	1	6146	0.033	0.623
Ps1	2	219	0.011	0.091
Ps2P	3	1106	0.044	0.136
Ps2	4	463	0.034	0.571
Ps3P	5	1280	0.066	0.498
Ps3	6	276	0.022	0.621
Ps4P	7	337	0.070	0.206
Ps4	8	231	0.019	0.756
Ps5P	9	517	0.050	0.309
Ps5	10	845	0.023	0.696
Ps6P	11	1190	0.051	0.562
Ps6	12	665	0.025	0.309
Ps7P	13	1071	0.029	0.139
Ps7b	14	1136	0.022	0.376
Psv1aP	15	2705	0.043	0.347
Psv1a	16	179	0.031	0.574
Psv1bP	17	291	0.034	0.464
Psv1b	18	1540	0.030	1.312
Psv2P	19	1203	0.048	0.580
Psv2	20	4536	0.066	2.220
Pg1P	21	3127	0.059	0.545

Pg1	22	8062	0.043	0.790
Pg2P	23	1699	0.063	0.522
Pg2	24	34585	0.054	0.260
Pg3P	25	7054	0.086	0.457
Pg3	26	16226	0.068	0.322
Pg4P	27	8965	0.069	0.284
Pg4	28	8539	0.068	0.301
Pm1P	29	13906	0.089	0.607
Pn1	30	10339	0.070	0.350
Pm2P	31	8333	0.145	1.604
Pn2	32	5697	0.152	2.050

Table SuppMat: MZI reflected or refracted phase name, number of explained events, residual mean-square, and normalized chi-squared value for MZI profile.