Online Material

Most bathymetric, gravimetric and magnetic data discussed in this paper have been acquired during cruise 135 of RV Marion Dufresne (october 2003). They complement data from earlier cruises mostly with RV Marion Dufresne and l'Atalante (Cannat et al., 2003; Mendel et al., 1997; Rommevaux-Jestin et al., 1997).

Processing of gravity data.

The residual mantle Bouguer anomaly (RMBA) was calculated from free-air ship gravity data by substracting first the effect of topography and of a constant thickness (3.4 km; i.e. the mean seismic crustal thickness determined near 66°E; (Muller et al., 1999)), constant density (2700 kg/m3) crust, then the effect of upper mantle cooling with age (using pickings of magnetic anomalies). The thermal correction model we used assumes a simple square root of age mantle cooling law (Parsons and Sclater, 1977). It predicts subsidence curves that fit observed seafloor deepening with age well (see Figure 3b in paper). In order not to over correct our gravity data for near axis upper mantle temperatures, we cut our thermal model 25 km off-axis, and used a constant temperature gradient in the intervening axial region.

We then inverted RMBA gravity data following the method of (Kuo and Forsyth, 1989) to obtain predicted thickness variations of the oceanic crust (Figure S1). This method assumes that gravity anomalies are due only to crustal thickness variations. It involves a downward continuation of RMBA to a constant depth below sea level, corresponding to the inferred average Moho depth. To avoid instabilities inherent to downward continuation of short wavelengths anomalies, a filter was applied which cosine-tapers the RMBA signal with wavelengths between 30 and 20km, and cuts off the RMBA signal with wavelengths <20 km (corresponding to sources located at depths less than the downward continuation depth). The characteristics of this filter were chosen so as to best fit the seismic crustal thicknesses determined by (Muller et al., 1999) along two profiles shown in Figure S2.

Seafloor morphology in conjugate oceanic crust.

Tectonic asymmetry is a characteristic of seafloor spreading in our study area. We used the plate rotation parameters listed in Table S1 to identify conjugate domains and to compare seafloor morphology and gravity signature in lithosphere inferred to have formed simultaneously on each side of the axial valley. In this process, we make simplifying assumptions that limit the accuracy of our reconstructions: symmetrical spreading, a linear plate boundary interpolated linearly for each age step from our nearest magnetic anomalies pickings. This adds to uncertainties attached to the plate rotation parameters themselves (Lemaux et al., 2002; Patriat and Segoufin, 1988), and to our delimitation of volcanic, corrugated and smooth seafloor terrains. Although we have not attempted to quantify the uncertainties in resulting conjugate seafloor reconstructions, it is reasonnable to assume that they are in the order of a few square kilometers at least.

Magnetic (time (Cande and Kent, 1995)) interval	Longitude of pole	Latitude of pole	Rotation angle
A0-A2a (0-2.581 Ma)	-42.5	6.8	0.338
A2a-A3a (2.581-5.894 Ma)	-49.39	12.1	0.434

A3a-A5 (5.894-10.949 Ma)	-62.99	17.29	0.819
A5-A6 (10.949-20.131 Ma)	5.21	-15	1.347
A6-A6c (20.131-24.118 Ma)	-89.19	31.5	1.453
A6c-A8 (24.118-26.554 Ma)	-89.99	28.21	1.622

Table S1. Plate rotation parameters used for analysis of seafloor morphology in conjugate oceanic crust. These parameters were obtained by fine-tuning plate rotation parameters published by (Lemaux et al., 2002; Patriat and Segoufin, 1988), to magnetic anomaly pickings in our study area.

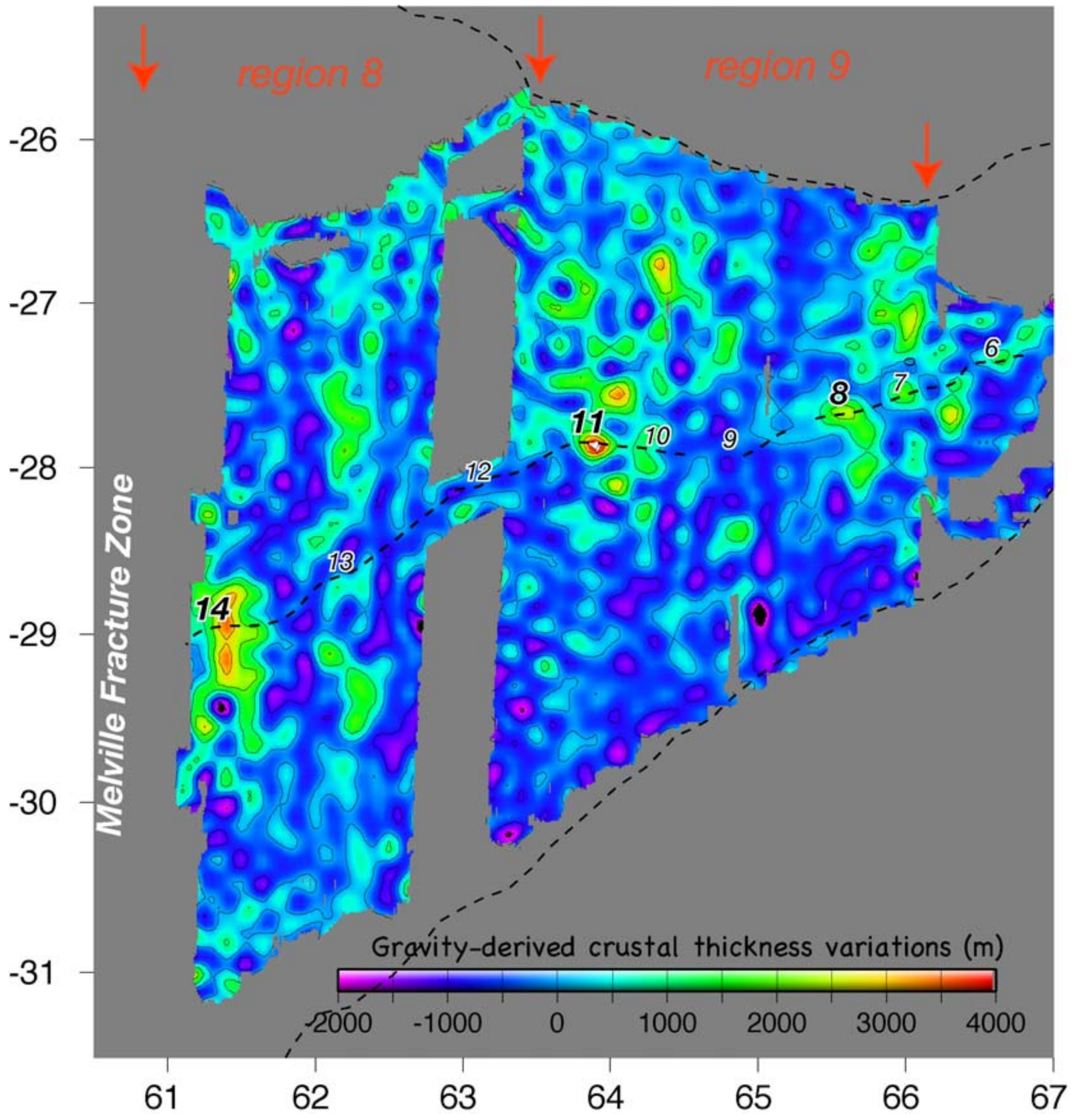

Figure S1. Crustal thickness variations, modelled from RMBA gravity data. Dashed lines: traces of the Rodrigues Triple Junction and present-day ridge axis drawn midway from pickings of magnetic anomaly A1. Numbers 6 to 14 refer to present-day ridge segments (Cannat et al., 1999). Red arrows: limits of oblique-spreading and orthogonal-spreading regions (as in Figure 1 of paper).

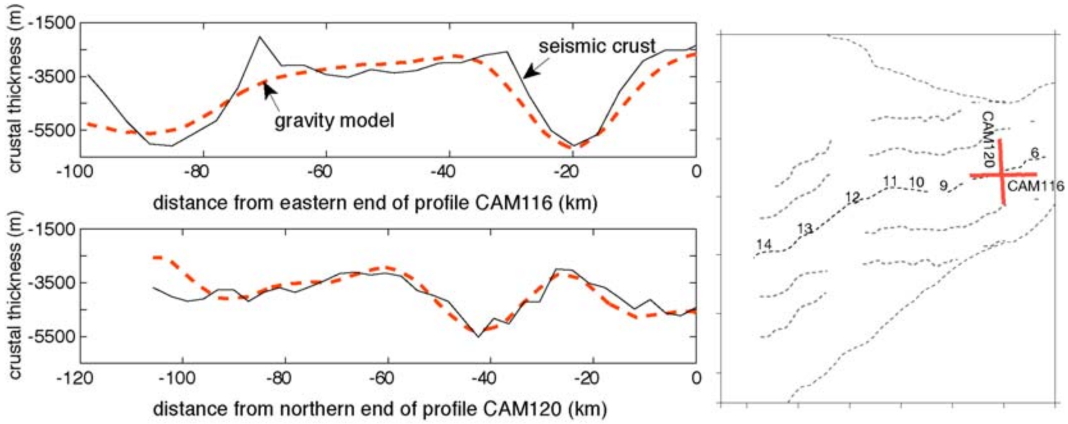

Figure S2. Test of the gravity-derived crustal thickness model (red dashed lines) against actual seismic crustal thickness data (thin black lines; (Muller et al., 1999) and T. Minshull, unpublished data). Modelled gravity-derived crustal thicknesses are very similar to seismic crustal thickness values along these two profiles.

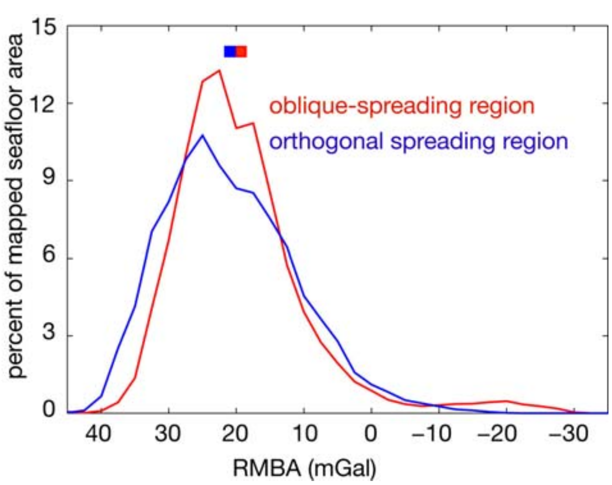

Figure S3. Histogramms of residual mantle Bouguer gravity anomaly (RMBA, per bins of 2.5 mGal) for the oblique-spreading ridge region, and for the near orthogonal-spreading ridge region (Figure 3a). Average RMBA values (red and blue squares) are similar, suggesting that there are no significant differences in the overall crustal thickness and melt supply between the two regions, over the period covered by our study (approximately the past 28 myrs).

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