Surface-ship gravimetry on board MR16-09 Cruise by R/V MIRAI - Characteristrics of gravity anomaly around the Chile Triple Junction

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MR16-09 cruise by R/V MIRAI traversed the Southeast Pacific and the Western Pacific from December 2016 to March 2017, with the portcall at Fiji, Chile, New Zealand and Mutsu. Gravity measurement was also carried out during the whole cruise except for within the EEZ of other countries.
During Leg2 of this cruise, the Segment SCR1 of the Chile Ridge, an active spreading ridge producing the Nazca plate and the Antarctica plate, was also surveyed in order to detect the characteristics of the gravity anomaly due to the subduction of the active mid-oceanic ridge below the South American Plate at the Chile Trench at the Chile Triple Junction (CTJ) located off Taitao Peninsula on the west coast of Chile.
The shipboard gravimeter used for the survey was a relative measurement system. Micro-g LaCoste air-sea gravity meter S-116 is equipped on board MIRAI. Normally, 'gravity tie' is carried out during the portcall at the wharf and the gravity base stations nearby where absolute value of gravity is known in order to obtain the absolute gravity value during the cruise. However, it was difficult to obtain accurate values after correcting the drift of the gravimeter because gravity tie was carried out only at 3 stations at the beginning (Shimizu), at the end (Sekinehama) and during the cruise (Punta Arenas). Therefore, correction of the value at the gravity measurement points on the survey lines was carried out using the latest global gravity 1' grid data (Sandwell et al., 2014, Sandwell et al., 2013, Sandwell et al., 2009) derived from satellite altimetry data etc.

Let the grid intervals in the x and y directions of the grid data be dx and dy, respectively. Let g11, g21, g12, g22 be the gravitational values at the four corner points of this area (approximated by a rectangle) enclosed by x1, x2 (x1 < x2) for x-coordinate and y1, y2 (y1 > y2) for y-coordinate. The linearly interpolated value at the point (x, y) within this the area is

$g1 = g11 * (x2 - x) * (y1 - y)$

$g2 = g21 * (x - x1) * (y1 - y)$

$g3 = g12 * (x2 - x) * (y - y2)$

$g4 = g22 * (x - x1) * (y - y2)$

Then,

$g = (g1 + g2 + g3 + g4) / (dx * dy)$.

Based on the difference between the gravity values obtained by this interpolation and the measured values, the drift rate at each leg was determined as,

Leg 1: 0.216 mgal/day

Leg 2: 0.520 mgal/day

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Leg 3: -0.599 mgal/day

Leg 4: 0.562 mgal/day.

The measured gravity was corrected using these drift rates to obtain the final free air anomalies during the cruise.

Bouguer anomaly along the 3 survey lines on the Segment SCR1 (including the CTJ) of the Chile Ridge off the Chilean west coast was obtained by the two-dimensional calculation (assuming that the same seafloor topography and sub-seafloor structure are continuous along the trench/ridge axis direction) by use of the profiles of free air anomaly and seafloor topography along these survey lines. Regardless of the topographic undulation on the western side of the ridge/trench, the Bouguer anomaly decreased relatively uniformly towards the trench/ridge axis. This pattern is similar to that of the normal trenches and mid-ocean ridges. The rate of decrease as approaching the trench is about 1.5˜2 mgal/km in the Western Pacific trench, <0.1 mgal/km for the Mid-Atlantic Ridge. However, the result of the current gravity survey shows that the decrease rate is 0.4˜0.8 mgal/km.

In addition, geophysical traverses across the Tonga-Kermadec arc-trench, the southern East Pacific Rise (Leg1), the Bellingshausen Sea, the Amundsen Sea, the Eltanin-Udintzev fracture zones (Leg3), the South Fiji Basin, the Solomon arc-trench, and the West Caroline Plateau were obtained during the cruise.

Keywords: Chile Triple Junction, Gravity Anomaly, R/V MIRAI

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