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Repeating earthquakes in the outer rise offshore southern Chile

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The properties of the oceanic plate and processes at the outer rise such as fluxing of fluid along normal faults strongly influence the seismogenic behaviour of the plate interface. We therefore need to make observations seaward of the trench to better characterize these properties and processes. Accordingly, from December 2004 to January 2005 two temporary arrays of ocean bottom seismometers and hydrophones (Project TIPTEQ, Sonne cruise SO181) were deployed to record the micro-earthquake activity of the outer rise region offshore Southern Chile. The southern array was located offshore the Chonos archipelago (45°S) on very young oceanic plate (6 Ma). No outer rise earthquakes are listed in the global catalogues for this region. The northern array is located off Chiloe island (43°S) on somewhat older plate (14 Ma).

Several normal faulting events have occurred in this area in the last 30 years. Nevertheless, during the temporary deployment, the southern region was far more active with nearly 500 locatable events with magnitudes between 0 and 2.5. Most events occured in the crust and the uppermost 1-2 km of the mantle. The locations of the micro-earthquakes define linear trends, which are aligned with the pre-existing (ridge-generated) seafloor fabric, but not with the trench axis. This suggests that most of the earthquakes are associated with specific faults, and that bending at the outer rise reactivates pre-existing faults, at least in this area. In contrast, only about half as many locatable events were recorded by the northern array (with magnitudes between 0.5 and 2.5), and most events are located outside the array. The depth of the few events within the array places them well into the mantle, deeper than the deepest events in the south. The moment b value differs significantly between both regions: it is 0.8 for the northern region and 1.2 for the southern region, consistent with the presence

of events in the global seismic catalogues only in the Northern region. The different properties of the outer rise seismicity in the North and South are likely to be related to the differences in temperature of the oceanic plate.

The event sets are remarkable in that a high proportion ($\sim$ 30%) of the events are repeating earthquakes, that is events with a high waveform similarity (correlation coeff. $>$0.9). In the southern array, they group into 74 clusters of various sizes, with the largest cluster consisting of 39 similar events. Recurrence times are highly irregular, with repeating earthquakes occasionally being separated by a few minutes only but some sequences stretching over the entire observational period. The repeating earthquakes may be associated with strong patches embedded within weak parts of a fault, with irregularities at the boundary between strong and weak parts, and with systematic changes in pore fluid pressure due to fluid diffusion.