Development of oceanic detachment and asymmetric spreading at the Australian-Antarctic Discordance

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The largest known oceanic detachment terrains occur in Segment B3 of the Australian-Antarctic Discordance (AAD). Using newly collected bathymetry, magnetic and gravity data, we show that Segment B3 is divided into two long-lived second-order segments of markedly contrasting character. The flanks of the western sub-segment B3W are characterized by normal well-ordered abyssal hills. The flanks of B3E, on the other hand, are characterized by rough, chaotic terrain including several megamullions. The largest megamullion terrain, at the inside corner of B3E, has 50-55 km long, continuous corrugations and is more than twice as large as typical megamullions of the MAR. Similar, but smaller domed structures with flow-line parallel striations are distributed on both northern and southern flanks. The megamullions in B3E are generally accompanied by 5~10 mGal residual mantle Bouguer anomaly highs, indicating thinner crust and/or denser lithosphere. In contrast, a lower MBA anomaly values along B3W suggest that the crust is more normal along this sub-segment. High magnetization areas occur along the off-axis traces of non-transform discontinuities (NTD) and over the megamullion terrains of the southern flank of B3E most likely reflecting induced magnetization caused by peridotite serpentinization. The association of chaotic seafloor morphology, thinner crust, megamullion structures and positive magnetization and high gravity indicate that extension along oceanic detachment faults has dominated the extension process in B3E and B4 for at least 2 million years. The presence of small megamullion terrains on the non-dominant (north) flank indicates either that the polarity of detachment has reversed for short periods, or that periodic southward relocation of the detachment plane has isolated and small sections of footwall and transferred them to the opposite (hanging wall) plate. Since 2 Ma, the full-spreading rate has remained close to the 70 mm/yr rate predicted by the global plate motion model. Despite the rapid northward motion of the plate boundary, spreading in B3W is almost symmetrical. In contrast, B3E (and B4) is dominated by highly (and unusually) asymmetrical spreading, with asymmetries up to 75% over the largest megamullion terrains. These extreme asymmetries reflect an unusual imbalance between low magma supply and (relatively) rapid spreading rate. The formation of chaotic seafloor terrain, reflecting a dominance of detachment faulting at the spreading axis, is presently restricted to a 100 km section of the axis in B3E and B4, apparently coinciding with the most magma-starved portion of the generally magma deficient AAD.