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Role of detachment faulting in lithospheric accretion along slow-spreading ridges (MAR 12-35˚N)

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Detachment faulting plays a role in lithospheric accretion along the slow-spreading MAR that is more important than previously recognized. Seafloor morphology from the Mid-Atlantic Ridge (MAR) near 13N shows features that are diagnostic of detachment faulting such as linear ridges marking the tops of rotated faults, and swales backing the ridges and separating exposed detachment faults. This seafloor morphology is distinctly different from that formed along segments characterized by ridge-parallel abyssal hills, that appear to have a higher melt supply. A reinterpretation of available bathymetry along the MAR between the Marathon and the Oceanographer Fracture Zones (12-35˚N) shows that detachment faulting dominates a much larger area than that indicated by the exposure of corrugated surfaces alone. In this region, ∼40% of the MAR axis is dominated by detachment accretion, while only ∼32% of its length can be associated with magmatic accretion; the remaining ∼28% of the axis cannot be confidently classified in either category, as it corresponds to either oblique portions of the MAR with complex tectonic and magmatic features, or to areas with limited data coverage. A similarly high proportion (∼50%) of the seafloor S of Kane FZ and extending 10 Ma off-axis is associated with detachment-related morphology. Detachment faulting is most prominent between the Marathon and Fifteen-Twenty FZs (∼60%) and reaches a minimum (∼15%) between the Hayes and Oceanographer FZs near the Azores hotspot. Active detachment accretion is systematically associated with high levels of seismic activity as identified from hydroacoustic monitoring. More magmatic sections display lower levels of seismicity, and segment centers are often aseismic. We propose that two disctinct modes

of seafloor accretion operate along the MAR, with contrasting thermal regimes and modes of strain partitioning. Detachment faults appear to operate in thick lithosphere, with plate separation accommodated almost exclusively by the detachment fault on one side of the axis, and leading to high rates of seismic activity. In contrast, magmatic segments show lower seismicity because of their hotter thermal regime, while distributing tectonic strain among numerous axis-parallel faults extending to 10-30 km off-axis.