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The origin of seafloor roughness

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Seafloor roughness varies considerably across the world's ocean basins and is a parameter fundamental to controlling the circulation and mixing of heat in the ocean and dissipating eddy kinetic energy. The relationships between seafloor roughness and various parameters have been previously investigated, with the role of seafloor spreading rates especially well-studied. We use a global 2-minute gravity anomaly grid, based on 1-minute satellite altimetry downward continued onto the seafloor, to compute root mean squared marine gravity roughness. Intraplate seamount trails and large igneous provinces are masked in order to exclude roughness caused by non-accretionary processes. We confirm the previously determined relationship between spreading rate (2-minute global grid) and marine basement roughness and then calculate a residual roughness grid where roughness attributable to spreading rate is removed. The influence of sediment thickness (2-minute global grid) is removed from the residual roughness grid in the same manner. The residual roughness grid is then used to investigate the roles of crustal thickness and spreading obliquity, which is the angular discrepancy between the direction of plate motion and the direction normal to the strike of the mid-ocean ridge, at 10 selected spreading regions. We find that a sharp increase in basement roughness occurs at spreading obliquity angles greater than 45˚. After the removal of roughness related to spreading rates, sediment thickness and spreading obliquity, long-term 5-20 mGal variations (tens of millions of years) in residual basement roughness remain in the ten selected regions. We suggest that these variations are related to mantle temperature and fertility, where smooth marine basement is caused by high mantle temperatures from either hotspots e.g. the North Atlantic, or continental aggregation, where flow wavelength enlargement can increase mantle temperatures that underlie juvenile mid-ocean ridges during break-up e.g. At-

lantic oceanic basement older than 80 Ma. Rough marine basement is caused by cold and/or depleted mantle conditions e.g. the Australian-Antarctic Discordance, and the Southwest Indian Ridge.