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Mapping Cretaceous Seafloor Fabric: A Changing View of the Equatorial Ellice Basin

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The plate tectonic revolution and decipherment of magnetic isochrons that followed the pioneering work of Marie Tharp and coworkers in visualizing the seafloor has led to a near-complete understanding of the first-order evolution of global seafloor spreading. However, lagging behind in exploration and understanding are areas of seafloor formed during the Cretaceous Normal Superchron (CNS, 121-83 Ma) when no magnetic reversals were recorded to guide investigators. Thus, for such regions tectonic interpretations are largely driven by mapping and identifying seafloor fabric indicators such as fracture zones, abyssal hills, rift propagators, and extinct spreading centers. Here, we focus on the relict spreading system of the Cretaceous Ellice Basin that was apparently formed by seafloor spreading that split the world's single largest oceanic plateau Ontong Java Nui, composed of present day Ontong Java, Manihiki and Hikurangi plateaus and other (now subducted) fragments. We examine what was known about this basin from historical single and multibeam bathymetry, what was revealed by the advent of satellite altimetry, and why bathymetric mapping is still required to infer short-length-scale tectonic fabric. High-resolution bathymetric data from the central basin were recently acquired by the University of Hawaii's vessel R/V Kilo Moana. Evolution of the spreading system is characterized by three main stages of spreading based on directional and morphological analyses of the seafloor fabric indicators identified from bathymetry. Spatially conjugate points symmetric about the spreading central zone were identified at the establishment and cessation of each spreading stage and were assumed to be of the same age to form pseudo-isochrons. Pseudo-isochrons were then utilized in reconstructing the basin through time. The earliest Stage 1 fracture zones trend E-W and consist of multiple closely spaced, parallel fault strands that were indistinguishable in satellite altimetry. A clockwise rotation of the spreading direction led to Stage 2 NW-SE trending fracture zones, which splayed from Stage 1 multistrands. An offset between Stage 2 fracture zones indicates a short-lived late Stage 3 that appears to be the result of a counter-clockwise rotation of the spreading direction shortly before spreading ceased. Seafloor evidence for the initial breakup and rifting between Ontong Java and Manihiki plateaus prior to Stage 1 has yet to be mapped. Basaltic rocks dredged from selected locations along the survey track promise to provide tighter temporal constraints on the evolution of Ellice Basin.