The influence of wrench tectonics on submarine volcanism in the NE Lau Basin (Tonga)

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The NE Lau Basin is one of the most dynamic places on the planet, characterized by ultra-fast subduction rates (24 cm/yr; [1]), and back-arc spreading distributed among several spreading centers. The Tonga trench has a sharp bend at it's northernmost extent, where there is a transition from convergence to transform motion. We explore the complex structural evolution of the NE Lau Basin, and it's influence on submarine volcanism, using nearly-continuous bathymetric data collected over several research cruises in the past decade (KM1024, KM1129, FK171110, and SO-263). Interpretations of the seafloor topography, combined with seafloor observations and rock sampling, have been combined to produce a remote-predictive geological map over ~40,760 km^2. This mapping highlights the abundance of off-axis distributed volcanism, manifest as extensive lava flows, large volcanic ridges with various orientations, and point-source volcanoes that sample a heterogenous mantle wedge, with sharp gradients and contrasts, including the presence of enriched and depleted compositions, and arc-affinity magmatism and non-affinity magmatism in different regions. Structural lineament analyses combined with CMT analysis reveal that the volcanic-compositional provinces are aligned with Riedel shear structures associated with wrench tectonics along the northern transform boundary. Importantly, two distinct sets of Riedel shears are identified, associated with a counter-clockwise rotation in the stress field, which we propose is related to collision with the Capricorn Seamount. The style of faulting is dominated by the reactivation of pre-existing structures. This study highlights the importance of seamount collisions on the structural and volcanic evolution of a back-arc basin.

[1] Bevis et al., 1995; Nature