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Numerical modeling for the geodynamic formation of the Tamu Massif, the largest single volcano on Earth

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The Western Pacific Ocean has most of the underwater volcanoes on Earth, and among them the Tamu Massif within the Shatsky Rise is proved to be the largest single volcano. By comparing thermo-mechanical models with gravity, topography, and seismic observations, we seek to address an important question: "How did this Earth's largest volcano form by the interaction between a ridge-ridge-ridge triple junction and a mantle plume?" We focus on the following tasks: 1.set up three-dimensional thermo-mechanical models to simulate the ridge-plume interaction; 2.calculate the coupled mantle flow and temperature structure, and constrain the model parameters (spreading rates, plume size and depth, loading time, magma types, melting conditions, source temperature) using magnetic anomalies and magmatic geochemistry characteristics; 3.compute model-based magma supply and compare with crustal thickness and crustal volume estimates from seismic sounding and gravity observations; 4.invert for model parameters and find the control parameters on the volcano's formation. It is creative to conduct a quantitative analysis of the volcano's formation, which can provide insights to the geodynamic evolution of thick oceanic crust. Our preliminary numerical simulations show (1) a significant velocity increase along the slowest spreading ridge axis (NE branch) and towards the triple junction, and (2) a sharp temperature increase with depth along the two fast spreading ridges (SW and SE branches) and towards the triple junction. We also calculated the wavelength-dependent degree of compensation (C) using the topographic and seismic Moho profiles of the Tamu massif. We inverted for effective lithospheric thickness (Te) at various wavelength considering surface load only. The inverted Te is close to zero (Airy isostatic state) at the longest wavelength of 550 km, in contrast with $\sim$ 10-20 km at the shorter wavelength of 35 km. The dependence of C on the wavelength is likely due to spatial variability in Te or sub-surface loading due to mantle plume.