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The Shatsky Rise Supervolcano

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Oceanic plateaus are enormous igneous mountains that apparently form from rapid, massive eruptions and emplacements of basalt and related igneous rocks. Because they are hidden beneath the sea and in remote parts of the globe, the structure and evolution of these mountains are poorly known. Shatsky Rise is an oceanic plateau, located ˜1500 km east of Japan, that formed during the Late Jurassic and Early Cretacous (˜145-125 Ma) near a triple junction of spreading ridges. It consists of three large volcanic massifs and a narrow volcanic ridge. It is inferred that eruptions began with the largest massif (Tamu Massif) and waned through time through the formation of the other massifs. Tamu Massif is a supervolcano, meaning that it appears to be a single volcanic edifice, like a seamount, but much bigger. It has an area similar to that of Olympus Mons on Mars, the largest volcano in the solar system. Geophysical data (bathymetry and seismic reflection profiles) show that Tamu Massif is elongated SW-NE, has a central summit, and a shape that is symmetric across its axis. Volcanic slopes are low, implying long lava flows with low viscosity. The cross-axis profile of the volcano is consistent with eruptions that flow outward from the axis region. Seismic profiles in some locations over these axes, especially near the summit, show normal faulting and grabens which imply that the volcanic axes are rift zones. Coring on Integrated Ocean Drilling Program (IODP) Expedition 324 recovered basalt flows of two general types: pillows and massive flows. The first type is indicative of normal seamount volcanism at low effusion rates whereas the second type implies high volume lava flows and high effusion rates. Massive flows are typical of continental flood basalts and are also found on other large plateaus. On Shatsky Rise, thick massive flows are found on Tamu Massif, whereas pillows and thin massive flows characterize the other massifs. This trend supports the idea that Tamu Massif was formed in an initial massive eruptive event and afterwards the volcanism waned as the other massifs were erupted. The fact that the cored lava flow sections on Tamu Massif appear similar to those cored by the Ocean Drilling Program from Ontong Java Plateau implies that these plateaus formed in similar fashion. Shallow water fossils and depth-diagnostic rocks and sediments indicate that the summits of Shatsky Rise massifs were near sea level at the time of formation. Expedition 324 cores also recovered hyaloclastites and volcanic sedimentary rocks which imply that explosive volcanism was significant near the volcano summit. Heavy alteration of rocks from the shallower parts of the Shatsky Rise volcanoes implies that fluids, perhaps driven by volcanic heat, flowed through the volcano summit rocks. In sum, the structure and evolution of Tamu Massif appears much like that of a typical seamount, except that it is much bigger and had correspondingly larger and widespread eruptions.

Keywords: large igneous province, oceanic plateau, volcanology, Integrated Ocean Drilling Program, seamount, Pacific Ocean