Research Provides Insight into the Formation of Tectonic Plates

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A new study by University of Idaho researchers provides insight into Earth's early tectonic activity and could be a stepping stone to help researchers better understand not only tectonic plates, but also earthquakes, volcanoes and mineral deposits that arise as the plates move and form.

The way oceanic tectonic plates separate, either by snapping or stretching apart, controls the shape of mid-ocean ridges, the underwater location where plates drift apart, according to a the study, which was published today in the journal Nature Geoscience.

U of I Assistant Professor Eric Mittelstaedt in the College of Science's Department of Geological Sciences, and Aurore Sibrant, a postdoctoral researcher at the European Institute for Marine Studies in Brest, France, who worked on this study as a post-doctoral researcher at U of I, were able to simulate the creation of mid-ocean ridges in the laboratory. Their study, which included scientists with Laboratoire FAST in Paris, France, is titled "Accretion Mode of Oceanic Ridges Governed by Axial Mechanical Strength."
"Oceanic ridges inform ocean crust structure, volcanic processes and plate tectonics as well as the age and formation of oceanic plates," said Sibrant, who is the lead author of the study. "Knowledge of these processes has many applications such as submarine cable routing, seismic risk studies and improved ocean circulation models, which inform long-term climate prediction."

Mid-ocean ridges do not traverse the ocean floor along straight lines, but rather meander across the landscape. Until now, researchers were unsure what determined the winding pattern of these ridges.

When tectonic plates pull apart, magma oozes upward onto the ocean floor and hardens, forming a thick crust. As the plates drift farther apart, the thick pile of hardened lavas must break to accommodate the plate movement, and will either snap or stretch apart. The researchers modeled this process in laboratory tanks filled with a silica-based fluid, a novel way of modeling mid-ocean ridge evolution. They varied the experimental conditions to simulate a variety of ridge shapes.

Calculations based on the laboratory experiments showed that the cooling rate of the lava and the spreading rate of the tectonic plates dictate the thickness of the hardened oceanic crust. In turn, the crust's thickness controlled whether the plates snapped or stretched apart. Ridges tend to develop into curvy shapes in places where snapping is common, while ridges are dramatically less curvy in stretchy regions, Mittelstaedt said.

"The study tells us that one of the primary controls on the shape of ridges is the way that the material breaks," Mittelststaedt said. "We found a physical explanation for why ridges behave the way that they do across all spreading rates and across all tectonic environments."

This project, "Emplacement of Regularly Spaced Volcanic Centers in the East African Rift: Melt Production or Melt Extraction," was funded under National Science Foundation grant EAR-1456664. The total amount of federal funds received for the project will be $225,924, which amounts to 100 percent of the total cost of the project.

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