Frontiers in international deep-ocean exploration of the Earth

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Probing the Earth beneath oceans is critical for our understanding of Earth's interior. More than 70% of Earth's surface is covered by oceans, much of which are deeper than 3,000 m. The deep oceans are linked to some of the most fundamental geoscience problems, ranging from planetary-scale recycling of the lithosphere, to deep-trench earthquakes and tsunamis, and to energy transfer and hydrothermal chemosynthetic life at mid-ocean ridges. The international deep ocean exploration is now entering a period of unprecedented opportunities thanks to the rapid development of deep-ocean vehicles, seafloor instrumentation/observatories, ocean drilling, and other advanced technologies. This presentation will highlight exciting recent advances in deep-ocean exploration through illuminating examples: (1) International exploration of ultra-slow seafloor spreading at both the Southwest Indian Ridge and the Gakkel Ridge under the Arctic Ocean, leading to the discovery of a new class of *amagmatic spreading*, occurring at the extreme conditions of ultra-low magma supply; (2) Seismic experiments probing ultra-deep trenches of the Challenger Deep at the Mariana and other subduction systems, revealing unique characteristics of slab geometry, earthquakes, and water recycling; and (3) Strong heterogeneities in global oceanic crustal structure, ranging from ultra-thick crust from ridge-hotspot interaction to ultra-thin crust of oceanic core complexes. The increasing probing of the mantle beneath oceans and investigation of active processes of the oceanic lithosphere have important global tectonic implications.