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Media Release

International Ocean Discovery Program drilling expedition to Walvis Ridge investigates interplay of mantle upwelling and oceanic crust evolution.

The Walvis Ridge is a complex chain of volcanoes, more than 3,000 km in length, formed by the upwelling of mantle material delivered to the crust. It has the potential to reveal new clues about mantle geodynamics, plate boundary tectonics, and the formation of large submarine volcanoes. This volcanic ridge is the focus of International Ocean Discovery Program (IODP) Expedition 391 "Walvis Ridge (Tristan-Gough) Hotspot," which aims to recover geologic samples at six locations along the ridge. A team of international scientists left the port of Cape Town on board the research drilling vessel *JOIDES Resolution* on 11 Dec 2021.

The IODP is an international research program supported by 22 nations, with the goals of exploring Earth's history and structure recorded in seafloor sediments and rocks, and monitoring sub-seafloor environments. IODP Expedition 391, which studies the Tristan-Gough-Walvis Ridge volcanic track, takes place from December 6, 2021 to February 5, 2022.

The overarching motivation of Expedition 391 is to gather sediments and rocks from below the seabed to develop a greater understanding of the workings of Earth's interior. The findings will provide insight into (1) how oceanic plates evolve, (2) the chemical make-up of Earth's mantle, and (3) how mantle upwellings (also called mantle plumes) interact with oceanic crust to form complex volcanic hotspot chains. An additional goal will be to determine the extent to which hotspots, such as the one that formed the Tristan-Gough-Walvis Ridge volcanic track, can mark past shifts in the geographic locations of Earth's poles, known as true polar wander.

While at sea, the *JOIDES Resolution* can provide personalized live ship-to-shore broadcasts to student groups (schools, universities, museums, etc.). Interested parties should contact thejoidesresolution@gmail.com for more information.

BACKGROUND

Science in search of Earth's secrets

It is widely known that tectonic plate activity is responsible for natural hazards such as volcanic eruptions, earthquakes, and tsunamis. Though scientific models exist to explain the mechanisms that drive tectonic activity, the fact that these processes often occur in the Earth's interior means that many questions about these processes remain unanswered.

One such question is the role of mantle plumes in the evolution of Earth's crust. Plumes are roughly cylindrical regions of higher-temperature mantle material that, due to their lower density and greater buoyancy, rise from the depths of the mantle. Hotspot ridges and seamount chains like the Walvis Ridge are believed to represent volcanic eruptions sourced from the plume tops, and therefore can provide valuable insight into such upwellings in Earth's mantle.

Walvis Ridge volcanoes hold clues to workings of Earth's planetary interior

Led by Co-Chief Scientists Will Sager (University of Houston) and Kaj Hoernle (GEOMAR Helmholtz Centre for Ocean Research Kiel), the scientists of Expedition 391 will sail to the Walvis Ridge, roughly 1,600 km off the coast of southwestern Africa, to drill into volcanoes that formed as part of the Tristan-Gough hotspot track. It is so named because the seamounts end at the active volcanic islands of Tristan da Cunha and Gough.

The Tristan-Gough hotspot track initiated ~132 million years ago with the opening of the South Atlantic Ocean. In its first 70 million years of activity, the hotspot interacted with the Mid-Atlantic Ridge, the constructive plate boundary separating the African and South American plates. A part of Walvis Ridge, named Valdivia Bank, is a huge volcanic mountain called an oceanic plateau. This mountain is atypical for hotspot seamount chains, which commonly form smaller volcanoes. Valdivia Bank also has an unusual history. It appears to have formed an elongated island or peninsula jutting into the ocean from Namibia, was eroded to sea level and subsided, then was ripped apart during or after its formation by tectonic forces at the Mid-Atlantic Ridge. Furthermore, it appears to have formed at the edge of a microplate (a bit of plate torn from the major plates), and it began erupting again, 40–50 million years after it had first gone extinct. Expedition 391 will collect core samples at three locations on Valdivia Bank to better understand its origin.

Farther to the southwest, Expedition 391 will investigate three seamounts at the "trident", the spot where the Walvis Ridge is often referred to as splitting from one chain into three. Coincidentally, the "trident" also marks a change in geochemistry of the seamounts, leading researchers to surmise that the hotspot tapped more than one source. No other known seamount chain contains this strange feature.

Dr. Hoernle says, "Major goals of the expedition are to test if the hotspot track is age progressive[1], to determine how far into the past the geochemical zonation extends and whether the younger (<70 Ma) track shows bi- or tri-lateral zonation, to evaluate latitudinal movement of the hotspot during formation of the track, and to constrain the role of microplates in the formation of the Walvis Ridge. We plan to drill six holes into the basement to resolve these issues." Dr. Sager adds, "We are trying to understand why Walvis Ridge is such a complicated volcanic track, but yet looks a lot like a classic hotspot trail… Our cores will give samples to a team of scientists to find new clues about the formation of this odd mountain range."

These six boreholes (one at each planned drill site), in some places greater than 4,000 m below the sea surface, will sample rocks from layers of lava flows. Studying rocks that span both distance and time enables scientists to better reconstruct the mantle processes that led to the formation of the Walvis Ridge, and therefore better understand the composition of the mantle source.

Ocean drilling in the time of a global pandemic

[1] Shows a clearly defined trend in age along the track. Classic hotspot trails, like the islands of Hawaii, decrease in age with proximity to the currently active volcano.

Originally scheduled to sail in December 2020, Expedition 391 will be the first IODP expedition to sail with most of its full science party since the onset of the COVID-19 pandemic. Participants quarantined for 7 days in Cape Town prior to boarding the *JOIDES Resolution*, and have undergone rigorous COVID-19 testing prior to travel and during quarantine, and will wear masks and practice social distancing during the initial two weeks of the expedition. Says Hoernle “We are very excited that IODP Expedition 391 to the Tristan-Gough-Walvis hotspot track will finally take place after a year's delay.”

Expedition 391 will sail with 21 scientists with expertise in a range of geoscience disciplines from the United States of America, Germany, United Kingdom, France, Sweden, Austria, Republic of Korea, Japan, and Namibia, with onshore support from China, India, Italy, and Canada. While at sea, the *JOIDES Resolution* laboratory infrastructure will be utilized for intensive sampling and investigation of the cores retrieved. This includes splitting, describing, and analyzing the cores, which will be made available to non-expedition scientists a year after the completion of the expedition. Data from these core samples will be used by scientists all over the world to answer questions about the oceanic cycle of plate tectonics, global cycles of energy and matter, and feedbacks in the Earth system.

More information:
About the expedition - https://joidesresolution.org/expeditions/walvis-ridge-hotspot
About the research program - www.iodp.org

Get involved:
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