INTERNATIONAL OCEAN DRILLING PROGRAMME

PROPOSAL 1102-S

The volcanic ash record from Ontong Java Plateau: testing models of subduction reversal, the reality of “soft-docking”, and the Eocene to Miocene history of wind transport in the western equatorial Pacific.

IODP^3 Proposal Cover Sheet

Proposal Title:

The volcanic ash record from Ontong Java Plateau: testing models of subduction reversal, the reality of “soft-do cking”, and the Eocene to Miocene history of wind transport in the western equatorial Pacific.

Project Abstract

The Ontong Java Plateau (OJP) is the largest oceanic plateau in the world. Collision of the OJP with a trench north of the Solomon Islands arc resulted in congested subduction, and the initiation of new subduction on the southern flank of the arc. This process is regarded as the prototypical example of subduction reversal. Plateau collision also resulted in the emplacement of basaltic and sedimentary rocks of the Malaita Terrane (Solomon Islands).

Three hypotheses for the collision have been advocated. Hypothesis 1 holds that collision occurred at ~25 Ma, shutting down subduction and accreting the Malaita Terrane. However, with no local stratigraphic signal for collision at 25 Ma, this event was described as “soft docking”. Initiation of new subduction south of the arc was delayed until the late Miocene. Soft docking has since been invoked in other collisional settings, and the 25 Ma event cited as the cause of a change in Australian plate motion. Hypothesis 2 dismisses the soft docking concept and considers a latest Miocene collision. Soft docking is also dismissed by Hypothesis 3, which posits a two-stage collision involving an earlier (late Eocene) collision of a fragment rifted from OJP and a later (late Miocene) collision of the main body of OJP.

ODP drilling of the OJP carbonate sequence has recovered multiple volcanic ash layers. Ashes spanning the late Eocene to late Oligocene have been interpreted as evidence of the close approach of the OJP to the arc, supporting Hypothesis 1. No analysis of these ashes has been reported in the literature. It is unknown whether the ashes are products of arc volcanism or are derived from the Samoan hotspot. Sedimentary rocks from the Malaita Terrane contain volcaniclastic components, but these have had only limited analysis. The SPARC proposal will isotopically fingerprint the OJP ashes. These will be geochemically and geochronologically compared with volcaniclastic rocks from the Malaita Terrane (to be analysed in a parallel study) and with existing analyses from the Samoan chain.

Identifying the source of the OJP ashes will also provide data on wind directions responsible for ash transport and paleoclimatic implications. By combining this information with a broader analysis of dispersed ash and other aeolian sediments in the carbonate sequence, we will reconstruct the Eocene to Miocene history of aeolian transport to the western equatorial Pacific. The results will allow us to track the emergence and amplification of the East Asian Monsoon.

Scientific Objectives

The project has both tectonic and paleoclimate objectives. The principal tectonic objective is to investigate the mechanism of subduction reversal. This will be achieved by testing the viability of the soft-docking model for the collision of OJP and Solomon Islands arc, and weighing this against alternative hypotheses (e.g., late Miocene single collision or a two-stage collision. We will address these objectives by determining the geochemical provenance of ashes preserved in cores from ODP sites on the OJP, and comparing these with volcaniclastic rocks from the Solomon Islands arc and the Samoan hotspot chain. Determining the source of the OJP ashes will constrain the relative positions and time of collision.

Secondary tectonic objectives relate to the history of Samoan hotpot activity and to the role of petit-spot volcanism prior to plateau collision. If the OJP ashes have a Samoan origin, the data will fill a gap in the Samoan hotspot record. The alternative two-stage collision model would imply that the alkaline volcanic sequence on the Malaita Terrane and early Miocene seamounts on OJP were erupted in similar settings on the outer-trench swell, and likely represent petit-spot volcanism. If so, this will enable on-land access to a petit-spot system.

The principal paleoclimate objective of this proposal is to unravel the sources of dust and volcanic ash to the OJP and reconstruct the history of aeolian deposition in this part of the western equatorial Pacific over key periods in the Cenozoic, including the onset of the East Asian Monsoon.

Science Communication Plain Language Summary

Ontong Java Plateau (OJP), in the western Pacific, is the world's largest oceanic plateau. South of OJP lies the Solomon Islands volcanic arc, on the Pacific—Australia tectonic plate boundary. Plate motion caused OJP to collide with the arc. Before the collision, the Pacific plate plunged into the Earth's mantle under the arc (a process called subduction). After the collision, the direction of subduction reversed: the Australian plate now is diving into the mantle, and the arc is now moving towards Australia. This process, called subduction reversal, is considered to be a cause of new subduction zones and changes in plate motion. Studying the OJP — Solomon Islands collision is important in understanding this process.

There are three theories about when the collision occurred. "Hypothesis 1" says the collision started at 25 million years ago (Ma), but produced few local effects, with the final subduction reversal delayed until 10 Ma - the lack of local effects led to this being termed "soft docking". "Hypothesis 2" says that the collision occurred as a single event at 5 Ma. "Hypothesis 3" says that two pieces of the plateau collided, the first at 35 Ma, and the rest at 10 Ma.

Scientific drilling on OJP collected cores of limestone rocks that accumulated on the seafloor since the plateau formed. Layers of volcanic ash scattered within the limestone recorded eruptions of nearby volcanoes, and it should be possible to tell which these were by a comparison of the chemistry of these ash layers with volcanic materials from the Solomon Islands and other volcanoes in the western Pacific. If the OJP ashes are different from the volcanic rocks from the Solomon Islands, "soft docking" is unlikely, and other, more detailed studies should allow a definitive answer of which hypothesis is correct.

To get from the volcanoes to the plateau, the ashes must have been transported by wind, and determining which volcanoes were the sources of the ash, and when they erupted, will indicate the prevailing wind direction in this part of the Pacific at the time. The ashes span a time of past climate change, when the East Asian Monsoon became the dominant control on western Pacific winds. Information from the ash layers, supported by analysis of other wind-blown sediments, will allow a reconstruction of how and when the developing monsoon changed the Pacific wind system, and will inform models of the effects of climate change.