Cruise Report for JR123, RRS James Clark Ross, 9-18 May 2005.

Introduction

The Soufrière Hills Volcano, Montserrat, West Indies, is a world-class natural laboratory that has provided a wealth of geological data in unprecedented detail on andesite volcanism within an island arc setting. Throughout the recent eruptive period (1995-present), pyroclastic flows generated by collapse of the andesite lava dome have entered the sea on numerous occasions. Over 90% of the 0.5 km^3 of extruded magma has been redistributed into the ocean, largely by the direct entrance of pyroclastic flows into the sea. The Soufrière Hills Volcano produced the largest documented historic dome collapse for any volcano on 12-13th July 2003. The dome collapse was the culmination of two years of continual dome building activity. The collapse occurred over an 18-hour period yielding >210 million m^3 of pyroclastic material that avalanched down the Tar River Valley (southeast Montserrat) into the ocean.

The JR123 research cruise of the RRS *James Clark Ross* (9-18th May, 2005) imaged and sampled pyroclastic deposits from the Tar River submarine pyroclastic fan and additional locations to the west and south of the volcanic island. Objectives of the voyage were to determine how the pyroclastic submarine fan evolved with time and to provide insight on the nature and dispersal of the submarine pyroclastic deposits. A rare opportunity is provided by the Soufrière Hills Volcano collapse events, in particular the July 2003 event, as the marine deposits can be studied in direct reference to well-documented subaerial eruptive activity.

Methods and Data Collected

Bathymetry and sub-bottom profiling (EM120 and TOPAS)

Sampling targets were identified by high-resolution EM120 swath bathymetry. The EM120 swath bathymetry system and TOPAS sub-bottom profiler were run throughout the cruise except while the vessel was on station or where we had already obtained swath coverage. Weather and sea conditions were favourable and the systems performed very well. Survey speed was generally 6-8 knots, to obtain sufficient resolution for a 25 m bathymetry grid in water depths from 50 to 1200 m. In a water depth of 1000 m and with a beam angle of 60°, equidistant mode gives an across-track resolution of ~20 m; a ping cycle of 5 seconds gives along-track resolution of ~20 m at 8 knots.

Sound velocity profiles were obtained from expendable bathythermographs (XBT's); of which two were deployed on passage east of Antigua before the science cruise so that we were ready to use XBT02 on the first line. The profile from XBT03 was not used as it was virtually identical to XBT02; XBT's 05 and 06 were slightly different and were used later in the cruise.

TOPAS and the EM120 were normally run in sequence using the Simrad Synchronisation Unit (SSU). For a detailed study of the acoustic character of the 2003 Tar River Valley flow deposit we used TOPAS alone on a 2 second ping cycle.

EM120 lines on the smooth upper slope (slope angle >20°, water depths of 150-400 m) were initially observed to suffer from severe interference and dropouts. These effects disappeared when the lines were run again without TOPAS. On a steep slope the time required for reception of the farthest EM120 return on the down slope side is considerably more than the SSU-calculated time assuming a level seabed, and the EM120 therefore hears the TOPAS echo as well as its own returns. The SSU has no provision for time add-on to the EM120, so the only solution to this problem is to run the EM120 and TOPAS on separate tracks. We have only rarely noticed this effect before, because in the Antarctic the upper slope is almost everywhere rough and gullied, so the TOPAS echo is too weak to interfere with the EM120.

Vibrocore, Box Core and Gravity Core Sampling

Seafloor sampling predominantly utilised a Vibrocore system developed by the British Geological Survey. This system is capable of coring soft, unconsolidated sediments up to a depth of 6 m below the seabed; in water depths of less than 2000 m. TOPAS sub-bottom profiler surveys aided the identification of sites suitable for vibrocoring. Two perpendicular survey passes were made over a potential target to identify areas of gentle slope with an absence of rough topography favourable for core penetration. A video camera and spotlight mounted on the Vibrocore rig provided real-time visual data of the targeted site. Minimal or no disruption of bedding and sedimentary structures occurred during core sampling and recovery. On occasion the uppermost layer of unconsolidated ash was liquified and lost during coring and rig recovery. Fifty-four (54) Vibrocore samples were recovered during the cruise. Core lengths ranged from 70 centimetres to approximately 5 metres. The samples recovered contained unconsolidated volcanic-sourced sedimentary deposited intercalated with submarine hemipelagic sediment.

A Box Core rig was used to recover undisturbed shallow surface sediment for pore-water chemistry, biological and sedimentological study. Five (5) Box Core samples were recovered, each providing four (4) sub-core samples for analysis. A single Gravity Core sample was recovered. However, as the penetration was significantly less than what could be obtained using the Vibrocore system the Gravity Core rig was not attempted again.

Summary

Eruptions of the Soufrière Hills volcano, Montserrat, provide an unprecedented opportunity to understand the hazardous, often catastrophic, and poorly understood events that transport sediment into marine environments surrounding andesitic volcanoes. Unusually detailed information is now available for both the subaerial and submarine component of events on this volcano. The comprehensive catalogue of core samples recovered during the JR123 cruise will allow us to: 1) compare the subaerial and submarine stratigraphic records; 2) develop a complete geochronological framework for the Soufrière Hills volcano; 3) document the evolution of a submarine pyroclastic fan and; 4) determine the dispersal and depositional processes involved when a pyroclastic flow enters the ocean.