ASAF ASHRAF

Core Laboratory
Graduate School of Oceanography
University of Rhode Island

CRUISE REPORT - R/V TRIDENT
CRUISE TR-86 (TERCEIRA I)
23 July-4 August 1970
(Also 6-10 August 1970)
AZORES ISLANDS

SCHEDULE

A 13-day cruise was made in the Azores Islands region of the North Atlantic Ocean from 23 July to 4 August 1970. The operations involved geological and geophysical studies. In addition, bathymetric and magnetic data was collected in transit from Ponta Delgada (Azores) to Rota (Spain) during the 5 days of 6-10 August 1970.

Leg I
23-29 July 1970. Ponta Delgada (San Miguel I) to Angra do Heroismo (Terceira I) (7 days).

Leg II
30 July-4 August 1970. Angra do Heroismo to Ponta Delgada (6 days).

In port
4-6 August 1970. Ponta Delgada

In transit
6-10 August 1970. Ponta Delgada-Rota (Spain) (5 days).

SCIENTIFIC PARTY

Dr. Dale C. Krause, co-chief scientist, URI (Legs I, II, in transit)
Dr. Jean-Guy Schilling, co-chief scientist, URI (Leg I)
Martin Fisk, graduate student, URI (Legs I, II, in transit)
John W. Richmond, Jr., graduate student, URI (Legs I, II, in transit)
William Hahn, oceanographic technician, URI (Legs I, II, in transit)
Joel Knee, oceanographic technician, URI (Legs I, II, in transit)
Dr. Frederico Machado, volcanologist, Ministerio do Ultramar, Portugal
(Legs I, II, in transit)
J. Hipolito Monteiro, geologist, Instituto Hidrografico, Portugal (Legs I, II)
Fred W. Haug, Jr., graduate student, University of New Hampshire (Legs I, II)
SHIP'S COMPANY

Barnes Collinson, master
C.A. Sawyer, chief mate
David LaCasse, second officer
Henry Martin, bos'n
Kyle Birk, radio officer
Herbert Stein, chief engineer
H. Carlson, first assistant engineer
Theo. Surette, second assistant engineer
Harry Rougas, electrician
Pat Neves, steward

David Bennett, second cook
Fred Russell, AB seaman
Robert Jenkins, AB seaman
Richard Boardman, AB seaman
Oscar Ammons, ordinary seaman
Joseph Moscatelli, ordinary seaman
Brad McGuire, ordinary seaman
Ernest Cherry, oiler
Allen Stopyra, oiler
C. Nelson, oiler

OPERATIONS

The cruise, "Terceira I", is the first of a two-part cruise (TR-86 and TR-89) designed to study the geologic evolution of the Azores region and to test the Krause-Watkins Azores tectonic model. The name is derived from the following facts: (1) this is the third cruise to the Azores (after TR-21 in 1964 and TR-28 in 1965), (2) the cruise is designed to study a crustal triple-junction and (3) the region of most intense study concerned the Terceira rift. The study was split into two parts in order to mesh with the TRIDENT's Mediterranean operations.

The cruise was initially planned to be devoted mainly to rock dredging operations (controlled by simultaneous bathymetric, magnetic and seismic profiling studies). However, at mid-cruise, a winch malfunction forced postponement of the remaining sampling program until October (TR-89).

LEG I. Ponta Delgada - Angra do Heroismo

Leg I was mainly devoted to the ridge along the southern flank of the East Azores Fracture Zone. The ridge is herein tentatively named "Agostinho Ridge" after the Azorean scientist, Jose Agostinho. He has been the long-famed and respected naturalist of the Azores for more than a half century. He is now living at the age of 90 in Angra de Heroismo, Terceira, and is often consulted by visiting scientists. He is the author of, among others, many geological papers about the Azores and teacher of Dr. Frederico Machado.

The seismic profiler was used to find outcrops which were then sampled. Eleven stations (see Table 1) were made of which nine were dredge stations and one each camera and gravity core stations. Of the dredge stations, coarsely crystalline gabbro was recovered on three (4D, 5D, 6D) and lithified calcareous ooze was found on six (2D, 3D, 4D, 6D, 8D, 9D). Manganese coatings of variable thickness occurred on five stations (3D, 5D, 6D, 8D, 9D).
In all places, a thick cap of pelagic ooze up to 500 meters thick covered the ridge. Basement, however, was exposed on the very steep, north facing scarps. The ridge decreased in height westward. A thickness of up to 1 km of turbidites and ooze are trapped on the north side of the ridge in a long linear trough.

Seismic (see Table 2), magnetic and bathymetric profiles were made over the shallow ridge trending south from San Miguel Island, over a northern portion of the East Azores Fracture Zone and across the Azores Plateau to Terceira (see Table 3 for equipment).

At Terceira, Schilling transferred direction of the cruise to Krause and departed.

LEG II. Angra do Heroismo - Ponta Delgada

Leg II was devoted to the study of the magnetic pattern, the sediment distribution and the bathymetry associated with the proposed Terceira Rift trending through Graciosa, Terceira and San Miguel Islands. Given the time, the study could not be detailed. However, several "survey experiments" were carried out.

(1) Terceira trend experiment. Five lines spaced 2\(\frac{1}{2}\) miles apart were run south of Terceira. As of this writing, the interpretation of the data is that magnetic trend is parallel to Terceira Rift.

(2) Azores plateau trends. South of the San Jorge trend, the magnetic anomaly pattern is not yet clear from the data. South of the Faial-Pico trend, the pelagic sediment overlies a more or less smoothly undulating basement whose magnetic trend is not yet clear.

(3) Junction experiment. At the suggestion of J.H. Monteiro a series of lines were run across the Terceira Rift west of Terceira in such a way as to test anomalies formed by the Terceira Rift and by the Mid-Atlantic Rift. Tentatively, the pattern is as expected from the Krause-Watkins model out to 13 million years. The crossings of the Terceira Rift approximately fit the theoretical model except for an absence of a large central anomaly sediment distribution is consistent with spreading of the Terceira Rift.

(4) Structure between Terceira and San Miguel. Six reconnaissance lines were run across the Terceira Rift in this region. A large topographic rift exists with a suitable sediment pattern. The magnetic pattern is permissible regarding the model.

These results were used to control dredging on cruise TR-89. Cruise TR-86 was supported by ONR contract N00014-68-A-0215-0003 and NSF Grant GA-21164.
<table>
<thead>
<tr>
<th>Station No.</th>
<th>Type</th>
<th>Provisional Position</th>
<th>Date 1970</th>
<th>Time on bottom</th>
<th>Depth m</th>
<th>Chief Operator</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1C</td>
<td>Core</td>
<td>36°38'N 25°59'W</td>
<td>24 July</td>
<td>1550</td>
<td>3665</td>
<td>Krause</td>
<td>Calcareous ooze, length = 100 cm in trough</td>
</tr>
<tr>
<td>2D</td>
<td>Dredge</td>
<td>36°36' 25°58'</td>
<td>24 July</td>
<td>1753-2254</td>
<td>2900-3600</td>
<td>Schilling</td>
<td>50 kg* calcareous ooze north side of ridge</td>
</tr>
<tr>
<td>3D</td>
<td>Dredge</td>
<td>36°35' 26°34'</td>
<td>25 July</td>
<td>1045-1615</td>
<td>3400-3700</td>
<td>Schilling</td>
<td>100 kg of soft calcareous ooze and 75 kg manganese covered indurated calcareous ooze north side of ridge</td>
</tr>
<tr>
<td>4D</td>
<td>Dredge</td>
<td>36°35' 26°32'</td>
<td>25 July</td>
<td>2029-2045</td>
<td>3000-3400</td>
<td>Krause</td>
<td>25 kg gabbro, 50 kg indurated calcareous ooze north side of ridge</td>
</tr>
<tr>
<td>5D</td>
<td>Dredge</td>
<td>36°34' 26°31'</td>
<td>26 July</td>
<td>1945-2230</td>
<td>2800-2860</td>
<td>Schilling</td>
<td>10 kg gabbro and manganese crust north side of ridge</td>
</tr>
<tr>
<td>6D</td>
<td>Dredge</td>
<td>36°34' 26°31'</td>
<td>26 July</td>
<td>0110-0222</td>
<td>2750-3000</td>
<td>Krause</td>
<td>10 kg manganese coated gabbro and indurated calcareous ooze</td>
</tr>
<tr>
<td>7F</td>
<td>Photo</td>
<td>36°33' 26°30'</td>
<td>27 July</td>
<td>0522-0547</td>
<td>2250-2300</td>
<td>Hahn</td>
<td>Manganese coated outcrops of indurated ooze and ripple marked drifts of soft ooze. Upper part of ridges north side. Plus-X film. F-8 = F stop</td>
</tr>
<tr>
<td>8D</td>
<td>Dredge</td>
<td>36°34' 26°29'</td>
<td>27 July</td>
<td>0824-1030</td>
<td>2450-2700</td>
<td>Schilling</td>
<td>100 kg soft and manganese-coated indurated calcareous ooze, a few igneous fragments. North side of ridge</td>
</tr>
<tr>
<td>Station No.</td>
<td>Type</td>
<td>Provisional Position</td>
<td>Date</td>
<td>Time on bottom 1970</td>
<td>Depth m</td>
<td>Chief operator</td>
<td>Results</td>
</tr>
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<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>9D</td>
<td>Dredge</td>
<td>36°30'N 26°27'W</td>
<td>27 July</td>
<td>1345-1550</td>
<td>2500-2900</td>
<td>Schilling</td>
<td>50 kg manganese coated calcareous ooze and 1 rounded schist (quartz biotite) cobble (probable glacial erratic). South side of ridge</td>
</tr>
<tr>
<td>10D</td>
<td>Dredge</td>
<td>36°35' 26°40'</td>
<td>27 July</td>
<td>1945-2103</td>
<td>3500-3600</td>
<td>Krause</td>
<td>No sample despite abundant action and &quot;hangups&quot;. Base of north cliff</td>
</tr>
<tr>
<td>11D</td>
<td>Dredge</td>
<td>36°35' 26°39'</td>
<td>27-28 July</td>
<td>0051-0315</td>
<td>3135-3385</td>
<td>Krause</td>
<td>Pinger used 200 m above dredge. Dredge lost when weak links broke during severe 'hangup.' Winch malfunction. North side of ridge</td>
</tr>
</tbody>
</table>

*Weights approximate
TABLE 2. Seismic profiles. Except for minor gaps for maintenance and repair, the TRIDENT made the following seismic profiles.

<table>
<thead>
<tr>
<th>Date</th>
<th>Distance</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1156, 23 July - 1140, 24 July</td>
<td>371 km (201 n.m.)</td>
<td>South of San Miguel I.</td>
</tr>
<tr>
<td>0052-0832, 25 July</td>
<td>120 km (65 n.m.)</td>
<td>Agostinho Ridge</td>
</tr>
<tr>
<td>0013-1809, 26 July</td>
<td>278 km (150 n.m.)</td>
<td>Agostinho Ridge</td>
</tr>
<tr>
<td>0824, 28 July - 1634, 29 July</td>
<td>496 km (268 n.m.)</td>
<td>East Azores Fracture Zone to Terceira I.</td>
</tr>
<tr>
<td>0636-1737, 30 July</td>
<td>189 km (102 n.m.)</td>
<td>South of Terceira I.</td>
</tr>
<tr>
<td>1925, 30 July - 0612, 1 Aug.</td>
<td>552 km (298 n.m.)</td>
<td>South and west of Terceira I.</td>
</tr>
<tr>
<td>0918, 1 Aug. - 1313, 2 Aug.</td>
<td>474 km (256 n.m.)</td>
<td>West of Graciosa I.</td>
</tr>
<tr>
<td>1828, 2 Aug. - 0412, 4 Aug.</td>
<td>540 km (292 n.m.)</td>
<td>Around Terceira I. and traverses across rift to San Miguel I.</td>
</tr>
<tr>
<td>0714-0806, 4 Aug.</td>
<td>12 km (7 n.m.)</td>
<td>Off San Miguel I.</td>
</tr>
</tbody>
</table>

Total: 5 days 22 hours 3032 km (1639 n.m.)

Table 3. Scientific Equipment

- Echo sounder: Alpine PESR recorder coupled with EDO sounder
- Magnetometer: Varian adapted station magnetometer
- Seismic profiler: Bolt air gun, WHOI-type 2000-element hydrophone, Raytheon PFR recorder, Sanborn 7-track FM tape recorder
- Gravity corer: SIO-type
- Rock dredge: chain bag, URI modified
- Bottom camera: EGG single camera and stroke, Benthos pinger
R/V TRIDENT 
CRUISE TRACK 
TR-86-87 TRANSIT 
6-10 AUGUST 1970 
NORTH ATLANTIC OCEAN