tory speed for this part of the Atlantic.

A sharp decrease in radon concentration with height above the dust layer is implied in the results of radon measurements made between Miami and Barbados. Figure 1 shows that these values are almost uniformly an order of magnitude or more below the higher values obtained immediately east of Barbados. These Miami-Barbados measurements were all obtained at an altitude of 12,000 to 13,000 feet and are evidently representative of air above the general haze top and, therefore, of air not previously in recent history subjected to convective contact with the African soil. This distribution is analogous to the vertical distribution of water vapor which, like radon gas, is also introduced from a ground source and stirred by convection to higher levels. We would expect the radon and water vapor concentration to decrease fairly rapidly in the lowest hundreds of meters and then to remain nearly constant or to decrease slowly with height to the top of the mixing layer; above this point we would expect the values to once again tend toward a rapid decrease with height. Except for a small peak near Hispaniola, West Indies, the radon values measured west of Barbados were close to the level of background radiation. The peak at Hispaniola is most likely a geographical phenomenon resulting from an enhancement of local cumulus convection over this large island, thus causing a penetration of the inversion and bringing up a fresh supply of radon and dust from below.

We believe that radon-222 can be extremely useful as a tracer for air moving from Africa into the equatorial Atlantic. The circulation patterns in this part of the tropical Atlantic are not well known; in addition, it has recently been established (*15*) that Africa is a dominant source region for Atlantic tropical disturbances, some of which develop into hurricanes. Furthermore, a significant fraction of the dust associated with the hazy radon-rich areas consists of clay minerals known to be efficient as ice nuclei (*5*).

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9. The apparatus employed in this work is the same as that used by C. R. Hosler and L. B. Lockhart, Jr. [*J. Geophys. Res.* **70**, 4537 (1965)].
10. The radioactivity of the filter was counted for a second time, again for 10 minutes, beginning 60 minutes after the end of the first counting period in order to verify the decay of the radon daughter products which collectively have an apparent half-life of approximately 35 minutes.
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22 October 1969; revised 1 December 1969

Active Submarine Volcanism in the Austral Islands

Abstract. *An active submarine volcano has been found on a southeastward extension of the Austral Islands chain. Its last eruption, in May 1967, was detected by North Pacific hydrophones. The position computed by sofar was 32 kilometers northwest of that found in a search by echo sounder, 29°01'S, 140°17'W. The minimum depth encountered was 460 meters.*

On 29 May 1967 a 4½-hour sequence of explosions was recorded on sofar hydrophones arrayed across the North Pacific. The source location was computed as 28.8°S, 140.5°W, on a southeastward extension of the Austral Islands chain. Norris and Johnson (see *1*) ascribe the origin of this sequence, and similar sequences from other regions, to submarine volcanic eruptions.

Marine acoustic detection of volcanic eruptions along the Andesite Zone has been reported on a number of occasions (*2–5*). The Austral Islands event is unique, however, in two respects: the source was in the central Pacific Basin and the source was remote from previously known active volcanoes.

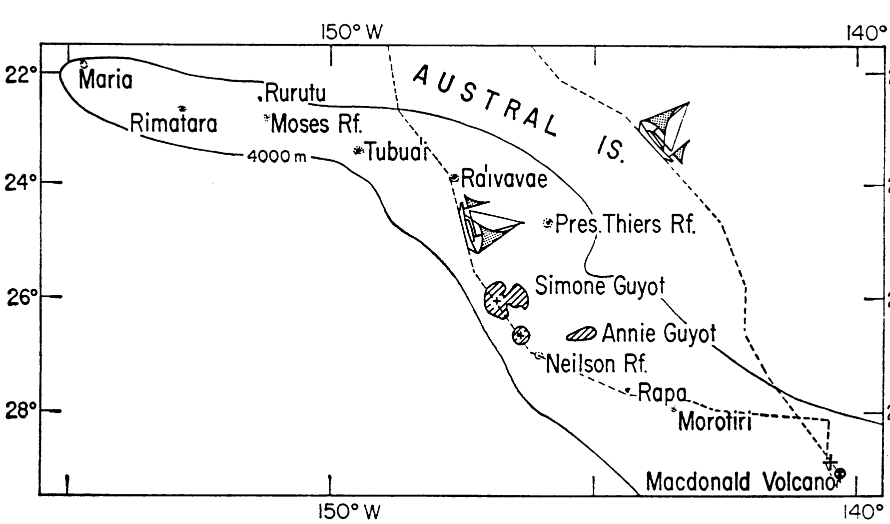
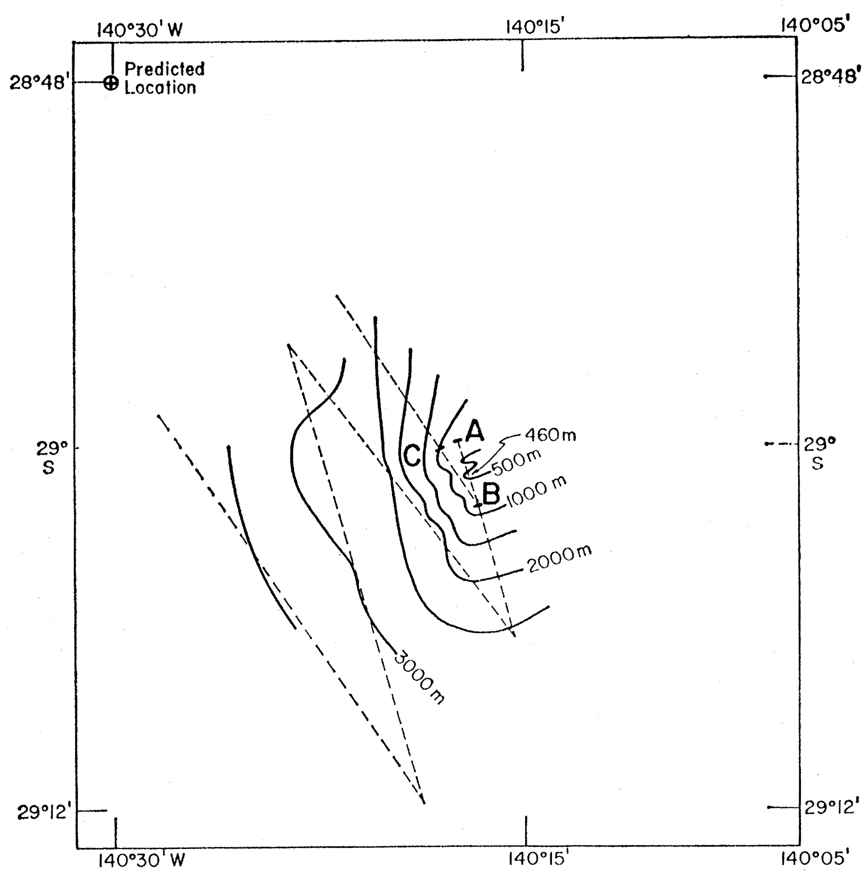


Fig. 1. Map of the Austral Islands. The position predicted by sofar for Macdonald Volcano is marked with a cross. The track of the *Havaiki* is indicated by the dashed line.



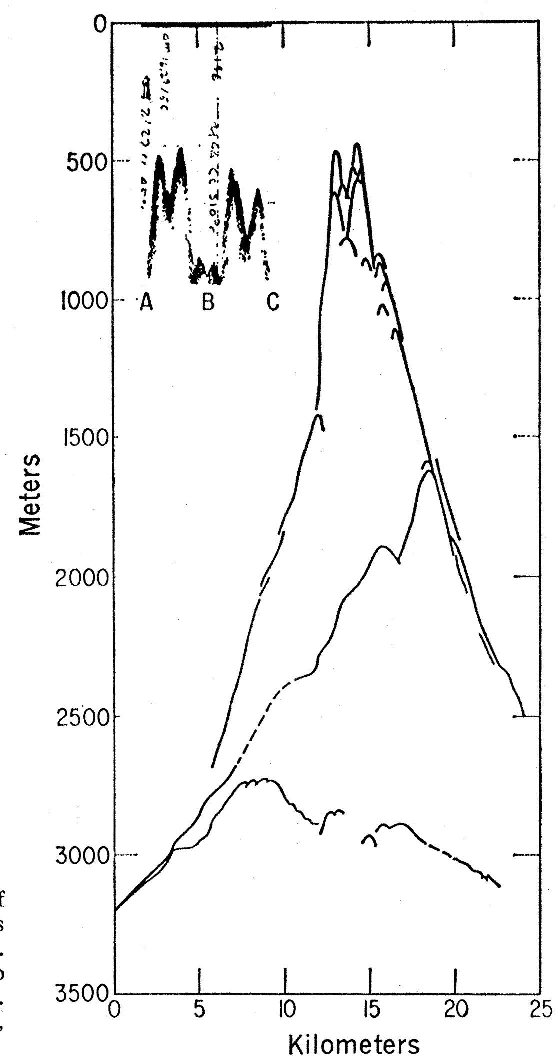


Fig. 2 (left). Uncorrected depth contours for Macdonald Volcano. The track of the *Havaiki* is indicated by the dashed line. The position predicted by sofar is marked with a cross. *A*, *B*, and *C* refer to the inset in Fig. 3. Fig. 3 (right). Composite echogram tracing for two traverses over the west flank and two traverses near the summit of Macdonald Volcano. Vertical exaggeration 16 : 1. The inset is a photograph of the echogram for the two shallow traverses. *A*, *B*, and *C* refer to positions in Fig. 2.

The Austral Islands chain is itself unique in that Mesozoic guyots intervene between Recent volcanoes (*6*). These islands extend from Maria Atoll to Morotiri, a group of rocks surmounting a nearly truncated volcano southeast of Rapa (Fig. 1). From the surface geology there is no clear evidence of a southeastward migration of a center of volcanism, which elsewhere in the Pacific is characteristic of island chains (*7*). A classic example of this migration is the Hawaiian Ridge, where active volcanism still persists on Hawaii, the southeasternmost island of the chain.

To corroborate the long-range acoustic evidence of active volcanism, I searched the source region by echo sounder in July 1969. The search was conducted from the yacht *Havaiki*, a 12-m fiber glass yawl, with my wife and four children, aged five through ten years, serving as crew. The echo sounder was a Furuno model F-812-H with a rated range of 2000 fathoms (3600 m). Electrical power for the echo sounder was provided by the main engine through alternator, batteries, and inverter.

Engine failure 2 days before arrival in the volcano region severely limited the time available for echo sounding. Accordingly, the search was concentrated along the axis of major uncertainty of the sofar fix. This was estimated as the bisector of the azimuthal sector containing the hydrophone net. Although the echo sounder had previously been operating continuously, soundings were taken only once each hour after engine failure.

On 20 July 1969, while on a south-southeasterly heading, *Havaiki* passed 7 km to the west of the predicted volcano location. During local apparent noon (2128 G.M.T.) the vessel lay-to while two 4-pound (1.8-kg) sofar bombs were detonated at a 4000-foot (1200-m) depth. At this time 53 solar-altitude measurements were taken during a 1-hour interval. The least-squares estimate of position (assuming zero speed) was later found to be 29°00.2′S, 140°27.4′W. Standard deviations of latitude and longitude were 0.12′ and 1.6′, respectively. The standard deviation of solar-altitude measurements was 0.8 minute of arc.

The course was continued to the southeast, nine solar altitudes being taken over a short interval about 0048 G.M.T. (21 July). The mean of these was combined with the noon observations to produce a running fix. At 0120 G.M.T., about 47 km beyond the predicted volcano position, the vessel was brought about to a heading just east of the predicted position. Upon the next hourly sounding we found a rising bottom.

Now operating the echo sounder continuously, we followed a zigzag track up the southwestern flank (Fig. 2). The minimum depth encountered was 460 m in 29°01′S, 140°17′W, at 0600 G.M.T. Tracings of the echogram are shown in Fig. 3. Owing to near-exhaustion both of the crew and of the electrical power, as well as to fear of grounding in the darkness, the survey was not continued northeastward of the 460-m sounding. An extrapolation of the two ridges in the shallow echograms indicates a near-surface summit about 3½ km farther northeast (*8*).

I propose to name the newly discovered volcano in honor of Gordon A. Macdonald, professor of geology at the University of Hawaii and an authority on Pacific volcanism.

On the assumption that the explosions recorded by sofar emanated from Macdonald Volcano, the sofar fix is found to be in error by 32 km. Although this is less than 1 percent of the distance to the hydrophones, it represents a speed of sound propagation about 5 m sec^{-1} faster than the sofar axis speed (*9*). This discrepancy is considerably greater than any reasonable uncertainty in the speed of sound in the ocean (*10, 11*). A likely interpretation is either that the explosion was sufficiently far off the sofar axis so that maximum energy was carried along higher-speed off-axis rays, or that intervening islands and seamounts intercepted the near-axis rays. In partial substantiation of the latter view, no signals from the sofar bombs detonated on 20 July were received at any of the hydrophone stations although a pair of bombs detonated on 17 July, in a position northeast of Morotiri, were recorded 15 db above background at Eniwetok and Wake islands.

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9. Sound speed at the sofar axis is about 1484 m sec^{-1} in the central Pacific.
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Refractory Oxide–Metal Composites: Scanning Electron Microscopy and X-ray Diffraction of Uranium Dioxide–Tungsten

Abstract. *Unidirectional solidification of a melt, consisting of uranium dioxide and 5 to 15 percent by weight of tungsten, formed well-ordered arrangements of tungsten fibers or platelets in the uranium dioxide matrix. Fiber shape and orientation relations of the components indicate the development of several dominant growth modes.*

Uranium dioxide–tungsten (5 to 15 percent by weight) composites were solidified unidirectionally by a modified floating-zone process named the internal centrifugal zone growth technique (*1*). The metal solidified with the oxide and yielded well developed tungsten fibers or platelets regularly dispersed in the UO_2 matrix. The lattice constants of the metal and oxide were 3.1650 ± 0.0003 Å and 5.4715 ± 0.0003 Å, respectively. These figures agree, within the experimental error, with generally accepted values. The

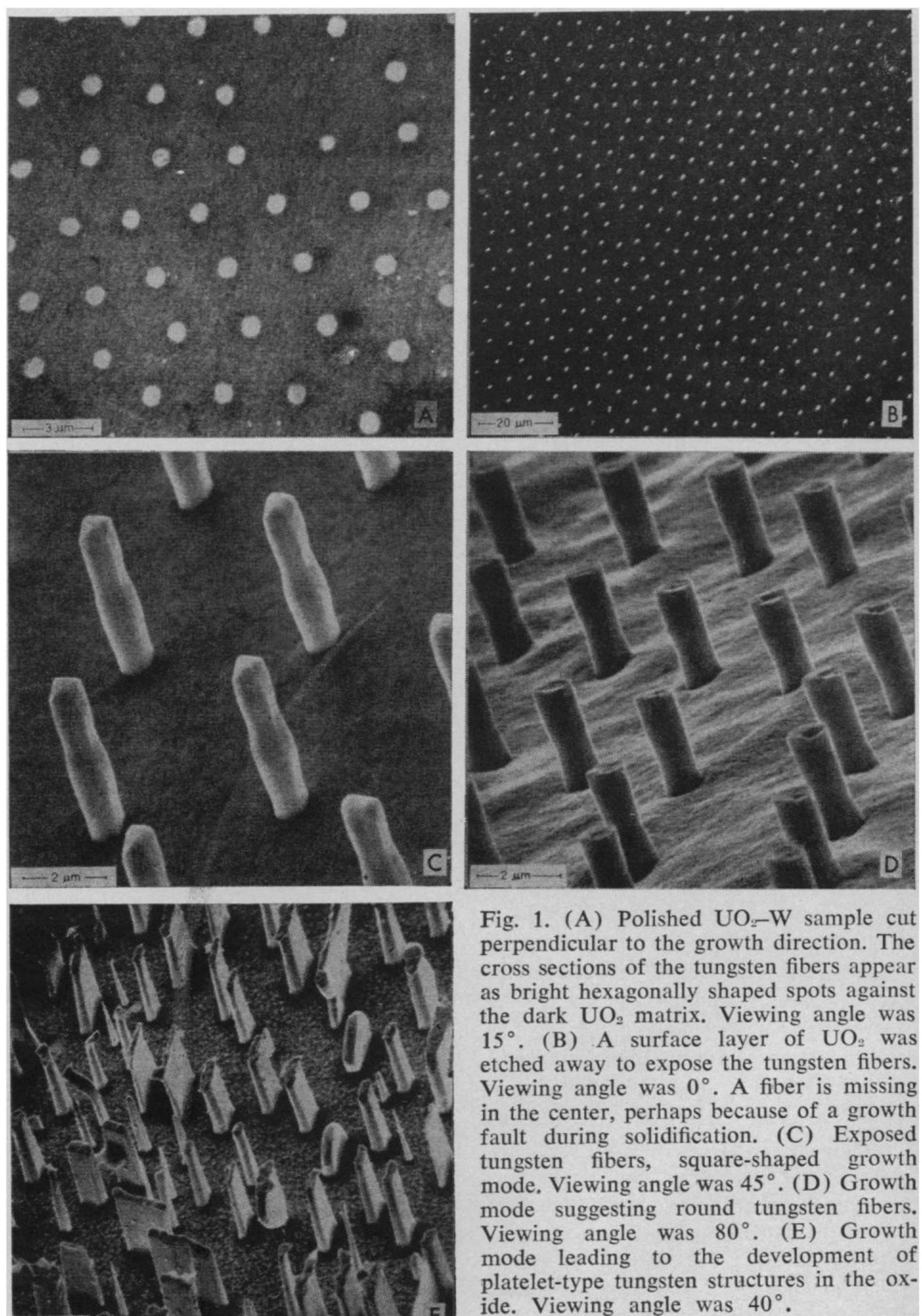

Fig. 1. (A) Polished UO_2–W sample cut perpendicular to the growth direction. The cross sections of the tungsten fibers appear as bright hexagonally shaped spots against the dark UO_2 matrix. Viewing angle was 15°. (B) A surface layer of UO_2 was etched away to expose the tungsten fibers. Viewing angle was 0°. A fiber is missing in the center, perhaps because of a growth fault during solidification. (C) Exposed tungsten fibers, square-shaped growth mode. Viewing angle was 45°. (D) Growth mode suggesting round tungsten fibers. Viewing angle was 80°. (E) Growth mode leading to the development of platelet-type tungsten structures in the oxide. Viewing angle was 40°.