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Fumarolic Activity in Marie Byrd Land, Antarctica

Abstract. *Ice towers, probably formed by recent fumarolic activity, have been found around the summit calderas of two volcanoes in Marie Byrd Land. These active (?) volcanoes lie within a broad belt of Mesozoic intrusion and late Cenozoic extrusion that appears to be part of the circum-Pacific orogenic province.*

The Marie Byrd Land Survey (1967 to 1968) covered a coastal sector approximately 720 km long and extending up to 320 km inland, between longitudes 110°W and 136°W. The volcanic nature of many mountains in this region had been established by oversnow traverses from Byrd Station (1957 to 1958 and 1959 to 1960). One age determination from a Mount Sidley specimen, at the southern end of the Executive Committee Range, yielded an eruption date of 6.2 million years ago (*1*). We now report evidence for recent fumarolic activity in two central Marie Byrd Land mountain ranges.

Fumarolic activity in Antarctica characteristically produces ice towers by the condensation and freezing of vapors. These features have been described from observations on Mount Erebus, Ross Island, first by Shackelton (*2*) and then by Holdsworth and Ugolini (*3*). Those features forming over active fumaroles show open central vents; the inactive fumaroles on Mount Erebus are marked by ice towers without open vents. Groups of ice towers, similar in size and shape to those pictured by Holdsworth and Ugolini, were observed at close range from helicopters around the summit calderas of Mount Berlin, in the Flood Range (135°50′W, 76°03′S), and Mount Hampton, in the Executive Committee Range (125°54′W, 76°29′S). The ice towers on Mount Hampton, which were also examined from the ground, are approximately 10 to 20 m high. No open central vents or gaseous emissions were observed, and no fumarolic condensates or sublimates could be sampled because each ice structure was mantled by fresh snow. A very recent origin for these structures is almost certain, because they stand completely unprotected from wind erosion at elevations exceeding 3000 m.

Antarctic volcanoes, known to be active because of recent eruptions or geothermal activity, include Mount Erebus, on the southwestern margin of the Ross Sea; Deception Island in the South Shetland Islands; and Mount Melbourne on the Hallett Coast (*4*). Mount Morning, 90 km southwest of Ross Island, is suspected of being geothermally active on the basis of a recent infrared scan (*5*). These recently active Antarctic volcanoes lie within a large belt of late Cenozoic volcanism that extends down the Antarctic Peninsula, across Marie Byrd Land, and northward along the Hallett Coast to Cape Adare and the Balleny Islands. Granitic plutons of late Mesozoic age underlie the eastern part of this volcanic terrain, in the Antarctic Peninsula and in Ellsworth Land (*6*). The coupling of these volcanic and plutonic characteristics is typical of the circum-Pacific orogenic belt as described in more accessible and better exposed areas (*7*). It has yet to be established however, that there is a continuity of these orogenic characteristics along the full length of the Antarctic margin of the Pacific Ocean basin. The presence of ice towers on Mount Berlin and Mount Hampton suggests that there has been recent volcanic activity in Marie Byrd Land, and that the circum-Pacific orogenic belt may extend without interruption, from Ellsworth Land across Marie Byrd Land. Our tentative conclusions require confirmation by a program of infrared scanning over this entire sector, and by determinations of the ages of granitic plutons in Marie Byrd Land mountain ranges.

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Scientific Uses of Pulsars

Abstract. *The recently discovered celestial sources of pulsed radio energy can be used to test general relativity, to study the solar corona, and to determine the earth's orbit and ephemeris time. The vector positions and transverse velocities of pulsars can be measured with radio interferometers; in combination with pulse-arrival-time data, the distance determination will yield the average interstellar electron density.*

The startling discovery (*1*) and subsequent investigations (*2, 3*) of celestial objects that emit intense bursts of radio energy at regular intervals has caused great consternation (*4*) among the theorists trying to explain this phenomenon. We have not solved this theoretical problem either but, rather, wish to point out how best advantage might be taken of the existence of pulsars. In particular, we discuss several potentially important experiments that might utilize their radiation. The interpretations of such experiments are, unfortunately, dependent to some extent on the theoretical model that is assumed to describe this radiation. We therefore postulate first that pulsar emissions are perfectly regular (*5*); we also discuss models for which this assumption is invalid and consider the consequences for the proposed experiments.

A number of applications can be based on pulsars being like "one-way" radars. From accurate measurements of the times of arrival of pulses from one, or preferably more, pulsars, the orbit of the earth can be determined with standard techniques (*6*). The orbit, determined with respect to pulsar locations, can be related to optical star