Hydrothermal supermounds

SIR — High-resolution sidescan sonar images have revealed huge mounds (up to 190 m tall) on the Reykjanes Ridge (northern Mid-Atlantic Ridge) southwest of Iceland. They occur on the eastern flank of a neovolcanic zone, lying along the plate boundary close to 58° N (arrowed in Fig. 1). Similar, albeit smaller, steep-sided features, found elsewhere along the Mid-Atlantic Ridge, have a hydrothermal origin.

The mounds, which cast long acoustic shadows towards the southeast (arrowed in Fig. 2) and away from the sidescan sonar vehicle, are located in the northwest corner of the image. The vehicle's track is northeast–southwest, and passes across the far top left-hand corner of the image. The size and shape of the mounds can be estimated from the length and shape of their acoustic shadows. We know from multi-beam echosounder data that the sea floor beneath the shadows is virtually flat (Parson *et al.*, personal communication), and that the vehicle passed the mounds at an altitude of 400 m, at a range of 500 m. We have identified four mounds, which are aligned northeast–southwest, and appear bell-shaped from their insonified sides. In order of position from northeast to southwest, the heights of the mounds above the sea floor (in metres) are: 190, 180, 135 and 185 (± 10). Their basal widths, measured parallel to the vehicle track, are: 150, 90, 135 and 160 (± 6); and their maximum slope angles (in degrees) are 57, 68, 71 and 54 (± 6), respectively.

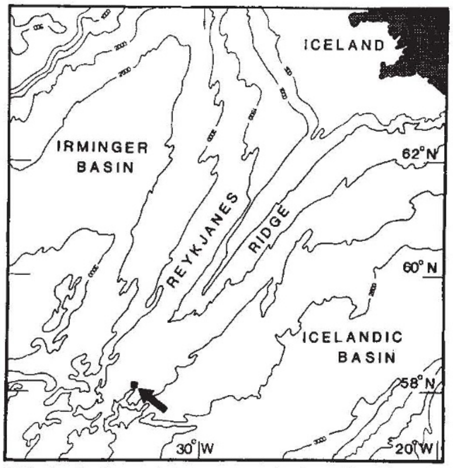

FIG.1 Bathymetric map of the Reykjanes Ridge locating the site of the supermounds (arrowed).

Elsewhere on the image the sea floor is characterized by volcanic ridges and faults trending northeast–southwest and parallel to the plate boundary. A conical volcano in the lower centre of the image, and a prominent shield volcano in the bottom left-hand corner (arrowed in Fig. 2), allow a comparison with the mounds. These unique images were obtained using the new towed ocean bottom instrument from the Institute of Oceanographic Sciences, Deacon Laboratory (IOSDL), which has a resolution of about 2 m (ref. 1).

The origin of the mounds remains enigmatic. They may be individual volcanoes, but their extremely steep slopes make such an explanation unlikely. One of the steepest flanked submarine volcanic seamounts reported to date, on the Mid-Atlantic Ridge at 24° N (Lawson *et al.*, personal communication), has a slope angle of about 30°. The mounds imaged on the Reykjanes Ridge are more than 20° steeper than this, so are unlikely to be volcanically constructed.

Alternatively, the mounds may have a hydrothermal origin. This explanation is consistent with their bell-like shapes and neovolcanic setting. We know from active hydrothermal fields on both the East Pacific Rise and the Mid-Atlantic Ridge that steep mounds and chimney-like structures are common. These arise from the precipitation of metal-sulphides around escaping high-temperature fluids. Hydrothermal mounds at the 'Snake-pit' field (23° N on the Mid-Atlantic Ridge) are beehive-shaped, 40 –100 m long by 20 m wide and up to 50 m high, with flank angles of between 50° and 70° (ref. 2). Similarly, the 'TAG' hydrothermal mound (26° N of the Mid-Atlantic Ridge) is 50 –100 m high and approximately 200 m across[3]. Have we seen a set of hydrothermal supermounds on the Reykjanes Ridge? Their shape suggests that we have, but their size is greater than any hydrothermal mounds or chimney-like structures reported previously.

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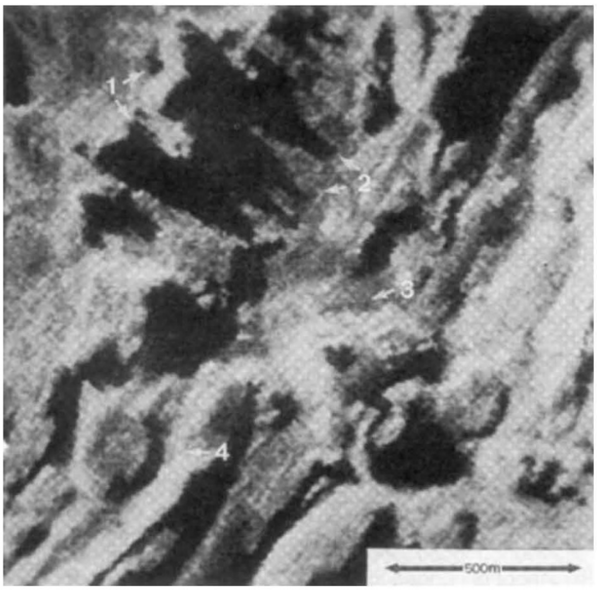

FIG. 2 High-resolution sidescan sonar image, produced using the IOSDL new towed ocean bottom instrument of the supermound site on the Reykjanes Ridge (Mid-Atlantic Ridge southwest of Iceland). The image, 1,500 × 1,500 m, was insonified from the top left-hand corner. It is similar to a monochrome photograph, with strong acoustic returns as bright tones and weak ones as dark tones. Arrowed and numbered on the image are: (1) the supermounds; (2) shadows cast behind the supermounds; (3) a conical volcano; and (4) a shield volcano.

CH^+ in the Red Rectangle

SIR — The CH^+ molecule was first discovered in diffuse interstellar clouds more than 50 years ago[1]. Although a great deal of research has been undertaken, the mechanism of its formation and the reason for its high abundance are not well understood[2]. In a recent spectroscopic study[3] of the star at the centre of the unusual Red Rectangle biconical nebula, the discovery of a set of emission lines near 4,200 Å was reported but the carrier was not identified. By comparing the reported wavelengths with known laboratory spectra, we show here that these lines arise from CH^+. Detection of the CH^+ molecule in a nebula presents a new opportunity to investigate the reason why CH^+ is such an abundant astrophysical molecule. The CH^+ spectrum will also provide a very useful probe of the chemical and physical conditions in the Red Rectangle.

The published Red Rectangle emission spectrum[3] covers the range 4,215 – 4,245 Å; the wavelengths of the six reported lines are given in the table, where comparison is made with the laboratory data[4] for CH^+. The excellent agreement between the observed and laboratory wavelengths is conclusive evidence that CH^+ is the carrier of the emission lines.