SEAMARC II SIDE-SCAN SONAR IMAGES OF VOLCANIFORM FEATURES IN THE MARIANA FORE-ARC AND ARC REGIONS: POTENTIAL ANALOGUES FOR VENUS. Patricia Fryer, Donald M. Hussong and Peter J. Mouginis-Mark, Hawaii Institute of Geophysics, University of Hawaii, Honolulu, HI 96822

The Earth's ocean floors have been proposed as a possible analogue to the surface of Venus, as it may be viewed by the Venus Radar Mapper[1-3]. Our knowledge of the ocean floor is currently quite poor. However, a recent development in seafloor mapping, SeaMARC II, a side-scan sonar mapping system, is dramatically improving our understanding. For the first time the diversity of seafloor features is being realized. Better understanding of this diversity is likely to aid in the interpretation of Venus data, and so we present here some of our interpretations of a volcanic chain within the Mariana Arc of the western Pacific.

Within a relatively small area, the Mariana island arc region provides examples of various plate margin processes. The fore-arc area, between the active convergence zone (trench) and the volcanic arc, contains some previously unexplained seamounts[4,5]. Small mounds and numerous fractures have been recently discovered in the fore-arc as well[4,5]. The active volcanic arc is composed of a set of currently erupting islands and seamounts located about 200 km from the trench axis, and sets of smaller volcanic chains oriented orthogonal to the strike of the arc. The chains of seamounts which strike across the arc lie within the small, actively spreading back-arc basin immediately west of the island chain[6]. This back-arc basin has a central ridge-transform fault system of the kind that occurs at mid-ocean ridges[7] Thus, the Mariana arc region provides not only examples of processes that occur at convergent plate margins, but also those that occur at divergent ones as well.

Recent studies in the Mariana fore-arc using SeaMARC II have shown details of many of these features (Fig.1). Despite their conical shape, the large (30 km dia., 2 km relief) seamounts which occur within 100 km of the trench axis are not of volcanic origin[4,5]. They represent either uplifted or diapirically emplaced fore-arc material. Uplift in the outer fore-arc is probably related to the subduction of plate seamounts[5]. Formation of the diapirs and their emplacement is likely caused by dewatering of the oceanic lithosphere and serpentinization of the overlying fore-arc[4]. The side-scan images of some of these diapiric seamounts show flow-like features very similar to various types of lava flows. However, dredge samples from these features show that they are not lava flows. A thick flow from one of the seamounts (Fig.2) is composed of plutonic igneous rocks undoubtedly emplaced by diapirism. A more sinuous flow-like feature on another of these seamounts yielded semi-consolidated siltstone (Fig.3). The sinuous flow features on this seamount may represent sediment that has been mobilized during emplacement of a diapir at depth[4].

SeaMARC II images of a series of cross-chain volcanoes (up to 25 km dia., 3 km relief) from the N. Mariana arc have been described elsewhere[3,6]. The flanks of many arc volcanoes are covered with volcaniclastic debris. The northern volcano in the cross-chain, which lies along the arc axis, does appear to have primarily debris covered flanks. However, the two volcanoes further south demonstrate clearly the diversity of flows that can occur on volcanoes in an arc setting. Lavas dredged from these flows contain hornblende phenocrysts and are highly vesicular (> 15% by vol. at depths of 1.5 - 3 km). Thus, they are presumed to be rich in volatiles (> 3% H_2O). Of the factors controlling the type of lava flows which can occur at a given volcano, composition (including volatile content) of the magmas may be the most important in these cross-chain volcanoes. These volcanoes may therefore provide an interesting analogue to possible venusian volcanoes where both high pressure and temperature will influence lava viscosity. In the venusian eruptions, high temperature may contribute to lowering the viscosity of lavas[8] just as high volatile content probably does in the cross-chain volcanoes. The presence of a suprising variety of flow types on the cross-chain volcanoes implies the possibility of a greater diversity of lavas than predicted by current models of venusian volcanic eruptions.

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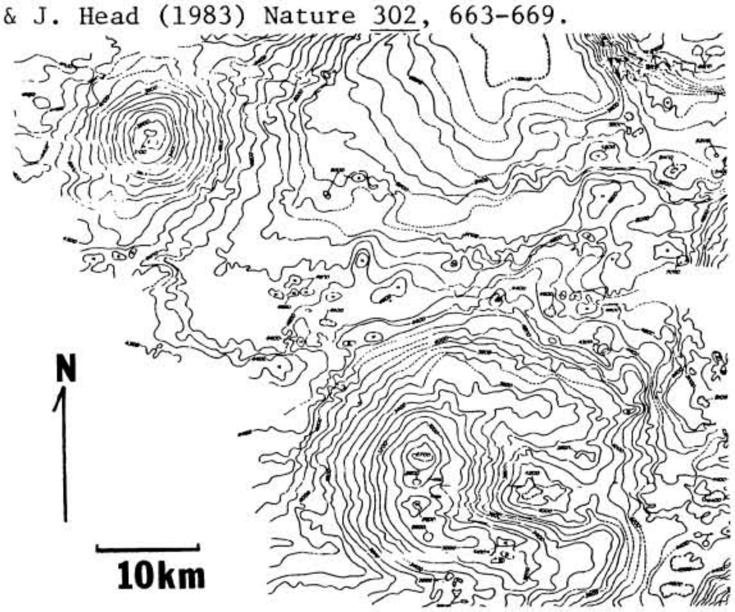
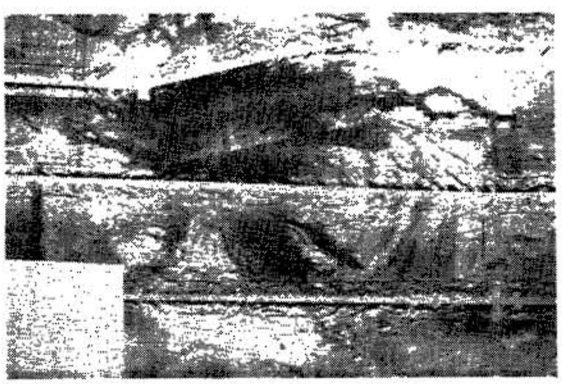


Fig. 1 (left): Bathymetric contour map of two seamounts in the Mariana fore-arc, based on SeaMARC II data. Contour interval is 100 m, dashed lines are interpolated data.



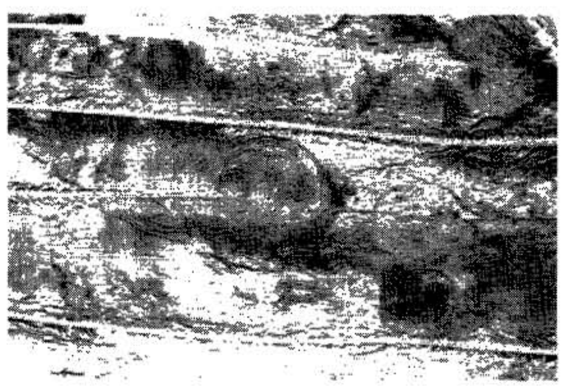


Fig. 2 (left): SeaMARC II side-scan sonar photo-mosaic of the conical seamount in the upper left of Fig. 1. Dark sinuous and braided flow-like features cover the summit and extend down the flanks of the seamount. Photo dimensions correspond to 22 by 35 km. Fig. 3 (right): SeaMARC II side-scan sonar photo-mosaic of the cresent-shaped seamount in the lower right of Fig.1. The oval-shaped feature in the center is a thick flow of diapirically emplaced arc rocks of plutonic origin emanating from near the summit of the seamount and flowing down the eastern flank between the cresent arm. Photo dimensions are 22 by 35 km.