TOPOGRAPHIC EVIDENCE FOR SHIELD VOLCANISM ON IO: IMPLICATIONS FOR COMPOSITION AND LITHOSPHERIC THICKNESS; J.M. Moore, A.S. McEwen, E.F. Albin, and R. Greeley, Department of Geology, Arizona State University, Tempe, Arizona 85287

A volcano has been identified on Io at 30°S, 246°W, whose morphology and topography extend current evidence for shield volcananism on Io. The feature was observed near the terminator, at a sun angle of 81°, so that the topography is clearly seen. Previously, the presence of shield volcanoes was inferred from the appearance of radial flows around the central calderas of features including Ra Patera and Maasaw Patera (1,2).

Slopes on the volcano were measured by photoclinometry. Photoclinometry is difficult on Io due to highly variable albedos and photometric behavior (3). However, the sensitivity of photoclinometry depends on illumination and viewing geometry (4), which are optimal in the case described here. Errors in slope range from <3° on the sun-facing (western) side to <1° on the eastern side. In addition, plume deposits from Pele mantle the volcano, and the albedo appears nearly uniform.

Two main components make up the feature (Fig. 1): a central edifice 40-50 km in diameter, and a broad elliptical base 75 by 90 km across. The boundary between the base and the surrounding plains is defined by a scarp or flow front. Slopes on the western side of the central edifice range from 10° to 14°, while the eastern slope is about 8° (Fig. 2). The outer apron slopes away from the center at 1-2°. The summit stands 2.5 ± 0.3 km above the surrounding plains. A caldera at the summit measures 5 km across and at least 100 m deep. Measurement of the true depth is limited by resolution. This feature is comparable both in size and morphology to large shield volcanoes found on Earth (Fig. 2). The steepening near the summit may result from shorter and/or thicker flows emplaced during late-stage eruptions.

The volcano may be composed primarily of basalt because: a) the morphology is similar to that of terrestrial shield volcanoes which are composed of basalt; b) the bulk density of Io is consistent with that of silicates; and c) the large topographic relief observed on Io requires the presence of some material with greater strength than sulfur in the lithosphere (5). Based on the topography of the structure and the relationship between viscosity and temperature for sulfur (5), the volcano might be composed of sulfur only if the heat flow is less than ~0.05 W m^{-2}, a minimum value for conductive heat flow of regions away from the hot spots (6). The heat flow was presumably much higher during the active stages of shield growth, however, so a sulfur composition seems unlikely.

If the 2.5 km height of this shield represents a density balance between the lava column and the rock column, then this is the height limit for volcano growth over this portion of the lithosphere (7). If we consider the basalt lithosphere model of Carr (8), with average lithospheric densities of 2.95 gm cm^{-4} (solid) and 2.78 gm cm^{-3} (magma), then a 2.5 km height limit yields a lithosphere thickness of 43 km.

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Figure 1. A shield volcano on Io and the line along which a topographic profile was constructed (mercator projection).

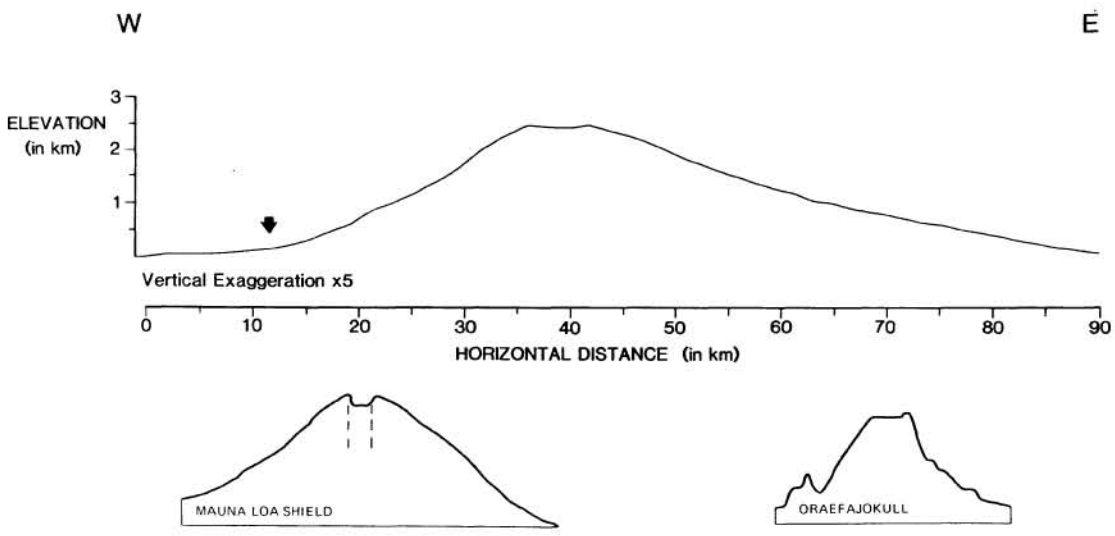

Figure 2. Profiles of the ionian shield and two terrestrial shield volcanoes drawn at the same horizontal and vertical scale. The portion of the ionian shield to the left of the arrow shows a typical slope for the outer base of the volcano.