VOLCANISM ON CALLISTO; Philip J. Stooke, Dept. of Geography, University of Western Ontario, London, Ontario, Canada N6A 5C2

INTRODUCTION. It has become common to refer to the surface of Callisto as dating from the period of late heavy bombardment (1, see also 2,3), and devoid of volcanic deposits. Although the central bright region of Valhalla may include volcanic flows, lighting and resolution prevent their identification in Voyager images. The only previously identified volcanic materials on Callisto are hummocky deposits of slightly higher albedo than their surroundings, at the foot of outward-facing scarps north of Valhalla (4,5). Indeed, most images of Callisto contain nothing but heavily cratered terrain, as expected. However, in this study, several exposures of cratered plains are identified near the centre of the trailing hemisphere, north of Asgard and north of Valhalla. Although deposits of this type are rare on Callisto, their existence has profound implications for the history of the satellite, including its early cratering history and degree of differentiation.

FIGURE 1 is a sketch of Voyager frame 1062J2-002 (and a small extension to the north mapped from adjoining frames). Major craters are identified for reference, and a rough lat/long grid (based on ref. 6) is shown for convenience Regions with sun angles higher than about 25 degrees were not mapped. Several patches of smooth material are identified. Some contain large craters, but the plains are not thought to be ejecta for the following reasons: (1) deposits are lacking around other large craters (e.g. at -5, 275); (2) some deposits contain no obvious source craters (e.g. at +30, 260, +5, 255); (3) radial symmetry is less apparent than might be expected. (4) Any association may be due instead to eruptions through crater-induced faults. The smooth material is lightly cratered compared with surrounding regions, but where well seen (e.g. at +30, 260), large craters are also visible Some appear mantled, with walls breached in places. Their presence, and the small areas of the deposits, make crater counting difficult. Boundaries of the smooth deposits are unclear and not always reproducible. GALILEO imaging should facilitate mapping. Even if some individual deposits are reinterpreted as ejecta, a volcanic origin for others appears likely.

FIGURE 2 shows additional smooth patches mapped from image 524J1+001, north of Asgard. In most cases they appear unrelated to ejecta The crater Ymir seems to be mantled. More smooth material, not mapped here, overlies Asgard rings NE of the crater Tornarsuk.

FIGURE 3 is a sketch of frames (323, 325, 339, 357)J1+001. Major craters and Valhalla scarps are indicated. Previously noted hummocky deposits along the scarps (4,5) appear to be volcanic in origin. At +50, 25 a lobe of similar material extends 500 km from a long scarp into the surrounding cratered terrain. This lobe, best seen in image 325J1+001, appears to be unique in the portion of Valhalla imaged at high resolution. A crater at +39, 32 is cut by a scarp. On the outer side (north) the crater rim is faintly visible, suggesting it was downdropped by a normal fault and partially masked by thin flows. Another smooth region, at +70, long. 0, is one of the largest on Callisto (500 x 400 km). It contains a very unusual 100 km crater at +75, 350. This crater appears partially filled with plains-forming material, including high albedo circular spots about 25 km across. The crater may be mantled by volcanic deposits, or may itself be a source of the plains material. Its southwest wall, facing the plains, is almost completely buried. Several nearby 'fissures' may be related to the volcanic deposits, or (more likely) may be secondary crater chains.

IMPLICATIONS. If volcanic resurfacing on Callisto is confirmed, the crust can no longer be described as unaffected by volcanism. Schenk and McKinnon (7) refer to regions hundreds of km across of differing albedo, and examination of frame 1062J2-002 suggests the possibility (not yet quantified) of crater density variations between such regions. The higher albedo terrain appears to be less heavily cratered, though this is hard to distinguish from processing effects due to reduced contrast in higher albedo regions. It has been suggested that low-albedo volcanic deposits buried the earliest crust of Ganymede (e.g. 8). At least part of Callisto may have been similarly resurfaced. The suggestion that the population of impacting objects differs substantially from that in the inner solar system (9) may need to be reconsidered if the crust of Callisto does not date from the period of late heavy bombardment. It has also been suggested that magmas in Ganymede became less ammonia-rich over time, and thus higher in albedo when weathered (8). The hummocky Valhalla flows and lobate deposit may represent low-ammonia magmas on Callisto, and the cratered plains flows elsewhere may be older and more ammonia-rich. Lastly, Callisto is unlikely to be wholly undifferentiated if it has experienced even the small degree of volcanism suggested here. This study and ref. 10 suggest that surfaces previously considered 'primitive' may be more complex than they seemed. Further detailed mapping is warranted. Images for this study were supplied by NSSDC through the WDC-A-R&S, to whom the writer extends his sincere thanks.

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