STUDIES OF THE FORMATION OF SUBGLACIALLY-FORMED VOLCANOES IN ICELAND USING PALEOMAGNETIC METHODS. David B. Wenner and Brooks B. Ellwood, Department of Geology, University of Georgia, Athens, GA 30602

Studies were made at several sites from the subglacially-formed volcanic Moberg Formation, a unit that covers a major portion of Iceland (1). Two general types of landforms are recognized within this formation, namely: (1) elongate ridges that consist of a basal sequence of pillow lavas succeeded by palagonized tuffs and breccias; and (2) isolated, steep sided and flat topped plateaus or tablemountains that ideally consist of a stratigraphic sequence of pillow lavas, palagonized tuffs and breccias, and subaerially erupted lava flows (1), (2), (3), (4), (5). These features have also been inferred to exist on Mars (6), (7), (8). A generally accepted interpretation of the formation of these types of landforms is that whereas the elongate ridges represent subglacial fissure eruptions, the tablemountains form during volcanic eruptions at a single site. In the latter case, it is generally presumed that: (1) the pillow lavas form during subaqueous extrusion deep within the meltwater pond created in the ice cap; (2) the tuffs form during a stage when the volcano reaches shallow water levels near the upper ice cap surface, with the pillow lavas undergoing explosive production of tuffs and breccias; and (3) the subaerial capping lavas result from extrusion at an elevation above the ice cap (2), (3), (4), (5); accordingly, the elongate ridges, which lack an upper subaerial lava cap, are presumed not to have breached the original ice cap surface. This generally accepted model for the formation of these landforms has led in turn to estimates of paleo-ice cap thicknesses (9).

We have attempted to understand the eruptive mechanism that formed these landforms by conducting paleomagnetic measurements at two sites within the Moberg formation. Samples of basal pillow lavas and pillow fragments and breccia blocks from the overlying tuffs were obtained using a gasoline powered drill from a well-described ridge at Kalfstindar in the Laugarvatn region of Southwest Iceland (Jones, 1970), and from an upper section of tuff and overlying subaerial capping lava from a tablemountain at Nupar in the vicinity of Kopasker along the North Coast of Iceland. The composite stratigraphy and paleomagnetic data are presented in the accompanying figure. This figure shows that whereas the basal pillow lava sequences, several of the overlying tuff and breccia units, and the capping lava are all normally magnetized in the direction of the present-day geomagnetic field, one tuff unit containing isolated pillows displays a dispersed paleomagnetic alignment pattern. Additionally, data were acquired for magnetic grain orientations from anisotropy of magnetic susceptibility (AMS) measurements from the non-layered, fine grained tuff (unit B). These data display a nearly flat, N-S long axis alignment, in keeping with the geologic setting of the sample site that suggests that the tuff originated from the south.

Our results indicate that the paleomagnetically aligned tuff-breccia units were emplaced at high temperatures, perhaps as basaltic ash flows, whereas pillow tuff unit D clearly formed after the individual pillows cooled, thus accounting for the observed dispersed paleomagnetic alignments. A high temperature emplacement of the tuffs is also supported by the AMS grain alignment data for tuff unit B. As might be expected, the pillows appear to have essentially cooled in-situ.

Although it is emphasized that these results are preliminary and that only small sections at two sites were sampled, these data suggest: (1) that remanent magnetic studies can provide meaningful information about the formation of palagonized tuffs; (2) that at least some tuff and breccia units, although generally envisioned as having formed subaquatically, may in fact represent subaerial, ash flow type environments; (3) that presently accepted models describing the formation of the Moberg formation may be oversimplified; and (4) that ice thickness estimates based on tablemountain heights may be in error. Clearly more detailed sampling at these and other sites within the Moberg formation are required before any general evaluation can be made of subglacially erupted volcanoes.

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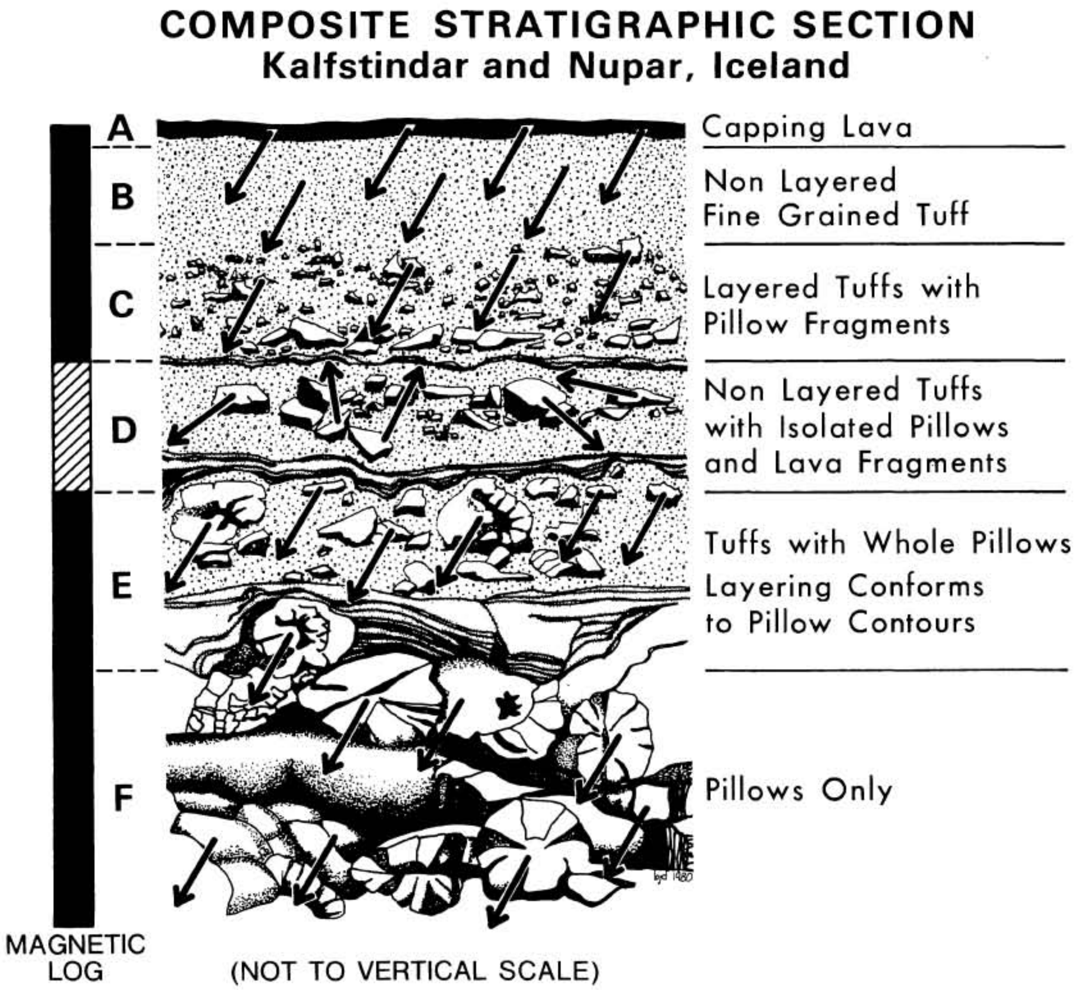

Stratigraphic description of the upper section of the tablemountain at Nupar (sections A, B, top of C) and the basal section of the palagonized ridge at Kalfstindar (sections C - F). Black arrows schematically portray paleomagnetic remanent directions after demagnetization, where diagonally downward-pointing arrows represent consistency with today's geomagnetic field in Iceland. The magnetic log indicates the consistency of magnetic directions with the geomagnetic field direction: black = close correspondence; cross hatched = scattered directions. Note: no single direction in unit D can be correlated with the geomagnetic field.