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EVIDENCE FOR LATE AMAZONIAN EXPLOSIVE VOLCANISM IN THE THARSIS REGION OF MARS: PHOTOGEOLOGY OF THE "STEALTH" RADAR FEATURE AND DISCOVERY OF A DUNE FIELD AMONG THE LAVA FLOWS WEST OF ARSIA MONS.

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INTRODUCTION: Extensive volcanic ash deposits blanketing the youngest geomorphic units on Mars would imply that major explosive volcanic events occurred relatively late in martian history. Discovery of the radar "Stealth" region that extends westward of Arsia and Pavonis Montes has led to the conclusion that the surfaces with "Stealth" characteristics are mantled by fine-grained volcanic ash [1–3]. In our present study, we have examined data sets that further illuminate the nature and origin of "Stealth": maps of albedo, thermal inertia, and rock abundance derived from Viking Thermal Infrared Mapper (IRTM) data [4–6], plus Viking images that range in resolution from 15 to 200 m/pixel.

RADAR STEALTH: The Stealth region was discovered in bistatic 3.5-cm radar observations [1]. It is defined as a region in which the backscatter cross section at normal incidence is very low (nearly zero, or below the 1-sigma noise value) [2]. "Stealth" is likely caused by the presence of an extremely underdense surface material containing no scatterers to some depth [1]. Stealth is at least 2 to 3 m thick, and might be 7 to 15 m thick [1–3]. The Stealth feature extends more than 2,000 km along the equator between Arsia Mons and Nicholson Crater, and it appears to be part of a region of generally low radar signal return that extends from Pavonis Mons westward to the Elysium Basin [2].

STEALTH IN RELATION TO GEOLOGIC FEATURES: To be observed from Earth, the radar Stealth area must consist of a material that is physically on top of (and therefore younger than) the lava flows, craters, and other features seen in the western equatorial Tharsis region. The youngest units overlain by Stealth are among the youngest on Mars (Late Amazonian). For example, Stealth overlies the Medusae Fossae Formation (units "Amu" and "Amm" in map by Scott and Tanaka [7]), which consists of gently undulating smooth and wind-sculpted (yardangs) surfaces interpreted by some to be volcanic ash deposits [8, 9]. Contrary to popular assumption, the Medusae Fossae units are not necessarily "stealthy." Indeed, the presence of yardangs requires that Medusae Fossae units are at least semilithified [8]. High resolution images (15 to 40 meters per pixel) of the lava flow-covered portion of the Stealth region between Arsia Mons and the Medusae Fossae reveal a landscape of mantled surfaces, pedestal craters, yardangs, wind streaks, and dunes.

Yardangs and pedestal craters indicate areas of aeolian erosion. Dunes and mantles are places of deposition. While the Stealth radar feature appears to be young relative to the geologic features it overlies, the high resolution views indicate a history of aeolian reworking of the fine-grained material.

A NEW DUNE FIELD: One of the largest dune fields outside the martial polar regions has escaped notice for more than 20 years. The dune field is located around 1.0°S, 130.5°W (see Viking image 387B29). All martian dune fields examined to date have thermal inertias around 7 to 10 x 10^–3 cal cm^–2 sec^–0.5 K^–1, consistent with particle sizes in the sand range [10]. The dune field near Arsia Mons is different: the albedo and thermal inertial can not be distinguished from the surrounding terrain. The Tharsis region has a relatively high albedo (> 0.26) and low thermal inertia (< 3 x 10^–3 cal cm^–2 sec^–0.5 K^–1), interpreted to indicate a mantling of fine, bright dust [12]. The observations suggest that the dune field is presently inactive and mantled by fine-grained material.

THE DUNE FIELD AS EVIDENCE FOR EXPLOSIVE VOLCANSIM: Aeolian processes commonly rework and redistribute pyroclastic deposits on earth [13, 14]. If enough sand-sized pyroclasts are present, dunes can form [15]. Most aeolian dunes on Earth form by reworking of fluvial or marine sediments. No channels or evidence of water action are evident anywhere near the dunes west of Arsia Mons; the only likely source is the reworking of pyroclasts. The dune field today is inactive either because of a change in climate which allowed dust to accumulate on the dunes, or because of later explosive eruptions which could have buried the dunes with enough fine ash as to prevent their reactivation. The dunes appear to enhance our hypothesis [16] that “Stealth” is related to Late Amazonian explosive volcanism.

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