
INTRODUCTION

We have started an investigation of the color and albedo of the planet Mercury utilizing Mariner 10 digital image data in order to more fully understand the regolith, and thus the crust, of this enigmatic planet. The majority of information concerning the geography of Mercury comes from the Mariner 10 image dataset. The three encounters between Mariner 10 and Mercury in 1974-75 incorporated different observation strategies but nearly identical illumination, so that only one hemisphere of the planet was imaged. The hand-laid mosaics from the first flyby are by far the best known, though images from the first and second flybys were later digitally mosaicked into 1:5,000,000 quadrangles [1]. Individual mosaics in this series exhibit average discontinuities of 20 km due to camera-pointing errors, and discontinuities between quadrangles can be worse. To correct these errors we are controlling the best Mariner 10 coverage for all of Mercury observed during the first two encounters (see below).

Very little is known about the regolith or the bulk composition of the mercurian crust [c.f. 2]. There are color images for only half of its surface [3], and its close proximity to the Sun makes terrestrial observations problematic at best [4]. From Earth-based spectral measurements it is proposed that Mercury has no gross hemispherical mineralogical differences, and that a weak Fe absorption feature might exist near 0.9 µm [4]. Due to Mercury's high bulk density it has been assumed to have a high bulk Fe content [c.f. 2]. However, there is no direct evidence of a high Fe content in the crust. Earlier analysis of Mariner 10 orange and uv images led to the startling inference that Mercury's regolith, and thus crust, may actually be deficient in Fe²⁺ and Ti⁴⁺ relative to the Moon [c.f. 5]. However, this apparent contradiction may not be real. An average impact event on Mercury should produce about twice the melt as a similar event on the Moon [6]. Agglutinate glasses formed from such impacts alter the spectral properties of the regolith [7,8,9,10,11]. Increased agglutinate content results in reduced overall spectral contrast and a general reddening of the visible slope. Cintala [6] has proposed that abundant agglutinates in the mercurian regolith are masking the 0.9 µm Fe absorption feature, thus the regolith and crust may not be deficient in Fe. There are many questions such as this that can be addressed with digital calibrated Mariner 10 image data. We are extending the original Mariner 10 color and albedo analyses [5,12] by refining the calibration for all four bandpasses (uv-polarized, uv, blue, orange) as well as the broadband visible filter [13], and by creating a high resolution (1 km) albedo map for all portions of Mercury imaged by Mariner 10. In particular it is relevant to compare the albedo and color of basin ejecta deposits, intercrater plains, smooth plains, and heavily cratered terrain. The excellent earlier color analysis [5] revealed several color boundaries that did not correspond with any mapped geologic units. This relationship was not expected and remains a mystery. We will combine our improved geometric and radiometric calibration and recent Earth-based remote sensing to investigate these problems in mercurian geology.

GEOMETRIC PROCESSING

We have completed geometrically controlled mosaics (and, in the process, reconstructed camera pointing information) for the Mariner 10 first encounter incoming and outgoing imaging sequences at a resolution of 1-2 km. Mosaicking involved the identification of 366 frame-to-frame match points (20 incoming images with 103 points, 34 outgoing images with 263 points). These match points are used to update the camera pointing geometry using an iterative least squares fit. Before this precise camera angle update was performed, it was first necessary to grossly approximate the viewing geometry using limb fits and tying

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geographic features to published coordinates because the existing camera ephemeris errors are larger than a mercurian radius. After our precise camera angle adjustment (frame-to-frame matching), the average misfit to the incoming points is 0.8 km, and the outgoing points misfit is 1.4 km. This geometric updating results in a geometrically seamless mosaic for each observed hemisphere. However, the absolute latitude and longitude control exhibits large discrepancies in the available control points listed in [1,14]. We find that it is impossible to make an internally consistent mosaic that matches the currently available control net without adjustments of up to 2° in latitude and longitude. The camera pointing angles will be further refined using limb fits, old control points [14], and new Earth-based radar points [15] through an iterative least squares fit that minimizes cartographic mismatches between frames (see details below), including an improved tie between the incoming and outgoing hemispheres by incorporating the southern hemisphere imaging sequence acquired during the Mariner 10 second Mercury encounter. This new mercurian control network will be produced in cooperation with M. Davies (RAND).

ADDITIONAL WORK

We will use a photometric-function model based on lunar properties to generate an albedo map for the imaged portions of Mercury at a resolution of 1-2 km. Additionally, all the high resolution images (up to 100 m/pixel) will be tied to the base map and mosaicked. These data will be most useful for examining morphology, topography (both stereo analysis and photoclinometry), and brightness (albedo) units. To investigate global color differences the lower resolution color sequences (4-20 km) will be calibrated [13] and geometrically tied to the base map. These data will be archived in PDS format and be available during the fall 1996.


Figure. Digital mosaic of 35 incoming 1-2 km resolution images of Mercury acquired during the first Mariner 10 encounter. Comparison of this new digital mosaic and the available control points listed in [1,14] reveal spatial discrepancies as large as 2° in latitude.