



Kibero Patera materials
 Unit 3, light—High-albedo deposits forming two flow lobes, one northeast and one northeast of vent centered at lat 11°S, long 305°W. Interpretation: Lava flows.
 Unit 3, dark—Low-albedo deposits associated with unit 3, light. Interpretation: Lava flows.
 Unit 2, mottled—Variable-albedo material north of patera. Interpretation: Lava flow.
 Unit 2, light—High-albedo deposit associated with unit 2, massive. Interpretation: Mantling deposits of sulfur dioxide frost.
 Unit 2, dark—Low-albedo deposits; occurs as lobes on margin of unit 2, massive. Interpretation: Possible low-viscosity "breakout" sulfur flows from unit 2, mottled.
 Unit 1—Low-albedo deposits associated with patera. Interpretation: Oldest flood-lava flows of patera.
 Galathea Patera material—Smooth, mottled deposits. Interpretation: Volcanic flows.
 Ghibi Patera material—Smooth, nearly featureless deposit; appears to underlie Kibero Patera materials. Interpretation: Flood lavas.

Mihir Patera materials
 Vent unit—Smooth, slightly mottled deposit surrounding patera; apparently overlies smooth unit. Interpretation: Volcanic flow.
 Smooth unit—Smooth, slightly mottled deposits east of patera. Interpretation: Volcanic flow.
 Plateau-forming unit—Widespread, flow(s); irregular, raised margin. Interpretation: Flow(s) produced by massive eruptions from patera; eroded to produce irregular margin.
 Podia Patera material—Widespread, mottled unit associated with patera. Interpretation: Volcanic flow associated with Podia Patera or early flow from Mihir Patera.

Mazda Catena materials
 Mottled unit—Mottled deposits associated with catena. Interpretation: Volcanic flows embayed by Ra Patera and plains unit.
 Plateau-forming unit—Smooth, high-standing unit south of catena. Interpretation: Early-stage volcanic flow erupted from catena, subsequently embayed by later flows from several sources.
 Shobdu Patera material—Smooth, featureless deposit. Interpretation: Volcanic flows.

Ninurta Patera materials—Interpretation: Volcanic flows
 Unit 2—High-albedo material near Ninurta vent.
 Unit 1—Mottled deposit on south flank of patera.
 INTERPATRA FLOW AND PLAINS MATERIALS
 Flow material, undivided—Forms lobes, massive, relatively smooth units; sources not identifiable. Interpretation: Lava flows of various ages but generally old; may have issued from central vent or fissures.
 Younger flow material—Massive, low-albedo deposit in southeastern corner of map area. Interpretation: Volcanic flow.
 Older flow material, undivided—Massive deposits in southeast corner of map area, also ranges from low to low; may be mottled. Interpretation: Volcanic flow.
 Older flow material, dark—Massive deposits, low albedo. Generally occurs within older flow material in southeastern corner of map area; also found in northwestern corner. Interpretation: Volcanic flows.
 Interpatra plains material—Smooth deposit, uniformly intermediate albedo; occurs throughout map area. Interpretation: Polygenetic plains unit that includes flood lavas and ash deposits.

MOUNTAIN MATERIALS
 Dome material—Forms dome-like feature near center of map area; displays central pit. Interpretation: Volcanic structure composed of lava and pyroclastic materials.
 Mountain material—High-relief material; forms linear and arcuate mountains south of Carancho Patera. Interpretation: Either old silicate substrates that have been eroded or parts of silicate constrict (Smith and others, 1979) that protrude above surrounding surface; appears embayed by younger units.

CONTACTS
 Dashed where inferred or approximately located.
 Line at top of scarp, hachures point downslope; dashed where inferred. Either erosional feature or flow front.
 Ridge—Resembles lunar mare-type wrinkle ridge.
 Narrow depression—Dashed where approximately located. May be fracture, fissure vent, or structural feature associated with caldera collapse.
 Irregular depression—Dashed where inferred. May be caldera or collapse pit.
 Arrow—Flow direction—Inferred.
 Dotted line—Boundary of possible mantling deposit—Deposit may consist of plume materials.

INTRODUCTION
 Io is one of the most geologically active planetary objects observed so far in the inner Solar System. It is dominated by volcanism, and it shows only minor surface modification by tectonic processes or erosion. Impact craters are not seen at the resolution (about 2 km/line pair) of Voyager images, which indicates the relative youth of the volcanic processes and material units. Because this area is covered by the highest resolution Voyager images obtained to date, results can be extrapolated to other areas of the planet.

MAPPING TECHNIQUES
 Photogeologic mapping was accomplished through use of Voyager images, and the map units were compiled on a controlled photomosaic. Lack of data on topography hampered interpretations, especially in defining superposition relations and flow directions. Conventional planetary photogeologic techniques, defined by Wilhelms (1972), were combined with techniques developed for mapping terrestrial volcanoes. Individual volcanic centers on Io were first identified and then their associated flows were mapped. Volcanoes and vents were classified according to morphology to provide a basis for interpreting styles of volcanism and general volcanic history. Like the mapping of terrestrial volcanoes, mapping of Io is complicated because flows from adjacent vents coalesce and interfinger, making it difficult to distinguish flow sequences and relative ages of volcanic centers. Annotations from single vents also complicate mapping of volcanic units. On Io, these problems are compounded by possible plume deposits and flows, derived from great distances, that may interweave with units within a map area. Despite these difficulties, many flows and other volcanic units were identified in the Ra Patera area and, where possible, assigned to their source vents.

GENERAL GEOLOGY
 The Ra Patera area is dominated by flows associated with central vents (Schaber, 1980, 1982). Few other units, such as various types of layered plains deposits, are observed, and the area is relatively free of materials derived from plume eruptions.
 Considerable controversy has arisen regarding the composition of the lava flows. On Spectral data indicate the presence of sulfur and sulfur-rich compounds (Sagan, 1979; Sil and Clark, 1982, p. 175-195). However, these materials may be only thin mantling deposits overlying silicate flows (Carr and others, 1979). The morphology of the vents and flows, for the most part, typical of terrestrial volcanism observed on Earth. However, sulfur has unusual rheological properties: its viscosity increases as temperature decreases from 320 to 185 °C, then decreases rapidly as temperature falls to 160 °C; below that temperature, its viscosity again increases. Thus several workers (Greenley and others, 1981; Fink and others, 1983) have speculated that the morphology of some sulfur or sulfur-rich flows may be distinguishable from silicate flows. Some of the volcanic units in the map area may reflect a sulfur flow morphology, described below in regard to Kibero Patera. In addition, Greeley and others (1984) suggested that the spectral data may represent secondary deposits of sulfur, as can occur in association with fumaroles. Silicate volcanism could then introduce sufficient heat to melt the sulfur and produce local sulfur flows, a process that has occurred in Hawaii. Fink and others (1982) also suggested that the sulfur flow units and suggested that these flows may be sulfur allotropes or sulfur-rich compounds; however, Young (1984) argued that the images used in the study by Fink and others (1982) do not represent the true colors on Io, and thus cannot represent sulfur allotropes. Although our mapping on the high-resolution images may shed light on some of these problems, the controversy will not likely be resolved until compositional data are obtained in place.



DESCRIPTION OF MAP UNITS

PATERA FLOOR MATERIALS
 Unit 2, dark—Patched, low-albedo deposits. Interpretation: Lava flows embayed in association with unit 2, light.
 Unit 1, light—Massive, high-albedo, relatively smooth deposits on north flank of patera; consists of multiple flows. Interpretation: Earliest volcanic flows from patera, erupted at relatively high rates of effusion.
 Unit 1, dark—Forms low-albedo patches within unit 1, light. Interpretation: Volcanic deposits associated with unit 1, light.
 Carancho Patera materials
 Unit 4—Fairly mottled deposit forming northeast flank of patera. Interpretation: Volcanic flow.
 Unit 3—Uniform to faintly mottled deposit. Interpretation: Volcanic flow.
 Unit 2—Massive deposit forming southern extension of patera. Interpretation: Early-stage lava flow from patera; alternatively, could be fissure flow erupted from mountain material centered at lat 5°S, long 318°W.
 Unit 1—Smooth, uniform deposit. Interpretation: Basal flow unit from patera; alternatively, could be layered plains unit unrelated to patera.
 Huo Shen Patera material—Smooth deposits from patera.
 Horus Patera material—Smooth, mottled deposits; source west of map area. Interpretation: Volcanic flows.
 Khalala Patera materials—Interpretation: Flood-lava flows.
 Unit 3, dark—Extensive, low-albedo, smooth material.
 Unit 2—Massive, widespread unit; albedo uniform to faintly mottled.
 Unit 1—Massive, widespread unit; albedo uniform to faintly mottled; southwestern distal part shows some lobes and linear depressions (collapse pits); large depression appears to have formed after emplacement of unit and is apparently unrelated.
 Purgnie Patera materials—Interpretation: Flood-lava flows.
 Unit 1, light—Massive, high-albedo deposits in northeastern corner of map area; embays depression to south.
 Unit 2, dark—Massive, low-albedo deposits associated with unit 2, light.
 Unit 1—Massive, relatively smooth deposit of uniform albedo south of Purgnie Patera.
 Hephæstus Patera materials
 Light unit—Multiple high-albedo deposits in northeastern corner of map area. Interpretation: Shield-building lava flows.
 Dark unit—Multiple low-albedo deposits. Interpretation: Shield-building lava flows.
 Undivided unit—Massive, widespread; albedo uniform to faintly mottled. Interpretation: Flood-lava flows.

INTERPATRA FLOW AND PLAINS MATERIALS
 Unit 2, dark—Massive, high-albedo, relatively smooth deposits within depressions. Interpretation: Ponded volcanic flows in pit craters or on caldera floors.
 Unit 3, dark—Forms low-albedo, smooth deposits within depressions. Interpretation: Ponded volcanic flows in pit craters or on caldera floors.
 Unit 4, light—Forms low-albedo, smooth deposits within circular to irregular-shaped depressions; may be mottled. Interpretation: Ponded volcanic flows in pit craters or on caldera floors.

MOUNTAIN MATERIALS
 Unit 2, dark—Patched, low-albedo deposits. Interpretation: Lava flows embayed in association with unit 2, light.
 Unit 1, light—Massive, high-albedo, relatively smooth deposits on north flank of patera; consists of multiple flows. Interpretation: Earliest volcanic flows from patera, erupted at relatively high rates of effusion.
 Unit 1, dark—Forms low-albedo patches within unit 1, light. Interpretation: Volcanic deposits associated with unit 1, light.

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GEOLOGIC MAP OF THE RA PATERA AREA OF IO
 By
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INDEX TO VOYAGER PICTURES
 The mosaic of Ra Patera was made with the Voyager 1 and 2 pictures outlined below.