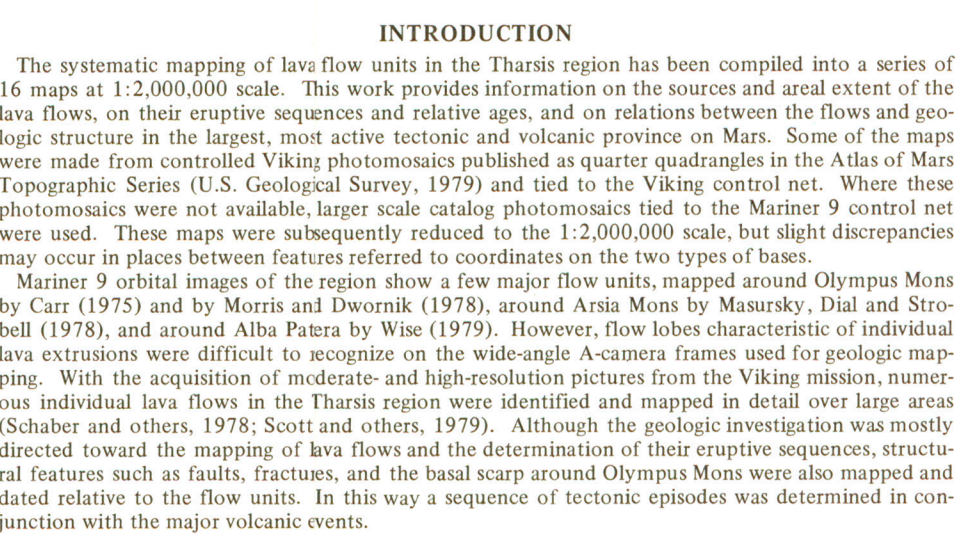
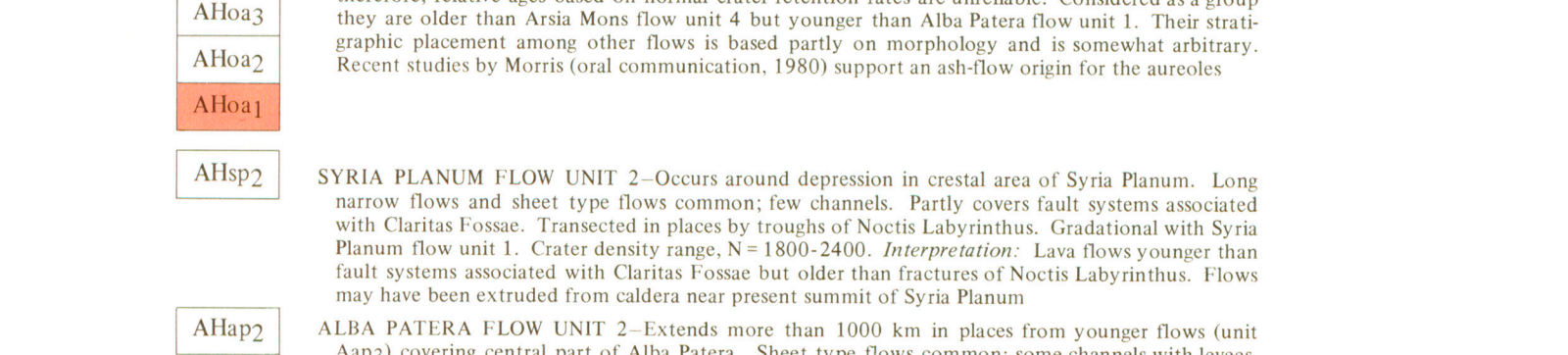
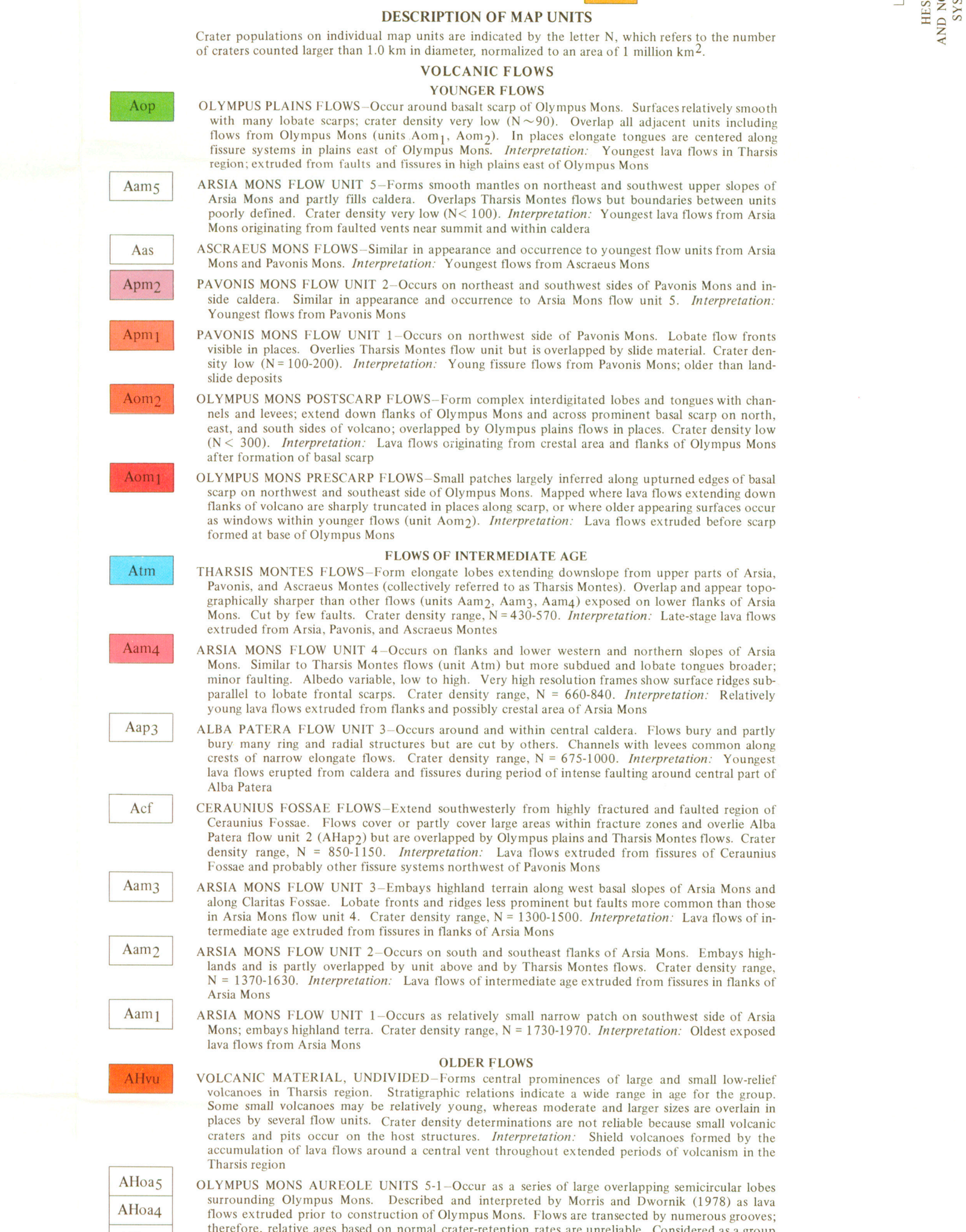




spire. However, these various units cannot be separated distinguishably in such small areas, and most exposed parts of the rock complex have been mapped as a basement material.

Large boulders of the same composition and texture as the bedrock have been mapped in a few places. They have been related directly – stratigraphically and by grain counts with respect to texture – to the bedrock. They are composed of the same material and have the same texture.

Llandilides are common around the large volcanoes in the Tharsis region. They occur along and below the basal scarp on the west side of Olympus Mons and on the northwest flanks of Eos, Pavonis, and Tharsis Montes. They are composed of dark, fine-grained, basaltic material, and are about 10 to 20 cm in diameter. They are mostly rounded and boulders near the head of a dissected area are more angular. They are composed of the same material as the bedrock and have the same texture. They are more resistant to the outflow from flow. Their deposits at Olympus Mons and Pavonis Mons are older than those from the central areas of these volcanoes but overlap slightly older flows on their flanks.

Tharsis Lava Flows

Tharsis has the largest and most extensive flow fields in the solar system. The Tharsis volcanic province has been continuously active throughout the broad history of the region. Certain distinctive units below are the number of craters larger than 1 km in diameter normalized to an area of 100 km².

Older Flows – Albia Fretum, Syrtis Planum, and the Arcines of Olympus Mons The flows from Albia Fretum and Syrtis Planum are the oldest flows in the Tharsis region. They are composed of dark, fine-grained, basaltic material, and are about 10 to 20 cm in diameter. They are mostly rounded and boulders near the head of a dissected area are more angular. They are composed of the same material as the bedrock and have the same texture. They are more resistant to the outflow from flow. Their deposits at Olympus Mons and Pavonis Mons are older than those from the central areas of these volcanoes but overlap slightly older flows on their flanks.

Younger Flows – Tharsis Montes, Eos, Pavonis, and Tharsis Montes The flows from Tharsis Montes, Eos, Pavonis, and Tharsis Montes are the youngest flows in the Tharsis region. They are composed of dark, fine-grained, basaltic material, and are about 10 to 20 cm in diameter. They are mostly rounded and boulders near the head of a dissected area are more angular. They are composed of the same material as the bedrock and have the same texture. They are more resistant to the outflow from flow. Their deposits at Olympus Mons and Pavonis Mons are older than those from the central areas of these volcanoes but overlap slightly older flows on their flanks.

[illegible][illegible]

FIGURE 1—Index map of the Tharsis volcanic province showing quadrangle locations. The number preceded by 1 refers to published 1:2,000,000 geologic map

The Tharis volcanic province is defined in this study covers some 18 million square kilometers, or 15.5% (Fig. 1). Within this province occur the four largest and youngest volcanoes on Mars: Olympus Mons, Tharsis Montes, the Tharsis volcanic plateau, and the Tharsis volcanic shield. The Tharsis volcanic shield, possibly similar to Aluta Plateau, but older; and Syris Planum, a very large domical shield.

The relative ages of major eruptive sequences were determined mainly by their stratigraphic relations and by morphology of the craters. Craters with similar units were grouped into age categories. The correlation between the craters in widely separated areas where the overlap relations could not be established. Crater size-frequency distributions were calculated from the crater size-frequency distribution of the Tharsis volcanic shield. Craters with subdued profiles were identified by the crater size-frequency distribution. Craters with subdued profiles and craters included variation in cloud cover, sub-elevation angle, and resolution in images of the Tharsis volcanic shield. Craters with subdued profiles and craters included variation in cloud cover, sub-elevation angle, and resolution in images of the Tharsis volcanic shield. Craters with subdued profiles and craters included variation in cloud cover, sub-elevation angle, and resolution in images of the Tharsis volcanic shield.

Flow fields or volcanic units; these areas range from about 36,000 km² to 176,500 km². All units have a diameter of 100 km or more. The Tharsis volcanic shield is the largest of the Tharsis volcanic shield. The Tharsis volcanic shield is the largest of the Tharsis volcanic shield. The Tharsis volcanic shield is the largest of the Tharsis volcanic shield.

(Scott and Carr, 1978). Differences between these assignments and those on the small map of Mars (the planet and craters) introduced by the Tharsis volcanic shield.

GEOLOGIC SUMMARY

[illegible]

STRUCTURE

Tectonism, as expressed by fractures and faults, culminated before the bulk of the lava flows in the Tharshir region were extruded. It did not cease altogether, however, but continued with diminishing intensity into the period of the youngest flows (Scott and Tanaka, 1980). Early episodes of major faulting were responsible for the highly disrupted surfaces at Claritas, Acherson, Ceraunius, and Memnonia Fossae. Faulting continued in these areas at lesser scales and also at Alba Pater, on the eastern plains, and on the flanks of the density of faults associated with individual flow units. Like crater density, reflects their relative ages. A summary of tectonic episodes as they relate to major volcanic events is shown in the Correlation of Map Units.

BASEMENT ROCKS

TERRA MATERIAL, UNDIVIDED—Occurs as both rough- and smooth-fractured at elevated terrain throughout Tharsis region; forms semicircular ring of Acheron fossae all other units. Generally highly cratered, but apparent density of craters varies fracturing. *Interpretation:* Rough surfaces represent ancient crustal material from flows and ejecta debris from unknown sources. Smooth surfaces probably mantle before fractures formed. Around Acheron Fossae represents rim material of old Alba Patera

Martian lava flows are a key to morphology to those on Earth and the Moon. They commonly exhibit overlapping, lobate, and creulated margins and occur chiefly as sheet flows or as channel- and tube-bedded flows (Carr and others, 1977). Sheet flows are more common on the plains and on the lower slopes of volcanoes, whereas channel flows are more common on the steeper slopes. The highest resolution they exhibit contains ridge-and-rough patterns superimposed to flow margins. Channel- and tube flows are more prevalent on the steeper slopes around volcanoes such as Olympus Mons and Tharsis Montes. The latter flows are more likely to be channel flows. The flows on Mars are younger flows have rougher textures than older ones that have been smoothed by erosion and mantled to various degrees by collan deposits. The Martian flows, like those on Earth, originated from the interior of the planet and were transported to the surface by a variety of mechanisms. They were removed from the volcanic edifices. Of the 24 major lava-flow sequences mapped in the Tharsis region of Mars, 13 emanated mostly from two large source volcanoes, Olympus Mons and Arsia Mons. Most of the remaining 11 flows were derived from smaller volcanoes, but 5 of these flows were removed from the summit areas of Tharsis volcanoes. The oldest flows erupted from calderas and associated fissures in two widely separated locations at Alba Platea (40° N, 116°) and Syria Planum (20° N, 10° E). Collectively, a large number of field studies and a high-resolution but low-resolution data set indicate that Mars has a large number of field studies and a high-resolution but low-resolution data set.

groups of flows. Their relative ages with respect to most other flow units in the Thariss region can be determined by their position in the stratigraphic column. They are overlapped by the flows of Olympus plains and the postcrater extrusives of Olympus Montes. There is no evidence, however, but less certain, that the aureole deposits may be overlapped in places (MC-9SW) by the Thariss Montes flows. Craters are of little value as age determinants because the ridged and grooved surfaces of the aureoles promote rapid deterioration of crater forms by mass wasting; their crater densities are abnormally low, for example, compared with younger adjacent plains that embay the aureoles in places. The relative ages of the aureole deposits, therefore, must be determined by their regional geology, their stratigraphic evidence and morphology. The aureole units of Olympus Montes are provisionally placed just above the Alba Patena and Syria Planum lavas in the eruptive sequence.

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NOTE: INDIVIDUAL MAPS MAY NOT SHOW ALL SYMBOLS

	Contact—Queried where location uncertain
	Individual flow unit—Line marks crest; hachures extend down lobate frontal scarp mantled by slide material. Represents contact in places
	Fault or narrow graben—Bar and half on downthrown side. Dashed where partly buried

STRATIGRAPHY

Basement rocks (unit HNHt) are undivided. They consist of both rough and smooth, highly fractured terrain; hilly and cratered material; and cratered plateau and cratered plains materials that form a large part of the ancient martian highlands (Scott and Carr, 1978). They occur mostly as relatively large blocks embayed and partly buried by various flows. Around the periphery of Olympus Mons, these older rocks may be exposed in the basal area and as uplifted blocks projecting above the lava flows in places. Some of this material may also represent segments of overlapping aureoles that formerly covered the present site of volcano and Olympus Mons flows that predates the basal

Flows of Intermediate—Tharisi Montes, Alta Patera, and Cerzanius Fossae. This group of lava flows has the greatest range in crater densities, from about 430 to 170, overlapping slightly with the flows of the lowest range. The flows of this range are the most diverse in composition, sampled from the upper to the lower slopes of the volcano. These flows show the greatest diversity in surface characteristics as well in relative ages. The lower, older flows around Asius Mons are more typical of the flows of the lowest range, but the upper flows are more like those of the highest range. If this condition applies at higher elevations where thermal inertias and residual temperatures decrease rapidly and are possibly indicative of fine particulate dust blankets (Kieffer and others, 1977), the Tharisi Montes flows are the youngest of the intermediate range. The Cerzanius Fossae flows, on the other hand, are older than the flows originating from Asius Mons, Pavonis Mons, and Ascraeus Mons cannot be recognized. Crater counts indicate that they are approximately the same age and they are mapped as a single unit (Atm.).

Flows of the Highest Range—The flows of this range are the least diverse in composition, with a unit area of 100 km² or less. They are the least diverse in surface characteristics, and they are the youngest of the flows of the intermediate range. They are mapped as a single unit (Atm.).

Flows from within and around the caldera have buried many fissures developed from earlier tectonics.

Flows of the Lowest Range—The flows of this range are the most diverse in composition, and subsequently broadest area of the fissures from which they were extruded. They extend southwesterly from their source area across the lava flows from Alta Patera and embay part of the highland terrain

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Streamlines—Indicate flow directions where individual units not mapped

Small channel—Volcanic or fluvial origin

Escarment around Olympus Mons—Line marks crest; dashed where buried. Represents places

Scarp—Line at base, barb points downslope. Represents contact in places

	Ridge crest—Represents contact in places
	Trough
	Caldera or rimless depression
	Impact crater rim crest—Represents contact in places

-  Impact crater larger than 10 km diameter—Relative age not determined but younger than unit in which superimposed
-  Impact crater larger than 10 km diameter—Older than surrounding map unit
-  Impact crater outline on terra material

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