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CHANNELING EPISODES OF KASEI VALLES, MARS, AND THE NATURE OF RIDGED PLAINS MATERIAL

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Our geologic mapping compiled at 1:500,000 scale of the northern Kasei Valles area of Mars (MTMs 25062 and 25067) indicates (1) at least three periods of Kasei Valles channeling, (2) the development of Sacra Fossae (linear depressions on Tempe Terra and Lunae Planum) in relation to Kasei channeling episodes, and (3) the nature of ridged plains material dissected by Kasei Valles on northern Lunae Planum. (The three channeling periods consist of two flood events and a later, sapping-related event.) These findings suggest hydrologic conditions and processes that formed Kasei Valles and associated features and terrains.

Two periods of flooding in the Kasei Valles region are indicated by different erosional levels [1,2,3]. The lower level (the Kasei floor) is more than 1 km lower than channel-dissected surfaces of Sacra Mensa (a mesa separated from Lunae Planum by the narrow south branch of Kasei), of Labeatis Mensa (west of the map area at lat 25.5° N., long 74.5°), and of northern Lunae Planum (whose erosional features are best seen at lat 21.7° N., long 72°) [2]. Streamlined features on the higher, Lunae Planum level lie at an angle to the north and south Kasei channels and are cut by them [1,2]. These streamlined features trend east and may be related to a large, east-trending, streamlined island at lat 18° N., long 78.5° (west of the map area). The island lies on the channel floor but does not align with the presumed water source of most recent flooding (Echus Chasma [4]); thus, the source region of the earlier flood may be west of northern Kasei Valles [5] and now buried beneath younger lava flows of Tharsis Montes [6].

The streamlined features on Sacra Mensa are cut by the Sacra Fossae; some of these depressions end as hanging valleys above the Kasei floor, a result of downcutting during the second period of outflow-channel development (lat 26.95° N., long 66.1°). Also, two Sacra Fossae depressions were apparently utilized and enlarged by younger flooding, which carved the narrow north and south Kasei branch channels that wind around the large mesa of Sacra Mensa [7]. Therefore, we interpret the Sacra Fossae to have developed during and between the two periods of Kasei flooding, which augments evidence cited above of cross-cutting streamlined features that support the same conclusion. Other Sacra Fossae depressions are enlarged and enclosed, indicating collapse into voids that may have developed through hydrofracturing and subsurface erosion by turbulent flow of ground water (lat 25.4° N., long 64.4°). Along the east edge of Sacra Mensa and the north edge of Lunae Planum, several fossae form large valleys having the same base level as Kasei Valles (best seen at lat 24.8° N., long 64°); the valleys apparently formed by sapping along joints and scarp retreat [8]. One large fossa at lat 24° N., long 66.5° on Sacra Mensa is thought to be the site of a catastrophic outbreak of ground water [9], because eroded and chaotic terrain borders the depression downslope. On the broad floors of Kasei Valles, narrow, rectilinear to sinuous channels document erosion by the third and final period of channel activity. The erosional features probably result from ground-water sapping of channel-floor material, perhaps immediately following the second period of flooding. Also, some discharge from plateau material is indicated by a channeled fan, which originated from a Sacra Fossa depression on the mesa and spills onto the Kasei channel floor at lat 26.9° N., long 67.1°.

Our mapping has also provided some insight into the nature of plains material on Lunae Planum marked by wrinkle ridges and rare lobate scarps; the morphology and occurrence of such ridged plains material has led to its interpretation as lava-flow material [10, 11]. It appears to be layered in several places along the walls of the plateau, both in the map area and farther east [12]; alternating layers have contrasting albedo. The surface layer and some lower layers appear resistant, because they form cap rock on streamlined islands on Sacra Mensa and on parts of the Kasei floor (e.g., at lat 27° N., long 70°). In places on Sacra Mensa where this resistant layer was eroded away by early flooding on the Lunae Planum level, an underlying, apparently friable layer was degraded into rough and knobby material (lat 26° N., long 65°). Many areas showing evidence of sapping indicate that the ridged plains material included relatively porous and permeable aquifers. Remnant ground ice within layers of the ridged plains material is suggested by moats surrounding Labeatis Mensa (west of the map area). The moats may have formed when lavas embayed ice-rich debris blankets that have since sublimated away [2, 13]. In addition, several impact craters on the plateau are associated with landslides; heat generated by impact may have melted ice, lubricating the slides.

In conclusion, an early period of flooding, whose source is perhaps buried beneath lava flows of Tharsis Montes, may have eroded streamlined features in northern Lunae Planum. Later floods originating from Echus Chasma carved the Kasei floor and formed the mesas adjacent to the plateau. The Sacra Fossae formed after the initial flooding and during the second flooding by sapping, outbreak, scarp retreat, and collapse along joints and fractures in ridged plains material. Later sapping discharge may have produced narrow, sinuous channels in the Kasei floor; discharge from fossae eroded some young fan deposits. Some layers of the ridged plains material were sufficiently porous and permeable to support sapping and outbreaks of ground water; hydraulic pressures may have reached levels capable of generating hydrofractures.

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