STRATIGRAPHIC ASSESSMENT OF GUSEV CRATER AS AN EXOBIOLOGY LANDING SITE; Ragnhild Landheim, *Departments of Botany and Geology, Arizona State University, Tempe, AZ,* Nathalie A. Cabrol, *Observatoire de Meudon, France,* Ronald Greeley, *Department of Geology, Arizona State University, Tempe, AZ,* Jack D. Farmer, *NASA Ames Research Center, Moffett Field, CA*

SUMMARY An exobiology goal is to identify sites on Mars that exhibit a variety of sediments, including those which have the potential for preserving organic compounds and fossils. Gusev crater, a candidate site to meet these objectives, was a major depo center for Ma'adim Vallis. Terraces within Gusev crater suggest former standing water that may have functioned as a local base level for the channel; multiple terraces along Ma'adim Vallis provide evidence for episodicity in stream flow.

This study involves regional geologic mapping using Viking data for the area of 5° to 30°S and 175° to 190°W. Local mapping was performed for the Gusev crater area (12.4° to 17.6°S, 180° to 190°W) at a scale of 1:500K.

REGIONAL GEOLOGY Gusev crater is ~160 km in diameter and located within highlands, near the border with the northern lowlands. The areas SE and SW of the crater are ancient Noachian terrain that has been extensively modified by fluvial [1,2,3] and tectonic processes. The fluvial valleys here are more subdued than the surface adjacent to the central and northern areas east of Gusev. This appearance might be due to resurfacing by flooding from Ma'adim Vallis.

STRATIGRAPHY The oldest features near the Ma'adim Vallis outlet are Gusev and two 30 km craters [Fig. 1]. Prior to the incision of Ma'adim Vallis into these craters they acted as a dam, preventing water from flowing further north [4] and causing water to pond locally and to serve as a temporary base level. Terraces within Ma'adim Vallis might have formed in response to base level fluctuations determined by long-term variations in stream discharge. Terrace formation probably corresponds to the deposition of two flood units [Fd1 and Fd2] in Gusev crater by overtopping of the southwest and east crater rims and subsequent channelization of the flows. Similarly, the three youngest terraces [T9-T11] may correlate to three stratigraphic units [Ch9-Ch11] in Gusev crater.

The oldest unit, Fd1, occupies the eastern 1/4 of Gusev crater where it forms a rugged terrain; this may reflect removal of fines by wind, or erosion to the level of underlying impact ejecta. The unit lies ~100 m above the next youngest unit, Fd2. Unit Fd1 is believed to have originally covered the entire floor of Gusev and was subsequently eroded. Fd2 covers the western 3/4 of the crater floor, and exhibits smooth plains which are ridged in the northern part. Fd2 appears to have been deposited during overflooding of the SW rim of Gusev crater. Unit Ch9 corresponds to the third depositional episode in the crater. The unit forms plateaus interpreted to be the remnants of an ancient delta. The fourth depositional episode within Gusev crater is recorded by unit Ch10, recognized as an elongate, SE/NW patch of low albedo that projects across the crater floor north of Ma'adim Vallis. Flow from the channel apparently drained north following the main slope of the crater floor, but stopped short of the northwestern rim.

The final outflow event through Ma'adim Vallis is recorded by unit Ch11. This unit includes high albedo material extending 50 km beyond the outlet of Ma'adim Vallis, and is interpreted to be reworked material derived from unit Ch9. Furthermore, unit Fd1 is covered locally by delta deposits [Dd], representing fluvially transported material derived from areas east of Gusev. It is difficult to assess the age relations of the Dd unit relative to Fd2, Ch9, Ch10, and Ch11.

The floor of Gusev crater is extensively modified by aeolian activity: high albedo wind streaks oriented SE-NW are present in the lee of craters beyond unit Ch9. These streaks are interpreted as aeolian deposits derived from unit Ch11; their orientation is consistent with the inferred wind direction based on dunes at 12.8°S, 181.9°W, as well as predictions from models of atmospheric circulation [5].

RELEVANCE TO EXOBIOLOGY Gusev crater exhibits at least eleven episodes of fluvial deposition, punctuated by periods of lacustrine sedimentation. Our analysis suggests prolonged hydrological activity and sediment deposition within Gusev crater, which make it a high priority for exobiology [6, 7, 8, 9]. Calculations of terrace relief based on shadow measurements suggest a minimum thickness of 500 m for fluvial sediments exposed in Ma'adim Vallis, and 900 m including the upper levels of the adjacent plateau. Fine-grained delta and lacustrine sediments are prime targets to sample for organic compounds on Mars, especially if they have low permeability and are cemented, which could protect organic materials against subsequent oxidation [6,10]. Furthermore, sediments exposed in channel walls along the southern margin of Gusev crater and the distal reaches of Ma'adim Vallis constitute important targets for future robotic missions designed to search for a fossil record and for high resolution imaging during orbital missions. High resolution images could allow more detailed analysis for planning surface missions, as well as give insight into stratigraphic relations to further evaluate our interpretations of long-term depositional processes and cycles in the Gusev crater region.

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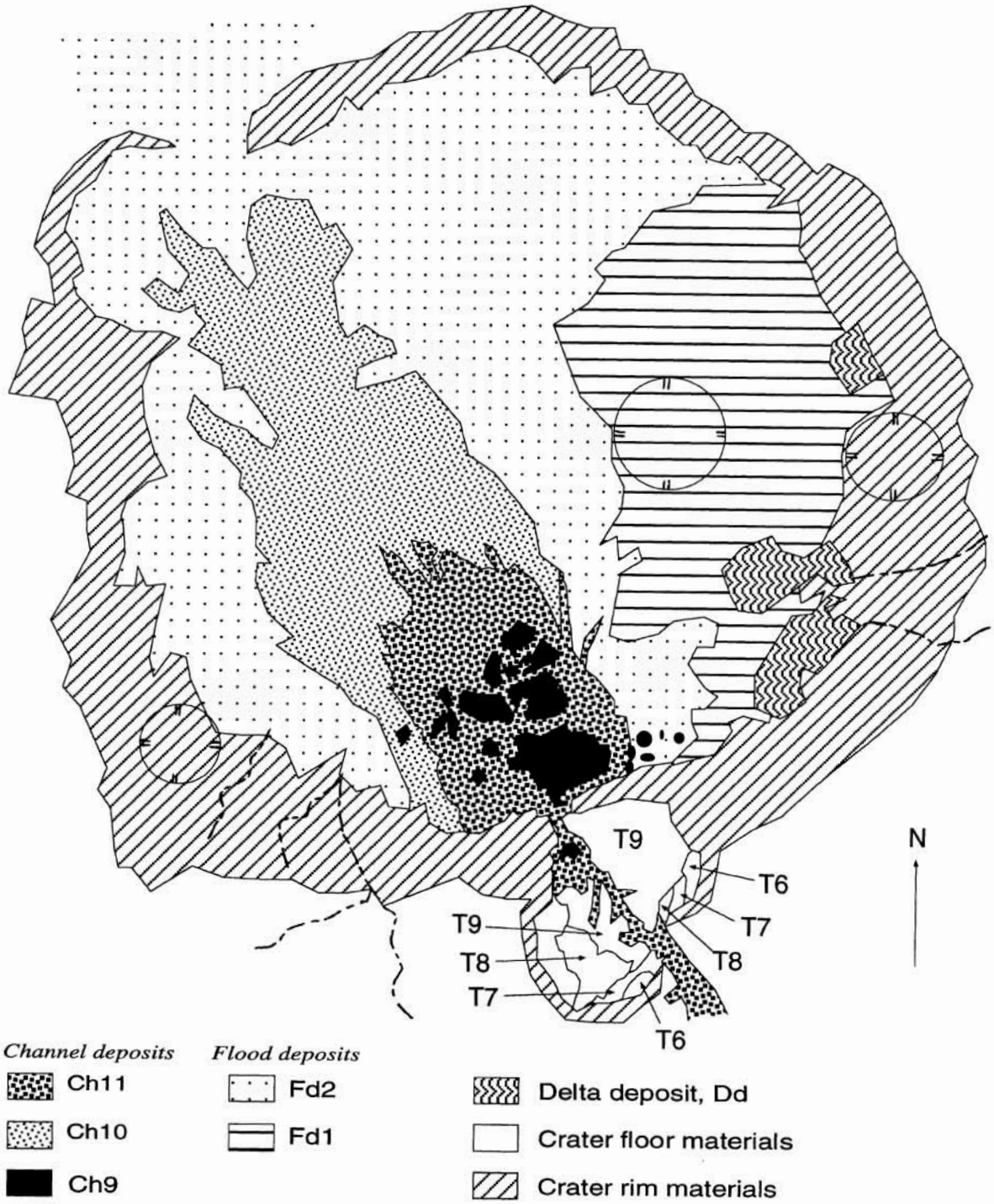

Figure 1. A geologic sketch map of Gusev crater.