



Ancient Martian Lakestands and Fluvial Processes in Iani Chaos: Geology of Light-Toned Layered Deposits and their Relationship to Ares Vallis Outflow Channels

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Iani Chaos is a ~30,000 square kilometers region that lies at the head of the Ares Vallis outflow channel system. Mapping of Ares Vallis reveals multiple episodes of erosion, probably linked to several discharge events from the Iani Chaos aquifer. We present the first detailed geomorphological map of the Iani region. Five chaos units have been distinguished with varying degrees of modification (primarily by erosion and fracturing), starting from a common terrain (Noachian highlands). We observe a general progressive decrease of their mean elevation from the Mesas, Mesas & Knobs and Hummocky (Hy) terrains to the Knobs and Knobby morphologies. This trend is consistent with an initial collapse of the original surface with an increase of the fracturing and/or of the erosion. Light-toned Layered Deposits (LLD) have been also mapped and described in Iani Chaos. These terrains are clearly distinguished by a marked light-toned albedo, high thermal inertia and a pervasively fractured morphology. LLD both fill the basins made by the collapsed chaotic terrains and are found to be partially modified by the chaos formation. LLD also overlap chaos mounds or are themselves eroded into mounds after deposition. These stratigraphic relationships demonstrate that LLD deposition occurred episodically in the Iani region and throughout the history of the development of the chaos.

Water seems to have had an active role in the geological history of Iani. The composition and morphologies of the LLD are consistent with deposition in an evaporitic environment and with erosion by outflows, requiring stable water on the surface. For the first time, we have also mapped and analyzed potential fluvial features (i.e. channels, streamlined islands, terraces, grooved surfaces) on the surface of the LLD. These landforms describe a fluvial system that can be traced from central Iani and linked northward to Ares Vallis. Using topographic data, we have compared the elevation of the LLD and channel units and find that their altitudes are remarkably similar to the altitude of the floors of the major Ares Vallis channels. This is decisive evidence of 1) a possible fluvial system within Iani linked to the Ares Vallis outflow system, characterized by five episodes of outflow at least (S1 to S5), and 2) of the existence of the LLD within Iani during the occurrence of the outflows (i.e. the LLD are coeval with or postdate the Ares Vallis outflow channels).

On the basis of our analysis, we propose the following formation model for Iani Chaos: 1) Initial fracturing and tectonic subsidence of the pristine Noachian materials and subsequent outflow erosion of the bedrock (Ares Vallis S1 channel origin); 2) Evaporitic deposition of older LLD units on top and between chaotic terrains. Layering suggests cyclic wetting and drying; 3) Tectonic subsidence and fluvial erosion of chaos and LLD (Ares Vallis S2 to S3 channels); 4) Deposition of younger LLD units in central and northern Iani; 5) Tectonic subsidence and outflows, erosion of chaos and LLD (Ares Vallis S4 to S5 channel origin and subsequent downdropping of NW and N(e) Iani).