The Diverse Channel Networks of Juventae Chasmas, Mars. Pragya Singh,1, Ranjan Sarkar,1, Alok Porwal,1, Binita Phartiyal2, 1Geology and Mineral Resources Group, CSRE, Indian Institute of Technology, Bombay, (pragya.singh@iitb.ac.in); 2Birbal Sahni Institute of Palaeosciences, Lucknow, Uttar Pradesh 226007 (binitaphartiyal@ymail.com).

Introduction: This study aims at constraining the origin of recent channels within the wallslopes of Juventae Chasma based on morphological and analogous evidences. Juventae Chasma is a box canyon oriented oblique to the main WNW-ESE trend of the Valles Marineris canyons system. Channels are observed in eastern, southern and western slope of the Chasma wall [1] which may have different formational histories (Fig.1).

Dateset: This study is based on data collected by Context Camera (CTX) [2] and High Resolution Imaging Science Experiment (HiRISE) [3] from Mars Reconnaissance Orbiter (MRO) and High/Super Resolution Stereo Color Imager (HRSC) [4, 5] on-board Mars Express.

Observations: In a previous paper we describe fluvial channels from the walls of Juventae Chasma and grouped them into four classes based on their morphology [1]. Following is the location-wise detailed description of channels with some more observations:

East Wall: A single channel about 42 km in length and > 1.5 km width emanates from an alcove and with occasional first order streams joining it (Fig.2). This channel occurs within a collapse pit inside a crater.

South Wall: The source region for the channels in most cases are alcoves in the chasma walls. The average length and width of these channels are ~3-4 km and ~500 m, respectively. A majority are first order channels and show degraded morphology (Fig.1). A normal fault, striking parallel to the chasm south wall offsets these channels.

West wall: Here we observe a dendritic network of channels, superposing an older generation of narrower inverted streams. Stream orders reach upto four. Except for one, none of the channels has a clear source region, these channels begin abruptly as shown in Fig. 3.

Inverted channels: Older generation of narrow inverted streams (2-3 km long, ~100 m wide) without well-defined source region are present on the West wall (Fig.3). These have been cut by younger dendritic channels. The infilling material appears to be the light toned mound forming material. Some of these channels appear to be present on the top surface of a detached block of chasm wall. Stream orders of three are observed in these channels. A second group of inverted channels of length 1-2 km and width ~150 m are present on the South wall. We observe that stream width increases upon merging of tributaries.

Channels originating from tributary canyons: Three channels (one on the South-East, and two on the North-West wall) originate from tributary canyons. The channel on the South-East wall is deeper and has an inner channel. The other two channels on the North-West wall are not easily recognizable because of low topographic contrast between channel floor and walls. Moreover it appears that some parts of the channels are buried under chaos blocks.

Analogues site: We compare the Martian fluvial features to channels in Ladakh which are formed by melting of valley glacier. Ladakh is a high altitude (3500 m-5500 m above sea level) cold and dry desert with salt lakes, low annual precipitation (102 mm), high diurnal and annual temperature variations (ranging from -30° to 30° Celsius) and high UV influx [8]. Figure 4 shows field image of a stream emerging through multiple alcoves fed by seasonally melt ice in Nubra valley (34°31’43”N 77°31’97”E). Such type of channels are also commonly associated with debris flows.

Discussion: The channels on the East and West walls appear similar to the Hesperian and Amazonian-aged valleys which occur in equatorial [9] and midlatitude regions [10, 11, and 12]. Age determination using crater count agree to the same [1]. In contrast, the channels on the South wall appear old and degraded. In addition, the offsetting of these South wall channels by a wall-parallel fault suggests that their formation took place at a time when chasm-forming tectonism was still active. Inverted channels on the West wall are also relatively degraded and superposed by other channel networks. These seem to represent a dense network of older channels. The channels emanating from the tributary canyons, particularly on the North-West wall are also old in appearance and are possibly superposed by chaos blocks. If this is true, they might also be quite old.

The higher stream order of the channels on the West wall, and apparent absence of a source region (such as an alcove) could suggest these channels were precipitation fed. The channel on the East wall, originates from an alcove on the inner wall of a collapse pit within a crater. The straight channel segments, associated alcoves, and tributaries which have a similar origin favor their formation from the melting of snow accumulated in the alcoves. However the long stream length suggest that there was a continuous supply of voluminous water which could be supplied by a stable ice body (such as a glacier), and not mere seasonal snow accumulation.
The South wall channels are mostly unbranched, and originate from chasm wall alcoves. These features favor their formation from water generated by melting of snow which accumulated in the alcoves. Whether this snow was glacial, seasonal, or ground-ice is a matter for further research. Channels emanating from amphitheater headed tributary canyons, are possibly caused by groundwater sapping, the source of which could be a shallow confined aquifer or deep cryovolcanism [13]. The inverted channels are an older generation of streams which were filled in with light toned materials (especially the ones on the West wall) and later these materials were lithified to become resistant, positive relief forming features. The high stream order indicate their formation from atmospheric precipitation of liquid water.

We find the morphology and setting of the channels on the East and South walls match our observation in Ladakh, which is fed by an ice source occurring within an alcove/cirque. Further study is required to distinguish channels fed by glaciers from those fed by seasonal snow/frost. The frequent association of debris flows [14] with these channels is again supportive of this view. The debris flows could suggest episodic flooding caused due to snowpack melting.

Overall, Juventae Chasma presents a variety of drainage networks of different ages. This clearly indicates that liquid water flow was a common phenomenon in this region of Mars, and it could have extended (may be episodically, if not continuously) post opening of the chasma to the Late Amazonian.