DECLARATION

I hereby declare that the thesis entitled “FLUVIAL MORPHOLOGICAL STUDIES OF CUSUS AND COLUMBIA VALLES ON MARTIAN SURFACE” submitted to Periyar University in partial fulfilment of the requirements for the award of degree of Doctor of Philosophy in GEOLOGY, is a record original research work carried out by me under the guidance and supervision of Prof. Dr. S. ANBAZHAGAN, and that it has not formed before the basis for the award of any Degree, Diploma, Associateship, Fellowship or any other similar titles in this or any other University or Institution of higher learning.

M. Chinnamuthu

Place: Salem -11
Date:
Acknowledgement

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M. Chinna Muthu
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Abstract

Planetary geoscientists are always having an interest on the origin of valley networks, channel formation and climatic condition on the Martian surface. Majority of the studies revealed that the origin of valley network formation is due to running water. The warm and wet climatic conditions prevailed during Noachian time period supported for atmospheric precipitation and existence of liquid water on Mars. The availability of liquid water is unstable in the present day climatic conditions on Mars. The development of outflow channels and source of water for such catastrophic flooding on Martian surface is remaining matter of debate among planetary scientists. With this background, a fluvial morphological study was conducted from selected Valles region on Mars. In this study two Martian Valles namely Cusus and Columbia Valles, respectively representing the rainfall induced valley network and channel development by catastrophic flooding were selected. Cusus Valles is located in the South East of Cassini crater at 14.34°N latitude and 50.5°E longitude. Columbia Valles is located at 9°25’S latitude and 317°04’ E longitude in the east of Valles Marineries region. Both Cusus and Columbia Valles are located in the southern highlands region. The morphological studies of Cusus and Columbia Valles were carried out with help of Mars Odyssey THEMIS IR day image, MGS MOLA data and MOM, MCC data. The ArcGIS 10.4, ENVI 5.2 and JMARS software were used for extracting the morphological features and profiles of the channels. Through CSFD method, age of Cusus Valles is estimated as 3.9 Ga, which fall in late Noachian time period. In comparison with Martian global time scale, this period associated with warm and wet climatic conditions. The geology, structure, geomorphology and morphometric parameters of Cusus Valles were studied in details. The results suggest that Cusus Valles is evolved by fluvial process controlled by hydrological cycle, surface runoff, erosion and infiltration processes during late Noachian to middle Hesperian time period. The
immature valley network formation observed in the Cusus Valles through morphometric analysis. The morphometric analysis is supported for the high permeability and infiltration processes dominated in the Cusus Valles. The Columbia Valles might have evolved approximately 668 million years, after the formation of Cusus Valles. The catastrophic flooding originated from rupturing of cryosphere is the major source for formation of Columbia Valles outflow channels. The Columbia Valles channel system, morphological features, longitudinal and cross-sectional profiles were studied in detail with the help of MOLA, THEMIS and MCC data. The catastrophic flooding originated from Valles Marineris region and Aurore Planum is stored in the Capri chasma later overflow and development of outflow channels. The outflow channels developed over 70-80km width and 3.72-6.2 km length. The presence of the very low channel sinuosity, broad valleys, streamlined highlands, cataracts, cliffs, fretted or hummocky terrain, butte and basin topography along Columbia Valles invariably indicates the catastrophic flooding and formation of outflow channels. We assume that the huge volume of water might have trapped below the permafrost layer at Aurore Planum. The increase of hydrostatic pressure and subsequent cryosphere rupturing developed catastrophic flooding at Columbia Valles. We have estimated the flow discharge in the Columbia Valles at various stages. The estimated overland flow in the Valles region immediately after the spillover from Capri chasma. 3.62 m³ s⁻¹ over the width of 60km. The total estimated flow in all six channels in Columbia Valles is 19.98 m³ s⁻¹. We estimated the age of the Columbia Valles is 3.59 Ga approximately during early Hesperian time period and during that time climatic conditions is also shifted from warm to cold conditions. Overall, the result revealed that the origin of Cusus Valles, prevailing climatic conditions and the time period of formation of valley networks. Similarly, the morphological studies of Columbia Valles is useful in understanding of the nature of catastrophic flooding, associated features and fluvial dynamics in the Valles regions.