EPSC Abstracts
Vol. 6, EPSC-DPS2011-1755, 2011
EPSC-DPS Joint Meeting 2011

Fluvial landforms over fresh impact ejecta on Mars

N. Mangold
Laboratoire de Planétologie et Géodynamique de Nantes, Université de Nantes/CNRS UMR6112, 2 rue de la Houssinière, BP 92208, 44322 Nantes, France, (nicolas.mangold@univ-nantes.fr / fax: 33 + 2 51 12 52 68)

1. Introduction

Fluvial valleys provide critical clues to the distribution and state of water throughout the history of the planet Mars. Early in Mars' history (<3.7 Gy), the climate may have been warmer than at present leading to valley networks, but the formation process of these valley networks is still debated. More recent valleys formed on volcanoes, Valles Marineris, and glacial landforms in conditions colder than in the primitive period. Rare examples of fluvial valleys over ejecta blankets have been reported for three impact craters. In the present study, tens of craters (12 to 110 km in diameter) with fluvial landforms on ejecta were found in the mid-latitude band (25-45°).

2. Observations

A survey of hundreds of large impact craters has been done to identify fluvial landforms, especially in regions lacking ancient valleys, using images from the High Resolution Stereo Camera (HRSC) instrument onboard Mars Express and from the Context Camera (CTX) instrument onboard Mars Reconnaissance Orbiter. Only craters with fresh continuous ejecta blankets were included in this study, because ancient craters of Noachian age (<3.7 Gy) are strongly degraded by erosion and hence lack visible ejecta. Grooves, rays, terminal lobes and megabreccias formed by the impact process were identified to determine ejecta boundaries. Fluvial valleys exhibit geomorphic features distinct from ejecta, including sinuous shapes and meanders, valley junctions, braiding and depositional fans. These observations show that valleys dissecting fresh ejecta are less than 65 km long. These valleys display isolated channels and a poor connectivity. Valleys are locally sinuous but also frequently braided suggesting a formation by episodic activity. Their origin as fluid flows is demonstrated by their relationship with topography: valleys always follow the main slope and do not follow radial ejecta patterns. Extended regional mapping was done to better understand the geographic distribution of these landforms. The resulting map displays a clear latitudinal zonation, which suggests a climatic influence on the valley formation. No example of fluvial landforms on ejecta was found over 117 craters >16 km in diameter in the equatorial regions (<25°N). The high percentage of craters with fresh ejecta eroded by fluvial landforms at mid-latitudes (>50% for craters of >22 km at the 30-44° latitude range) suggests that this process was common at these latitudes. Mid-latitudes (>25°) contain landforms such as pitted terrains or lineated fills that are interpreted as being due to shallow ice deposited by atmospheric processes. A melting of these deposits could have provided the water required for fluvial activity. Climatic variations with, for example, high summer temperatures could have provided the energy for melting ice. In a second scenario, the crater itself could have provided the energy necessary for ice melting explaining the possible disconnection of fluvial episodes. The thermal effect of crater increases with the crater diameter because of the higher kinetic energy provided.

Conclusions

Fresh ejecta blankets studied are preserved enough to demonstrate that no long-term period of fluvial erosion occurred after their formation. While late-stages of climatic variations could explain some local fluvial valleys at mid-latitude, processes associated with impact craters such as shallow ice melted by warm ejecta can explain the occurrence of scattered fluvial activity. Significant morphological differences exist between the studied landforms on fresh ejecta and ancient widespread valley networks formed during early Mars, limiting the implication of these observations. Nevertheless, identifying fluvial activity over craters ejecta in global valley maps could be important to interpret valleys true climatic signature as well as their timing, and their link with global ice distribution.