

Is Early Development of Large Volcanic Channels Typical of all Rocky Planets?

David Leverington

Department of Geosciences, Texas Tech University

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The vestiges of large volcanic channels are preserved at the surfaces of the Moon, Venus, Mercury, Mars, and Io. The largest of these systems have widths of tens of kilometers and lengths of thousands of kilometers. Component channels were incised by voluminous low-viscosity lava flows, and are the surface expressions of magmatic systems that helped to dissipate internal heat accumulated through processes of accretion, differentiation, tidal interactions, and radioactive decay. Most of the more than 200 channels on the Moon are relatively simple systems that developed in the first ~1.5 Ga of solar system history. Lunar channels have widths of up to ~5 kilometers and lengths of up to several hundred kilometers. The more than 200 channels on Venus may have developed during the most recent 1 Ga. Some Venusian systems variously have lengths of thousands of kilometers, widths of tens of kilometers, and channel forms of remarkable complexity. Ten channel systems on Mercury have lengths of up to ~160 km and widths of up to tens of kilometers, and likely developed ~3.7 Ga before present as conduits for flood lavas emplaced across adjacent lowlands. The outflow channels of Mars have lengths of up to thousands of kilometers and widths of up to tens of kilometers, and mainly formed in the first ~1.5 Ga of solar system history. These systems are interpreted by most researchers as products of large aqueous outbursts from aquifers. However, support for aqueous interpretations is weak, and it is increasingly apparent that the characteristics of Martian outflow channels closely match those expected of volcanic systems. Widespread past development of large volcanic channels on rocky bodies beyond Earth suggests the possible formation of analogous systems on the Earth during the Hadean or Archean, a time frame of heightened internal temperatures and eruption of low-viscosity magmas. More generally, the geological record of the inner solar system suggests a predisposition of all rocky planets for early incision of large volcanic channels.