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Effect of the Beta-Alta-Themis anomaly on the spatial distribution of craters on Venus.

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Abstract

The regional concentration of volcanism on Venus known as BAT anomaly has a significant effect in the spatial distribution of craters due to the interaction of cratering and volcanic resurfacing. I have evaluated this effect using realistic Monte Carlo simulations. A pure catastrophic evolution can reproduce the slight depletion of craters in the BAT area observed on Venus. Nevertheless, equilibrium models generate a significant low density of craters in the BAT area that is incompatible with the observations.

1. Introduction

The main characteristics of the crater population of Venus are, a global low number of craters, ≈942, [5] with a spatial distribution that cannot be distinguished from a uniformly random distribution [7, 10, 11], and a small fraction of craters partially covered by younger volcanic units (modified craters). Two opposite hypothesis have been proposed to explain the properties of the crater population: a) a catastrophic event that resurfaced the major part of the planet followed by a decay of the volcanic activity [10, 11]; or b) an equilibrium steady-state evolution where the low number of craters was maintained through small-scale time-transgressive resurfacing events [4,7]. Monte Carlo simulations of the interaction between volcanic resurfacing and cratering on Venus have been performed in order to test the viability of both hypotheses [1,2,4,7,9,10,11]. The Monte Carlo Models generated by [9] included a random generation in space and time of volcanic units using the frequency-area distribution observed on Venus by [8]. The models also included, for the first time, the concentration of volcanism related to the Beta-Alta-Themis (BAT) anomaly [3], and a 3D approach for crater modification. The effect that including the BAT anomaly in the models has in the crater populations obtained from the Monte Carlo simulations of different planetary evolutions (catastrophic - equilibrium) is studied in detail in the present contribution.

2. Monte Carlo Models

The Monte Carlo models used are based on those profusely described by [9]. The simulation generates an initially determined number of craters randomly in space and time. The rim crater diameter is assigned following a modified frequency-size distribution depleted in large craters. The ejecta diameter is calculated using the continuous ejecta average extent power-laws for craters bigger and smaller than 20 km derived from the crater population by [5]. The crater rim height is obtained from the power-law relation deduced for bright-floored craters, that are considered to be pristine, calculated by [6]. The total number of craters generated is an indication of the duration of the models.

I have tested four different possible evolutions for Venus, two of them are catastrophic and two are in equilibrium. The catastrophic models include: (1) a catastrophic model in which the global resurfacing event (800 Ma ago) is followed by a drastic decay of the magmatic activity (Pure Catastrophic); and (2) a catastrophic model characterized by a gradual decay of the magmatic activity after the global resurfacing event (Modified Catastrophic). The models in equilibrium include: (3) a model of equilibrium with decay event in which an equilibrium evolution is followed by a drastic decay of the magmatic activity in the last 500 Myrs (Equilibrium Decay); and (4) a model of equilibrium with a magmatic event that took place 500 Myr ago also followed by a decay of the magmatic activity (Equilibrium Magmatic Event).

3. Effect of the BAT anomaly

The concentration of volcanic units in the BAT anomaly area improves in that area the processes of crater modification and crater burial by volcanic embayment. Therefore the BAT anomaly has an effect on the spatial distribution of pristine craters and modified craters. This effect is more evident in the equilibrium models than in the catastrophic models due to the higher number of volcanic units of the former. I have compared the spatial distribution of craters and modified craters in respect to the center of the BAT anomaly obtained from four evolutions of the planet with the spatial distribution of the Venusian craters, which is characterized by a slightly lower density of craters in the BAT area than the planet average.

4. Conclusions

On the one hand, the Pure Catastrophic model shows the best correlation with Venus, only a slightly lower density of craters in the BAT area than the planet average. The Modified Catastrophic model shows a reduction of the crater density in the BAT anomaly area that is a bit higher than the observation. On the other hand, the equilibrium models are far form reproducing Venus observations providing a strong reduction of the craters in the BAT area.

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