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How Late Veneer impacts affect the evolution of Venus and its volatile reservoirs.

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The primordial state of terrestrial planets, and Venus in particular, is a determining factor for their evolution. This earlyl history (the first 500 Myr) is heavily influenced by collisions. We investigate how Late Veneer impacts change the initial state of Venus and their consequences on its coupled mantle/atmosphere evolution.
We focus on volatile fluxes: atmospheric escape and mantle degassing. Mantle dynamics is simulated using the StagYY code with a compressible, anelastic mantle with infinite Prandtl number in 2D, spherical annulus geometry. Rheology is assumed independent of composition and includes Newtonian diffusion creep plus plastic yielding. Atmosphere escape covers both thermal and non-thermal processes, as well as their evolution with changing solar conditions. Surface conditions are calculated with a one-dimensional radiative-convective gray atmosphere model. Feedback of the atmosphere on the mantle through surface temperature is included.
Large impacts are capable of contributing to atmospheric escape, volatile replenishment and energy transfer to the solid planet. We use the SOVA hydrocode to take into account volatile loss and deposition during a collision. The mantle is affected by impacts through deposition of energy due to shock pressure and following adiabatic decompression. A thermal anomaly is superposed to the regular mantle temperature field to model this phenomenon.
Large impacts are not numerous enough to substantially erode Venus' atmosphere. Single impacts don't have enough eroding power. Swarms of small bodies (<50km radius) might be a better candidate for this process, especially when taking into account airburst processes. The amount of volatiles brought by large ordinary chondrite impactors is superior to losses and comparable to the degassing caused by the impact. Carbonaceous chondrite impactors are unlikely: the amount of volatile they release is too large. It cannot be removed fast enough from the atmosphere by escape processes, causing surface temperature to stay above 900K up to present-day.
Mantle dynamics can also be modified by the heating caused by impacts. Heated material propagates by spreading across the upper mantle due to its buoyancy. Old crust is destroyed or remixed in the mantle. A large part of the upper mantle melts, leading to its depletion and degassing. With enough evenly distributed high energy impacts, the mantle can be depleted by more than 90% of its volatiles during Late Veneer. This drastically cuts down degassing in the late history of the planet and leads to lower present-day surface temperatures. Total depletion of the mantle seems unlikely, meaning either few large impacts (1 to 4) or low energy (slow, grazing…) collisions. Combined with the lack of plate tectonics and volatile recycling in the interior of Venus, Late Veneer collisions could help explain why Venus seems dry today.