# A micrometeoritic "volcanism" in the early thermosphere

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Our scenario, "EMMA" (Early Micrometeorite Accretion), describes the formation of the Earth's atmosphere through the destruction of volatile-rich micrometeorites during their frictional heating in the thermosphere [1]. We recently improved EMMA by taking into account: (i) measurements of the C, N and S contents of Antarctic micrometeorites (AMMs) [2, 3]; (ii) studies of the Wild 2 cometary grains showing that AMMs could have a cometary origin [e.g., 4]; and (iii) studies of unweathered AMMs recovered from ultra-clean snow in Central Antarctica [5].

About 99% of the AMMs are related to the volatile-rich hydrous-carbonaceous chondrites. The Earth's atmosphere has a "micrometeoritic-like" composition : the average values of D/H ratios and the Ne, $N_2$, $H_2O$ and C contents of a few hundreds of AMMs are similar to that of the $\sim 2 \times 10^{24}$ grams of the Earth's atmosphere that formed about 4.4 Ga ago. This micrometeoritic "purity" of the Earth's atmosphere can be most simply interpreted if the Moon forming impact blew off most of the complex pre-lunar atmosphere at a time when the young Earth was already mostly degassed.

This similarity also suggests that the composition of the micrometeorite flux was invariant with time since the formation of the Moon. This invariance yields a simple accretion formula to estimate the total amount, $M_A$, of any given species, $A$, deposited on the Earth by the degassing of AMMs during their atmospheric entry after formation of the Moon:

$$M_A \sim [A(\%) / 100] \times \Phi_0$$

where, $\Phi_0$ is the integrated mass flux of micrometeorites since the formation of the Moon, and $A(\%)$, the wt.% of specie $A$ in AMMs. We derived three independent estimates of $\Phi_0 = \xi \times 10^{24}$ g, relying on: (i) the AMM content of either Ne ($\xi \sim 4.3$) or N ($\xi \sim 6.1$), and their total amounts in the atmosphere; (ii) the lunar cratering rates reported by W.K.Hartmann ($\xi \sim 5.6$). These three surprisingly similar $\xi$ values yield calculated amounts of Ne, $N_2$, $H_2O$ and $CO_2$ that actually fit their observed contents in the atmosphere within a factor of 2 to 3. The Earth's atmosphere, as well as the early Hadean climat [1], were thus likely produced by the degassing of cometary micrometeorites during the post lunar period.

## References

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# Characterization of the silicon isotopic composition of the terrestrial biogenic output from a boreal forest in Northern Sweden

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During the last decade, the potential plant impact on the biogeochemical cycle of Si via the large terrestrial biogenic Si reservoir formed by vegetation has attracted considerable interest. It has been concluded that the release of silicic acid from dissolution of soil phytoliths might exceed the Si mobilized by weathering of Si-containing primary minerals, which implies that the biogenic contribution to the total content of Si in the soil profile must be considered in weathering studies.[1]

Information about Si isotopes can potentially be used for differentiation between relative contributions from biogenic and mineral sources in natural waters, soil solutions and plants. This would, however, require thorough characterization of the terrestrial biogenic Si reservoir, a task that received somewhat limited attention to date.[2]

The aim of the present study was to characterize the Si isotopic composition of a boreal forest, with bedrock consisting of dolomitic limestone, in Northern Sweden. Representative biomass from the forest area exhibited a surprisingly homogenous Si isotopic composition, ranging from $\delta^{29}Si$ ($-0.14 \pm 0.05$)‰ ($2\sigma$) to ($0.13 \pm 0.04$)‰. Further, a change in the Si isotopic composition of ($+0.39 \pm 0.04$)‰ has been detected in *Leymus arenarius*, indicating predominant accumulation of heavier isotopes from spring to autumn.

Recent studies of Si isotopic composition in plants have been focused on the root uptake of dissolved silicic acid as the only Si accumulation path. Results acquired during the present study provide compelling evidence to suggest that exogenous Si is also incorporated in the surface structure of the plant material.[3] A surface contribution in excess of 5% of the total Si would introduce a significant shift in the bulk isotopic composition (>0.1‰) assuming that the exogenous material differed by 2‰ from the biogenic Si. This strongly suggests that the surface contribution must be carefully considered during *in situ* uptake studies.

## References

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