IMPLICATIONS OF ^{36}A EXCESS ON VENUS

(Letter to the Editor)

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Abstract. The finding of ^{36}A excess on Venus by the mass-spectroscopic measurement of the Venus Pioneer appears to endorse the more rapid accretion theory of Venus than the Earth and the secondary origin of the terrestrial atmosphere.

A mass-spectrometer on board of the Pioneer Venus found about 100 times larger amount of ^{36}A on Venus than on the Earth (Hoffman, 1978). We shall argue that this is the evidence of (1) more rapid accretion of Venus than the Earth and of (2) difficulty of escape of heavy gases once trapped in the atmosphere from Venus and the Earth.

Venus revolves more rapidly around the Sun than the Earth. The territory of Venus is smaller than that of the Earth. The solar gravitational force acts more strongly at the orbit of Venus than at that of the Earth, and thus the sedimentation time of dust grains in the solar nebula to form thin unstable dust disk in the center of the nebula, which would have fragmented to form planetesimals (Safronov, 1969; Goldreich and Ward, 1973), is much shorter for Venus than for the Earth. We have already shown by using this argument why the mass of Venus is almost equal to that of the Earth and why Venus is more oxidizing than the Earth (Shimizu, 1978). In reality, the computations showed that the accretion of Venus in the solar nebula had completed in several million years after the formation of planetesimals (Hayashi *et al.*, 1977), while that of the Earth in vacuum had completed in about twenty million years (Safronov, 1969). The T Tauri wind from the Sun appears to have started to blow off the solar nebula about ten million years later than the fragmentation of the dust disk. It is likely that Venus had accreted in the presence of tenuous solar nebula, while the Earth had accreted in the absence of it.

It is known that the mass ratio among and the absolute amounts of various non-radiogenic rare gases in the terrestrial atmosphere is explained by degassing mechanism of these gases from the interior of the Earth, whose bulk composition might be represented by some chondritic substances (Fanale and Cannon, 1972). If the primary atmosphere, the remnant of the solar nebula, had remained even a little on the Earth, the rare gas pattern cannot be figured out. This means that the Earth might have accreted in vacuum. The finding of the presence of a primary atmosphere on Venus is another strong evidence for the absence of the primary atmosphere on the Earth. The primary atmosphere, if it existed, should have been blown off by the T Tauri wind or by the solar ultraviolet radiation. Venus which is nearer to the Sun than the Earth should have a stronger influence of the Sun than the Earth, while Venus had retained its primary atmosphere. It can

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TABLE I

The contribution of the primary and secondary primitive atmospheres to the present atmospheres of the Earth and Venus (italic letters shows the composition of the present atmospheres)

	Venus		Earth
Gases	Primary	Secondary	Secondary alone
H_2	~100 × 1000[a] (mb)	_ (mb)	~1000[a] (mb)
H_2O	~100[b]	~1000 × 1000[b]	400 × 1000[c]
CO	~10[d]	~1000[d]	~1000[e]
CO_2	–	*90 × 1000*	50 × 1000[f]
N_2	~10	*~1000*[g]	*800*
^{40}A	–	*~10*[g]	*8*
^{36}A	*8*[h]	*~1/30*	*1/37*

[a] Lost to space later.
[b] Almost lost to space and absorbed to interior by the runaway greenhouse effect followed by photodissociation. Only 10 mb remains in the atmosphere; for the details see Shimizu (1978).
[c] Ocean.
[d] Oxidized to CO_2 later.
[e] Converted to C_3O_2 and, then, to the living system. See the details in Shimizu 1978, 1979a, 1979b).
[f] Calcites at ocean bottom.
[g] Data of the Venera 9 and 10 (Keldysh, 1978).
[h] Data of the Venus Pioneer (Hoffman, 1978).

be concluded that heavy gases once trapped in the atmosphere would have never escaped from the Earth.

Lewis (1973) argued that water and sulphur in the Venus atmosphere might have accreted by the infall of cometary substances. The ratio of H_2O to CO_2 is 10^{-3} (Keldysh, 1978) and that of ^{36}A is 10^{-5}. The above ratio of O in H_2O to ^{36}A is in accord with the cosmic abundance. However, the infall number of comets on the Earth should have been larger than that of Venus, since the Earth has a stronger gravitational force and is nearer to the nest of comets than Venus. The amount of ^{36}A on the Earth should be expected to be larger than that of Venus, which is against the ^{36}A evidence of the Venus Pioneer.

Table I summarizes the contribution of the primary and secondary atmospheres to the present atmospheres of the Earth and Venus.

Note added. The Venera 11 found that $^{36}A/^{40}A$ is about one, in accord with our argument in the text, the results of the Venera 9 and 10, and those of the Venus Pioneer 2.

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