PREPLANETARY EVOLUTION AND PROTOMATTER OF VENUS

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Conditions and processes of the formation of Venus have been modelled. They include P-T conditions, physical processes and chemical evolution of matter in the preplanetary gas-dust disk. The modelling is based, firstly, on the astrophysical data (I), which allow estimates of (a) the time scale of collapse of the protosolar nebula and of formation of the preplanetary disk, (b) the time scale of the disk's dissipation, and (c) the angular momentum of the protosolar nebula. These parameters influence the thermal conditions in the disk. Secondly, the modelling is based on the interpretation of the geochemical and cosmochemical data used in the geochemical models of the accretion of the Earth (2, 3). We also use current views on the formation of primitive atmospheres (4). As a result of our modelling several preliminary conclusions are presented concerning the conditions of Venus' formation and of its primitive chemical composition.

I. The maximum temperature reached in the preplanetary disk at the radial distance of Venus was higher than the condensation temperature of metallic iron and magnesian silicates. Then after 0.I Ma the temperature was reduced to $\simeq$ I000 K. This time was enough for the formation at the distance of Venus of the planetesimals up to I00 km in size. They consisted of the refractory reduced matter without moderately volatile and volatile elements (component A). Due to the internal heating (its possible source was ^{26}Al) these planetesimals had rather hot interiors to become layered with the metallic core and silicate mantle.

2. After 0.I Ma in the formation zone of Venus the matter appeared that had been transported from larger radial distances in the disk. This transport was caused by the radial drift of bodies due to gas drag and - at the later phase of planetary accretion - by the radial diffusion of the gravitationally interacting large bodies. The matter which came from the region $R \gtrsim 2$ AU was oxidazed and contained moderately volatile elements in the abundances characteristic for C1 chondrites. The matter which came from the region $R > 3$—4 AU had all elements in C1 abundances. This matter transported from the larger radial distances (component B) was swept up by the planetesimals growing in the zone of Venus. As a result this matter, accreted by the planet, contributed all elements in the C1 abundances except the highly volatile elements - carbon, nitrogen, hydrogen (mainly in H_2O) ets., which entered with lower abundances.

3. In the process of its formation Venus had the possibility to accrete the same or almost the same quantity of component B as the Earth did, that is I0 - I5 %. Therefore Venus would have had abundances of moderately volatiles similar to the terrestrial values. This conclusion is in rather good agreement with the data on potassium.

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4. The abundances of siderophile elements in the mantles of Venus and Earth are expected to be similar because these elements would had been acquired by the mantles with component B. The chemical isolation of the mantle's substance from that of the core (indicated for the Earth mainly by the abundances of siderophiles) could be explained by the special features of the evolution of the preplanetary matter at the phase of the existence of 100 - 1000 km sized planetesimals. This isolation would be the common feature for the Earth and Venus.

5. Venus probably received amounts of volatiles similar to terrestrial quantities as for nitrogen, carbon and water which were accreted with component B in the form of organic compounds and hydrosilicates. This result is in agreement with the data on abundances of nitrogen and carbon in the atmospheres of the Earth and Venus. There is also no contradiction with models which argue that the venusian atmosphere later had lost all the water.

6. The abundances of nonradiogenic isotopes of the noble gases in the atmosphere of Venus would essentially have been affected by the following processes during the formation of the planets: (a) accretion of gas from the preplanetary disk and (b) the fractional dissipation of atmospheres of the preplanetary bodies and the growing planet.

References:

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