Abstract. The model in which the differences of chemical composition of the terrestrial planets are
determined by special conditions at the later stage accumulation is discussed. Impact heating would
rapidly lead to differentiation of Mercury's interiors. Subsequent high-velocity collisions of Mercury
with planetesimals of a comparable size would erode away much of the silicate crust and mantle; such
silicates would be accumulated by Venus and fall into the Sun. This model is in agreement with the
current models of the terrestrial planets internal constitution.

Explanation of composition of planets and satellites is closely related to the
problem of their origin and evolution. Primarily the conclusion about similarity
of composition of the terrestrial planets formed in the inner zone of the protoplanet
cloud was based on the mean densities of the planets. Later for more detailed
investigation of the composition of the planets many models of their inner consti-
tution were worked out. Cosmical investigations and accumulation of theoretical
and experimental data concerning properties of the matter at high pressures al-
lowed to obtain more precise starting data for calculations of planet models, but
the conclusions remain ambiguous.

The bulk densities of the terrestrial planets (reduced to standard conditions)
decrease with increasing distance from the Sun, but Venus violates the tendency
(Table I). To account for the anomaly attempts were made to construct such a
model for Venus that would satisfy a monotonous change of densities of the
terrestrial planets. This condition is fulfilled in a Venus model with pure iron
core and with the mantle depleted in oxidized iron comparative to the Earth
(Kozlovskaya, 1982) and in a model of Venus with a core of melted iron (Zharkov
et al., 1971).

The calculations of planet models (Anderson and Kovach, 1967; Kozlovskaya,
1969, 1972, 1976, 1982; Reynolds and Summers, 1969) has led to the conclusion
that the terrestrial planets do not have the same composition. To explain the
difference of composition of the terrestrial planets Lewis (1972, 1973, 1974) used
the model of successive condensation in the protoplanetary cloud and different
degree of iron reduction at various distances from the Sun. But high mean density
of small Mercury and low density of the Moon were not explained in the model.
This led to an idea to explain the difference of the terrestrial planets composition
in the framework of the accumulation theory assuming a homogeneous distribution
TABLE I

<table>
<thead>
<tr>
<th>Planet</th>
<th>$M/M_\oplus$</th>
<th>Mean density g cm$^{-3}$</th>
<th>Mean density (at 10 kb) g cm$^{-3}$</th>
<th>Fe (%)</th>
<th>Mantle 1</th>
<th>Mantle 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>0.05526</td>
<td>5.45</td>
<td>5.10</td>
<td>62.4</td>
<td>64.6</td>
<td></td>
</tr>
<tr>
<td>Venus</td>
<td>0.8150</td>
<td>5.249</td>
<td>3.98</td>
<td>30.6</td>
<td>34.6</td>
<td></td>
</tr>
<tr>
<td>Earth + Moon</td>
<td>1.0123</td>
<td>5.514*</td>
<td>4.02*</td>
<td>32.5</td>
<td>36.3</td>
<td></td>
</tr>
<tr>
<td>Moon</td>
<td>0.0123</td>
<td>3.33</td>
<td>3.71</td>
<td>23.6</td>
<td>28.1</td>
<td></td>
</tr>
<tr>
<td>Mars</td>
<td>0.10745</td>
<td>3.95</td>
<td>3.71</td>
<td>23.6</td>
<td>28.1</td>
<td></td>
</tr>
</tbody>
</table>

*Only the Earth.

of chemical composition in the region of the terrestrial planets (Vityazev et al., 1984).

One of the principal conclusions obtained by planetary cosmogony during recent years was the possibility of collisions of thousand kilometer-size bodies with growing planets. Such collisions should to cause effective heating of planet interiors, melting and gravitational differentiation of material and formation of mantles already during accumulation of the planets. Investigation of the peculiarities of Mercury formation (its orbit is near by the inner boundary of preplanetary disk) showed (Vityazev et al., 1984; Vityazev and Pechernikova, 1985) that at a later stage of growth average velocity of bodies relative to Mercury reached about 10 \( \sqrt{2} \) km s$^{-1}$, i.e., it becomes much higher than the escape velocity from proto-Mercury (current escape velocity from Mercury \( v_e = 4.3 \) km s$^{-1}$). This means that energy released during such collisions of proto-Mercury with large bodies (macro-impacts) was sufficient to disrupt and eject some part of matter of the upper mantle of the growing planet from Mercury’s sphere of influence into heliocentric orbits. Loss of primary silicate mantle of proto-Mercury increased a percentage of iron in Mercury. Some fraction of this silicate matter was captured by neighbouring Venus and this allowed to account for a small silicate excess for Venus compared with that of the Earth (Vityazev et al., 1988).

In the present paper the estimates are made for a redistribution of matter within the inner zone of preplanetary disk in the process of planet accumulations. These estimates are based on models of internal structure of the terrestrial planets. For the model calculations (Kozlovskaya, 1969, 1972, 1982) the data on internal constitution and chemical composition of the Earth was used. Total iron content \( \Sigma \text{Fe} \) (metallic + bound) was also calculated for all models (Kozlovskaya, 1976, 1982). The values of \( \Sigma \text{Fe} \) are convenient characteristics of bulk planet composition, as well as mean atom weight of a planet, which depends both on total iron content and on a degree of its reduction. The principal uncertainty in estimation of \( \Sigma \text{Fe} \) is explained by ambiguity of chemical composition of the Earth mantle. Hence, two models were used to estimate iron content in the Earth mantle: Mantle