EXPERIMENTAL STUDY OF THE MECHANISMS OF METALLIC, SULPHIDE AND SILICATE PHASES SEPARATION AT DEFINITE DEGREES OF MELTING OF THE SYSTEM (A SIMULATION WITH THE HELP OF A HIGH-TEMPERATURE CENTRIFUGE)

E.B.Lebedev, A.A.Kadik, N.N.Kononkova
Vernadsky Institute of Geochemistry and Analytical Chemistry RAS, Moscow

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At early stages of the formation of planetary bodies, silicate, metallic, and sulfide phases, which have been formed in the course of the partial or complete fusion of the initial planetary substance, were subject to a gravitational differentiation.

It is assumed that sulfur is one of the major elements entering the composition of metallic cores of the Earth and the Moon.

The goal of this study is to conduct, by using a high-temperature centrifuge, the experimental simulation of the gravitational differentiation of a partially molten sulfide- and *metal* containing silicate substance - the olivine -basalt mixture, which can be considered, in a first approximation, as a model of the planetary substance. Our main objectives are: (i) to elucidate the mechanisms of the separation of metallic and sulfide phases from the silicate crystalline matrix and the accumulation of these phases at different degrees of melting of the silicate substance; (ii) to determine the possibility of the formation of an independent layer of the metallic and sulfide phase by means of its percolation through the crystalline matrix; (iii) to apply the results of the study to the solution of problems of the chemical differentiation of the Moon and other planetary bodies in the thermal and gravitational fields.

A simulation of the migration and accumulation of metallic (Fe) and sulfide phases (FeS) under gravity, with the partial fusion of a model planetary substance (olivine - basalt mixture), is carried out in a high-temperature centrifuge. The separation and motion of metal and sulfides in the intercrystalline space is shown to be in an intimate relationship with the degree of fusion of a silicate material.. If the fraction of the silicate melt present in the space between the olivine crystals exceeds 5 -- 10 vo1.%, this quantity is enough to produce a set of mutually related channels between the grains, through which a percolation of silicate, metallic and sulfide liquids becomes possible. Droplets of the sulfide melt do not mix with the silicate melt and can move along the silicate intergranular channels under the influence of gravity. Thus, the mixture consisting of olivine crystals, silicate, metallic and sulfide melts, after being separated in a centrifuge, is differentiated in density. As a result, the metallic, sulfide and silicate phases are divided into independent layers.

In the SC – 8 specimen (67.5 vo1.% Ol, 22.5 vol. % Bas, 10 vol.% FeS) containing -23 vo1.% of the silicate melt, a sharply irregular height distribution of phases is observed. The following main zones are distinguished in the vertical section of the specimen. The top zone (A) of the floated-up basalt melt, represented by glass and quenched pyroxene crystals, does not contain olivine crystals and sulfide globules. The central zone (C), which constitutes the main part of the specimen, predominantly contains olivine crystals in amounts of 85–90 vo1.% (crystalline matrix) with the silicate melt (glass) in between. The width of the intergranular channels ranges from 3 to 30 pm. In the lower part of this zone, in basaltic glass (as a rule, in the central parts of the channels), fine sulfide globules up to 1 pm in size are located. The sulfide content in this zone does not exceed 1–3 vo1.%. Between the top (A) and central (C) zones of the specimen, a narrow transition zone (B) is observed, in which olivine crystals abruptly replace the glass of the basalt melt. The lower, near-bottom zone (D) of the specimen completely consists of iron sulfide - pyrrhotine, which was formed from the sulfide liquid at the instant of specimen quenching.

The observed distribution of phases over the height of the SC-8 specimen clearly demonstrates the result of the gravitational differentiation of the substance: the segregation of phases in density. Under the influence of gravity, the sulfide phase easily percolates (is filtered) through the crystalline matrix along the intergranular channels and is almost completely accumulated in the near-bottom part of the specimen in the time of the experiment. In the central part, only an insignificant sulfide portion is etained in the form of very fine globules (drops), which had no time to settle down. Clearly, the filtration of the silicate liquid occurs in the opposite direction - into the top part of the specimen, where a layer of the pure melt is formed.

In the SC -12 specimen (60 vo1.% Ol, 20 vol. % Bas, 10 vol.% Fe, 10 vol.% FeS) a sharply irregular height distribution of phases is observed. The following main zones are distinguished in the vertical section of the specimen. The top zone of the floated-up basalt melt, represented by glass and quenched pyroxene crystals. The central zone (C), which constitutes the main part of the specimen, predominantly contains olivine crystals in amounts of 85 - 90 vo1.% (crystalline matrix). In the lower part of this zone, in basaltic glass (as a rule, in the central parts of the channels), fine sulfide globules, containing of iron globules, are located.. The lower, near-bottom zone (D) of the specimen consists of iron sulfide - pyrrhotine, containing of iron globuls.

The results of the experiments have shown that the mixture consisting of olivine crystals, a basaltic silicate melt, an iron and an iron sulfide melts, after heing subjected to centrifuging, is differentiatecl in density only at definite degrees of melting of the silicate substrate.

In this work we carried out, with the help of a high-temperature centrifuge, the simulation of the processes of the accumulation and migration of metallic and sulfide phases corresponding to the partial melting of the model substance in the planet's interior. Experiments led us to conclude that the separation of metallic and sulfide phases and their motion in the intercrystalline space are in a close relationship with the degree of the mantie's fusion. The results of our study lead to the following conclusions. The mixture of olivine crystals, a silicate basaltic melt, and a metallic and sulfide melt, subjected to centifugal separation, is differentiated in density. As a result, the *iron,* iron-sulfide and silicate phases are separated into independent layers.