COMPONENTS OF MARTIAN DUST FINDING ON TERRESTRIAL SEDIMENTARY DEPOSITS WITH USE OF INFRARED SPECTRA

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Introduction: Scientists suppose that seas and lakes on Mars existed during earlier geological periods. Accordingly it can be supposed that on Mars can be find rests of sedimentary deposits of seas and lakes or products of transformation of ones. Therefore the Earth sedimentary deposits of seas and lakes, especially ancient, can be used as analogue objects for the analysis of possible sedimentary deposits of ancient Martian seas and lakes.

It was supposed the presence of similar minerals in chemical composition of terrestrial sedimentary deposits and Martian dust, as it can be the transformed sedimentary deposit. Accordingly it was supposed a probability of similar chemical and physical transformations of sediment substances occur during natural or organized artificially processes.

Chemical base for contemplates. In course of scientific researches the mineralogical composition of lakes sedimentary deposits – sapropels and mineral sediment – trepel were studied to recognize separate minerals in sediments.

Trepel is bottom sediment of an ancient sea. It practically does not contain the organic substances. One important practical use of trepel is manufacturing of building materials, for example, cements [1]. From crushed raw minerals prepare a homogeneous mix to produce a cement clinker. The mix of clinker's minerals undergoes the physical and chemical transformations during high temperature processing when sintering processes occur. In the structure of trepel the smallest particles of various minerals form the homogeneous mix naturally. This feature influences on phase transformations and reactions between minerals during the calcinations.

Calcinations and new compounds. Most important result of calcinations of clinker mix is appearing of new phases and new compounds mainly silicates of calcium. Trepel includes clinker minerals: calcium carbonate, clay, amorphous silicon and oxides. The structure of the mineral base of sapropels varies but usually amorphous silica prevails. During heating of sedimentary deposits clay minerals are decomposed. Following calcinations decompose carbonates. And calcium oxide reacts with silica, aluminum and iron oxides forming clinker silicates and aluminates. Main clinker compounds are $2CaO*SiO_2$, $3CaO*SiO_2$, $3CaO*Al_2O_3$ and $4CaO*Al_2O_3*Fe_2O_3$ ($2CaO*Al_2O_3*SiO_2$ – gehlenite can be formed also) [1]. If calcium carbonate prevails in trepels structure, then calcinated product contains abundant calcium oxide. Calcinations of sapropels, included organics, can lead also to forming of ceramics compounds. In both cases at clinkering or at ceramics forming calcinations, from clay, presenting in sapropels and trepels, can be formed mullite. As chemically inactive compound it can be examined as an end product of transformations of sedimentary deposits.

Hydration, decomposition. Interaction between clinker minerals and water causes the formation of hydrated compounds and following hardening. Hydrated silicates and aluminates of calcium are the knitting base of cement concretes. If sulfates participate in reactions, the rapid-setting concrete massive is formed. By-products of hydration reactions are hydroxides of calcium, aluminum or iron. Thus hydrated materials, received from calcinated sediments, have alkaline reaction. Thermal actions transform hydroxides in corresponding oxides again. Dehydration and destruction of cemented materials gives in results simple silicates: $CaO*SiO_2$ – wollastonite, amorphous olivine [1]. Thus clinker minerals and hydrated compounds can be expected in processed sapropels and trepel.

Accordingly, in case of alternating high thermal events and hydration stages on Mars, the presence of clinker minerals, hydrated calcium and aluminum silicates, end products of destruction, including UV, can be expected in the dust structure. Some inert to water or low active end products can be accumulated, probably, mullite, wollastonite, oxides of aluminum and iron.

IR-spectra and experiments. To analyze and distinguish specific compounds in the composition of Martian dust, in the same range of the wavelengths, spectral data of different instruments were used. Data of emission and transmission infrared spectra of Martian surface and dust (MGS TES, IRIS) [2] and laboratory data of transmission infrared spectra of minerals [3] and terrestrial sedimentary deposits sapropels and trepel were compared.

In the infrared spectra of Martian surface and dust can be noted two appreciable distinctive features. Adsorption increases by a "step" in the interval approximately from 1250 cm^{-1} or 1000 cm^{-1} and further up to 400 cm^{-1}. Such characteristic spectra bright regions of Mars have. The "step's" increasing of absorption is not observed in spectra of ice and clouds. Infrared spectra of Martian dark surface and Martian dust show the smooth peak of absorption near 910 cm^{-1} [4]. And specific is also a "bimodal distribution" in peaks of absorption (spectra of Hebes Chasma, Syrtis Major) on a background of "step" increasing absorption.

Infrared spectra of cement and calcium silicates have the smooth peak of absorption with a maximum 910 cm^{-1} about. The spectral curve is almost symmetric in the range 700 – 1250 cm^{-1}. Hydrated clinker silicates have no sharp peaks of OH-oscillations, characteristic for spectra of micas. The shape of OH-absorption in hydrated silicates is stretched from 1000 cm^{-1} or 1250 cm^{-1} to side of long waves (similar to Palygorskite, for example). Interesting that mullite spectrum has two smooth peaks also: near 1100 and 900 cm^{-1}.

After heating and calcinations (on different temperatures) of samples of sapropels (Grodno region, Belarus) and trepel (Mogilev region, Belarus) a set of products was received. Using an infrared spectroscopy transmission instrument IRS-29 (FTIR) spectra of received products were recorded. Infrared transmission spectra showed the appearance of new synthetic compounds during high temperature (up to 1100 C°) processing of samples. The infrared spectrum of calcinated trepel show the presence of calcium silicates and hydrated silicates formed at contact with water from air even. In received spectra the characteristic "step"-increasing of absorption (from Christiansen feature to side of long waves) is observed. Connected with oscillations of tetrahedral SiO_4 (peak is near 910 cm^{-1}) the spectral feature of calcium silicates appear in spectra of carbonates sapropels (Ant-lake). Sapropels include amorphous silica that causes a similarity of their ashes spectra to spectra of Martian dust that evidently show ratios of spectra. However the most similar, on shape and peaks position, is a spectrum of the product prepared artificially by processing of trepel. It includes amorphous silica (peaks near 1080 cm^{-1}) and new sintered compounds (weak peak at 910 cm^{-1}). Also computer simulations with use of a set of transmission spectra select hydrated components, amorphous silica and silicates of calcium for a modeled spectrum of dust.

Conclusions. Martian dust can be observed as product of physical and chemical transformations of the ancient Martian sedimentary deposits. They could be formed in seas and lakes then may be transformed during thermal processes [5], processes of hydration, dehydration and destruction. Martian dust and soil include various products of destruction of surface materials. And it can include also significant amounts of sintered products similar to clinker silicates.

In connection with presence of sulfates [6] it will be probable the fast cementation with creating of crusts in places where water condensates. Creating of cement crusts can occur on surfaces in places with gradient of temperatures.

Thus Martian dust, may be, is colored cement dust that can cause failures of landing apparatus.

Signatures of life. Sedimentary deposits of lakes and seas accumulate substances in specific composition and high homogeny form that allow thermal synthesis of specific compounds. The presence of such "signature" as clinker silicates or cements in the infrared spectra can help to specify the past of planets.

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