

THERMOGRAVIMETRIC STUDIES OF OUTGASSING OF METEORITE ALLENDE CV3.

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Introduction: The thermal outgassing of volatiles during and after planetary accretion is important for the origin of early planetary atmospheres, thermal metamorphism of meteorites, the chemistry and mineralogy of asteroids, the survival of presolar material in asteroids, satellites, and other bodies, the formation of the early crust of the Earth and Moon, and many other topics. As well known, the major outgassed volatiles from ordinary chondritic material are CH₄, H₂, H₂O, N₂, and NH₃ (the latter at conditions where hydrous minerals form) [1]. Carbonaceous CI, CV, and CM chondrites can adsorb CO₂ and H₂O depending on its primitive composition with abundant clay and total FeO as oxyhydroxides [2]. A lack of correlation between CO₂ adsorption and water abundance rules out hydrogen bonding or the formation of carboxyl or carbonate groups as the primary adsorption mechanism for main types of meteorites. The CO₂ adsorption characteristics are instead dependent on grain size as well as meteorite composition. Finer-grained meteorites and those that contain complex clays and oxyhydroxides with significant microporosity adsorb CO₂ more strongly than do meteorites without these materials. We want to explore this relationship for other types of volatile and present first results for Allende, carbonaceous chondrite CV3, (fall, Chiawa, Mexico 1969) [3].

Methods: The method of thermogravimetry [4] combined with FT-IR spectroscopy using precision thermomicrolibra TG209F1 (Netzsch GmbH) and FT-IR console Alpha (Bruker Inc.) was brought to the study of thermal stability of the Allende samples. Atmospheres of nitrogen and air in the temperature range from 30 to 1100 °C as dynamic gas flow with value of 75 ml/min were used for analysis of pieces as well as of dispersed powder of the meteorite. The analysis was performed in a corundum crucible with an open top. The calibration of the device (thermogravimetry) was performed in nitrogen and air. The mass of different samples were 8.80 mg and 9.51 mg.

On the resulting graphs are represented by curves loss/increasing the mass (TG/DTG-curves) of the studied samples. The total mass loss for pieces under nitrogen atmosphere is 0.84 % and 0.77 % for powder. Throughout the entire temperature range in a nitrogen atmosphere, there are many processes of decomposition. After reaching the temperature in 800 °C, there is a process of decomposition of carbonate compounds (as evidenced by the results from the IR-spectrometer for registration of gases, CO and CO₂). It should be noted that for the powder is lost to 10% change of mass. The detailed identification of gases in the IR spectra is difficult due to the small mass change of the samples.

The piece of meteorite at the air atmosphere is characterized by the increase of the mass, after reaching a temperature of 250-260 °C about 2.61% (2.51% for powder) due to the oxidation of metals included as composed minerals in the sample. Together with the process of oxidation, decomposition of the samples is also observed after reaching 800 °C and its associated with the decomposition of carbonate compounds.

Results and Discussion: The difference in sizes of particles leads to a change in the conditions of diffusion of formed gases, which affects the rate of reaction and hence the shape of the TG-curve. In general, with decreasing particle size decreases as the initial as final decomposition temperature. But, this effect in our case is not significant, since the outgassing of strong coupled compounds occurs by the similar peak temperatures for both types of samples (pieces and powder) as you can see from the table below

*T _p (piece) °C	86.55	215.49	459.25	613.31	707.91	943.72	Residual mass - 99.16%
*T _p (powder) °C	90.66	294.30	405.48	613.17	-	914.15	Residual mass - 99.23%

* T_p is the temperature at which the rate of mass decrease is maximum.

However, for a piece there are a number of additional temperatures at which occurs a mass decrease missing for the powder. This indicates additional mechanisms for retention of gases in the pores or on the grain boundaries and requires further research.

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References:

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