THERMAL PROPERTIES OF CHELYABINSK METEORITE.

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Introduction: Knowledge of bulk density and porosity of meteorites enables one to predict thermal properties of meteorites and their parent bodies [1-5]. Mineralogy, petrology and selected physical properties of Chelyabinsk chondrite (LL 5, S4, W0) have been studied since its fall on February 15th, 2013 [6, 7]. The aim of the study was to determine thermal properties of Chelyabinsk meteorite: specific heat capacity, volumetric heat capacity, thermal diffusivity, and thermal conductivity at room and low temperatures.

Methods: Specific heat capacity *Cp* was determined using relationship between *Cp* and bulk density ρ_{bulk} of meteorites [1], and using abundance and composition of constituent minerals of Chelyabinsk chondrite [6,7]. Thermal diffusivity *D*, and thermal conductivity *K* were determined using relationships: between *D* and ρ_{bulk} [2], between *K* and ρ_{bulk} [3], and between *K* and porosity *P* [4,5]. Literature data on mean bulk density ρ_{bulk} = $(3.32\pm0.09)\cdot10^3$ kg/m^3, mean porosity *P* = (6.0±3.2)% of the Chelyabinsk meteorite [6], and on the normative composition of the chondrite [7] were used in calculations.

Results: Specific heat capacity of Chelyabinsk meteorite predicted by $Cp(\rho_{bulk})$ dependence is *Cp* = 701 J/(kg·K) at 300K. When the correcting factor c (c=1.33±0.03) responsible for the low temperature decrease in *Cp* values is taken into considerations we have *Cp* = (527±12) J/(kg·K) at 200 K. Using data on the normative composition of Chelyabinsk chondrite [7], and constituent minerals thermal data gives: *Cp* = 684 J/(kg·K) at 300 K, and (514±12) J/(kg·K) at 200 K. The main contribution to Chelyabinsk *Cp* comes from olivine (60%), pyroxenes give 18%, feldspar 13%, troilite 5%, kamacite 2%, and the rest of the constituent minerals gives 2% contribution. The volumetric heat capacity of Chelyabinsk *Cvolumetric* = $2.33\pm0.03\cdot10^6$ J/(m^3·K) at RT, and is close to the value characteristic of stony meteorites ($2.5\cdot10^6$ J/(m^3·K) [1]). Thermal diffusivity *D* of Chelyabinsk is $(0.77\pm0.20)\cdot10^{-6}$ m^2/s at 200 K, and $(0.80\pm0.50)\cdot10^{-6}$ m^2/s at 300 K. Thermal conductivity *K* of Chelyabinsk is 4.5±0.4 W m^{-1} K^{-1} at 200 K, and (4.1±1.4) W m^{-1} K^{-1} at 300 K. Calculations show that a significant spread noted in ρ_{bulk}, and *P* values of various Chelyabinsk samples (ρ_{bulk},= $(3.14\text{-}3.60)\cdot10^3$ kg/m^3, *P* = 1.5-11.4% [6]) leads to the range of values: *Cp* = (670-723) J/(kg·K), *K* = (1-8) W m^{-1} K^{-1}, *D* = $(0.1\text{-}1.8)\cdot10^{-6}$ m^2/s at 300 K, i.e. to the range of values expected for direct measurements.

Conclusions: Estimated thermal properties of Chelyabinsk LL5 chondrite are comparable with thermal properties of Kilabo (LL6), NWA 4560 (LL3.2), and Sołtmany (L6) chondrites.

References: [1] Szurgot M. 2011. Abstract #1150.pdf. 42nd Lunar & Planetary Science Conference. [2] Szurgot M. and Wojtatowicz T.W. 2011. Abstract #5036. 74th Annual Meeting of the Meteoritical Society. [3] Szurgot M. 2011. Abstract #5074. 74th Annual Meeting of the Meteoritical Society. [4] Opeil C.P. et al. 2012. *Meteoritics & Planetary Science* 47:319-329. [5] Szurgot M. et al. 2012. *Meteorites* 2:53-65. [6] Kohout T. et al. 2014. *Icarus* 228:78-85. [7] Galimov E. M. et al. 2013. *Geochemistry International* 51:522-539.