HEAT CAPACITY OF ASTEROID VESTA, VESTAN CORE, MANTLE AND CRUST.

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Introduction: Important data for asteroid 4 Vesta supplied by the Dawn mission [1, 2] can be used for determination of thermal properties of Vesta, parent body of HED meteorites. The aim of the paper was to estimate mean specific heat capacity, heat capacity, and thermal capacity of Vesta, Vestan core, mantle and crust at room temperature.

Results: Specific heat capacity *Cp* of Vesta, Vestan core, mantle and crust was calculated using the relationship

$$Cp = a + b/d, \qquad (1)$$

where *Cp* is the value of *Cp* (J/kg·K) at room temperature, *d* (kg/m^3) is the bulk density, and *a* and *b* are constants (a = 303 J/(kg·K), $b = 1.31\cdot10^6$ J/(K·m^3)) [3]. Substituting values: *dcore* = 7400 kg/m^3 [2], *dmantle* = 3170 kg/m^3 [2], and *dcrust* = 2990 kg/m^3 [2], into eq. (1) gives: *Cpcore* = (480 ± 10) J/kg·K, *Cpmantle* = (716 ± 15) J/kg·K, *Cpcrust* = (741 ± 10) J/kg·K, and *CpVesta* = (682 ± 10) J/kg·K. The results show that the mean value of specific heat capacity of Vesta is determined mainly by the material of mantle (60 % contribution), but also by material of core (20 % contribution), and crust (20 % contribution).

Heat capacity *C* of Vesta, its core, mantle and crust was determined using the equation

$$C = M\cdot Cp, \qquad (2)$$

where *M* is the mass, and *Cp* is specific heat capacity. Literature data on Vesta's mass *MVesta* = $2.59\cdot10^{20}$ kg [1], and Vestan core *Mcore/MVesta* = 0.18 [1] have been used, and literature data on volume of Vesta, core, mantle and crust [2], together with data on densities [2] allowed to determine *Mmantle/MVesta* = 0.62, and *Mcrust/MVesta* = 0.20. Calculations show that: *Ccore* = $(2.3 \pm 0.1)\cdot10^{22}$ J/K, *Cmantle* = $(1.2 \pm 0.1)\cdot10^{23}$ J/K, *Ccrust* = $(3.9 \pm 0.1)\cdot10^{22}$ J/K, and *CVesta* = $(1.8 \pm 0.1)\cdot10^{23}$ J/K. It is seen that the main contribution to Vesta's heat capacity comes from its mantle (*Cmantle/CVesta* = 0.66); crust and core give contributions: *Ccrust/CVesta* = 0.21, Ccore/CVesta = 0.13.

Thermal capacity *Cvol* (heat capacity per unit volume) was determined using the relation

$$Cvol = Cp\cdot d. \qquad (3)$$

Calculations show that: *Cvolcore* = $3.55\cdot10^6$ J/(m^3·K), *Cvolmantle* = $2.27\cdot10^6$ J/(m^3·K), *Cvolcrust* = $2.22\cdot10^6$ J/(m^3·K), *CvolVesta* = $2.36\cdot10^6$ J/(m^3·K) at room temperature. *Cvolcore* value is close to *Cvol* value established for iron meteorites ($3.6\cdot10^6$ J/(m^3·K) [3], and both *Cvolmantle* and *Cvolcrust* values are close to *Cvol* value established for stony and stony-iron meteorites ($2.5\cdot10^6$ J/(m^3·K) at room temperature [3]. Since

$$Cvol = K/\alpha, \qquad (4)$$

where *K* is thermal conductivity, and α is thermal diffusivity, Vesta's matter shows the sequence of ratios:

$$(K/\alpha)crust : (K/\alpha)mantle : (K/\alpha)core = 1:1.02:1.6.$$

Conclusions: Specific heat capacity, heat capacity, and thermal capacity of Vesta are determined mainly by mantle of Vesta. Knowledge of core and mantle temperatures, and mean, global Vesta's temperature is necessary to improve the thermal data.

References: [1] Russell C.T. et al. 2012. *Science*, 336:664-686. [2] Konopliv A.S. et al. 2012. Abstract #2600. 43rd Lunar & Planetary Science Conference. [3] Szurgot M. 2011. Abstract #1150. 42nd Lunar & Planetary Science Conference.