CORE MASS FRACTION AND MEAN ATOMIC WEIGHT OF TERRESTRIAL PLANETS, MOON, AND PROTOPLANET VESTA. M Szurgot, Lodz University of Technology, Center of Mathematics and Physics, Al. Politechniki 11, 90 924 Lodz, Poland, (mszurgot@p.lodz.pl).

Introduction: Knowledge of mean atomic weight is useful to characterize planets, moons, comets and asteroids. The aim of the paper was to determine mean atomic weight of the solar system inner planets, moon, protoplanet Vesta, and to determine mass fraction of planetary cores.

Results and discussion: Recent results by Szurgot [1] show that mean atomic weight *Amean* of rocky planets and moon can be determined using chemical composition, planetary uncompressed density *d* *(g/cm^3)*, and mass fraction of core *wcore* (wt%):

Amean = $1/\sum(wi/Ai)$, (1)

Amean = $(7.51\pm0.13)\cdot d + (-2.74\pm0.55)$, (2)

Amean = 1/ [-0.02724·*wcore* + 0.04673], (3)

where *wi*(wt%) is the mass fraction of i*th* element, and i*th* oxide, *Ai* is atomic weight of i*th* element, and/or mean atomic weight of i*th* oxide.

Mass fraction of the core, and uncompressed planetary density can be predicted by *Amean* using the equations [1]:

wcore = $(-36.716 \pm 1.15)/Amean + (1.716\pm0.041)$, (4)

$d = (0.133 \pm 0.002)\cdot Amean + (0.37 \pm 0.07)$. (5)

Two interrelationships between *d* and *wcore* result from eqs. (2) and (3):

d = 1/ [-0.2046·*wcore* + 0.3514] + 0.365, (6)

wcore = 1.7175 - 1/ [0.2046·*d* - 0.07464], (7)

which enable one to determine *wcore* using *d(g/cm^3)*, and to determine *d* using *wcore*.

Table 1 collects values of *Amean*, calculated by eqs. (1-5) employing chemical composition predicted by various researchers, e.g. [2-5], and Table 2 compiles values of *wcore* calculated by eqs. (4) and (7).

Table 1 Mean atomic weight *Amean* of inner planets, Earth's moon, planetary cores, and protoplanet Vesta determined by eqs. (1)-(3).

Planet	Eq.(1)	Eq. (2)	Eq(3)	Core
Mercury	35.8	34.8	35.5	53.5
Venus	25.8	26.3	26.3	51.2
Earth	26.5	27.0	26.4	50.4
Moon	21.8	21.8	21.7	50.3
Mars	25.2	25.0	24.5	50.9
Vesta	24.2 ± 1.0	24.0**	23.9*	53 ± 2#

Vesta: *for *wcore* = 0.18, **for *d* = 3.56, #range of *Amean* = 50.2 - 56.2, bulk silicates *Amean* = 22.2±1.0.

Table 2 Mass fraction of planetary cores determined using eqs. (4) and (7), and literature data on uncompressed density of planets *d* [8]. Literature data on *wcore* values [5,6,9] are also shown.

Planet	*d*	*wcore* Eq.(4)	*wcore* Eq.(7)	*wcore*
Mercury	*5.0*	0.69	0.66	*0.68*
Venus	*3.87*	0.29	0.32	*0.32*
Earth	*3.955*	0.33	0.356	*0.325*
Moon	*3.27*	0.03	0.03	*<0.02* [5]
Mars	*3.70*	0.26	0.25	*0.217*
Vesta	*3.56*• *3.456#*	0.18* 0.20^	0.19 0.14	*0.18* [6]

* For *Amean* = 23.9 ± 0.7 we get *wcore* = 0.18 ± 0.04.
^ For *Amean* = 24.2 ± 1.0 we get *wcore* = 0.20 ± 0.06.
•*d* = *dgrain* for porosity 3%, and *dbulk* = 3.456 [6].
#Vestan bulk density [6].

The comparison of *Amean* values determined in this paper (Table 1) with values established by Anderson and Kovach [7]: 36 for Mercury, 26.4 for Venus, 27 for Earth, 22 for Moon, and 25.3 for Mars reveals a good agreement. Vestan *Amean* = 24.2 ± 1.0 is close to average values for EL chondrites *Amean* = 23.8, L chondrites *Amean* = 23.7, and Martian *Amean* = 25.2.

Conclusions: Core mass fraction of the solar system inner planets, Earth's moon, and of protoplanet Vesta can be determined using mean atomic weight, and uncompressed density. New relationships derived for determination of mass fraction of metallic cores of planetary bodies and their mean atomic weights have been successfully verified. *Amean* and *wcore* values predicted for terrestrial planets, and Earth's moon, and *wcore* values predicted for protoplanet Vesta are in good agreement with the literature data.

References: [1] Szurgot M. (2015) *LPSC 46th*, Abstract #1536. [2] Smith J. V. *Mineral. Mag. (1979) 43*, 1-89. [3] Anderson, D. L., *Theory of the Earth* (1989), Blackwell, Boston. [4] Lodders K. (2000) *Space Sci. Rev. 92*, 341-354. [5] Taylor S. R. and McLennan S. M., *Planetary crusts: Their composition, origin, and evolution* (2009), Cambridge. [6] Russell C. T. et al. *Science* (2012) *336*, 684-686. [7] Anderson D. L. and Kovach R. L. (1967) *Earth Planet. Sci. Lett. 3*, 19-24. [8] Stacey F. D. (2005) *Rep. Prog. Phys., 68*, 341-383. [9] Righter K. (2007) *Chemie der Erde 67*, 179–200.