RELATIONSHIP BETWEEN DENSITY OF PLANETARY MATERIALS AND IRON TO SILICON RATIO. PREDICTING GRAIN DENSITY FOR ORDINARY CHONDRITES, AND UCOMPRESSED DENSITY FOR MOON, EARTH, VENUS, AND MARS.

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Introduction: Knowledge of densities, iron to silicon ratios, and mean atomic weights is important to characterize minerals and rocks, planets, moons, asteroids, and meteorites. The aim of the paper was to reveal relationship between density and *Fe/Si* ratio for planetary materials, to verify uncompressed density of terrestrial planets and Moon, and grain density of LL, L, and H chondrites, and to verify their *Fe/Si* atomic ratios. Literature data on chemical composition and densities [1-7] have been used to establish, and apply *d(Fe/Si)* relatiornship.

Results and discussion: There exists relationship between density *d* and *Fe/Si* atomic ratio given by the equation:
$d(Fe/Si) = 0.765 \cdot Fe/Si + 3.11$, for which uncertainty is between 0.04-0.09 g/cm^3. (1)

Substituting *Fe/Si* = 0.21 [2] into eq. (1) gives *d* = 3.27 ± 0.04 g/cm^3 for uncompressed density of the Moon, and *Fe/Si* =1.10 [1] gives *d* = 3.95 ± 0.15 g/cm^3 for uncompressed density of the Earth. Literature data [3] indicate the same values of densities: 3.27 g/cm^3 for the Moon, and 3.955 g/cm^3 for the Earth (Table 1). Substituting *Fe/Si* = 0.52 [8] into eq. (1) gives *d* = 3.51 g/cm^3, which is close to the mean value for grain density for LL falls (3.52 g/cm^3 [7]).

Apart from the *Fe/Si* ratio, also mean atomic weight *Amean* and core mass fraction *Wcore* enable one to predict uncompressed density *d* for planets, moon, and asteroids [9,10], and grain density for ordinary chondrites. *d(Amean)* dependence is expressed by the equation:
$d(Amean) = 0.133 \cdot Amean + 0.37$, for which RMSE = 0.07 [9-11], (2)
and *d(Wcore)* dependence by the equation [10]:
$d(Wcore) = 0.365 + 1/ [-0.2046 \cdot Wcore + 0.3514]$. (3)

Table 1. *Fe/Si* atomic ratios, mean atomic weights *Amean*, *Wcores*, uncompressed densities, and grain densities predicted by *d(Fe/Si)*, *d(Amean)*, and *d(Wcore)* dependencies (eqs. (1) - (3)).

Planet/Moon/ Chondrites	*Fe/Si*	*Amean* [8,9,10]	*Wcore* [10]	*d(Fe/Si)* (g/cm^3)	*d(Amean)* (g/cm^3)	*d(Wcore)* (g/cm^3)	*d*(g/cm^3)* [3,7]
Earth	**1.10** [1]	**26.5**	0.325	**3.95**	3.89	3.87	**3.955**
Moon	**0.21** [2]	**21.8**	0.03	**3.27**	**3.27**	**3.26**	**3.27**
Venus	**0.991** [5]	**25.8**	0.32	**3.87**	3.80	**3.86**	**3.87**
Mars	**0.814** [6]	**25.2**	0.217	**3.73**	**3.72**	3.62	**3.70**
H	**0.807#** [8]	**24.6#**	-	**3.73**	3.64	**-**	**3.71#**
L	**0.594#** [8]	**23.7#**	-	**3.56**	3.52	**-**	**3.58#**
LL	**0.520#** [8]	**22.9#**	-	**3.51**	3.42	-	**3.52#**

*Literature data on uncompressed densities and grain densities [3, 7]. #Mean values for meteorite falls.

Table 1 shows that relationship between density and *Fe/Si* atomic ratio predicts precisely uncompressed density for Earth, Moon,Venus, and Mars, and grain density for ordinary chondrites. *d(Amean)* dependence leads to precise density for Moon, and for acceptable density for Mars, Earth, Venus, and to low, but acceptable grain densities for ordinary chondrites falls. Our data show that *d(Wcore)* relation is a useful tool for density and *Wcore* predictions.

Equation (1) enables one to predict *Fe/Si* ratio if *d* is known. For literature values of uncompressed (grain) densities, collected in the last column of Table 1, equation (1) predicts satisfactory values of *Fe/Si* atomic ratios: 1.10 for Earth, 0.21 for Moon, 0.99 for Venus, 0.77 for Mars, and 0.78 for H, 0.61 for L, and 0.53 for LL chondrites.

Conclusions: Grain density for ordinary chondrites, and uncompressed density for rocky planets, and for Moon can be verified by *d(Fe/Si)* relationship, and their *Fe/Si* atomic ratios can be predicted or verified by their densities.

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