Mean Atomic Weight of L'Aigle Meteorite

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INTRODUCTION

L'Aigle meteorite is a typical **L6 chondrite**, moderately shocked (S4) which fell in 1803 in **France. Mean atomic weight** is a physical property important to characterize minerals, rocks, planets, moons and asteroids, useful to classify meteorites.

The aim of the paper was to **determine** and **analyze mean atomic weight *(Amean)*** and **mean atomic number *(Zmean)*** of the **L'Aigle meteorite,** and to **predict grain density *(dgrain)*** of the **silicates**, **metal**, and **the whole rock** of the chondrite.

RESULTS

Bulk elemental composition of the meteorite [1,2] has been used to calculate mean atomic weight *Amean* and mean atomic number *Zmean* using the following formulas

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

$$Zmean = \sum wi / \sum (wi/Zi), \quad (2)$$

where *wi*(wt%) is the mass fraction of *ith* element and *ith* oxide, *Ai* is atomic weight of *ith* element and *ith* oxide, and *Zi* is atomic number of *ith* element and *ith* oxide.

Apart from the **bulk composition** data, also ***Fe/Si* ratio**, **grain density *dgrain***, and **magnetic susceptibility *χ*** were used to predict ***Amean*** values by ***Amean(Fe/Si), Amean(dgrain),*** and ***Amean(logχ)* relationships**, recently established by **Szurgot** (e.g. [3-7]):

$$Amean(Fe/Si) = 5.72 \cdot Fe/Si + 20.25, \quad (3)$$

$$Amean(dgrain) = 7.51 \cdot dgrain - 2.74, \quad (4)$$

$$Amean(\log\chi) = 1.49 \cdot \log\chi + 16.6. \quad (5)$$

$$Amean(Fe/Si,d,\chi) = [Amean(Fe/Si) + Amean(dgrain) + Amean(\log\chi)]/3. \quad (6)$$

Table 1 compiles values of *Amean, Zmean* and *Amean/Zmean* ratios calculated for L'Aigle meteorite, and average values for L6 chondrites.

Table 1. Mean atomic weight *Amean,* mean atomic number *Zmean, Amean/Zmean* ratio, and *Fe/Si* atomic ratio of L'Aigle, and mean for L6 chondrites.*L6's data were established by Szurgot [3].

Meteorite	*Amean (Bulk composition)*	*Zmean*	*Amean/Zmean*	*Fe/Si atomic ratio*
L'Aigle L6	**24.21**	**11.87**	**2.040**	**0.626**
L6 Average#	24.06 ± 0.16*	11.89	2.023 ± 0.002	0.60 ± 0.04*
L6 Range	*23.6 - 24.4*	*11.7-12.1*	*2.021 - 2.027*	*0.53 - 0.65**

Table 2 *Amean* values of L'Aigle determined by bulk composition (eq.(1)), and by relationships (eqs (3) - (6)).

Amean (Bulk composition)	*Amean(Fe/Si)*	*Amean(dgrain)*	*Amean(logχ)*	*A (Fe/Si, dgrain, χ)*
24.21	**23.83**	**24.52***	**23.86***	**24.07 ± 0.39**

*L'Aigle *Fe/Si* = 0.626, *dgrain* = 3.63 g/cm^3 [9], and $\log\chi$ = 4.87 [9]. # Average for ten L6 chondrites

Tables 1, 2 and 3 show that:

i) ***L'Aigle Amean(Bulk composition)* = 24.21** is close to the **mean atomic weight** of **L6 chondrite falls** (average: **24.06** ± 0.16, range: 23.6-24.4), and is also close to **H/L intermediate group**: average **24.32**±0.07 [5].

ii) ***L'Aigle Fe/Si* atomic ratio = 0.626** is close to the average for **L6 falls**: **0.60** ± 0.04, and is within the **L6 range**: **0.53 - 0.65** [3].

iii) L'Aigle ***Amean/Zmean* ratio = 2.040** is close to the **average *Amean/Zmean* L6's ratio**: **2.023** ± 0.002 .

iv) L'Aigle **silicates** and **Fe, Ni metal** show ***Amean* values**: **21.81,** and **56.24.**

vi) ***dgrain(Amean)* relationship (eq.(7))** shows **grain density** values: **3.59**, **3.27**, and **7.85 g/cm³**, for the **whole rock**, **silicate fraction**, and **Fe,Ni metal**, respectively.

vii) ***dgrain(Fe/Si)* relationship (eq.(8)) reveals grain densities: 3.59 g/cm³ for the whole rock, and 3.33 g/cm³ for silicates.**

To **verify grain density *dgrain*** of the **L'Aigle chondrite and to predict *dgrain* of its silicates and metal** two relationships discovered by **Szurgot** [3-8] have been used.

The first relationship is between grain density and **mean atomic weight *dgrain(Amean)***. It is expressed by the equation [3,4]:

$$dgrain(Amean) = 0.133 \cdot Amean + 0.37. \quad (7)$$

Substituting ***Amean* = 24.21** into eq. **(7)** gives ***dgrain* = 3.59 ± 0.07 g/cm³** for **grain density of the whole rock of L'Aigle meteorite.**

The same equation leads to grain density of silicates: 3.27 ± 0.07 g/cm³ (*Amean* = 21.81), and **7.85 ± 0.07 g/cm³ for metal** (*Amean* = 56.24).

Second relationship is between **density *dgrain* and *Fe/Si* atomic ratio**. It is given by the equation [8]:

$$dgrain(Fe/Si) = 0.765 \cdot Fe/Si + 3.11. \quad (8)$$

Substituting ***Fe/Si* = 0.626** into **eq. (8)** gives ***d* = 3.59 ± 0.07 g/cm³ for grain density of L'Aigle meteorite. This equation leads to grain density of silicates: 3.33 ± 0.07 g/cm³** (***Fe/Si* = 0.287**).

Grain density value predicted for the whole rock of **L'Aigle meteorite: 3.59 ± 0.07 g/cm³ is close to the value of grain density determined experimentally by Macke: 3.63 ± 0.13 g/cm³ [9] (Table 3).**

Predicted values of grain density for silicates: 3.27 ± 0.07 and 3.33 ± 0.07 g/cm³ (mean **3.30 ± 0.04 g/cm³**), and **for metal: 7.85 ± 0.07 g/cm³** are reasonable.

Table 3 Grain density *d(g/cm³)* of L'Aigle meteorite, predicted by relationships *d(Fe/Si)* and *d(Amean)* expressed by eqs. (7) – (8), and experimental data ***dexp*** measured by Macke [9].

	d(Fe/Si)	*d(A)*	*dexp* [9]
L'Aigle	**3.59**	**3.59**	**3.63**
Silicates	***3.33***	***3.27***	
Metal	**-**	***7.85***	

CONCLUSIONS

1. **Mean atomic weight, mean atomic number, *Amean/Zmean* ratio,** and ***Fe/Si* ratio** indicate that **L'Aigle belongs to L6 chondrites**, as previously established.
2. ***Fe/Si* atomic ratio, grain density, and magnetic susceptibility satisfactorily predict *Amean* values.**
3. ***Amean* and *Fe/Si* ratio satisfactorily predict grain density of L'Aigle meteorite.**

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