EXPERIMENTAL STUDY OF NORTHWEST AFRICA 12370 METEORITE'S MECHANICAL PROPERTIES.

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Introduction: Usually, pre-entry 10-100 meter scale interplanetary meteoroids are typically highly fractured and can break up under tensile stresses of 0.03 + 1 MPa [1]. The exception is the fall (September 15, 2007) of the Carancas stony meteorite in Peru that caused the formation of a 13 m wide impact crater. It was classified as an ordinary chondrite H4-5 W0 S3 with an estimated initial size ~ 0.9 + 1.7 m, a compressive strength ~ 20 + 40 MPa and a tensile strength ~ 1.2 + 2.4 MPa, depending of the trajectory [2]. So, the Carancas meteorite is a rare example of a monolithic meteoroid that was almost free of internal cracks. Such meteorites are the most dangerous to the Earth and we have tried to study their mechanical properties more fully with the help of the most appropriate analogue. The very similar meteorite, Norhtwest Africa 12370, was purchased at the mineralogical exhibition (Mineralientage München, Germany) in October 25, 2018 from the Mr. Ait Ha Lahcen from Erfoud, Morocco (see table 1 for theirs comparison). It was classified by Lorenz C.A., Vernadsky Institute, as H5 W1 S2 [3].

Table 1. Mineral compositions

Meteorite, name	Classification	Fayalite (mol %)	Ferrosilite (mol %)	Wollastonite (mol %)	Oxygen isostopes (‰)
Carancas	H4-5 W0 S3	18.4±0.5	16.1±0.2	No data	$\Delta^{17}O = 3.017$; $\delta^{18}O = 4.519$; $\Delta^{17}O = 0.667$
NWA 12370	H5 W1 S2	19.3±0.6	16.1±0.3	1.5±0.9	No data

Methods: The study of mechanical properties of the meteorite sample was performed in accordance with the following regulatory documents: ASTM D2845-08 Standard Test Method for Laboratory Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock.The testing was carried out at the Institute of Geology and Petroleum Technologies, Kazan Federal University. Measurement of the velocity of the longitudinal and transverse ultrasonic wave is performed at the PEAK-ULTRASONIC-EP installation. The system consists of two ultrasonic sensors, a signal source, an oscilloscope, an RLC and a relay systems. The source generates a signal with a frequency of 1 MHz. The signal is received by one of the sensors, which excites the pulses of S and P waves. The waves pass through the sample installed in the core holder and are detected by a second ultrasonic measurement sensor.
Results and Discussion: The calculation of the dynamic elastic moduli (Young's and Poisson's ratio) were carried out according to the formula (1)

$$R = V_p/V_s = \sqrt{2(1-\mu)/(1-2\mu)}, \quad E = V_p^2\,\rho\,(1+\mu)(1-2\mu)/(1-\mu), \qquad (1)$$

where R - ratio of longitudinal and transverse waves, Vp - velocity of longitudinal waves, Vs - velocity of transverse waves, μ - dynamic Poisson's ratio, E - dynamic Young's modulus, ρ - density of rocks. Cylindrical sample of NWA 12370 with length 41.74 mm and diameter 29.55 mm had a density ρ = 3.518 g/cm^3.

Table 2. Results of determining the velocity and dynamic elastic parameters of NWA 12370

Pressure, MPa	**Vs, km/s**	**Vp, km/s**	***E* (dyn), GPa**	**Poisson ratio (dyn)**
1	3.413	5.471	95.97	0.1814
10	3.441	5.773	101.12	0.2245
30	3.528	5.773	104.35	0.2019

Dynamic parameters and values obtained by static load of meteorites [4] may differ significantly. Full consideration will be given in the following article.

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References:

[1] Popova O. et al. 2011. Meteoritics and Planetary Science, **46**(10): 1525-1550.[2] Connolly H. C. et al. 2008. The Meteoritical Bulletin, No. 93. Meteoritics and Planetary Science, **43**: 571-632. [3] Lorenz C.A. et al. 2019. The Meteoritical Bulletin, No. 108 (in preparation). [4] Voropaev S., Nugmanov I., Dushenko N. et al. 2017. Doklady Astronomy&Physics, 62(10): 486-489.