STUCTURE ANISOTROPY OF ORDINARY CHONDRITES

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Introduction: As a result of experimental studies, the strong anisotropy of physical and mechanical properties was found in the most widespread type of stony meteorites-ordinary chondrites, when in one of the three directions the compressive strength limit exceeds by 60% the values in the other two directions [1]. Similar anisotropy in terrestrial rocks is usually due to the ordered orientation of grains and crystals of one or several major minerals in sedimentary rocks or in magmatic rocks with flow structure. Probably, such an ordered structure in stony meteorites and asteroids could have formed during the segregation and consolidation of the primary substance under the condi-tions of a highly asymmetric physical medium in a protoplanetary cloud (a strong magnetic field?). The study of the nature of anisotropy will allow us to evaluate the physical conditions in the protoplanetary cloud that existed at the earliest stage of the formation of the solar system.

Methods: The physical and mechanical properties of the meteorites were studied by the comprehensive estimation of strength under repeated splitting and compression in accordance with the established standard [2]. In order to investigate physical and mechanical properties in three areas, the Sayh al Uhaymir 001 Meteorite's fragment 9×10×12 cm in size was cut into three perpendicular plates with a thickness of 20 mm each (Fig. 1a) and one cube with sides being parallel to all three plates and a size of 40×40×40 mm. Two different fragments of the Tsarev Meteorite (nos. 15384.1 and 15390.9) were cut each into three mutually perpendicular plates with a thickness of 20 mm each and a few cubes with sides being parallel to all three plates and with a size of 40×40×40 mm (Figs. 1b, 1c). The fragment no. 15384 in its primary form represented a cone-shaped polygon with a size of 28×28×23 cm and with a weight of 24.8 kg [3]. The primary fragment no. 15390 was characterized by a polyhedral elongated shape, size 50×38×31 cm, and weight 104.2 kg [3].

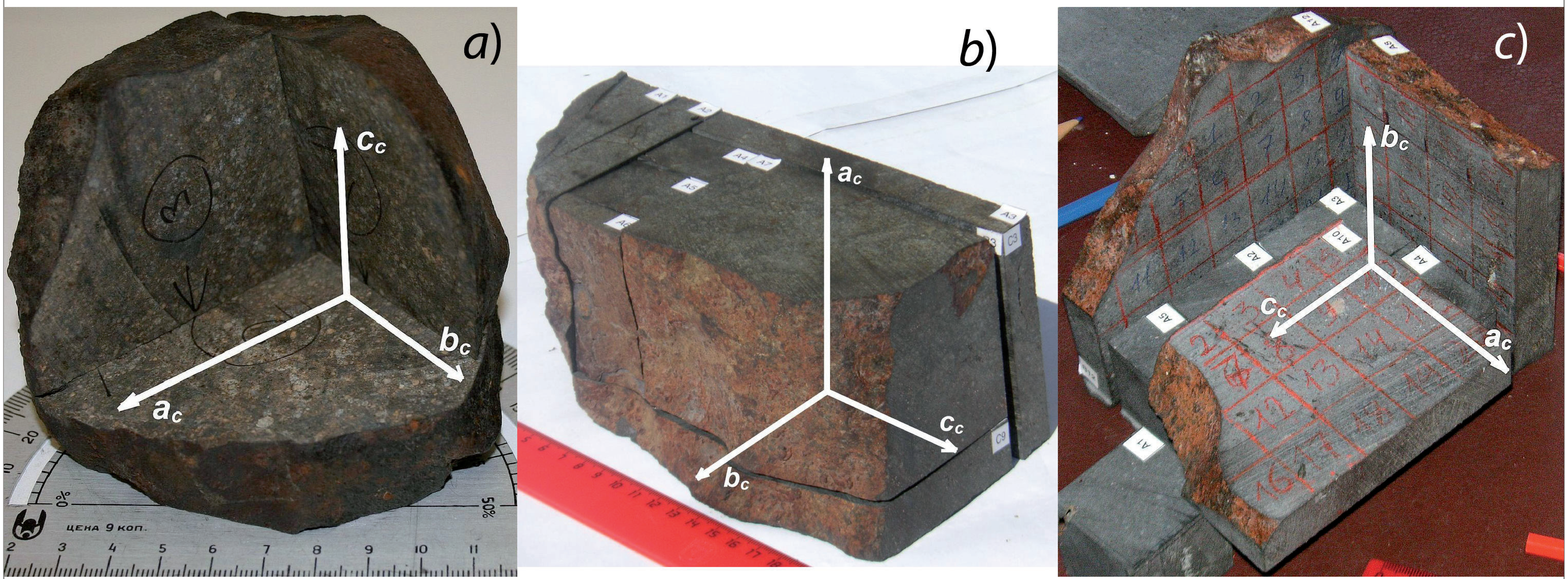

Fig. 1. Orientation of the ellipsoid of anisotropy of physicomechanical properties with semiaxes of *ac*>*bc*≥*cc* in fragments of meteorites: a) meteorite SAUH 001; b) meteorite Tsarev, fragment number 1539; (c) Meteorite Tsarev, fragment No. 15384.1.

Depending on size, each plate was split into cubes with a semiregular shape and a size of 20×(20–30)×(20–30) mm (Fig. 2). The tensile direction was perpendicular to the splitting line. A compression strength was determined by compression crushing of cubic samples with a semiregular form obtained in the course of splitting of plates after determination of the tensile strength (Fig. 3a) and by compression crushing of a cube with a size of 40 × 40 × 40 mm during measurement of strain parameters. The compression axis was perpendicular to the plate plane. Stresses exceeding the compressive strength resulted in explosive fragmentation of the studied sample (Fig. 3b). This phenomenon is referred to as a rheological explosion [4].

Results: The observed structural anisotropy in ordinary chondrites is approximated by an elongated ellipsoid with the ratio of the main semiaxes a:(b=c)=1.6:1 (Fig. 1). The measured compressive strength of ordinary chondrites taking into account the average values in three directions is in the range from 91 to 262 MPa (Table 1). The tensile strength is also in the range from 17 to 34 MPa, taking into account the values for individual directions. It should be noted that the measured tensile strength is the upper limit value limiting the maximum destructive aerodynamic load for stone meteoroids [5].

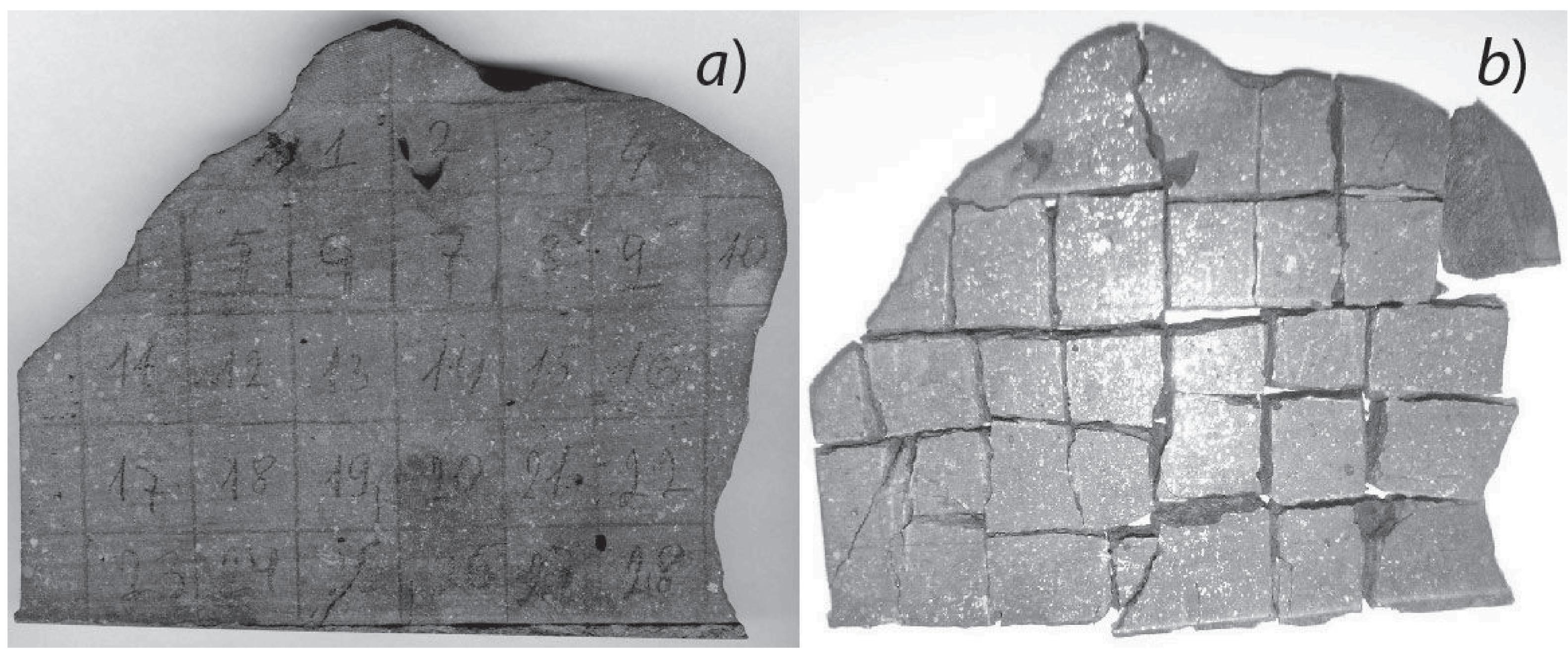

Fig. 2. Determination of a tensile strength by oriented splitting of plates of the Tsarev Meteorite fragment no. 15384.1: (a) plate marking; (b) plate split into cubes with a semiregular shape.

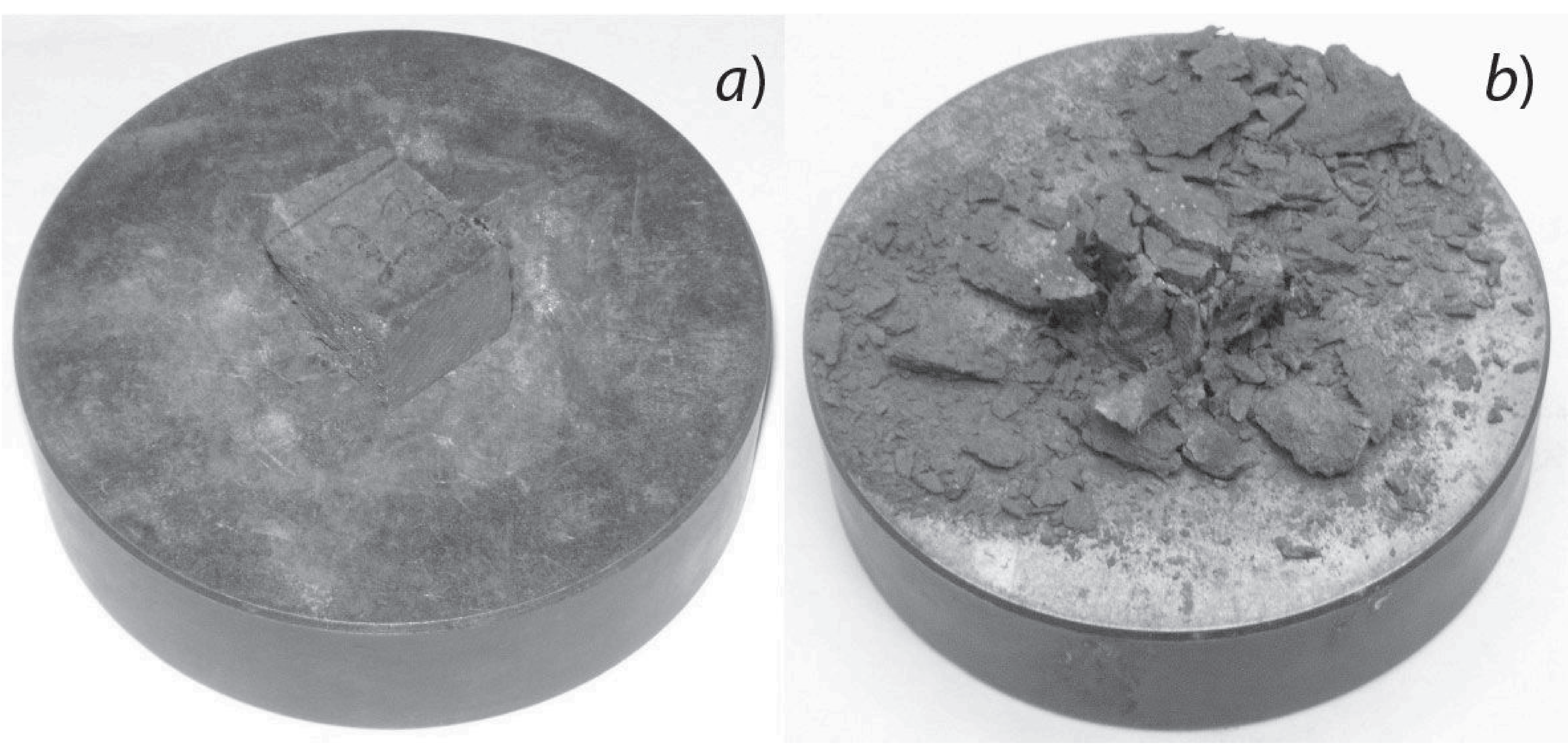

Fig. 3. Determination of a compression strength by compressive crushing of cubic samples with a semiregular shape obtained by plate splitting

Table 1. Three-dimensional distribution of physical and mechanical properties in ordinary chondrites.

Name	Axis of an anisotropy ellipsoid			Average for sample
	a_c	***b_c***	***c_c***	
Meteorite SAUH 001 (***a_c/c_c*=1.6**)				
Compressive strength, MPa	**143**	**94**	**91**	**105**
Number of measurements	6	7	10	23
Variation coef., %	20	29	23	31
Tensile strength, MPa	**18**	**17**	**18**	**18**
Number of measurements	13	13	14	40
Variation coef., %	28	26	27	27
Meteorite Tsarev, fragment №15390,9 (***a_c/c_c*=1.6**)				
Compressive strength, MПa	**262**	**168**	**160**	**203**
Number of measurements	25	27	13	65
Variation coef., %	19	37	29	35
Tensile strength, MПa	**28**	**34**	**27**	**29**
Number of measurements	23	20	33	76
Variation coef., %	32	35	31	34

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