SHAPE DISTRIBUTION OF ORDINARY CHONDRITES, IRON METEORITES AND METALLIC ASTEROIDS. E.N. Slyuta, Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences, 119991, Kosygin St. 19, Moscow, Russia. slyuta@mail.ru.

Odinary chondrite: Data on sizes of all collected fragments of Tsarev meteorite is presented in summary table 1. Tsarev is a stony meteorite shower found at 1968 in Volgograd Province in Russia [1]. On composition the meteorite is ordinary chondrite of L5 type [5]. Samples of Tsarev meteorite usually have polyhedral shape with well expressed sides on which there was destruction in atmosphere [1]. The majority of meteorite fragments (if not all) are individual samples which are usually characterized by the aerodynamic shape and sides typical for individual samples. There are relict rhegmaglypsts on a surface of some fragments. It is to be noted that polyhedral or pyramidal shape with various numbers of sides is prevailing for fragments of ordinary chondrites [6].

Average value of shape distribution of fragments of Tsarev meteorite is of b/a=0.76, c/a=0.59 (Table 1), and the relation between axes - a:b:c=1.7:1.3:1. It is interesting that the main axes relation a/c of fragments of a meteorite (1.7) actually coincides with magnitude of anisotropy ellipsoid of physical-mechanical properties of ordinary chondrites (a/c=1.6), which is oriented along long axe of a meteorite fragment [7]. For samples in mass less than 1 kg (Table 1) the relation of a:b:c corresponds to 1.7:1.3:1, for samples in mass of 1-10 kg - a:b:c=1.8:1.3:1, for samples in mass more than 10 kg - a:b:c=1.7:1.3:1. Thus, shape parameters of meteorite fragments practically does not depend on mass and size of fragments and remains to a constant, which is characteristic as for the given meteorite, and, perhaps, as for ordinary chondrites as a whole. It is necessary to notice that shape parameters of fragments of each type of terrestrial rock under certain conditions of destruction (for example, explosive) are a constant and stable indicator [8]. Analogue of ordinary chondrites among terrestrial rocks is polymetallic ore (a:b:c=1.7:1.3:1) [8], which with Tsarev meteorite besides shape parameters unites only a similar fine-grained homogeneous structure without expressed layering.

Iron meteorites: Shape parameters of iron meteorites have been measured for 824 individual fragments of Sikhote-Alin meteoric rain in mass from 5 to 500 g [9]. Average relations of the main axes of fragments of Sikhote Alin iron meteorite is of b/a=0.66, c/a=0.43, or a:b:c=3:1.5:1. The average shape parameters of fragments of an iron meteorite Chinge measured for 146 fragments in mass from 80 g to 20 kg is b/a=0.67, c/a=0.33, or a:b:c=2.4:2.0:1 [9].

Table 1. Fragments of meteorite Tsarev [1-4]

#	Sample	Size, cm			Mass, g	Dens., g cm^{-3}
		a	*b*	*c*		
1	15380	44	33	29	52800	
2	15381	46	29	29	58500	
3	15382	51	35	32	72900	
4	15383	46	31	26	67800	
5	15384	28	28	23	24800	3.51
6	15385	37	26	23	26600	
7	15386	33	28	25	41800	
8	15387	45	41	29	80400	
9	15388	75	63	29	283800	
10	15389	36	30	26	40000	
11	15390	50	38	31	104200	
12	15391	31	25	21	25100	3.28
13	15392	31	22	21	18700	
14	15393	28	28	20	24500	
15	15394	40	27	26	50000	
16	15395	25	12	8	2200	
17	15396	32	22	17	14811	3.40
18	15397	16	11	9	2205	3.32
19	15398	26	17	9	8622	3.44
20	15399	14	10	8	1900	
21	15400	35	27	25	46000	
22	15401	27	20	13	12687	3.26
23	15402	18	16	10	7652	3.50
24	15403	28	22	18	17803	3.48
25	15404	26	20	14	13747	3.48
26	15405	10	9	4	760	3.33
27	15487	34,4	28,0	12,5	18300	3.48
28	15488	25,5	25,0	15,2	13100	3.50
29	15489	36,7	25,1	14,5	19300	3.51
30	15490	31,0	29,0	19,5	28600	3.50
31	15491	21,4	12,8	11,4	5690	3.33
32	15492	21,3	13,0	12,0	5400	3.23
33	15493	19,8	16,2	10,8	4410	3.49
34	15494	24,6	17,3	15,9	7950	3.35
35	15495	16,4	12,3	9,5	2920	3.27
36	15496	11,4	7,3	6,6	877	3.55
37	15497	10,5	9,4	7,5	832	3.49
38	15498	23,9	14,7	11,0	6270	3.53
39	15499	3,6	2,8	2,8	50	3.41
40	15500	23,4	18,4	16,6	9750	3.49
41	15501	7,3	5,6	4,5	251	3.38
42	15502	10,5	6,5	5,8	631	3.37
43	15503	6,3	5,1	4,2	251	3.40
44	15504	6,5	5,8	5,1	346	3.30
45	15557	44,1	17,7	10,8	13540	3.26
46	15558	23,4	29,6	13,2	8877	3.40
47	15559	20,1	19,3	9,9	4985	3.52
48	15560	24,2	16,9	14,3	9059	3.34
49	15561	16,3	12,1	9,6	2520	3.34
50	15562	12,8	11,8	8,3	1894	3.38
51	15563	12,9	10,5	7,8	1681	3.54
52	15564	12,6	8,4	7,9	1235	3.38
53	15565	6,8	6,0	4,5	275	3.22
54	15566	4,8	3,9	2,3	79	3.29
55	15567	10,0	7,5	7,5	983	3.45
56	15568	16,8	11,4	9,7	2610	3.54
57	15569	13,6	11,2	8,3	1980	3.43
58	15570	10,5	7,0	6,7	815	3.52
59	15571	16,3	10,3	8,3	2522	3.52
60	15572	36,9	26,0	14,3	19080	3.39
61	15573	14,3	10,0	9,6	2388	3.52
62	15574	23,0	16,3	15,5	9102	3.51
63	15575	26,6	21,2	15,8	14680	3.32
64	15576	13,1	11,2	6,1	1538	3.51
65	15602	2,4	1,9	1,2	10	3.38
66	15603	4,0	2,6	1,2	15	3.20
67	15604	1,5	1,0	0,8	2	-
68	15605	2,6	1,9	1,1	11	3.23
69	15606	5,7	4,5	2,8	107	3.27

Shape distribution of fragments of the basalt target, obtained from laboratory impact experiments, is characterised by the well defined shape distribution of 2:√2:1, or b/a=0.73, c/a=0.50 [10]. Basalt fragments fall between ordinary chondrites and iron meteorites (Fig. 1). Fragments of iron meteorites of Chinge and Sikhote Alin differ from ordinary chondrites and basalt fragments and are longer and flat in shape (Fig. 1). But fragments of Chinge meteorite at the same relative width are characterized by less thickness, i.e. they are more flat. Fragments of Tsarev meteorite are shorter and characterized by shape close to prolate ellipsoid (Fig. 1). There are no shape distribution analogues of iron meteorites among terrestrial rocks and ores [8].

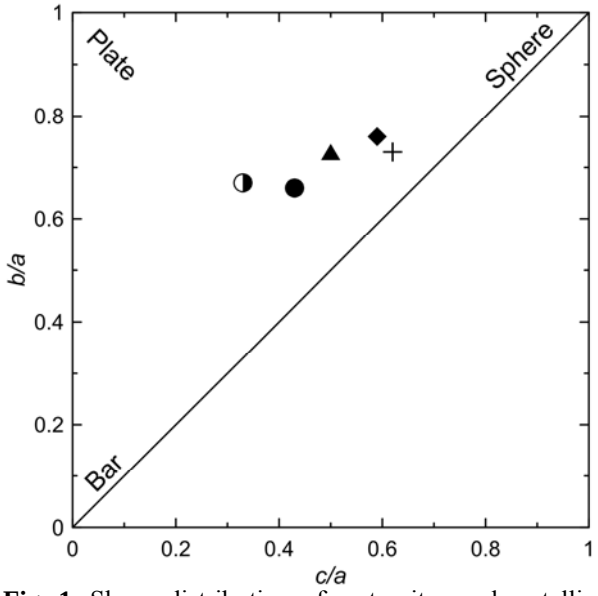

Fig. 1. Shape distribution of meteorites and metallic asteroids: ◆ - ordinary chondrites (Tsarev); ● - iron meteorite (Sikhote-Alin); ◑ - iron meteorite (Chinge); ▲ - basalt fragments [10]; ✚ - metallic asteroids.

Metallic asteroids: Metallic asteroids belong to M-class [11]. Radar wavelength observations can determine whether an asteroid is metallic and provide information about the porosity and regolith depth. From 19 investigated asteroids of M and X-type only 7 objects (16 Psyche, 129 Antigone, 216 Kleopatra, 347 Pariana, 758 Mancunia, 779 Nina and 785 Zwetana) have high radar albedo, which average value is equal of 0.41±0.13 [12]. 69 Gesperija (Hesperia) has metallic structure and high radar albedo (0.45±0.12) too [13]. On the basis of comparative analysis with spectra of meteorites from library of spectra RELAB it was revealed that spectra of asteroids of 55 Pandora and 872 Holda coincide with spectra of iron meteorites [14]. Unfortunately there are no radar data on these two asteroids. So, 10 asteroids of M-type have metal structure. Only for 7 asteroids from 10 considered above shape parameters are known (Table. 2). The average shape parameters of metallic asteroids is of b/a=0.73, c/a=0.62, or a:b:c=1.7:1.2:1.

Table 2. Shape of metallic asteroids

Asteroid	Diameter, km	Ef. diam., km	b/a	c/a	Ref.
16 Psyche	240×185×145	186±30	0.77	0.60	[16]
55 Pandora	-	66.7	0.83	0.69	[17]
69 Hesperia	135×106×95	110	0.79	0.70	[13]
129 Antigone	152×109×95	113±17	0.72	0.63	[16]
216 Kleopatra	217×94×81	67.5±2.9	0.43	0.37	[18]
347 Pariana	-	51±5	0.74	0.57	[16]
785 Zwetana	57×46×45	49	0.80	0.79	[16]

Unlike meteorites, formation of a metal asteroid's shape was influenced actively by collisional evolution (meteoritic bombardment). But even taking into account this factor shape of metal asteroids too strongly differs from shape of fragments of iron meteorites formed as a result of destruction of a parental body (meteoroid). They are just another. Such distinction may be caused by different mechanics of formation of these bodies' shape. Unlike fragments of iron meteorites metal asteroids, apparently, are not fragments of larger metal parental bodies. Probably, they are remnants of planetesimals [15].

Summary: Shape parameters of ordinary chondrite fragments does not depend on size of fragments and remains to a constant. Shape of iron meteorites differ from ordinary chondrites and from basalt fragments and are longer and flat. There are no shape distribution analogues of iron meteorites among terrestrial rocks and ores. The shape of metal asteroids strongly differs from the shape of fragments of iron meteorites. Such distinction may be caused by different mechanics of formation of these bodies' shape. Unlike fragments of iron meteorites metal asteroids, apparently, are not fragments of larger metal parental bodies.

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