Table A. Bulk chemical composition (wt%) of the cosmic spherules analyzed for oxygen isotope studies.

Type	#	Sample name	Size (μm)	Na_2O	SiO_2	MgO	Al_2O_3	CaO	TiO_2	Cr_2O_3	MnO	FeO	NiO	Total
Scoriaceous	1	SP007-P70	205	0.2	35.9	33.1	0.2	0.6	–	0.3	0.3	27.3	0.2	98.0
	2	SP007-P86	210	–	33.3	31.4	0.4	2.7	–	0.2	0.3	26.4	0.1	94.9
	3	SP007-P88	115	0.1	26.9	16.4	3.0	0.7	0.1	0.2	0.3	46.8	0.1	94.5
	4	SP007-P162	102	0.4	35.3	19.2	2.9	3.5	0.4	0.6	0.6	33.1	0.2	96.3
	5	SP007-P171	135	0.6	39.4	31.6	3.7	0.6	0.1	0.4	0.3	19.2	0.3	96.2
	6	SP007-P197	120	–	20.5	16.4	12.9	0.3	0.3	1.9	0.1	44.2	0.1	96.7
	7	AAS-38-167-1-P122	240	0.1	41.6	34.8	2.6	1.3	0.1	0.5	0.2	18.7	0.7	100.7
	8	SP005-P147	195	0.1	36.1	25.3	2.1	1.5	–	0.4	0.1	31.4	0.2	97.2
	9	SP005-P520	121	0.8	38.1	25.7	4.1	0.2	–	0.2	0.3	25.5	0.3	95.1
	10	SP005-P665	92	0.1	27.9	15.3	3.8	0.3	–	0.5	0.3	43.2	1.1	92.4
	11	MS-I35-P2	175	0.5	43.1	21.5	3.2	1.6	0.1	0.4	0.1	25.6	–	96.1
	12	MS-I35-P52	142	0.1	31.7	29.2	0.9	0.4	0.1	0.4	0.3	34.4	0.3	97.8
	13	MS-I3-P7	289	–	36.9	31.8	1.2	0.5	0.1	0.4	0.2	29.0	0.6	100.9
Porphyritic	1	AAS-38-167-1-P17	240	–	39.8	48.0	0.1	0.1	–	0.2	0.2	10.9	0.1	99.4
	2	MS-I3-P58	181	–	39.8	40.2	0.4	–	–	0.4	0.2	19.2	–	100.3
	3	MS-I3-P34	211	0.3	40.4	23.0	3.0	2.2	0.1	0.2	0.4	30.7	0.6	101.0
	4	MS-I3-P11	268	0.3	50.2	26.7	2.7	1.5	0.1	0.3	0.4	16.5	0.1	98.7
	5	MS-I3-P38	245	–	41.8	31.4	2.1	1.1	0.1	0.6	0.2	23.3	0.1	100.8
	6*	SP005-P1078	98	–	42.9	25.8	2.9	2.2	–	0.4	0.3	21.6	0.1	96.4
	7	SP007-P20	90	–	32.8	25.0	1.9	4.1	–	0.1	0.3	32.1	0.1	96.4
	8	SP007-P25	85	–	33.8	19.2	0.9	0.7	0.2	0.1	0.4	42.7	0.1	98.0
	9	SP005-P233	153	0.2	44.0	33.8	1.9	1.0	–	0.6	0.3	14.8	0.0	96.6
	10	SP007-P10	158	0.0	30.4	24.6	3.3	0.1	0.2	0.6	0.4	39.1	0.2	98.9
	11	SP007-P68	66	–	40.9	55.0	0.0	0.3	0.1	0.5	0.1	1.4	0.1	98.4
Barred	1	MS-I3-P5	234	–	39.0	26.3	2.2	2.0	0.1	0.1	0.2	28.2	1.0	99.1
	2	MS-I3-P8	324	–	42.6	35.3	2.0	1.5	0.1	0.3	0.2	17.8	0.3	100.2

	3	MS-I3-P9	222	0.1	32.9	20.8	7.6	2.2	0.3	0.3	0.2	34.5	0.5	99.4
	4	AAS-38-167-1-P1	426	–	39.6	28.8	3.6	2.4	0.2	0.1	0.2	24.9	–	99.8
	5	AAS-38-167-1-P11	484	–	39.1	29.4	2.3	2.8	–	0.2	0.2	23.4	1.0	98.3
	6	AAS-38-167-1-P49	288	–	38.4	28.3	3.0	1.8	0.1	0.3	0.3	26.1	–	98.4
	7	AAS-38-167-1-P48	363	–	40.7	27.5	3.5	2.5	0.2	0.1	0.2	25.1	0.2	99.9
	8	AAS-38-167-1-P118	264	–	41.3	29.5	2.8	1.8	0.1	0.5	0.3	24.5	0.1	100.8
	9	AAS-38-167-1-P128	270	–	38.0	28.1	2.8	1.2	0.1	0.5	0.3	29.6	0.3	100.8
	10	AAS-62-61-P9	386	–	39.8	29.3	3.5	2.6	0.1	0.1	0.2	25.3	–	101.0
	11*	MS-I3-P21	243	–	40.6	38.2	0.8	0.7	–	0.4	0.3	20.5	–	101.4
	12	MS-I3-P33	189	–	38.0	28.5	0.9	1.4	0.1	0.4	0.1	32.9	0.4	102.5
	13	MS-I3-P39	255	–	42.9	21.7	7.8	3.1	0.3	0.3	0.8	24.0	–	100.8
	14	MS-I3-P42	257	–	38.1	24.3	2.3	1.0	0.1	0.4	0.4	34.8	0.1	101.4
	15	MS-I3-P60	175	–	39.6	37.1	0.4	0.3	–	0.4	0.2	20.4	1.7	100.1
	16*	SP007-P4	75	–	37.3	27.9	3.9	3.5	0.2	0.3	0.2	24.2	–	97.6
	17*	SP007-P20a	115	–	41.8	33.7	2.8	2.3	0.1	0.4	0.7	14.7	0.5	97.0
	18*	SP007-P269	132	–	43.8	20.4	1.8	2.0	0.1	0.3	0.4	28.8	–	97.6
Cryptocrystalline	1	MS-I3-P6	262	–	33.6	21.0	3.0	1.7	0.1	0.4	0.3	39.8	1.3	101.3
	2	AAS-38-167-1-P16	277	–	38.2	25.9	3.6	2.1	0.1	0.1	0.3	29.0	0.4	99.6
	3	AAS-38-167-1-P93	287	–	39.7	28.0	3.1	2.5	0.2	0.0	0.2	26.8	–	100.5
	4	SP005-P244	158	–	37.5	30.9	1.2	0.3	–	0.4	0.3	24.4	3.3	98.2
	5	SP005-P182	67	–	31.7	21.2	2.8	1.6	–	0.6	0.2	38.2	1.2	97.5
	6	SP005-P550	146	–	40.3	25.9	2.8	2.5	–	0.4	0.4	25.2	–	97.5
	7	SP005-P666	88	–	40.4	21.5	3.9	1.8	–	0.3	0.2	29.0	1.0	98.0
	8	SP005-P682	77	–	42.1	29.2	2.3	1.9	–	0.4	0.5	21.1	0.6	98.1
	9	MS-I3-P10	310	–	39.1	33.6	1.2	0.1	–	0.1	0.3	26.3	0.1	100.9
	10	MS-I3-P20	188	–	43.9	26.8	3.4	2.3	0.2	0.2	0.4	23.7	0.1	100.8
	11	MS-I3-P22	183	–	34.9	23.2	2.8	1.5	0.1	0.5	0.3	35.3	1.4	99.9
	12	MS-I3-P35	204	–	39.3	34.6	2.1	1.0	0.1	0.3	0.2	21.5	1.4	100.4
	13	MS-I3-P40	299	–	42.6	30.4	3.3	1.8	0.1	0.3	0.4	22.8	–	101.6

	14	MS-I3-P44	291	–	40.4	27.6	2.8	2.3	0.1	0.2	0.3	26.6	0.5	100.8
	15	MS-I3-P53	168	–	32.8	24.7	3.6	1.4	–	0.5	0.3	37.2	0.1	100.6
	16	MS-I3-P56	206	–	41.1	25.8	4.8	4.1	0.2	0.1	0.3	24.2	0.7	101.3
	17	MS-I3-P57	169	–	37.2	26.4	2.0	1.6	0.1	0.4	0.3	30.8	1.6	100.3
	18	MS-I35-P23	241	–	39.7	29.5	2.7	2.2	0.2	0.3	0.3	22.9	0.2	97.9
	19	MS-I35-P21	235	–	37.6	25.4	2.5	1.7	0.1	0.6	0.3	30.4	0.2	98.9
	20	SP005-P1077	139	–	36.2	22.2	4.0	1.0	–	0.5	0.3	33.0	0.1	97.3
	21	SP007-P155	70	–	43.0	31.1	3.1	1.8	0.1	0.1	0.3	15.7	0.2	95.5
	22*	SP005-P1176	87	–	40.5	24.9	3.0	2.2	0.1	0.4	0.4	25.1	–	96.5
Glass	1	AAS-38-167-1-P126	191	–	47.0	25.6	1.1	1.2	0.1	0.0	0.2	25.3	0.1	100.7
	2	AAS-62-61-P37	357	–	41.6	30.8	3.1	2.3	–	0.0	0.3	20.7	0.5	99.6
	3	AAS-62-61-P62	233	–	42.3	30.4	3.1	1.3	0.2	0.1	0.3	21.6	0.1	99.3
	4	MS-I3-P27	199	–	39.6	28.2	3.9	2.6	0.1	0.0	0.2	26.6	–	101.1
	5	MS-I3-P28	171	–	42.1	23.7	2.4	4.4	0.1	0.1	0.2	28.0	0.4	101.4
	6†	MS-I3-P55	198	–	51.3	36.3	1.2	0.7	0.1	0.1	0.2	9.7	0.1	99.7
	7†	MS-I35-P22	203	–	49.7	26.8	3.1	1.2	0.1	0.6	0.3	16.6	0.1	98.6
	8	SP005-P1208	78	–	48.6	30.7	2.0	1.9	–	0.2	0.5	14.6	0.2	98.7
	9	SP005-P1210	86	–	45.1	29.6	3.8	3.0	–	0.2	0.3	14.3	0.1	96.4
	10	SP005-P1177	69	–	57.5	30.2	1.9	0.8	–	0.0	0.4	9.3	–	100.0
	11	SP005-P1182	65	–	50.5	34.8	2.6	2.1	–	0.1	0.1	5.9	–	96.1
	12	SP005-P1160	109	–	43.9	25.6	1.9	1.4	–	0.1	0.4	20.9	1.2	95.3
	13	SP005-P1138	55	–	42.3	29.3	3.4	1.6	0.1	–	0.3	20.7	0.1	97.8
	14	SP005-P77	83	–	40.4	34.0	3.4	2.8	–	–	0.1	16.6	–	97.3
	15	SP005-P86	124	–	51.5	33.7	1.4	1.1	–	0.6	0.3	10.3	0.1	99.1
	16	SP005-P14	119	–	44.6	18.1	1.2	1.1	–	0.5	0.4	32.6	–	98.5
	17	SP005-P158	159	0.1	48.2	26.3	3.1	4.8	–	0.1	0.3	15.6	–	98.5
	18	SP005-P618	146	–	49.9	35.0	1.0	0.8	–	–	0.8	10.9	0.1	98.4
	19	SP005-P577	136	–	47.6	30.3	6.9	5.7	–	–	0.2	8.3	–	98.9
	20	SP007-P3	95	–	42.5	46.5	4.9	3.5	0.2	–	0.0	0.2	–	97.8

	21	SP007-P44	80	–	45.3	34.9	1.8	1.9	0.1	–	0.5	11.8	0.2	96.4
	22	SP007-P69	127	–	44.3	39.4	5.2	4.0	0.2	–	0.2	3.7	0.3	97.3
	23	SP007-P76	52	–	38.4	29.6	3.4	2.6	–	–	0.3	21.3	0.4	96.0
	24	SP007-P100	156	–	40.1	36.3	4.9	5.9	0.2	–	0.1	9.7	0.1	97.3
	25	SP007-P138	96	–	45.7	31.4	2.6	2.0	0.2	0.4	0.6	12.9	0.2	95.9
	26*	MS-I3-P59	221	0.1	51.7	24.7	2.6	1.3	0.1	0.5	0.4	18.2	0.1	99.7
	27*	SP005-P1174	123	–	43.3	28.9	2.9	2.1	–	0.5	0.6	21.0	0.1	99.3
	28*	SP005-P10	165	–	41.7	28.2	3.1	7.0	–	0.4	0.2	18.3	–	98.9
	29*	SP005-P17	88	–	44.8	29.2	2.8	2.0	–	0.5	0.3	17.6	0.1	97.3
	30*	SP005-P34	124	–	40.4	24.5	3.7	2.6	–	0.5	0.3	26.7	0.0	98.7
	31*	SP005-P349	136	–	41.3	30.7	4.7	3.8	–	0.0	0.1	16.1	0.2	97.1
	32*	SP005-P1071	97	–	42.2	22.3	2.9	2.9	–	0.3	0.2	27.7	–	98.5
	33*	SP005-P293	102	–	47.4	32.9	2.1	2.0	0.1	0.3	0.2	12.8	0.1	97.9
	34*	SP005-P294	128	–	40.9	27.6	2.3	0.6	–	0.5	0.3	24.5	–	96.7
	35*	SP005-P296	144	0.1	43.1	33.3	3.1	2.5	–	–	0.3	15.7	0.1	98.1
	36*	SP005-P157	187	–	41.1	22.4	2.6	1.0	–	0.7	0.2	30.0	0.1	98.1
	37*	MS-I35-P39	132	0.4	43.8	20.3	3.9	4.8	0.2	0.2	0.3	22.8	0.1	96.7
CAT	1	SP007-P28	72	–	37.1	43.4	8.7	7.5	0.4	–	–	0.1	–	97.1
	2	SP007-P236	74	0.1	38.5	42.6	9.3	8.3	0.4	–	0.1	–	–	99.3
	3†	SP007-P255	102	–	37.7	48.2	5.9	4.9	0.3	–	–	–	–	97.0
I-type	1	AAS-38-167-1-P32	263 (5)	–	–	–	–	–	–	–	–	87.8	8.0	95.8
	2	AAS-38-167-1-P81	266 (10)	–	–	–	–	–	–	0.1	–	92.5	4.7	97.3
	3	AAS-38-167-1-P92	268 (6)	–	–	–	–	–	–	0.1	–	91.4	6.3	97.8
	4	AAS-38-167-1-P115	185 (9)	–	–	–	–	–	–	–	–	92.8	3.7	96.5
	5	AAS-38-167-1-P116	206 (11)	–	–	–	–	–	–	0.2	–	94.3	3.3	97.8
	6	AAS-38-167-1-P121	242 (10)	–	–	–	–	–	–	0.5	–	93.0	4.2	97.7
	7	AAS-62-61-P14	295 (4)	–	–	–	–	–	–	0.1	–	99.0	2.2	101.3
	8	AAS-62-61-P17	258 (8)	–	–	–	–	–	–	0.1	–	95.5	3.1	98.6
	9	AAS-62-61-P44	265 (6)	–	–	–	–	–	–	0.1	–	93.9	3.9	97.9

	10	AAS-62-61-P72	224 (5)	–	–	–	–	–	–	0.4	–	95.3	3.7	99.4
	11	AAS-62-61-P74	261 (6)	–	–	–	–	–	–	0.5	–	92.9	4.2	97.6
	12†	AAS-62-61-P87	186 (3)	–	–	–	–	–	–	–	–	96.6	4.7	101.3
	13	AAS-62-61-P89	255 (2)	–	–	–	–	–	–	0.1	–	95.0	4.3	99.4
	14	AAS-62-61-P90	265 (3)	–	–	–	–	–	–	0.1	–	96.2	4.5	100.8
	15	AAS-62-61-P105	213 (6)	–	–	–	–	–	–	–	–	91.6	5.5	97.1
G-type	1	AAS-38-167-1-P33	208	–	18.2	–	2.2	1.3	0.1	–	2.1	70.2	0.2	94.3
	2	AAS-38-167-1-P103	210	–	1.6	0.0	0.5	0.0	0.6	0.1	1.0	91.4	0.1	95.3
	3	SP005-P148	119	–	39.3	35.3	1.1	0.9	–	0.4	1.1	19.3	0.4	97.9
	4	SP005-P515	105	0.1	38.7	35.9	0.5	0.9	–	0.2	0.4	23.9	0.3	100.9
	5	SP005-P516	121	–	33.6	19.9	2.7	1.3	–	0.3	0.3	39.2	0.8	98.0
	6	SP005-P523	133	–	30.0	23.0	2.8	1.3	–	0.2	0.2	40.8	0.9	99.1
	7	SP005-P646	90	–	5.1	2.6	0.4	0.4	–	0.2	0.0	87.6	0.2	96.4
	8	SP005-P650	95	0.1	38.2	27.3	3.8	2.9	–	0.2	0.3	24.7	1.5	99.1
	9	MS-I35-P42	164	–	36.0	23.8	0.8	0.5	0.1	0.1	0.1	32.4	3.5	97.4
	10	MS-I35-P50	164	–	33.8	22.7	2.8	2.4	0.1	0.2	0.2	35.3	1.1	98.6
	11	MS-I35-P66	151	0.1	35.0	29.4	2.3	1.9	0.1	0.2	0.1	26.9	2.1	98.0
	12	MS-I35-P93	158	0.1	37.9	33.7	2.0	3.3	0.1	0.3	0.2	21.0	0.4	99.0
	13	MS-I35-P117	179	–	39.9	24.8	2.9	2.7	0.2	0.2	0.3	28.2	0.6	99.7
	14	MS-I35-P126	144	–	34.6	22.2	2.9	1.6	0.1	0.3	0.3	37.1	0.5	99.7
	15	SP005-P777	146	–	17.9	10.2	1.3	0.7	–	0.1	0.0	68.2	0.1	98.4
	16	SP005-P150	209	–	28.6	20.6	2.4	1.4	–	0.3	0.2	43.3	1.3	98.0
	17	SP005-P1137	65	–	27.7	16.6	6.6	2.4	0.1	0.1	0.1	41.3	0.0	94.8
	18*	SP005-P207	65	–	6.8	3.3	0.6	0.5	0.0	0.9	0.1	81.7	0.0	93.8

The number in parentessi of I-type particles is the thickness of magnetite rim in μm.

"*" indicates particles with metal bead.

"†" indicate that metal bead has escaped from the spherule.

Table B. Elemental composition (wt%) of the bead from cosmic spherules analyzed for oxygen isotopes studies.

Type	#	Sample name	S	Fe	Co	Ni	Total
Porphyritic	1	SP005-P1078	17.4	79.0	0.2	6.2	102.8
Barred	1	SP007-P4	–	76.2	0.5	23.4	100.1
	2	SP007-P20a	–	69.9	1.2	30.3	101.4
	3	SP007-P269	–	73.1	0.9	26.9	100.8
	4	MS-I35-P21	–	78.5	0.9	18.8	99.8
Cryptocrystalline	1	SP005-P1176	5.2	11.9	2.1	64.2	83.9
Glass	1†	MS-I3-P55	–	–	–	–	–
	2†	MS-I35-P22	–	–	–	–	–
	3	MS-I3-P59	–	93.3	0.5	5.5	99.2
	4	SP005-P1174	–	71.0	0.9	26.6	98.5
	5	SP005-P10	–	86.9	0.5	13.9	101.3
	6	SP005-P17	–	89.7	0.3	7.5	97.7
	7	SP005-P34	5.8	66.7	1.1	27.1	100.7
	8	SP005-P349	–	66.7	0.6	30.0	97.2
	9	SP005-P1071	15.0	44.7	1.3	38.0	98.9
	10	SP005-P293	–	73.4	0.8	18.8	93.1
	11	SP005-P294	4.4	59.7	1.2	24.4	89.7
	12	SP005-P296	0.9	78.0	0.7	16.2	95.9
	13	SP005-P157	33.2	42.9	0.6	21.8	98.5
	14	MS-I35-P39	–	36.2	0.1	64.3	100.6
CAT	1†	SP007-P255	–	–	–	–	–
I-type	1†	AAS-62-61-P87	–	–	–	–	–
G-type	1	SP005-P207	0.0	86.6	0.4	10.2	97.3

"†" indicate that metal bead has escaped from the spherule.