Supplementary Material for:

PALEOMAGNETISM OF THE VOROGOVKA GROUP (YENISEI RIDGE): TOWARDS THE SUBSTANTIATION OF THE VENDIAN GEOMAGNETIC PHENOMENON

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This file contains:

Table S1. Paleomagnetic directions and coordinates of the corresponding virtual geomagnetic poles in the studied rocks for the VSC component.
Table S2. Selected Vendian–Early Cambrian paleomagnetic poles from the Siberian platform and its framing structures.
Table S3. Chemical composition of magnetic particles from limestones of the Severnaya Rechka Formation.
Table S4. Chemical composition of magnetic particles from limestones of the Mutnina Formation.
Table S5. Chemical composition of magnetic particles from limestones of the Sukhaya Rechka Formation.

Figure S1. The fold test results illustrated by stereoplots in situ and tilt corrected correspondingly and tectonic correction graph for VSC component. «Modern field» is the direction of the modern geomagnetic field at the sampling site according to IGRF 13-th model [Alken et al., 2021].
Figure S2. SEM images of magnetic particles from limestones of the Severnaya Rechka Formation and areas of compositional study (see Table S3).
Figure S3. SEM images of magnetic particles from limestones of the Mutnina Formation and areas of compositional study (see Table S4).
Figure S4. SEM images of magnetic particles from limestones of the Sukhaya Rechka Formation and areas of compositional study (see Table S5).

Table S1. Paleomagnetic directions and coordinates of the corresponding virtual geomagnetic poles in the studied rocks for the VSC component.

Sample site, rock	S_{lat} (N)	S_{long} (E)	n(S)/N	In situ		Tilt corrected		K	α_{95}	Plat	Plong	A_{95}
				D (°)	I (°)	D (°)	I (°)					
Severnaya Rechka Formation												
14ek08, sandstone	60.958	89.911	10/10	**122.1**	**78.7**	144.3	55	25.3	9.8			
14ek09, sandstone	60.958	89.911	8/11	**159.3**	**80.4**	163.3	55.5	31.6	10			
14ek10, sandstone	60.954	89.917	11/11	**21.4**	**77.4**	124.9	53.3	32	8.2			
14ek11, sandstone	60.954	89.917	10/10	**344.7**	**84.8**	3.1	-14.9	38.3	7.9			
14ek12, sandstone	60.954	89.917	14/15	**36.7**	**79.1**	17.3	48	20	9.1			
14ek13, limestone	60.900	89.941	10/12	**214.8**	**65.1**	202.7	41.5	27.4	9.4			
14ek14, limestone	60.902	89.942	11/11	**121.2**	**83.6**	168.9	66.3	21	10.2			
Mutnina Formation												
14ek07, sandstone	60.862	89.927	9/10	**311.3**	**82.1**	222.1	38.9	27.5	10			
14ek15, sandstone	60.896	89.921	10/11	**155.6**	**81.1**	199.4	64.7	47.2	7.1			
14ek16, sandstone	60.893	89.919	8/10	**223.7**	**66.5**	225.5	46.5	63.6	7			
14ek17, sandstone	60.898	89.925	12/13	**242.8**	**81.9**	206.9	53.9	21.8	9.5			
14ek19, limestone	60.877	89.928	10/11	**182.1**	**79.9**	176.2	70	51.4	6.8			
14ek20, sandstone	60.877	89.928	11/11	**182.6**	**57.9**	180.6	48	27.3	8.9			
14ek21, sandstone	60.868	89.921	9/11	**72**	**68.1**	17.8	52.6	52.1	7.2			
14ek27, sandstone	60.808	89.931	7/10	**249.7**	**46**	244.6	22.1	19.3	14.1			
Sukhaya Rechka Formation												
14ek05, limestone	60.846	89.928	8/10	**260.8**	**64.2**	268.3	22.7	29.9	10.3			
14ek06, limestone	60.847	89.928	8/10	**272.9**	**66.5**	278.1	21.7	82.1	6.2			
14ek22, sandstone	60.811	89.873	10/10	**272.1**	**84.7**	252.1	20.1	56.2	6.5			
14ek23, sandstone	60.811	89.873	9/10	**358.9**	**79.2**	266.9	27.1	40.4	8.2			
14ek24, sandstone	60.811	89.873	9/10	**195.4**	**77**	238.6	22	19.7	11.9			
MEAN for VSC (60.9° 89.9°)			(20)	**224.4**	**83.5**	**-**	**-**	**20.6**	**7.4**	**50.8**	**75.7**	**A_{95}=14.4**
			(20)	-	-	231.3	60.5	3.3	21.5	-	-	-
modern field (2014) in the work area				**8.3**	**78.8**				Model Used: IGRF2020 [Alken et al., 2021]			

Note: n(S)/N – number of individual vectors (sampling sites) used in statistics to the total number of studied samples; D – declination; I – inclination; K, α_{95} – Fisher statistic parameters: precision and 95% confidence circle radius; Plat, Plong – latitude (N degrees) and longitude (E degrees) of the mean paleomagnetic pole, A_{95} – radius of the 95% confidence ellipse for the pole.

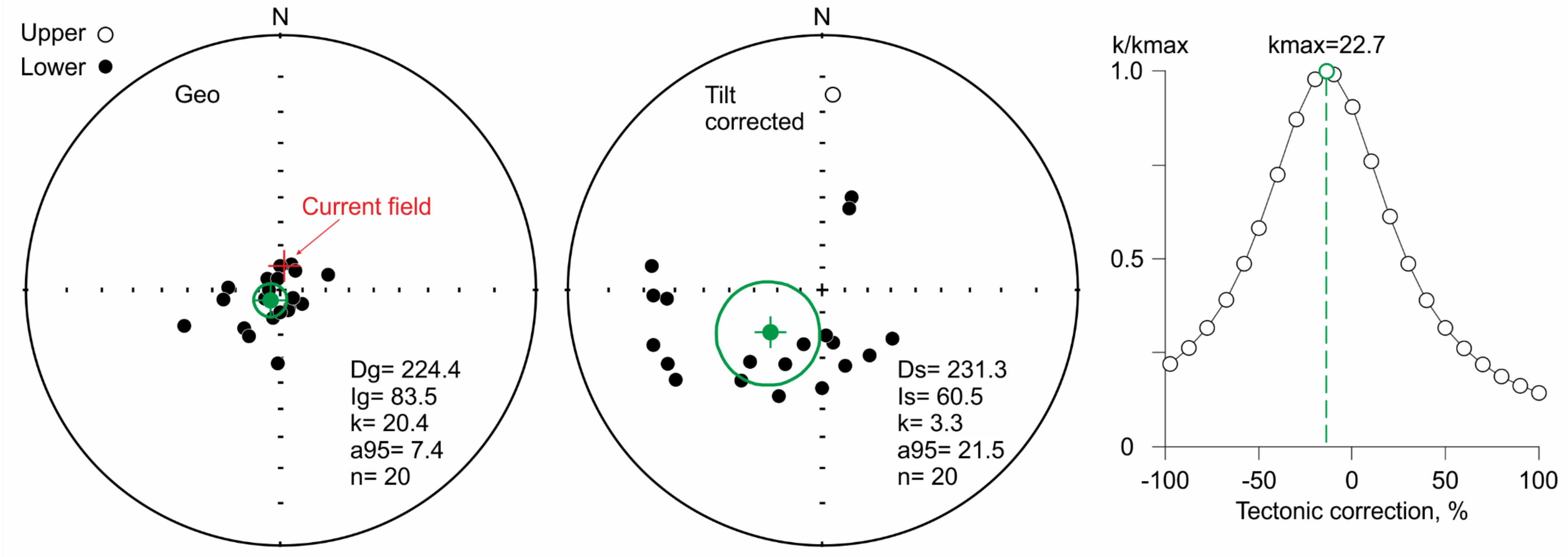

Figure S1. The fold test results illustrated by stereoplots in situ and tilt corrected correspondingly and tectonic correction graph for VSC component. «Modern field» is the direction of the modern geomagnetic field at the sampling site according to IGRF 13-th model [Alken et al., 2021].

Table S2. Selected Vendian–Early Cambrian paleomagnetic poles from the Siberian platform and its framing structures. The poles of the KHR are highlighted in green, the poles of the KRS are highlighted in pink, and the metachronic poles coinciding with the KHR are highlighted in blue.

№	Formation	Place	Age	Slat	Slong	N/n	Dec	Inc	a95	Plat	Plong	A_{95} (dp/dm)	Authors, year
1	Sukharikha Formation Old Result	Sukharikha River, Igarka Uplift	540–530	67	87	-	272	36	10	-19	170	(7/12)	Goncharov in [Khramov, Sholpo, 1967]
2	Kostinskaya Formation Old Result	Nizhnyaya Tunguska River, Turukhansk Uplift	530–520	66	89	-	281	-47	6	21	157	(5/8)	Goncharov in [Khramov, Sholpo, 1967]
3	Chara Formation Old Result	Olekma River	530–520	60.5	134	-	299	18	8	-25	206	(3/6)	Osipova in [Khramov, Sholpo, 1967]
4	Podkrasnotsvetnaya Formation Old Result	Lena River	525–513	60.5	120.5	17/34	345	-58	8	10	133	(8.7/11.8)	Osipova, 1971
5	Charsk Formation Old Result	Olyokma River	525–513	60.5	121	11/22	135	-59	11	-54	195	(12.3/16.4)	Osipova, 1971
6	Podkrasnotsvetnaya and Charsk formations Old Result	Lena and Olyokma rivers	525–513	60.5	120.8	28/56	153	14	13	-19	150	(6.8/13.3)	Khramov, 1984
7	Ust-Tagul Formation Old Result	Tagul and Biryusa rivers, Biryusa Uplift	600–542	55.5	97.5	/87	330	32	3	-44	140	(1.9/3.4)	Davydov, Kravchinsky, 1971
8	Pestrotsvet Formation Old Result	Maya and Yudoma rivers, Aldan	545–525	59.5	135	2/19	328	39	8	-46	181	(5.7/9.5)	Osipova, 1975
9	Karagas Group Old Result	Tagul and Ilmiga rivers, Biryusa Uplift	1600–700	54.5	98.5	/23	141	9	6	-22	141	(3.1/6.1)	Davydov, Kravchinsky, 1971
10	Emyaksa Formation Old Result	Olenek River	535–515	68.5	112.5	4/20	147	-40	9	-39	153	(6.5/10.8)	Osipova, 1975
11	Ust-Tagul Formation Old Result	Tagul River, Biryusa Uplift	600–542	55.3	97.5	1/66	353	39	3	-56	110	(2/4)	Gurevich, 1982
12	Motskaya and Ushakovka formations Old Result	Revunya and Udzha rivers, Baikal Region	600–542	56.5	108	2/51	305	28	7	-32	176	(4/8)	Gurevich, 1981
13	Motskaya (Nizhneusatovskaya) Formation Old Result	Chaya River, Baikal region	600–542	58	110	1/46	192	-28	9	-46	92	(5/10)	Gurevich, 1982
14	Yudoma Group Old Result	Belaya River	670–600	62	137	1/9	238	23	9	-3	81	(5/10)	Komissarova, 1982
15	Ushakovka Formation Old Result	Sarma River, Akshaya Creek	600–542	53	107	48/84	60	-36	8	-1	53	(5/9)	Komissarova, Pisarevsky, 1982
16	Ushakovka Formation Old Result	Lena River, Badanzhinsky Creek	600–542	54	108	4/112	136	-25	5	-36	165	(3/6)	Komissarova, Pisarevsky, 1982
17	The composite pole of the Lower Cambrian of Siberia		545–520			3/				-44	157	8	Khramov et al., 1982
18	Turkut and Khatyspyt formations Old Result	Khorbosuonka River, Olenek Uplift	550–530	71	124	10/10	223	-9	13	-18	79	(6.6/13.1)	Gurevich, 1986
19	Tomtor Formation Old Result	Tomtor River, Biliro-Udzha Uplift	600–545	71.5	116	8/8	349	15	9	-26	127	(4.7/9.2)	Rodionov, 1984
20	Pestrotsvet and Perekhod formations	middle course of the Lena River	542–525	61	126.8	-/50	58.1	3.9	6.2	-16.6	64.5	5 (3.1/6.2)	Kirschvink,J.L., Rozanov,A.Yu., 1984
21	Udzha River Sediments Old Result	Udzha River	545–518	71.5	116	/40	341	28	7	-32	137	(4.2/7.7)	Rodionov, 1986
22	Ust-Yudoma Formation of the Yudoma Group	Belaya and Maya rivers	690–545	59.5	135	2/18	159	-18	21	-40	162	(11.5/21.8)	Rodionov, 1986

	Old Result												
23	Dolerite dike Old Result	Udzha River, Biliro-Udzha Uplift	1229–568	71.5	116	1/10	32	-12	5	-9	84	(2.6/5.1)	Rodionov, 1986
24	Pestrotsvet and Inikanskaya formations Old Result	Inican River, Aldan	545–525	59	135	2/18	341	32	4	-40	137	(2.5/4.5)	Osipova, 1986
25	Kharayuttekh Formation Old Result	Ukhta River, Chekurovka anticline	650–545	71	128	1/21	78	7	11	-7.2	48.2	(5.6/11.1)	Komissarova, 1989
26	Lower Cambrian sediments on the Olenek River Old Result	lower course of the Olenek River	545–518	71	122.5	12/	169	-32	7	-36	135	(4.4/7.9)	Pisarevsky, 1986
27	Erkeket Formation *	lower course of the Olenek River	535–518	70.9	122.6	8/23	331.5	47.4	6.8	-44.8	158.7	(5.7/8.8)	Pisarevsky et al., 1997
28	Kessyusa Formation *	lower course of the Olenek River	543–518	70.9	122.6	4/12	324.6	39.8	12.8	-37.6	165	(9.3/15.4)	Pisarevsky et al., 1997
29	Red sediments from the Lena River section	Western margin of Lake Baikal in the region of Cisbaikalia	650–580	54	108	-/32	296.3	-27.7	9.2	-2.7	168.2	7.4 (5.5/10.1)	Pisarevsky et al., 2000
30	Shaman Formation	Shaman Rock on the Irkut River	650–545	52.08	103.83	10/40	207.3	2.3	13.8	-32	71.1	(6.9/13.8)	Kravchinsky et. al., 2001
31	Minya Formation	Chaya River outcrop from the Baikal region	650–545	58	110	1/12	237.7	-35.9	12.7	-33.7	37.2	(8.6/14.7)	Kravchinsky et. al., 2001
32	Shaman Formation of the Motskaya Group (metachronic)	Shaman Rock on the Irkut River	650–545	52.08	103.83	6/35	313.1	-5.8	32.7	-22.3	155.8	(16.5/32.8)	Kravchinsky et. al., 2001
33	Nokhtui Formation	Bolshoy Patom River	600–542	60.2	116.1	-/81	218	-16	5.2	-31	71	(2.7/5.3)	Konstantinov, 1998
34	Padrocan and Yangud Formations	Muya region	650–545	57	115	-/29	32	-9	12.3	-23	80	(6.3/12.4)	Konstantinov, 1998
35	Kholodninskaya and Tukolamiya formations	Upper Angara river, Severo-Baikal region	600–542	56.2	110.5	-/38	341	-15	6.1	-28	133	(2.7/5.5)	Konstantinov, 1998
36	Yudoma Group and Pestrotsvet Formation	Aldan River, “Dvortsy” section	560–530	58.83	129	2/34	50.4	21.2	10.5	-29.3	68.8	(5.8/11.1)	Kazansky, 2002
37	Pestrotsvet Formation	Lena River, "Bachyk" section	545–525	61.17	126.33	1/14	49.2	18.6	5.7	-27.2	69.2	(3.1/5.9)	Kazansky, 2002
38	Undifferentiated limestones	Yenisei River, "Plakhino" section	560–530	67.83	86.5	2/14	31.1	23.6	27	-33.1	61	(15.3/28.8)	Kazansky, 2002
39	Erkeket Formation *	Khorbusuonka River, Olenek Uplift	535–518	70.9	122.6	2/35	171.6	-54.6	5	-53.3	135	6 (5/7.1)	Gallet et al., 2003
40	Kharayuttekh and Tyuserian formations	Lena River, Chekurovka anticline	580–530	71.1	127.4	/25	333.4	56.6	5.9	-53.4	164.1	7.3 (6.2/8.5)	Pavlov et al., 2004
41	Kharayuttekh and Tyuserian formations	Lena River, Chekurovka anticline	580–530	71.1	127.4	/19	23.6	-4.1	12.1	-15.2	102.9	(6.1/12.1)	Pavlov et al., 2004
42	Turkut Formation *	Khorbusuonka River, Olenek Uplift	550–530	71.4	123.9	/12	337.6	55.4	6.6	-52.5	160.8	7.9 (6.4/8.9)	Pavlov et al., 2004
43	Alyoshin Formation	Taseeva River	600–540	57.8	94.5	1/17	58.6	26.6	9.6	-28.3	24.3	7.7 (5.6/10.4)	Shatsillo et al., 2006a
44	Moshakovka and Chistyakovka formations	Angara River	600–540	58.2	95	9/42	16.6	5.2	8.6	-32.9	75.1	6.1 (4.3/8.6)	Shatsillo et al., 2006a
45	Redkolesnaya Formation	Angara and Irkineeva rivers	560–530	58.2	95	8/60	15.3	50	4.6	-60.8	68.1	5.1 (4.1/6.1)	Shatsillo et al., 2006a

46	Moshakovka, Chistyakovka and Ostrovnaya formations	Angara River	600-530	58.2	95	8/65	324.7	45	8.6	-48	149.1	3.6 (6.9/10.9)	Shatsillo et al., 2006a
47	Kurtun Formation	Southern Baikal region	540–530	52.7	105.8	/63	352.5	42.7	5.1	-61.5	120.2	5 (3.9/6.3)	Shatsillo et al., 2005
48	Kurtun Formation	Southern Baikal region	540–530	52.7	105.8	/15	224.9	0.2	17	-25.3	54.5	12 (8.5/17)	Shatsillo et al., 2005
49	Aisa Formation	Biryusa River and Tagul River, Biryusa Uplift	550–540	55.5	97.75	4/43	17.3	14.4	16.5	-39.9	79.1	12.1 (8.7/16.9)	Shatsillo et al., 2006a
50	Ust-Tagul Formation	Tagul and Biryusa rivers, Biryusa Uplift	540–530	55.9	97.7	/21	358.9	43.9	7	-57.5	96.8	6.9 (5.5/8.8)	Shatsillo et al., 2006a
51	Aisa and Ust-Tagul formations	Biryusa River and Tagul River, Biryusa Uplift	550-530	55.5	97.75	8/112	342.8	39	3.5	-54.3	125.8	3.2 (2.5/4.2)	Shatsillo et al., 2006a
52	Ushakovka Formation	Southern Baikal region	550–540	52.7	105.8	1/29	347.2	37.7	5	-56.9	128.1	4.5 (3.5/5.9)	Shatsillo et al., 2005
53	Ushakovka Formation	Southern Baikal region	550–540	52.7	105.8	1/16	218	-8.4	14.8	-32.3	59.2	10.6 (7.5/14.9)	Shatsillo et al., 2005
54	Uluntui Formation	Central Baikal region, Elokhin Cape	590–530	54.5	108.5	/46	44	8.2	8.8	-21	60.6	6.3 (4.5/8.9)	Shatsillo et al., 2006b
55	Ust-Angarsk complex	Angara River, Yenisei Ridge	626	58.03	93.3	6/46	75.9	18.8	5.2	-15.7	10.7	4.7 (2.8/5.4)	Metelkin, 2012
56	Ust-Angarsk complex (metachronic)	Angara River, Yenisei Ridge	626	58.03	93.3	8/71	319.4	33.1	10.5	-40.2	147.3	9 (6.8/11.9)	Metelkin, 2012
57	Karagas Group (metachronic)	Uda and Biryusa rivers, Biryusa Uplift	800–700	55	97.9	8/55	322.8	29.7	10.2	-41.2	149.4	8.4 (6.3/11.3)	Metelkin et al., 2010
58	Nersa complex (metachronic)	Biryusa Uplift	1600–740	55.01	97.94	5/42	319	28.1	11.3	-38.2	153	8.9 (6.8/12.4)	Metelkin et al., 2005
59	Usatovo Formation	Chaya River, Patom Highland	540–525	57.8	110	3/46	46.1	2.3	6.7	-22.6	58.7	1 (3.4/6.7)	Rodionov, 2014
60	Emyaksa Formation	Olenek River	535–515	68	112.2	/19	36.7	19.1	10.3	-26.5	70.7	9.8 (5.6/10.7)	Rodionov, 2014
61	Lopata Formation	Teya River, Yenisei Ridge	580–540	60.3	92.6	1/33	223.4	0.4	2.5	-20.9	45.2	1.8 (1.3/2.5)	Shatsillo et al., 2015
62	Zimoveyniy massif (Underheated/ undercleaned samples)	Yenisei River, South Yenisei Ridge	576–546	57.22	93.42	7/59	170.1	-13.6	3.9	-39	106.1	(2/4)	Kadilnikov et al., 2018
63	Nemchanka Formation	Chapa and Teya rivers, Yenisei Ridge	540–530	60.5	92	/19	209.3	-10	9.8	-30.7	57.5	7 (5/9.9)	Shatsillo et al., 2018
64	Podyom Formation	Teya River, Yenisei Ridge	540–530	60.8	92.6	/26	200	-16.1	6.4	-36.1	67.2	4.7 (3.4/6.6)	Shatsillo et al., 2018
65	Emyaksa Formation *	Bol'shaya Kuonamka River, Anabar Uplift	535–515	70.6	112.8	/47	342.3	57.6	3.9	-56.3	138.3	4.9 (4.2/5.7)	Pavlov et al., 2018
66	Pestrotsvetnaya Formation *	Maya and Belaya rivers, Uchur–Maya region	545–522	59.3	135	4/52	0.1	53.3	4.7	-64.6	134.8	5.4 (4.5/6.5)	Pavlov et al., 2018
67	Basic sills of the Chekurovka anticline	Lena River, Chekurovka anticline	540	71.2	127.7	2/17	222.1	-16.1	3.8	-21.8	82.1	2.8 (2/3.9)	Pavlov et al., 2018
68	Sardana Formation	Aldan River, Kyllakh Uplift	540–530	61.6	135.6	1/14	24	51.3	7.6	-56.5	96.8	8.5 (7/10.3)	Pavlov et al., 2018
69	Nichatka Formation	western slope of the Aldan Shield	635–580	58	118.2	38/80	255.1	-0.5	4.7	-8.1	40.6	4.4 (2.4/4.7)	Shatsillo et al., 2019
70	Emyaksa Formation *	Udzha River, Udzha and Anabar Uplifts	530–520	70.7	117.4	7/73	330.3	47.4	3.7	-44.7	155	3.9 (3.1/4.8)	Pasenko et al., 2020
71	Medvezh Formation *	Fomich River, Udzha and Anabar Uplifts	530–520	71.9	110.6	/51	327.3	56.2	4.9	-51.1	154.2	6 (5.1/7.1)	Pasenko et al., 2020

72	Dolerites of the Tas-Yuryakh volcanic complex	Khorbusuonka River, Olenek Uplift	530	71.21	123.76	9/102	317.9	75.8	7.3	-72.3	208.2	12.9 (12.4/13.4)	Metelkin et al., 2022
73	Alyoshin, Moshakovka and Chistyakovka formations of the Taseeva Group	Angara, Taseeva and Nizhnyaya Terya rivers	600–540	58.2	94.9	14/119	26.1	22	6.2	-39.2	61.1	4.8 (3.5/6.6)	Vinogradov et al., 2023
74	Moshakovka and Chistyakovka formations of the Taseeva Group	Nizhnyaya Terya and Angara rivers	600–540	58.2	94.9	13/114	312.4	32.1	5.5	-36.4	156	4.6 (3.5/6.2)	Vinogradov et al., 2023
75	Redkolesnaya Formation	Angara River, the Greben Rock location	560–530	58.19	94.96	1/13	22.3	53	5.5	-61.2	54	6.3 (5.3/7.6)	Vinogradov et al., 2023
76	Severnaya Rechka and Sukhaya Rechka formations of the Vorogovka Group	Vorogovka River in the northwestern Yenisei Ridge	580–535	60.84	89.90	6/56	215.7	-16.8	6.5	-31.6	47.4	4.7 (3.5/6.7)	This work
77	Severnaya Rechka and Mutnina formations of the Vorogovka Group (metachronic)	Vorogovka River in the northwestern Yenisei Ridge	580–535	60.9	89.9	15/118	314.8	46.4	7.7	-46.6	153.2	8.3 (6.3/9.9)	This work
78	Mutnina Formation of the Vorogovka Group	Vorogovka River in the northwestern Yenisei Ridge	580–535	60.81	89.93	3/22	299.5	0.7	11.3	-14.3	153.7	9.3 (5.7/11.3)	This work

N – number of sites in the study; n – number of samples in the study; * – In a significant number of samples, magnetic cleaning reveals trends that can be considered as an indication of the presence of a bipolar component with a “Kirschvink” direction in the rocks. This component is not isolated in its “pure form”. From [Pasenko et al., 2020].

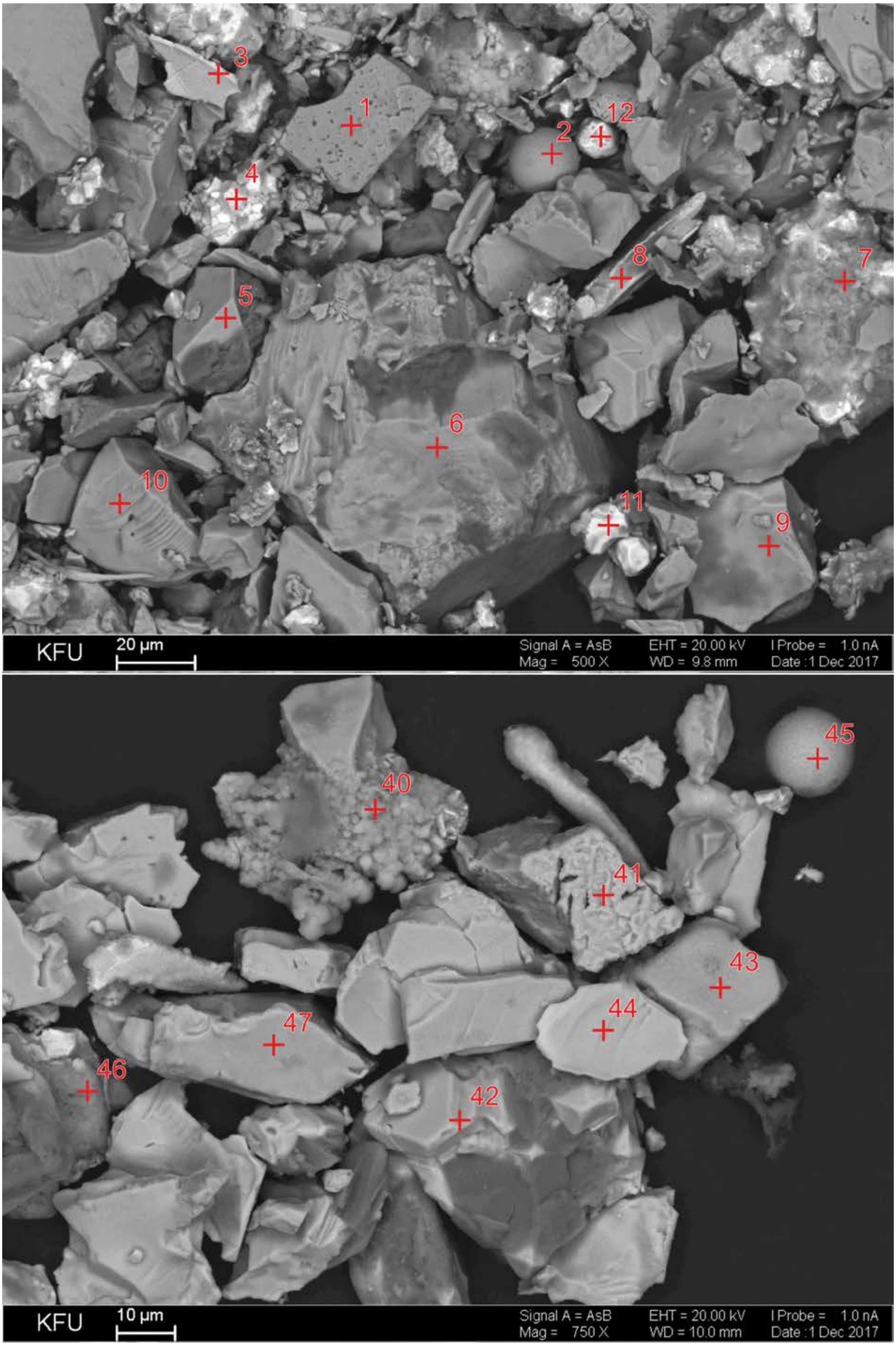

Figure S2. SEM images of magnetic particles from limestones of the Severnaya Rechka Formation and areas of compositional study (see Table S3).

Table S3. Chemical composition of magnetic particles from limestones of the Severnaya Rechka Formation.

Component	1	2	3	4	5	6	7	8	9	10	11	12	40	41	42	43	44	45	46	47
C, Wt. % / Atom. %	4.04 / 9.58	3.13 / 8.22	7.71 / 27.43	7.90 / 28.52	3.69 / 8.91	3.26 / 8.98	5.53 / 17.74	13.61 / 36.92	5.29 / 12.44	3.23 / 9.15	7.49 / 24.75	7.04 / 22.68	9.04 / 20.26	4.29 / 10.85	2.90 / 9.34	9.31 / 23.42	4.53 / 11.52	5.31 / 12.80	9.30 / 18.48	4.88 / 11.21
O	31.87 / 56.81	26.09 / 51.36	2.51 / 6.70	6.08 / 16.48	31.32 / 56.87	21.71 / 44.89	13.28 / 31.96	7.45 / 15.18	28.45 / 50.21	20.21 / 43.01	11.15 / 27.67	11.73 / 28.36	28.73 / 48.33	27.40 / 52.01	12.85 / 31.04	19.43 / 36.71	26.36 / 50.34	29.39 / 53.22	38.56 / 57.54	33.72 / 58.17
Na						0.15 / 0.21			0.19 / 0.23						0.25 / 0.42					
Mg	0.39 / 0.45	0.25 / 0.33			0.30 / 0.36	1.08 / 1.47	5.24 / 8.30	1.09 / 1.46	2.93 / 3.40	0.58 / 0.81		1.23 / 1.96			0.57 / 0.90	0.60 / 0.75	0.28 / 0.35			0.28 / 0.32
Al	0.16 / 0.17	0.19 / 0.22		0.71 / 1.14		0.13 / 0.16	0.25 / 0.36	0.35 / 0.43	0.15 / 0.16	0.11 / 0.14	0.78 / 1.15	0.58 / 0.83	0.40 / 0.40			0.25 / 0.28			1.05 / 0.93	
Si	0.22 / 0.22	0.34 / 0.39	0.21 / 0.32	0.23 / 0.35	0.32 / 0.33	1.06 / 1.25	9.09 / 12.46	1.39 / 1.61	3.11 / 3.13	0.55 / 0.67	0.44 / 0.62	1.54 / 2.13	1.85 / 1.78		0.72 / 1.00	1.13 / 1.22	0.20 / 0.22	0.19 / 0.20	1.51 / 1.29	0.19 / 0.18
P													0.71 / 0.62			0.47 / 0.46			1.15 / 0.89	
S							0.20 / 0.23				0.17 / 0.21	0.28 / 0.34	0.21 / 0.18			0.08 / 0.07			0.53 / 0.40	
Cl							0.17 / 0.18												0.16 / 0.11	
K							0.13 / 0.13						0.86 / 0.59			0.24 / 0.18			0.50 / 0.31	
Ca							1.70 / 1.63				0.33 / 0.32	0.14 / 0.13	0.35 / 0.24			0.72 / 0.55			2.10 / 1.25	
V														0.13 / 0.08						
Cr	12.35 / 6.77	0.21 / 0.13	0.31 / 0.25	0.38 / 0.32	1.01 / 0.56	0.45 / 0.28		0.19 / 0.12	4.70 / 2.55	6.76 / 4.42					0.99 / 0.74	0.79 / 0.46	0.50 / 0.29			
Mn	0.53 / 0.27									0.56 / 0.35									0.34 / 0.15	
Fe	49.57 / 25.31	69.78 / 39.36	7.82 / 5.99	56.88 / 44.18	63.36 / 32.96	72.16 / 42.75	23.10 / 15.93	75.92 / 44.29	54.46 / 27.53	67.99 / 41.44	53.99 / 38.38	54.06 / 37.44	55.09 / 26.55	68.18 / 37.07	81.72 / 56.56	63.96 / 34.62	68.14 / 37.28	65.11 / 33.78	38.86 / 16.61	60.93 / 30.11
Ni	0.39 / 0.19		81.45 / 59.31						0.72 / 0.35											
Co			0.63 / 0.47																	
Cu			0.62 / 0.42																	
Zn	0.49 / 0.22		0.27 / 0.18				0.94 / 0.55						1.30 / 0.53			0.91 / 0.42			3.60 / 1.31	
As													1.45 / 0.52			2.10 / 0.85			2.35 / 0.75	
Zr			1.17 / 0.56																	
Pr			3.91 / 1.20				5.83 / 1.59				3.99 / 1.12	3.38 / 0.93								
Nd			13.12 / 3.95				21.49 / 5.74				13.62 / 3.75	12.53 / 3.36								
Gd			8.12 / 2.24				13.06 / 3.20				8.06 / 2.03	7.47 / 1.84								
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

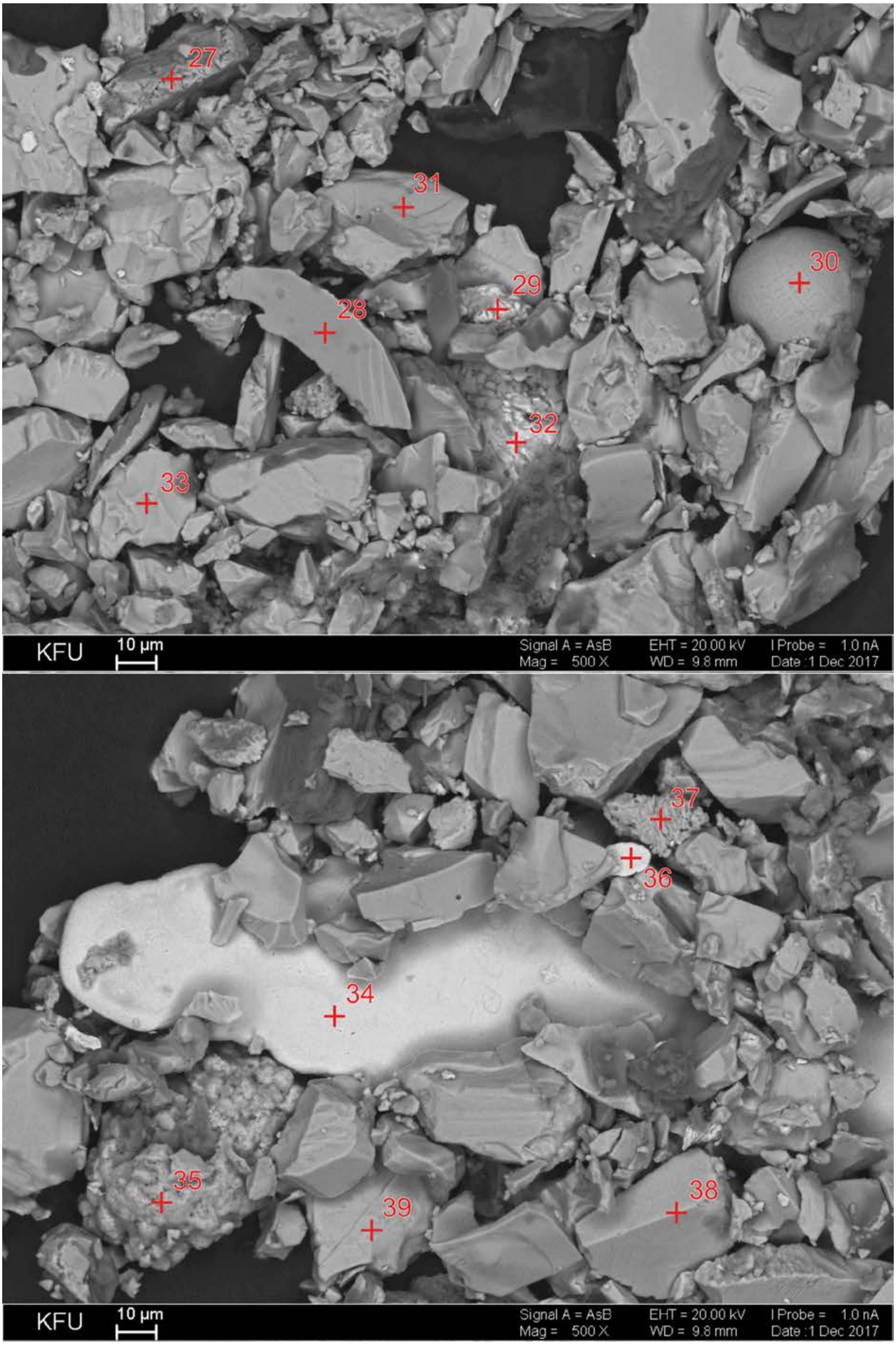

Figure S3. SEM images of magnetic particles from limestones of the Mutnina Formation and areas of compositional study (see Table S4).

Table S4. Chemical composition of magnetic particles from limestones of the Mutnina Formation.

Component	27	28	29	30	31	32	33	34	35	36	37	38	39
C, Wt. % / Atom. %	18.23	3.36	3.31	3.11	5.67	2.62	3.45	3.54	7.81	3.19	4.79	4.77	4.75
	40.93	9.22	13.25	8.21	16.54	10.54	8.54	13.76	21.57	12.56	10.79	11.10	11.46
O	16.20	22.96	1.36	26.04	15.36	1.90	29.83	2.16	4.06	2.18	34.86	33.04	30.19
	27.30	47.24	4.08	51.58	33.65	5.76	55.50	6.32	8.42	6.43	58.99	57.64	54.73
Na			0.09										
			0.19										
Mg			0.14			0.32	0.23				0.96		
			0.28			0.64	0.29				1.07		
Al						0.14	0.16				0.26		
						0.25	0.18				0.26		
Si	0.20	0.12	0.41		0.15	0.33	0.21	0.45	0.14	0.32	0.08	0.32	
	0.19	0.15	0.69		0.18	0.57	0.23	0.75	0.16	0.53	0.08	0.32	
S						0.13			39.82				
						0.20			41.21				
K						0.15							
						0.19							
Ca						0.27							
						0.32							
V	0.20										0.22		
	0.11										0.12		
Cr	0.24	0.45	0.42	0.27	3.98	0.58	1.02	17.04	0.18	15.18	4.95	0.56	0.64
	0.13	0.28	0.38	0.17	2.68	0.54	0.58	15.30	0.12	13.81	2.58	0.30	0.36
Mn								1.39	1.38	1.21			
								1.18	0.83	1.04			
Fe	64.92	73.11	93.80	70.57	74.53	93.20	65.09	67.55	46.61	70.20	53.56	61.30	64.42
	31.34	43.11	80.76	40.05	46.77	80.73	34.69	56.47	27.69	59.44	25.96	30.64	33.45
Ni					0.31			7.40		7.21	0.32		
					0.18			5.89		5.81	0.15		
Cu								0.47		0.51			
								0.34		0.38			
Zn			0.48			0.36							
			0.35			0.27							
Total	100	100	100	100	100	100	100	100	100	100	100	100	100

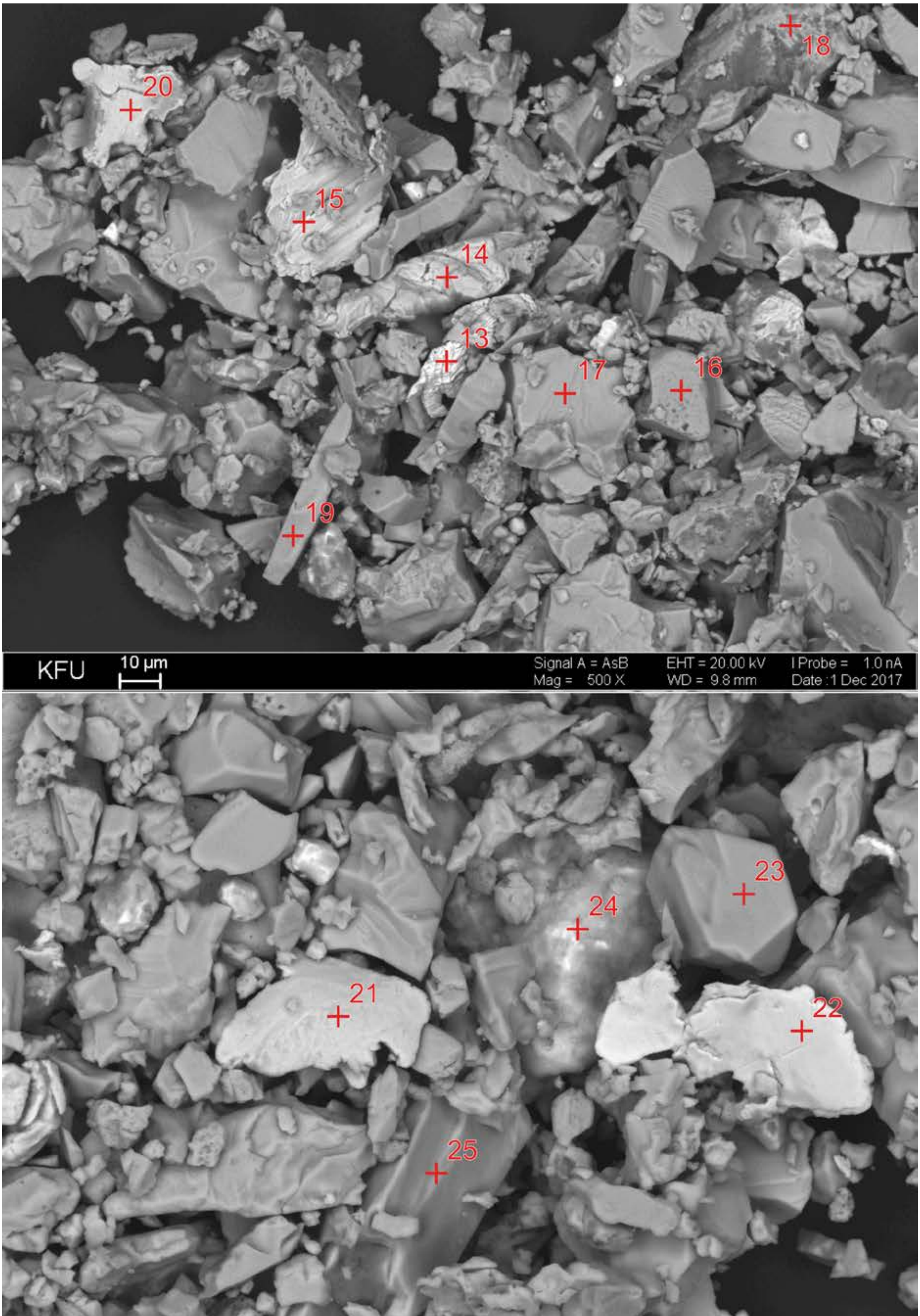

Figure S4. SEM images of magnetic particles from limestones of the Sukhaya Rechka Formation and areas of compositional study (see Table S5).

Table S5. Chemical composition of magnetic particles from limestones of the Sukhaya Rechka Formation.

Component	13	14	15	16	17	18	19	20	21	22	23	24	25
C, Wt. % / Atom. %	4.92 / 20.57	2.10 / 8.54	5.03 / 17.46	3.52 / 8.45	2.93 / 7.69	3.72 / 10.60	6.95 / 16.19	4.55 / 18.12	2.87 / 11.30	9.19 / 31.83	2.77 / 8.11	2.28 / 11.84	2.74 / 9.84
O	3.35 / 10.50	2.68 / 8.17	5.18 / 13.49	31.76 / 57.27	26.67 / 52.55	18.46 / 39.53	29.75 / 52.04	0.21 / 0.35	2.92 / 8.65	1.55 / 4.04	19.31 / 42.51	4.17 / 16.26	7.66 / 20.67
Mg				0.56 / 0.66		1.00 / 1.40							0.10 / 0.18
Al			0.20 / 0.31	0.14 / 0.15		0.81 / 1.03					0.10 / 0.13	0.09 / 0.20	
Si		0.12 / 0.21	2.46 / 3.66	0.38 / 0.39		1.22 / 1.49			0.24 / 0.41		0.16 / 0.20	0.11 / 0.25	0.17 / 0.25
S										0.35 / 0.46			
K						0.17 / 0.15							
Ca												0.55 / 0.85	
Ti						0.11 / 0.08							
V						0.22 / 0.15							
Cr	0.21 / 0.20	0.30 / 0.29	0.36 / 0.29	5.55 / 3.08	0.43 / 0.26		1.12 / 0.60	0.19 / 0.18	0.27 / 0.24	0.18 / 0.14	2.14 / 1.45		0.66 / 0.55
Mn		1.54 / 1.36	0.57 / 0.43					0.71 / 0.62	0.68 / 0.59				
Fe	6.55 / 5.88	93.25 / 81.42	86.20 / 64.36	57.57 / 29.74	69.97 / 39.50	74.30 / 45.58	62.18 / 31.16	94.34 / 80.73	93.02 / 78.81	18.87 / 14.05	75.07 / 47.33	44.00 / 49.14	88.67 / 68.51
Ni	2.77 / 2.37			0.52 / 0.26						69.85 / 49.48	0.45 / 0.27	0.51 / 0.54	
Cu	69.99 / 55.30												
Zn												0.55 / 0.53	
Sn	12.22 / 5.17												
Pr												10.21 / 4.52	
Nd												27.60 / 11.93	
Gd												9.92 / 3.94	
Total	100	100	100	100	100	100	100	100	100	100	100	100	100

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