

Attachment 1. EPMA results of minerals in black shale-hosted vanadium deposits (wt%)

Mannardite	TiO ₂	BaO	CaO	Cr ₂ O ₃	V ₂ O ₃	SiO ₂	Al ₂ O ₃	ZnO	NiO	FeO	MnO	MgO	Total
SHSD11-01	59.72	18.74	0.01	0.65	19.02	0.11	0.01	0.00	0.00	0.06	0.01	0.00	98.33
SHSD11-02	58.97	18.46	0.00	0.52	18.37	0.15	0.04	0.04	0.00	0.13	0.07	0.00	96.75
SHSD11-03	59.06	18.64	0.01	0.55	18.06	0.11	0.02	0.00	0.00	0.10	0.00	0.01	96.56
SHSD11-04	59.10	17.86	0.02	0.64	17.55	0.12	0.02	0.00	0.00	0.09	0.00	0.02	95.41
SHSD11-05	59.12	18.58	0.00	0.53	18.26	0.17	0.08	0.00	0.00	0.09	0.02	0.03	96.88
SHSD11-06	58.78	18.80	0.00	0.59	18.47	0.09	0.02	0.00	0.00	0.02	0.03	0.00	96.79
SHSD11-07	59.35	18.25	0.02	0.66	18.25	0.28	0.06	0.04	0.06	0.06	0.00	0.02	97.06
SHSD11-08	59.41	18.00	0.00	0.74	18.87	0.18	0.04	0.04	0.00	0.10	0.00	0.00	97.38
SHSD11-09	58.87	18.53	0.00	0.72	17.96	0.19	0.06	0.00	0.06	0.11	0.00	0.00	96.50
SHSD11-10	59.39	18.64	0.03	0.84	18.77	0.03	0.04	0.04	0.00	0.05	0.03	0.00	97.86
SHSD11-11	59.19	18.55	0.02	0.65	18.57	0.09	0.01	0.06	0.02	0.07	0.00	0.01	97.24
SHSD11-12	58.69	18.79	0.01	0.67	18.70	0.41	0.05	0.06	0.03	0.15	0.00	0.00	97.55
SHSD11-13	58.54	18.76	0.00	0.61	18.49	0.30	0.11	0.00	0.00	0.12	0.00	0.00	96.92
SHSD11-14	58.73	18.28	0.02	0.62	17.77	0.66	0.06	0.03	0.00	0.07	0.02	0.01	96.25
SHSD11-15	59.23	18.77	0.00	0.72	18.97	0.12	0.02	0.05	0.00	0.12	0.01	0.01	98.01
SHSD11-16	57.44	17.85	0.03	0.73	18.35	0.23	0.06	0.12	0.03	0.73	0.01	0.00	95.58

SHSD11-17	58.53	18.50	0.00	0.84	18.64	0.78	0.03	0.00	0.00	0.07	0.03	0.00	97.42
SHSD11-18	59.14	18.50	0.00	0.68	18.17	0.22	0.03	0.00	0.00	0.17	0.01	0.00	96.92
SHSD11-19	58.57	18.55	0.00	0.76	18.94	0.36	0.17	0.00	0.00	0.06	0.04	0.00	97.45
SHSD11-20	59.35	18.77	0.01	0.76	18.38	0.10	0.02	0.00	0.00	0.05	0.03	0.00	97.46
SHSD11-21	59.67	18.62	0.00	0.80	19.56	0.11	0.00	0.00	0.04	0.05	0.02	0.00	98.88
SHSD11-22	59.05	18.42	0.00	0.79	18.74	0.49	0.04	0.00	0.04	0.10	0.00	0.00	97.67
SHSD11-23	58.15	18.76	0.01	0.60	18.91	1.18	0.04	0.00	0.02	0.11	0.00	0.00	97.76
SHSD11-24	58.16	18.30	0.00	0.58	18.04	0.75	0.33	0.00	0.00	0.07	0.00	0.00	96.23
SHSD11-25	58.58	18.57	0.00	0.53	19.11	0.23	0.08	0.00	0.02	0.17	0.06	0.01	97.37
SHSD11-26	57.80	18.46	0.04	0.55	18.17	0.60	0.20	0.00	0.00	0.15	0.00	0.05	96.01
SHSD11-27	56.86	18.00	0.03	0.71	18.90	0.92	0.23	0.03	0.00	0.86	0.01	0.00	96.53
SHSD11-28	59.57	18.66	0.00	0.60	19.49	0.08	0.00	0.06	0.01	0.13	0.01	0.00	98.61
SHSD11-29	58.92	18.74	0.01	0.59	18.95	0.06	0.02	0.00	0.02	0.09	0.02	0.00	97.43
SHSD11-30	58.59	18.52	0.00	0.72	19.10	0.24	0.01	0.00	0.02	0.15	0.00	0.01	97.36
SHSD11-31	59.28	18.64	0.03	0.69	18.93	0.12	0.02	0.04	0.00	0.07	0.00	0.02	97.82
SHSD11-32	58.36	18.42	0.00	0.64	18.79	0.35	0.03	0.00	0.01	0.31	0.01	0.01	96.94
SHSD11-33	59.29	18.52	0.05	0.62	19.16	0.08	0.03	0.02	0.00	0.08	0.00	0.00	97.83
SHSD11-34	58.39	18.51	0.02	0.78	19.17	0.08	0.04	0.01	0.01	0.12	0.00	0.00	97.12

SHSD11-35	59.23	18.59	0.00	0.73	18.86	0.44	0.05	0.00	0.00	0.12	0.00	0.02	98.03
SHSD11-36	58.09	18.10	0.00	0.69	18.00	1.68	0.68	0.00	0.00	0.10	0.02	0.03	97.37
Average	58.81	18.49	0.01	0.67	18.62	0.34	0.08	0.02	0.01	0.14	0.01	0.01	97.20
Sigma	0.80	0.27	0.01	0.09	0.49	1.23	0.12	0.03	0.02	0.17	0.02	0.01	
Illite	K ₂ O	NiO	CaO	TiO ₂	Na ₂ O	Al ₂ O ₃	SiO ₂	V ₂ O ₃	FeO	F	MgO	Total	
SHSD11-1	7.30	0.07	0.00	0.37	0.31	30.97	49.09	0.06	2.16	0.22	1.60	92.14	
SHSD11-2	5.97	0.01	0.02	0.38	0.21	31.87	48.25	0.07	2.09	0.11	1.74	90.71	
SHSD11-3	7.56	0.07	0.02	0.35	0.29	31.95	47.22	0.09	2.14	0.16	1.87	91.71	
SHSD11-4	7.77	0.03	0.00	1.21	0.18	32.06	47.88	0.25	0.52	0.13	2.58	92.61	
SHSD11-5	8.90	0.02	0.02	0.37	0.23	28.95	49.52	0.18	2.70	0.13	2.33	93.35	
SHSD11-6	7.62	0.02	0.01	0.41	0.57	34.85	45.05	0.05	0.82	0.15	0.50	90.04	
SHSD11-7	7.61	0.00	0.00	0.43	0.51	36.05	45.19	0.06	0.86	0.07	0.41	91.18	
SHSD11-8	9.53	0.00	0.00	0.15	0.14	28.70	47.27	0.02	4.70	0.00	2.52	93.03	
SHSD11-9	9.47	0.01	0.00	0.12	0.12	29.22	48.13	0.00	4.01	0.00	2.06	93.14	
SHSD11-10	8.75	0.00	0.33	0.21	0.60	32.40	46.36	0.09	1.29	0.23	1.11	91.38	
SHSD11-11	7.84	0.00	0.01	0.26	0.61	33.07	45.51	0.71	1.23	0.05	1.25	90.54	
SHSD11-12	8.47	0.07	0.21	0.08	0.19	26.10	47.25	0.16	2.32	0.04	2.92	87.79	
Average	8.07	0.02	0.05	0.36	0.33	31.35	47.23	0.15	2.07	0.11	1.74	91.47	

Pyrite	S	Mn	Fe	As	Ni	V	Total	
SHSD15-21	52.75	0.20	45.43	0.12	0.44	0.06	99.23	
SHSD15-22	52.10	0.18	44.57	0.40	0.30	0.07	98.63	
SHSD15-23	52.03	0.07	45.25	0.12	0.65	0.05	99.35	
Average	52.29	0.15	45.08	0.21	0.46	0.06	99.07	
Quartz	K ₂ O	SiO ₂	Al ₂ O ₃	FeO	V ₂ O ₃	Total		
SHSD15-01	0.05	96.43	0.30	0.09	0.05	96.91		
Phengite	K ₂ O	BaO	Na ₂ O	SiO ₂	Al ₂ O ₃	FeO	V ₂ O ₃	Total
SHSD15-17	4.99	0.24	0.02	71.66	16.98	0.09	0.00	93.98
SHSD15-18	6.73	0.28	0.08	70.08	20.02	0.08	0.03	97.31
Average	5.86	0.26	0.05	70.87	18.50	0.08	0.02	95.64

Note: The analytical accuracy is less than 1% (relative) for the major oxides (> 5 wt%), less than 5% (relative) for the minor oxides (1–5 wt %) and 5–10% (relative) for the trace oxides (< 1 wt%).