

Rare Earth Elements and Other Critical Metals in Deep Seabed Mineral Deposits: Composition and Implications for Resource Potential

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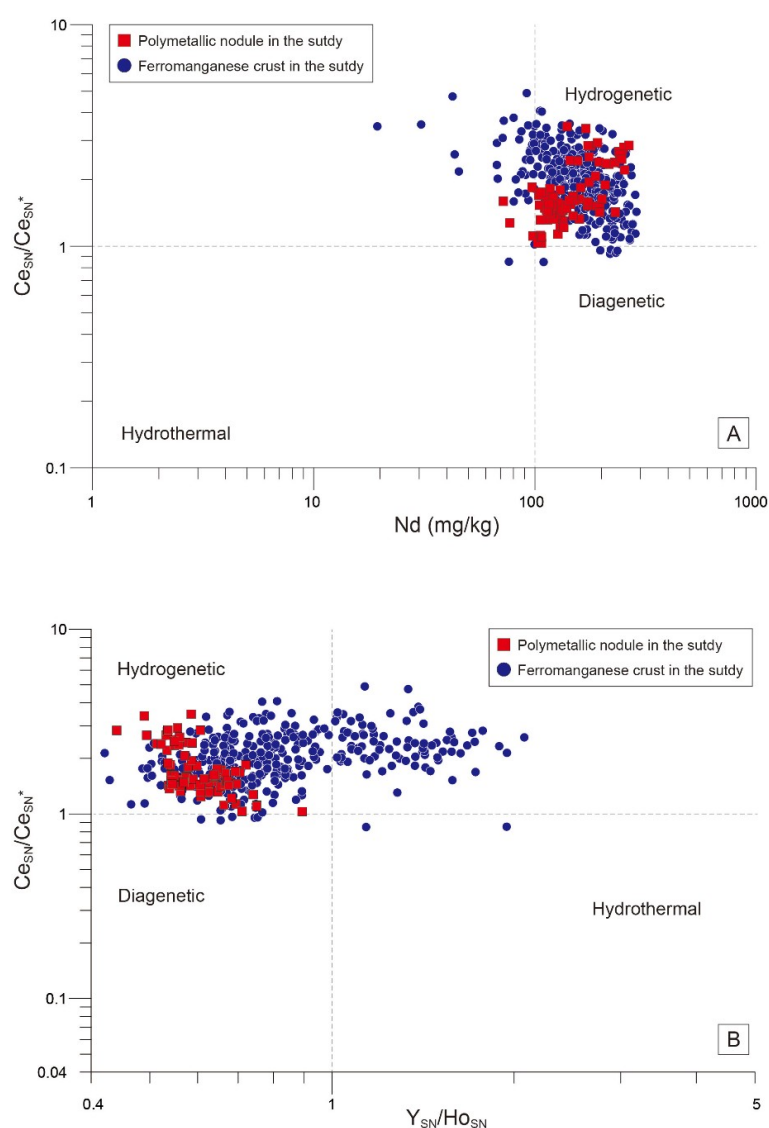


Figure S1. Discrimination diagrams using the relationship between (A) Ce_{SN}/Ce_{SN}^* ratio vs. Nd concentration and (B) Ce_{SN}/Ce_{SN}^* ratio vs. Y_{SN}/Ho_{SN} ratio in individual layers of nodule and crust samples, where $Ce_{SN}^* = 0.5 \times La_{SN} + 0.5 \times Pr_{SN}$ and SN = shale (PAAS) normalised. Fields for hydrogenetic, diagenetic and hydrothermal layers are defined according to [1].

Table S1. Total rare earth oxide grades and ore tonnage of 75 land-based rare earth deposits with the polymetallic nodule and deep-sea sediment deposits.

Deposit or District	Location	Grade (% TREO)	Tonnage (Mt)	Contained TREO (Kt)	Deposit Type	Resource Classification	References
Ak-Tyuz	Kyrgyzstan	1	15	150	alkaline rock	U	[2]
Araxa	Brazil	4.2	28	1193	carbonatite/laterite	MR	[3]
Bald Mountain	USA	0.08	18	14	placer	U	[4]
Barrytown	New Zealand	0.00055	73	0.4	placer	U	[4]
Bayan Obo	China	6.0	800	48,000	carbonatite	U	[5]
Bear Lodge	USA	2.8~2.6	14~27	395~686	carbonatite	MR	[6]
Biggejavri	Norway	0.2	0.1	0.1	others	U	[7]
Bokan Mountain	USA	0.7	5.2	34	alkaline rock	MR	[8]
Brockman	Australia	0.2	41	87	alkaline rock	PR	[9]
Catalao I	Brazil	5.5	119	6545	pegmatite/vein	U	[10]
Chatrapur	India	0.3	224	779	placer	PR	[4]
Chavara	India	0.09	115	101	placer	U	[4]
Cumberland	USA	0.011	241	27	placer	U	[4]
Cummins Range	Australia	1.7	4.2	72	carbonatite	MR	[11]
Daluxiang (Dalucuo)	China	5.0	15	760	carbonatite	U	[12]
Deep-Sea sediment	Korea	0.13	16,500	21,450	sediment	U	this study
Diamond Creek	USA	1.2	5.8	71	pegmatite/vein	U	[4]
Dong Pao	Vietnam	1.4	500	7000	carbonatite/laterite	U	[13]
Dubbo	Australia	0.9~0.7	73~36	651~268	alkaline rock	MR	[11]
Eco Ridge (Elliott Lake)	Canada	0.14	47	67	placer	MR	[14]
Gallinas Mountains.	USA	3.0	0.05	1.4	others	U	[4]
Gold Fork-Little Valley	USA	0.0098	296	29	placer	U	[4]
Green Cove Springs	USA	0.0045	110	5.0	placer	U	[4]
Hall Mountain	USA	0.05	0.1	0.05	pegmatite/vein	U	[15]
Hicks Dome	USA	0.4	15	62	carbonatite	U	[4]
Høgtuva	Norway	0.15	0.4	0.525	others	U	[7]
Horse Creek	USA	0.026	19	4.94	placer	U	[16]
Iron Hill	USA	0.4	619~2424	2600~9696	carbonatite	U	[4]
Jianghua area	China	0.4	3.4	12	ion adsorption	U	[16]
John Galt	Australia	8.0	0.4	30	pegmatite/vein	U	[11]
Kangankunde Hill	Malawi	4.2	2.5	107	carbonatite	MR	[11]
Kasagwe	Burundi	1.5	0.1	1	alkaline rock	U	[4]
Kizilcaoren	Turkey	2.8	4.7	131	pegmatite/vein	U	[17]

Table S1. *Cont.*

Deposit or District	Location	Grade (% TREO)	Tonnage (Mt)	Contained TREO (Kt)	Deposit Type	Resource Classification	References
Kodal	Norway	0.17	70	119	Iron oxide	U	[7]
Kvanefield	Greenland	1.1	67	733.6	Peralkaline intrusion	MR	[14]
Lemhi Pass	USA	0.3	0.5	1.7	metamorphic rock	U	[4]
Lovozero	Russia	1.1	593.0	6642	alkaline rock	U	[11]
Lovozero-Partomchorr	Russia	0.2	877	1755	alkaline rock	U	[11]
Manavalakuruchi	India	1.4	104	1421	placer	U	[4]
Manganese nodule	Korea	0.12	188	226	manganese nodule	MR	this study
Maoniuping	China	2.9	50	1451	carbonatite	PR	[12]
Mau Xe North	Vietnam	1.4	557	7800	carbonatite	U	[13]
Mineville	USA	0.9	9	80	pegmatite/vein	U	[11]
Misværdalen	Norway	0.07	30	21	alkaline rock	U	[7]
Mount Weld CLD	Australia	10.8~8.8	9.9~15	1069~1320	carbonatite/laterite	PR	[18]
Mount Weld Duncan	Australia	4.7	8.2	385	carbonatite/laterite	MR	[18]
Mountain Pass	USA	8.0	17	1333	carbonatite	PR	[11]
Mrima Hill	Kenya	3.9	159	6137	alkaline rock	MR	[11]
Mushgai Khudag	Mongolia	1.1	8.7	96	carbonatite	U	[11]
Music Valley	USA	8.6	0.1	4.3	metamorphic rock	U	[4]
Narraburra	Australia	0.03	73	22	alkaline rock	MR	[14]
Nolans Bore	Australia	2.6	56	1456	alkaline rock	MR	[19]
Norra Karr	Sweden	0.6	3.1	19	alkaline rock	MR	[20]
North Henry	USA	0.12	3.2	3.8	placer	U	[16]
Oak Grove	USA	0.09	175	157	placer	U	[16]
Oka	Canada	0.13	210	267	carbonatite	U	[11]
Olympic Dam	Australia	0.4	10,400	43,680	Iron oxide	U	[14]
Pajarito Mt.	USA	0.18	2.2	4	alkaline rock	U	[4]
Pea Ridge	USA	12.0	0.6	72	Iron oxide	U	[21]
Pilanesberg	South Africa	0.7	14	95	carbonatite/laterite	U	[22]
Pitinga	Brazil	0.15	164	246	alkaline rock	U	[23]
Pulmoddai	Sri Lanka	0.08	1.6	1.3	placer	U	[16]

Table S1. *Cont.*

Deposit or District	Location	Grade (% TREO)	Tonnage (Mt)	Contained TREO (Kt)	Deposit Type	Resource Classification	References
Round Top	USA	0.05	1051	525	others	MR	[24]
Sæterasen	Norway	0.5	8	42	alkaline rock	U	[7]
Sarysai	Kyrgyzstan	0.2	7	14	others	U	[25]
Scrub Oaks	USA	0.4	10	38	Iron oxide	U	[11]
Seis Lagos	Brazil	1.5	2900	43,500	carbonatite	U	[11]
Silica Mine	USA	0.0079	27	2.1	placer	U	[4]
Steenkampskraal	South Africa	11.8	0.2	30	metamorphic rock	MR	[26]
Strange Lake	Canada	0.09	492	443	alkaline rock	MR	[27,28]
Tantalus	Madagascar	0.09	628	565	ion adsorption	MR	[29]
Tapira	Brazil	0.03	150	45	carbonatite	U	[16]
Thor Lake (Lake Zone)	Canada	1.4	312	4270	alkaline rock	MR	[11]
Thor Lake (North T)	Canada	0.7	1.1	8	alkaline rock	MR	[11]
Yangibana	Australia	1.1	12	136	carbonatite/laterite	MR	[9]
Zandkopsdrift	South Africa	2.2	43	948	carbonatite/laterite	MR	[30]
Zeus (Kipawa)	Canada	0.4	23	98	alkaline rock	MR	[14]

MR = measured, indicated or inferred resource, PR = proven or probable reserve, U = unclassified resource.

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