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THE DISTRIBUTION OF LANTHANIDES AND YTTRIUM IN THE MINERALS OF THE MONAZITE FAMILY

by

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Abstract

Minerals of the monazite structural group include arsenates, phosphates, and silicates with the general formula ABO_4 where A = Bi, Ca, Ce, La, Nd, Th, U, and/or Y; and B = P^{+5}, As^{+5}, and/or Si^{+5}. Monazite-family minerals contain essential REE and PO_4, and may have minor amounts of other elements. Monazite-(Ce) is the predominant species, constituting 763 analyses (Tables 1 to 3). Another 18 analyses are for other species of monazite and gasparite-(Ce) (Table 4), cheralites (Table 5), and huttonites (Table 6). Two additional tables list average compositions of monazite-(Ce) from various rock types, and a final table indexes the analyses of monazite-(Ce) according to the localities.

List of Tables

Abbreviations used in tables for methods of analysis

AAS	atomic absorption spectrophotometry
CH	chromatographic
EP	electron microprobe
ICC	inductively coupled plasma
INA	instrumental neutron activation
OS	optical spectrography
XF	x-ray fluorescence

The monazite structural group of minerals consists of monoclinic arsenates, phosphates, and silicates of the general formula ABO_4, where A = Bi, Ca, Ce, La, Nd, Th, U, and/or Y; B = As^{+5}, P^{+5}, and/or Si^{+4}. The minerals in this group are:

Brabantite, $CaTh(PO_4)_2$
Cheralite, $(Ca,Ce,Th)(P,Si)O_4$
Gasparite-(Ce), $(Ce,La,Nd)AsO_4$
Huttonite, $ThSiO_4$
Monazite-(Ce), $(Ce,La,Nd,Th)(P,Si)O_4$
Monazite-(La), $(La,Ce,Nd)PO_4$
Monazite-(Nd), $(Nd,La,Ce)PO_4$
Rooseveltite, $BiAsO_4$

Rooseveltite has not been reported to contain rare earth elements (REE) and will not be considered further here.

Brabantite has been reported to contain 3.05% RE_2O_3, but individual lanthanides were not determined. Figure 1 (modified from Bowie and Horne, 1953) shows the relationships of monazite, cheralite, huttonite, and brabantite.

Within the monazite group, the monazite family consists of minerals essential REE as cations, and essential phosphate (arsenate in gasparite-(Ce)) as the anion. Non-essential Th, Ca, Mg, and Pb may substitute for the REE and Si may substitute for P; both substitutions can be up to 25 percent, as indicated in Bowie and Horne (1953), Figure 1.

The distribution of lanthanides and yttrium in monazite family minerals has been the subject of many papers. Monazite was recognized long ago to be a mineral that is a concentrator of the light lanthanides, in accordance with their occupancy of positions with co-ordination number ten (10). However, the considerable effect of the geologic environment of formation on the distribution of the lanthanides was not recognized until the work of Murata and co-workers (1953, 1957, 1958), confirmed in a review by Fleischer and Altschuler (1969).

Other reports describing monazite (and other REE minerals) in specific rock types include those by Holt (1965) (carbonatites), Marchenko (1967) (gneiss and migmatite), Heinrich and Wells (1980) (several associations), and Clark (1984) (several associations). In addition, papers by Ploshko (1961) and by Marchenko and Goncharova (1964) discuss formation of monazite by pneumatolytic and hydrothermal processes. Finally, we note that papers by Balashov and Pozharitskaya (1968) and by Wells (1977) dwell on the physical-chemical reasons for fractionation of REE found in rocks and minerals.

This report is an update of Fleischer and Altschuler (1969) and includes a compilation of all available determinations of the lanthanides and yttrium in minerals of the monazite structural group, 786 in all. Monazite-(Ce) is the overwhelmingly dominant mineral, comprising no less than 763 of the analyzed samples. In Tables 1 to 6, atomic percentages of the REE plus contents of ThO_2 and U_3O_8 are listed in order of increasing sigma (the sum of the atomic percentages of La + Ce + Pr).

The averages tabulated in Tables 7 and 8 show the effect of the type of geological occurrence on the distribution of REE in monazite-(Ce), namely the increase in atomic percent of the light lanthanides and decrease of the yttrium content, from granitic pegmatites to granitic rocks to alkalic rocks and carbonatites. However, the range of composition is far less than in minerals of low REE content, and the variation of rare earth content in monazite is far less satisfactory as a guide to type of host rock than the variation in either apatite (Fleischer and Altschuler, 1969, 1986) or titanite (Fleischer, 1978).

The compositions of monazite-(Ce) in granitic rocks and in gneisses are not notably different. As discussed in detail by Rosenblum and Mosier (1983), the average composition of dark monazites (Table 7, column F) is distinct from those of (yellow) monazites of different genesis, and especially in their high content of europium. It should be noted that only one dark monazite (Table 4, no. 4) is not a monazite-(Ce).

Table 9 is an index in two parts. Table 9a lists localities and rock type for the analyses in Tables 1 through 6; Table 9b gives localities for Tables 1 through 3.

Table 1-1. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent.

	1	2	3	4	5	6	7	8	9	10
La	11.9	21.5	20.3	9.9	21.3	8.6	13.7	10.3	12.4	10.4
Ce	35.4	29.7	32.3	35.2	32.8	39.8	41.7	39.3	37.3	42.1
Pr	-	-	-	8.4	-	5.8	-	6.6	8.4	5.8
Nd	31.9	23.8	30.4	26.1	28.0	24.1	26.0	38.0	24.2	28.5
Sm	12.7	6.0	8.9	11.3	5.3	16.3	9.2	5.8	9.7	10.1
Eu	0.8	0.6	0.7	-	0.6	-	-	-	0.2	-
Gd	5.4	4.7	3.3	7.7	4.2	5.4	9.4	-	5.6	3.1
Tb	0.6	0.9	0.7	0.5	0.8	-	-	-	0.6	-
Dy	1.3	5.3	2.8	0.9	3.5	-	-	-	1.2	-
Ho	-	-	-	-	-	-	-	-	0.1	-
Er	-	1.9	0.2	-	0.8	-	-	-	0.3	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	5.6	0.4	-	2.7	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(2.6)	(33.7)	(4.5)	-	(23.1)	(4.7)	(8.9)	-	-	(5.3)
Method	OS	OS	OS	XF	OS	XF	INA	EP	XF	XF
Σ = La+Ce+Pr	47.3	51.2	52.6	53.5	54.1	54.2	55.4	56.2	58.1	58.3
La-Nd	79.2	75.0	83.0	79.6	82.1	78.3	81.4	94.2	82.3	86.8
Sm-Ho	20.8	17.5	16.4	20.4	14.4	21.7	18.6	5.8	17.4	13.2
Er-Lu	-	7.5	0.6	-	3.5	-	-	-	-	-
RE_2O_3, wt.%	-	-	-	-	-	-	60.12	68.96	-	-
La/Nd	0.37	0.90	0.67	0.38	0.76	0.36	0.53	0.27	0.51	0.36
ThO_2, wt.%	-	-	-	-	-	4.1	6.18	0.20	-	3.8
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 1-2 - Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	11	12	13	14	15	16	17	18	19	20
La	10.3	10.4	24.2	13.7	7.9	11.9	16.6	16.2	19.0	14.2
Ce	41.9	41.9	35.9	40.9	47.3	40.1	36.9	38.3	37.9	40.6
Pr	6.2	6.1	-	6.0	5.4	9.0	7.8	7.1	5.0	7.1
Nd	24.4	26.6	28.1	33.2	36.1	31.1	27.0	20.3	19.9	21.1
Sm	10.1	11.1	6.1	4.3	2.3	5.1	3.4	10.2	11.0	8.7
Eu	0.5	-	0.4	-	0.4	0.3	-	0.2	-	-
Gd	6.6	3.9	2.9	1.9	0.4	2.5	8.3	5.3	7.2	5.2
Tb	-	-	0.4	-	-	-	-	0.7	-	0.6
Dy	-	-	1.5	-	0.2	-	-	1.1	-	1.8
Ho	-	-	-	-	-	-	-	0.2	-	0.1
Er	-	-	0.2	-	-	-	-	0.2	-	0.2
Tm	-	-	-	-	-	-	-	-	-	0.1
Yb	-	-	0.3	-	-	-	-	0.2	-	0.2
Lu	-	-	-	-	-	-	-	-	-	0.1
Y/(Y+La)x100	(4.0)	(4.6)	(3.7)	(4.2)	(0.3)	(4.6)	(5.0)	-	-	-
Method	INA	XF	OS	OS	-	OS	OS	XF	XF	XF
Σ = La+Ce+Pr	58.4	58.4	60.1	60.6	60.6	61.0	61.3	61.6	61.9	61.9
La-Nd	82.8	85.0	88.2	93.8	96.7	92.1	88.3	81.9	81.8	83.0
Sm-Ho	17.2	15.0	11.3	6.2	3.3	7.9	11.7	17.7	18.2	16.4
Er-Lu	-	-	0.5	-	-	-	-	0.4	-	0.6
RE_2O_3, wt.%	66.48	-	-	-	69.36	-	-	-	-	53.26
La/Nd	0.42	0.39	0.86	0.41	0.22	0.38	0.61	0.80	0.95	0.67
ThO_2, wt.%	1.21	4.0	-	-	0.17	-	-	-	-	13.00
U_3O_8, wt.%	0.26	0.1	-	-	-	-	-	-	-	-

Table 1-3. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)
((b) Tb + Y calc'd as Y)

	21	22	23	24	25	26	27	28	29	30
La	15.3	19.0	20.9	16.6	15.2	19.3	21.7	9.1	13.6	19.5
Ce	38.6	36.4	30.8	40.7	38.3	38.4	35.3	47.7	45.7	38.9
Pr	8.1	6.8	10.7	5.4	9.2	5.1	6.1	6.5	4.2	5.1
Nd	20.8	22.1	35.3	14.6	20.6	19.7	20.3	25.1	14.7	20.5
Sm	10.5	9.2	1.1	9.7	10.3	11.2	6.4	7.7	12.7	12.1
Eu	-	-	-	-	-	-	-	-	-	-
Gd	5.1	4.7	1.2	10.3	4.9	6.3	6.2	3.5	8.5	3.9
Tb	0.5	0.4	-	-	0.4	-	-	b	-	-
Dy	0.7	1.0	-	2.4	0.7	-	2.7	0.3	0.6	-
Ho	0.2	0.2	-	0.2	0.2	-	-	-	-	-
Er	0.2	0.2	-	-	0.2	-	1.3	0.1	-	-
Tm	-	-	-	0.1	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	-	-	(1.2)	(5.3)	-	-	(2.2)	(6.7)[b]	(2.9)	-
Method	XF	XF	OS	-	-	-	XF	CH	OS	-
Σ = La+Ce+Pr	62.0	62.2	62.4	62.7	62.7	62.8	63.1	63.3	63.5	63.5
La-Nd	82.8	84.3	97.7	77.3	83.3	82.5	83.4	88.4	78.2	84.0
Sm-Ho	17.0	15.5	2.3	22.6	16.5	17.5	15.3	11.5	21.8	16.0
Er-Lu	0.2	0.2	-	0.1	0.2	-	1.3	0.1	-	-
RE_2O_3, wt.%	-	-	-	-	-	-	-	55.2	59.2	-
La/Nd	0.74	0.86	0.59	1.14	0.74	0.98	1.07	0.36	0.93	0.95
ThO_2, wt.%	5.47	-	-	-	-	-	9.0	5.53	8.3	-
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 1-4. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	31	32	33	34	35	36	37	38	39	40
La	14.4	24.1	18.5	17.6	25.4	15.1	15.6	19.8	17.3	22.9
Ce	44.3	39.8	39.9	39.6	29.2	43.3	43.5	36.0	41.4	34.0
Pr	5.2	-	5.6	7.1	10.0	6.5	6.7	9.1	6.3	8.1
Nd	24.8	28.9	15.5	22.3	33.0	26.2	25.3	27.5	19.5	20.9
Sm	4.7	4.7	4.5	6.0	1.0	6.2	6.0	5.7	6.6	7.4
Eu	-	0.5	0.2	0.1	-	-	-	-	0.5	-
Gd	5.2	1.2	4.5	5.0	1.1	2.7	2.9	1.9	3.3	4.9
Tb	0.4	0.2	0.7	0.3	-	-	-	-	0.5	-
Dy	0.6	0.5	3.5	1.6	-	-	-	-	1.8	1.2
Ho	-	-	0.9	-	-	-	-	-	0.4	-
Er	-	-	2.4	0.3	0.3	-	-	-	1.8	0.6
Tm	-	-	0.3	-	-	-	-	-	0.2	-
Yb	0.4	0.1	3.0	0.1	-	-	-	-	0.4	-
Lu	-	-	0.5	-	-	-	-	-	-	-
Y/(Y+La)x100	(8.1)	(1.6)	-	-	-	(7.8)	(8.3)	(2.6)	-	-
Method	XF	OS	XF	XF	OS	OS	OS	OS	XF	XF
Σ = La+Ce+Pr	63.9	63.9	64.0	64.3	64.6	64.9	65.8	64.9	65.0	65.0
La-Nd	88.7	92.8	79.5	86.6	97.6	91.1	91.1	92.4	84.5	85.9
Sm-Ho	10.9	7.1	14.3	13.0	2.1	8.9	8.9	7.6	13.1	13.5
Er-Lu	0.4	0.1	6.2	0.4	0.3	-	-	-	2.4	0.6
RE_2O_3, wt.%	64.5	-	-	-	54.8	-	-	-	-	-
La/Nd	0.58	0.83	1.19	0.79	0.77	0.58	0.62	0.72	0.89	1.10
ThO_2, wt.%	4.36	-	-	-	-	16.3	15.5	-	-	-
U_3O_8, wt.%	0.34	-	-	-	-	-	-	-	-	-

Table 1-5. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (contd.)

	41	42	43	44	45	46	47	48	49	50
La	25.3	19.8	20.0	21.1	18.2	21.8	20.2	21.8	15.7	15.3
Ce	39.7	39.7	40.2	35.1	41.5	35.1	37.9	37.0	45.6	43.4
Pr	-	5.7	5.0	9.2	6.3	9.1	8.2	7.5	5.1	7.7
Nd	28.6	22.0	22.1	22.2	24.3	24.8	27.7	29.2	12.9	26.6
Sm	3.5	12.8	8.3	6.4	5.8	6.0	4.4	1.5	9.8	4.0
Eu	0.8	-	-	0.1	-	0.2	-	-	0.2	0.4
Gd	1.4	-	4.4	3.6	3.9	3.0	1.6	2.1	6.9	1.7
Tb	-	-	-	0.4	-	-	-	-	0.9	0.2
Dy	0.5	-	-	1.5	-	-	-	-	1.5	0.4
Ho	-	-	-	0.3	-	-	-	-	0.2	-
Er	0.1	-	-	-	-	-	-	0.5	0.4	0.1
Tm	-	-	-	-	-	-	-	-	-	-
Yb	0.1	-	-	0.1	-	-	-	0.1	0.7	0.2
Lu	-	-	-	-	-	-	-	0.3	0.1	-
Y/(Y+La)x100	(1.7)	-	(7.4)	(6.2)	-	(3.1)	(0.8)	-	(20.7)	-
Method	OS	XF	OS	OS	XF	OS	OS	OS	XF	XF
Σ = La+Ce+Pr	65.0	65.2	65.2	65.4	66.0	66.0	66.3	66.3	66.4	66.4
La-Nd	93.6	87.2	87.3	87.6	90.3	90.8	94.0	95.5	79.3	93.0
Sm-Ho	6.2	12.8	12.7	12.3	9.7	9.2	6.0	3.6	19.5	6.7
Er-Lu	0.2	-	-	0.1	-	-	-	0.9	1.2	0.3
RE_2O_3, wt.%	-	-	-	51.6	-	-	-	47.0	-	65.0
La/Nd	0.89	0.90	0.91	0.95	0.75	0.88	0.73	0.75	1.22	0.58
ThO_2, wt.%	-	-	12.1	9.89	-	-	-	-	-	-
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 1-6. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (contd.)
(a) Eu + Gd calcd. as Gd

	51	52	53	54	55	56	57	58	59	60
La	16.8	17.2	26.8	16.6	21.8	22.6	14.9	17.1	20.3	17.6
Ce	42.2	41.2	40.1	46.3	38.8	39.0	47.5	45.7	38.7	43.5
Pr	7.6	8.4	-	4.2	6.8	5.8	5.1	5.0	8.8	7.1
Nd	24.9	23.9	25.3	21.9	20.5	20.6	20.4	21.1	24.1	23.2
Sm	3.3	3.4	4.2	3.7	6.0	5.7	6.0	8.3	3.8	3.2
Eu	-	-	0.7	-	0.1	0.1	a	-	-	-
Gd	5.2	5.9	1.5	5.8	3.5	3.8	4.1[a]	2.8	3.9	5.4
Tb	-	-	-	0.3	0.5	0.5	0.3	-	-	-
Dy	-	-	0.9	0.7	1.5	1.5	1.4	-	-	-
Ho	-	-	-	-	0.2	0.3	0.1	-	-	-
Er	-	-	0.2	0.1	-	-	0.2	-	0.4	-
Tm	-	-	-	-	0.1	-	-	-	-	-
Yb	-	-	0.3	0.4	0.2	0.1	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(4.8)	(6.6)	(3.3)	(8.4)	(6.7)	(5.3)	(8.1)	(2.0)	-	(5.0)
Method	OS	OS	OS	XF	OS	OS	CH	XF	OS	OS
Σ = La+Ce+Pr	66.6	66.8	66.9	67.1	67.4	67.4	67.5	67.8	67.8	68.2
La-Nd	91.5	90.7	92.2	89.0	87.9	88.0	87.9	88.9	91.9	91.4
Sm-Ho	8.5	9.3	7.3	10.5	11.8	11.9	11.9	11.1	7.7	8.6
Er-Lu	-	-	0.5	0.5	0.3	0.1	0.2	-	0.4	-
RE_2O_3	-	-	-	60.63	73.1	56.2	-	-	58.5	-
La/Nd	0.67	0.72	1.06	0.76	1.06	1.10	0.73	0.81	0.84	0.76
ThO_2, wt.%	-	-	-	7.01	8.90	14.8	-	10.7	-	-
U_3O_8, wt.%	-	-	-	0.34	-	-	-	-	-	-

Table 1-7. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	61	62	63	64	65	66	67	68	69	70
La	21.0	23.4	18.3	22.5	23.3	18.2	19.0	22.7	24.9	20.9
Ce	41.9	38.8	38.7	38.4	45.3	43.3	43.4	42.0	41.6	41.7
Pr	5.4	6.2	11.5	7.6	-	7.2	6.4	4.1	4.1	6.2
Nd	21.0	20.4	24.9	27.8	23.6	27.5	18.1	21.6	21.0	22.0
Sm	4.8	5.3	4.9	1.5	3.4	3.8	9.5	3.5	3.3	5.7
Eu	-	0.1	-	-	0.3	-	-	-	-	-
Gd	5.9	2.9	1.7	2.2	1.8	-	3.6	6.1	5.1	3.5
Tb	-	0.5	-	-	0.4	-	-	-	-	-
Dy	-	1.9	-	-	1.4	-	-	-	-	-
Ho	-	0.3	-	-	-	-	-	-	-	-
Er	-	-	-	-	0.2	-	-	-	-	-
Tm	-	0.1	-	-	-	-	-	-	-	-
Yb	-	0.1	-	-	0.3	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	-	(6.3	(2.0)	(3.7)	(4.9)	-	(8.3)	(2.6)	(5.3)	-
Method	XF	OS	OS	OS	OS	-	EP	EP	EP	XF
Σ = La+Ce+Pr	68.3	68.4	68.5	68.5	68.6	68.7	68.8	68.8	70.6	68.8
La-Nd	89.3	88.8	93.4	96.3	92.2	96.2	86.9	90.4	91.6	90.8
Sm-Ho	10.7	11.0	6.6	3.7	7.3	3.8	13.1	9.6	8.4	9.2
Er-Lu	-	0.2	-	-	0.5	-	-	-	-	-
RE_2O_3, wt.%	-	52.6	-	-	-	-	53.5	-	-	-
La/Nd	1.00	1.12	0.74	0.81	0.99	0.66	1.05	1.05	1.19	0.95
ThO_2, wt.%	-	12.1	-	-	-	-	18.5	-	-	-
U_3O_8, wt.%	-	-	-	-	-	-	0.6	-	-	-

Table 1-8. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

(b) Tb+Y calcd as Y

	71	72	73	74	75	76	77	78	79	80
La	15.4	18.3	24.5	14.3	16.7	17.4	18.5	19.0	22.3	14.3
Ce	46.2	43.4	35.4	46.9	44.9	45.9	43.5	43.3	42.4	50.7
Pr	7.3	7.2	9.1	8.0	7.6	6.0	7.3	7.2	4.8	4.5
Nd	23.0	27.3	25.1	18.4	21.6	19.0	27.5	20.0	21.1	22.8
Sm	4.3	3.8	2.2	7.2	4.1	4.6	3.2	4.2	6.5	4.3
Eu	-	-	-	-	-	0.1	-	0.2	-	-
Gd	1.9	-	3.0	5.2	3.3	2.8	-	3.7	2.9	3.1
Tb	0.1	-	-	b	0.3	0.4	-	0.4	-	-
Dy	0.9	-	-	-	1.2	1.5	-	1.3	-	-
Ho	-	-	-	-	0.1	0.3	-	0.1	-	0.3
Er	0.3	-	0.4	-	0.1	0.2	-	0.3	-	-
Tm	0.3	-	-	-	-	0.2	-	-	-	-
Yb	0.3	-	0.1	-	0.1	1.5	-	0.3	-	-
Lu	-	-	0.2	-	-	0.1	-	-	-	-
Y/(Y+La)x100	-	-	-	(2.7)[b]	-	(4.0)	-	-	(4.6)	(4.0)
Method	XF	-	OS	CH,INA	XF	XF	-	XF	OS	CH
Σ = La+Ce+Pr	68.9	68.9	69.0	69.2	69.2	69.3	69.3	69.5	69.5	69.5
La-Nd	91.9	96.2	94.1	87.6	90.8	88.3	96.8	89.5	90.6	92.3
Sm-Ho	7.2	3.8	5.2	12.4	9.0	9.7	3.2	9.9	9.4	7.7
Er-Lu	0.9	-	0.7	-	0.2	2.0	-	0.6	-	-
RE_2O_3, wt.%	-	-	50.9	-	-	-	-	-	-	-
La/Nd	0.67	0.67	0.98	0.78	0.77	0.92	0.67	0.95	1.06	0.63
ThO_2, wt.%	-	-	-	-	-	-	-	-	10.7	-
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 1-9. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	81	82	83	84	85	86	87	88	89	90
La	22.0	24.8	21.9	16.5	18.1	24.4	22.5	17.4	17.5	17.9
Ce	41.7	35.7	41.8	47.8	51.5	37.8	39.9	47.1	45.9	46.6
Pr	5.8	9.0	5.9	5.3	-	7.5	7.3	5.2	6.3	5.3
Nd	23.1	25.2	21.9	22.7	30.4	19.2	19.9	20.1	24.3	21.8
Sm	4.4	2.2	4.8	6.0	-	4.2	5.1	7.5	5.4	6.1
Eu	-	-	-	-	-	-	0.1	-	-	-
Gd	3.0	3.1	3.7	1.7	-	5.1	2.7	2.7	-	2.3
Tb	-	-	-	-	-	-	0.4	-	-	-
Dy	-	-	-	-	-	1.2	1.81	-	0.6	-
Ho	-	-	-	-	-	-	0.2	-	-	-
Er	-	-	-	-	-	0.6	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	-	(5.4)	-	(5.1)	(9.3)	-	(5.8)	(1.5)	(3.0)	(1.2)
Method	XF	OS	XF	XF	OS	XF	OS	XF	EP	XF
Σ = La+Ce+Pr	69.5	69.5	69.6	69.6	69.6	69.7	69.7	69.7	69.7	69.8
La-Nd	92.6	94.7	91.5	92.3	100.0	88.9	89.6	89.8	94.0	91.6
Sm-Ho	7.4	5.3	8.5	7.7	-	10.5	10.3	10.2	6.0	8.4
Er-Lu	-	-	-	-	-	0.6	0.1	-	-	-
RE_2O_3, wt.%	-	-	-	-	-	-	61.8	-	-	-
La/Nd	0.95	0.98	1.00	0.73	0.60	1.27	1.13	0.87	0.72	0.82
ThO_2, wt.%	-	-	-	10.1	11.4	2.0	14.3	11.2	3.3	9.5
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	0.1

Table 1-10. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

(b) Tb+Y calcd. as Y

	91	92	93	94	95	96	97	98	99	100
La	21.9	17.4	28.6	21.8	19.6	22.2	20.8	19.6	15.9	20.8
Ce	41.8	44.4	41.2	39.7	50.3	40.8	43.1	40.5	46.1	44.0
Pr	6.1	8.0	-	8.4	-	7.0	6.1	9.9	8.1	5.4
Nd	21.9	22.5	24.5	25.9	30.1	17.4	19.2	22.9	24.7	20.8
Sm	5.0	3.1	3.4	2.0	-	6.6	4.7	3.5	3.5	5.6
Eu	-	-	0.4	-	-	0.1	-	-	-	-
Gd	3.3	4.6	1.4	2.2	-	3.4	3.5	3.6	1.0	3.4
Tb	-	-	-	-	-	0.4	b	-	-	-
Dy	-	-	0.4	-	-	1.6	1.1	-	0.3	-
Ho	-	-	-	-	-	0.2	0.9	-	0.2	-
Er	-	-	-	-	-	-	0.6	-	0.1	-
Tm	-	-	-	-	-	0.1	-	-	-	-
Yb	-	-	0.1	-	-	0.2	-	-	0.1	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	-	(6.0)	(2.0)	(2.9)	(8.3)	(7.2)	(5.4)[b]	(4.1)	(2.1)	-
Method	XF	OS	OS	OS	OS	OS	CH	OS	EP	XF
Σ = La+Ce+Pr	69.8	69.8	69.8	69.9	69.9	70.0	70.0	70.0	70.1	70.2
La-Nd	91.7	92.3	94.3	95.8	100.0	87.4	89.2	92.9	94.8	91.0
Sm-Ho	8.3	7.7	5.6	4.2	-	12.3	10.2	7.1	5.0	9.0
Er-Lu	-	-	0.1	-	-	0.3	0.6	-	0.2	-
RE_2O_3, wt.%	-	-	-	-	-	70.7	-	-	71.6	-
La/Nd	1.00	0.77	1.17	0.84	0.65	1.28	1.08	0.85	0.64	1.00
ThO_2, wt.%	-	-	-	-	5.3	12.2	7.37	-	-	-
U_3O_8, wt.%	-	-	-	-	-	-	0.08	-	-	-

Table 1-11. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	101	102	103	104	105	106	107	108	109	110
La	20.3	15.9	22.4	17.9	23.0	28.5	22.4	20.4	18.7	22.3
Ce	44.5	48.8	39.4	52.3	36.9	41.8	42.5	43.8	48.1	42.1
Pr	5.4	5.5	8.4	-	10.4	-	5.6	6.3	3.8	6.2
Nd	22.2	22.8	25.5	29.8	21.6	24.0	22.4	25.8	20.2	21.6
Sm	5.8	6.0	2.0	-	6.0	3.5	4.9	1.8	3.6	4.8
Eu	-	-	-	-	-	0.8	-	0.2	-	-
Gd	1.8	1.0	2.1	-	2.1	1.0	2.2	1.2	4.7	3.0
Tb	-	-	-	-	-	-	-	0.2	-	-
Dy	-	-	-	-	-	0.3	-	0.3	0.9	-
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	0.2	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	0.1	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(3.3)	(1.0)	-	(1.9)	(4.2)	(1.6)	-	-	(12.8)	-
Method	OS	XF	-	OS	OS	OS	XF	XF	OS	XF
Σ = La+Ce+Pr	70.2	70.2	OS	70.2	70.3	70.3	70.5	70.5	70.6	70.6
La-Nd	92.4	93.0	95.7	100.0	91.9	94.3	92.9	96.3	90.8	92.2
Sm-Ho	7.6	7.0	4.1	-	8.1	5.6	7.1	3.7	9.2	7.8
Er-Lu	-	-	0.2	-	-	0.1	-	-	-	-
RE_2O_3, wt.%	-	-	54.0	-	-	-	-	52.3	57.4	-
La/Nd	0.91	0.70	0.88	0.60	1.06	1.19	1.00	0.79	0.93	1.03
ThO_2, wt.%	15.5	9.9	-	8.0	-	-	-	-	8.3	-
U_3O_8, wt.%	-	0.1	-	-	-	-	-	-	0.30	

Table 1-12. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	111	112	113	114	115	116	117	118	119	120
La	15.6	21.2	16.5	19.0	18.3	11.3	21.3	11.4	18.9	32.5
Ce	49.3	48.1	45.7	42.6	52.4	55.3	42.6	55.4	46.8	33.6
Pr	5.7	1.4	8.5	9.1	-	4.2	6.9	4.1	5.2	4.9
Nd	22.4	22.2	22.4	23.6	29.3	16.2	23.7	16.2	20.7	20.1
Sm	5.4	4.2	3.4	3.8	-	9.0	2.8	9.0	5.9	3.5
Eu	-	-	0.3	-	-	-	-	-	-	-
Gd	1.6	2.5	1.6	1.9	-	4.0	2.3	3.9	2.5	4.4
Tb	-	-	0.2	-	-	-	-	-	-	-
Dy	-	-	0.6	-	-	-	-	-	-	1.0
Ho	-	-	-	-	-	-	0.4	-	-	-
Er	-	-	0.3	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	0.5	-	-	-	-	-	-	-
Lu	-	0.4	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(4.8)	(1.8)	(7.2)	(1.5)	(7.5)	(4.3)	(4.0)	-	(3.2)	(7.2)
Method	XF	EP	-	OS	OS	OS	CH	-	XF	-
Σ = La+Ce+Pr	70.6	70.7	70.7	70.7	70.7	70.8	70.8	70.9	70.9	71.0
La-Nd	93.0	92.9	93.1	94.3	100.00	87.0	94.5	87.1	91.6	91.1
Sm-Ho	7.0	6.7	6.1	5.7	-	13.0	5.5	12.9	8.4	8.9
Er-Lu	-	0.4	0.8	-	-	-	-	-	-	-
RE_2O_3, wt.%	-	69.1	-	-	-	59.9	-	-	-	-
La/Nd	0.70	0.95	0.74	0.81	0.62	0.70	0.90	0.70	0.91	1.62
ThO_2, wt.%	9.2	-	-	-	5.7	7.35	-	-	7.7	-
U_3O_8, wt.%	-	-	-	-	-	0.24	-	-	-	-

Table 1-13. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	121	122	123	124	125	126	127	128	129	130
La	24.3	19.6	17.7	22.9	15.5	21.2	21.4	22.6	20.3	24.3
Ce	42.1	44.8	47.5	43.4	49.9	44.0	43.4	43.4	44.4	43.3
Pr	4.7	6.7	5.9	4.9	5.8	6.0	6.4	5.3	6.6	3.7
Nd	17.7	19.1	22.5	19.9	22.0	23.0	23.6	18.9	20.6	21.0
Sm	7.6	4.2	5.2	3.5	5.7	4.3	2.6	6.0	3.5	2.8
Eu	-	0.2	-	-	-	-	0.2	-	0.2	0.3
Gd	3.6	3.6	1.2	2.6	1.1	-	1.3	3.8	2.1	2.2
Tb	-	0.3	-	-	-	-	0.2	-	0.3	0.3
Dy	-	1.2	-	1.3	-		0.4	-	1.2	1.1
Ho	-	0.1	-	-	-	1.5	0.1	-	0.2	-
Er	-	0.1	-	1.3	-		0.2	-	0.3	0.3
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	0.1	-	0.2	-	-	0.2	-	0.3	0.7
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(4.6)	(5.0)	(6.3)	(2.9)	(6.9)	(8.6)	-	-	-	-
Method	OS	XF	XF	CH	XF	OS	XF	XF	XF	-
Σ = La+Ce+Pr	71.1	71.1	71.1	71.2	71.2	71.2	71.2	71.3	71.3	71.3
La-Nd	88.8	90.2	93.6	91.1	93.2	94.2	94.8	90.2	91.9	92.3
Sm-Ho	11.2	9.6	6.4	7.4	6.8	5.8	4.8	9.8	7.5	6.7
Er-Lu	-	0.2	-	1.5	-	-	0.4	-	0.6	1.0
RE_2O_3, wt.%	-	-	-	52.4	-	-	49.2	-	59.8	-
La/Nd	1.37	1.03	0.79	1.15	0.70	0.92	0.91	1.20	0.99	1.16
ThO_2, wt.%	1.59	-	7.1	7.80	7.3	19.4	-		-	-
U_3O_8, wt.%	-	-	-	-	0.1	-	-	-	-	-

Table 1-14. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	131	132	133	134	135	136	137	138	139	140
La	24.1	19.7	18.9	20.0	25.0	26.5	19.5	17.9	14.9	13.5
Ce	38.3	46.2	46.9	44.9	41.3	40.4	46.4	50.1	52.9	58.4
Pr	9.0	5.5	5.6	6.5	5.2	4.9	5.9	3.9	4.1	-
Nd	19.9	20.5	20.7	25.6	19.2	19.5	21.2	17.4	19.4	28.1
Sm	4.5	6.2	6.1	1.8	5.6	4.1	4.1	3.4	4.6	-
Eu	0.1	-	-	-	-	-	0.4	-	2.4	-
Gd	2.0	1.9	1.8	1.2	3.7	2.7	2.0	5.1	1.7	-
Tb	0.3	-	-	-	-	-	0.1	0.5	-	-
Dy	1.4	-	-	-	-	1.9	0.4	0.9	-	-
Ho	0.3	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	0.1	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	0.1	-	-	-	-	-	-	0.7	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(5.4)	(2.4)	(1.9)	-	-	-	-	(12.4)	-	(6.6)
Method	OS	XF	XF	-	XF	XF	-	XF	EP	OS
Σ = La+Ce+Pr	71.4	71.4	71.4	71.4	71.5	71.8	71.8	71.9	71.9	71.9
La-Nd	91.3	91.9	92.1	97.0	90.7	91.3	93.0	89.3	91.3	100.0
Sm-Ho	8.6	8.1	7.9	3.0	9.3	8.7	7.0	9.9	8.7	-
Er-Lu	0.1	-	-	-	-	-	-	0.8	-	-
RE_2O_3, wt.%	36.3	-	-	-	-	-	-	56.29	47.2	-
La/Nd	1.21	0.96	0.91	0.78	1.30	1.36	0.92	1.03	0.77	0.48
ThO_2, wt.%	7.65	10.4	11.8	-	-	-	-	8.35	25.4	2.6
U_3O_8, wt.%	-	0.1	-	-	-	-	-	0.56	-	-

Table 1-15. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	141	142	143	144	145	146	147	148	149	150
La	24.7	19.6	20.7	26.1	23.6	18.6	22.0	21.6	19.3	23.2
Ce	39.6	46.5	45.6	41.1	43.3	47.0	45.0	41.4	47.0	45.7
Pr	7.7	5.9	5.8	4.9	5.3	6.6	5.2	9.2	5.9	3.3
Nd	19.0	21.2	18.9	21.6	19.7	20.3	20.9	22.8	24.2	24.8
Sm	4.4	4.0	5.0	2.6	5.1	3.6	4.6	2.7	0.4	1.4
Eu	0.1	0.4	-	0.5	-	0.3	-	-	0.7	-
Gd	2.2	2.0	4.0	2.6	3.0	2.6	2.3	2.1	0	1.6
Tb	0.4	0.1	-	-	-	0.2	-	-	0.3	-
Dy	1.6	0.3	-	-	-	0.6	-	-	-	-
Ho	0.2	-	-	0.1	-	0.2	-	-	-	-
Er	-	-	-	0.3	-	-	-	0.2	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	0.1	-	-	0.2	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(5.5)	-	(6.4)	(5.3)	-	-	-	-	-	(3.5)
Method	OS	-	OS	-	XF	-	XF	OS	-	OS
Σ = La+Ce+Pr	72.0	72.0	72.1	72.1	72.2	72.2	72.2	72.2	72.2	72.2
La-Nd	91.0	93.2	91.0	93.7	91.9	92.5	93.1	95.0	96.4	97.0
Sm-Ho	8.9	6.8	9.0	5.8	8.1	7.5	6.9	4.8	3.6	3.0
Er-Lu	0.1	-	-	0.5	-	-	-	0.2	-	-
RE_2O_3, wt.%	59.0	-	-	-	-	-	-	52.8	67.89	57.1
La/Nd	1.30	0.92	1.10	1.21	1.20	0.92	1.05	0.95	0.80	0.94
ThO_2, wt.%	10.2	-	17.5	3.6	-	-	-	-	-	4.10
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	0.08

Table 1-16. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)
(a) Eu + Gd calcd. as Gd; (b) Tb + Y calcd. as Y.

	151	152	153	154	155	156	157	158	159	160
La	19.8	24.7	27.7	18.7	20.9	17.0	21.5	23.9	22.4	19.3
Ce	46.6	41.9	39.7	47.0	44.6	51.0	41.6	42.5	44.2	47.3
Pr	5.9	5.7	4.9	6.6	6.8	4.4	9.3	6.1	6.0	6.0
Nd	17.5	18.8	19.3	20.3	20.8	18.0	23.0	22.7	18.1	21.3
Sm	4.1	3.6	3.8	3.6	4.3	3.5	2.6	2.9	4.0	3.4
Eu	a	-	-	0.3	-	a	-	-	0.2	0.2
Gd	3.4[a]	2.3	2.9[a]	2.5	2.6	2.8[a]	2.0	1.9	2.7	1.8
Tb	b	-	b	0.2	-	b	-	-	0.3	0.2
Dy	0.9	1.4	0.6	0.6	-	1.8	-	-	1.1	0.5
Ho	0.4	-	0.2	0.2	-	0.1	-	-	0.1	-
Er	1.0	1.4	0.4	-	-	0.7	-	-	0.4	-
Tm	-	-	0.2	-	-	0.1	-	-	0.3	-
Yb	0.4	0.2	0.3	-	-	0.6	-	-	0.1	-
Lu	-	-	-	-	-	-	-	-	0.1	-
Y/(Y+La)x100	(4.9)[b]	(1.5)	(5.3)[b]	-	-	(12.8)[b]	(1.8)	(0.9)	(3.5)	-
Method	CH	CH	CH	-	EP	CH	OS	-	XF	-
Σ = La+Ce+Pr	72.3	72.3	72.3	72.3	72.3	72.4	72.4	72.5	72.6	72.6
La-Nd	89.8	91.1	91.6	92.6	93.1	90.4	95.4	95.2	90.7	93.9
Sm-Ho	8.8	7.3	7.5	7.4	6.9	8.2	4.6	4.8	8.4	6.1
Er-Lu	1.4	1.6	0.9	-	-	1.4	-	-	0.9	-
RE_2O_3, wt.%	52.42	58.0	55.14	-	68.92	55.6	-	-	-	-
La/Nd	1.13	1.31	1.44	0.92	1.00	0.94	0.93	1.05	1.24	0.91
ThO_2, wt.%	8.52	5.50	8.50	-	-	8.0	-	5.7	-	-
U_3O_8, wt.%	-	-	-	-	-	-	-	0.1	-	-

Table 1-17. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	161	162	163	164	165	166	167	168	169	170
La	22.7	22.7	24.6	24.4	25.0	21.7	27.4	21.1	21.6	21.0
Ce	45.3	39.0	39.4	43.1	42.4	45.2	41.0	45.9	45.3	52.3
Pr	4.6	11.1	8.8	5.5	5.6	6.2	4.9	6.3	6.4	-
Nd	21.6	20.6	23.9	22.1	24.8	18.3	18.9	22.8	23.7	26.7
Sm	4.0	5.1	2.0	4.9	1.2	3.7	3.3	2.4	1.8	-
Eu	-	0.2	0.1	-	-	-	0.1	-	-	-
Gd	1.8	1.3	1.2	-	1.0	3.2	2.5	0.7	0.6	-
Tb	-	-	-	-	-	0.1	0.3	0.2	-	-
Dy	-	-	-	-	-	1.3	1.2	0.5	0.4	-
Ho	-	-	-	-	-	-	0.3	-	-	-
Er	-	-	-	-	-	0.3	-	0.1	0.2	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	0.1	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(4.6)	(1.2)	(1.8)	-	(1.4)	-	(5.7)	-	-	(10.3)
Method	XF	OS	OS	XF	CH	XF	OS	-	-	OS
Σ = La+Ce+Pr	72.6	72.8	72.8	73.0	73.0	73.1	73.3	73.3	73.3	73.3
La-Nd	94.2	93.4	96.7	95.1	97.8	91.4	92.2	96.1	97.0	100.0
Sm-Ho	5.8	6.6	3.3	4.9	2.2	8.3	7.7	3.8	2.8	-
Er-Lu	-	-	-	-	-	0.3	0.1	0.1	0.2	-
RE_2O_3, wt.%	-	-	-	-	-	-	63.8	-	-	-
La/Nd	1.05	1.10	1.03	1.10	1.01	1.19	1.45	0.92	0.91	0.79
ThO_2, wt.%	-	-	-	-	-	-	6.46	-	-	6.3
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 1-18. Monazite from igneous and metamorphic rocks, atomic percent (cont'd)
(a) Eu + Gd calcd. as Gd; (b)Tb + Y calcd as Y

	171	172	173	174	175	176	177	178	179	180
La	19.3	22.4	24.4	27.3	24.8	23.8	20.2	21.9	27.6	24.3
Ce	47.8	45.5	41.0	41.6	43.5	40.9	47.1	47.0	39.9	45.0
Pr	6.3	5.5	8.1	4.6	5.2	8.9	6.3	4.8	6.2	4.4
Nd	18.7	19.0	18.0	20.0	20.7	21.5	24.4	13.7	14.9	16.0
Sm	3.6	3.6	4.1	3.1	3.7	2.0	0.8	3.5	4.7	3.8
Eu	-	a	0.1	0.2	-	-	0.1	0.2	-	a
Gd	2.9	2.3[a]	2.2	1.9	2.1	2.9	0.7	2.5	3.4	3.7[a]
Tb	-	b	0.3	0.2	-	-	0.2	0.6	-	b
Dy	1.4	0.6	1.5	0.8	-	-	0.2	1.6	3.3	1.8
Ho	-	0.5	0.2	0.3	-	-	-	0.6		
Er	-	0.6	-	-	-	-	-	1.1	-	0.4
Tm	-	-	-	-	-	-	-	0.6	-	-
Yb	-	-	0.1	-	-	-	-	1.1	-	0.6
Lu	-	-	-	-	-	-	-	0.8	-	-
Y/(Y+La)x100	(3.1)	(7.4)[b]	(5.1)	(2.3)	-	(1.5)	-	(1.6)	(13.3)	(0.5)[b]
Method	XF	CH	OS	OS	XF	XF	XF	XF	OS	CH
Σ = La+Ce+Pr	73.4	73.4	73.5	73.5	73.5	73.6	73.6	73.7	73.7	73.7
La-Nd	92.1	92.4	91.5	93.5	94.2	95.1	98.0	87.4	88.6	89.7
Sm-Ho	7.9	7.0	8.4	6.5	5.8	4.9	2.0	9.0	11.4	9.3
Er-Lu	-	0.6	0.1	-	-	-	-	3.6	-	1.0
RE_2O_3, wt.%	-	43.65	75.5	66.1	-	-	53.8	44.8	-	45.4
La/Nd	1.03	1.18	1.36	1.37	1.20	1.11	0.83	1.60	1.85	1.52
ThO_2, wt.%	3.0	9.41	11.5	5.92	-	-	-	-	4.4	8.62
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 1-19. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)
(a) Eu + Gd calcd. as Gd; (b) Tb + Y calcd. as Y

	181	182	183	184	185	186	187	188	189	190
La	19.1	24.8	22.5	23.5	18.2	24.0	26.2	28.2	19.8	21.5
Ce	48.2	43.5	45.5	45.6	49.5	40.9	37.5	40.8	48.9	46.9
Pr	6.4	5.4	5.8	4.7	6.1	8.9	10.2	5.0	5.3	5.6
Nd	20.1	20.7	10.2	18.6	20.2	21.3	21.4	18.5	18.7	19.1
Sm	3.7	3.9	11.8	3.4	2.0	1.9	1.8	3.4	3.9	3.8
Eu	a	-	-	-	0.2	-	-	0.1	a	0.1
Gd	1.7[a]	1.7	4.2	3.5	2.3	2.8	2.6	2.2	2.3[a]	2.2
Tb	b	-	-	-	0.2	-	-	0.3	b	0.2
Dy	0.8	-	-	0.7	0.8	-	-	1.1	0.6	0.4
Ho	-	-	-	-	0.1	-	-	0.3	0.1	-
Er	-	-	-	-	0.2	0.2	0.3	-	0.2	0.1
Tm	-	-	-	-	-	-	-	-	0.1	-
Yb	-	-	-	-	0.2	-	-	0.1	0.1	0.1
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(3.9)[b]	-	(8.4)	(6.8)	-	-	-	(4.3)	(6.1)[b]	-
Method	CH	XF	EP	OS	-	OS	OS	OS	CH	-
Σ = La+Ce+Pr	73.7	73.7	73.8	73.8	73.8	73.8	73.9	74.0	74.0	74.0
La-Nd	93.8	94.4	84.0	92.4	94.0	95.1	95.3	92.5	92.7	93.1
Sm-Ho	6.2	5.6	16.0	7.6	5.6	4.7	4.4	7.4	6.9	6.7
Er-Lu	-	-	-	-	0.4	0.2	0.3	0.1	0.4	0.2
RE_2O_3, wt.%	58.8	-	46.3	60.6	-	56.8	57.15	65.9	55.6	-
La/Nd	0.95	1.20	2.21	1.26	0.90	1.13	1.22	1.52	1.06	1.13
ThO_2, wt.%	-	-	19.5	7.1	-	-	-	6.44	8.0	-
U_3O_8, wt.%	-	-	1.6	-	-	-	-	-	-	-

Table 1-20. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

(a) Eu + Gd calcd. as Gd

	191	192	193	194	195	196	197	198	199	200
La	27.6	24.4	18.7	25.6	25.9	21.1	26.2	23.0	24.9	25.0
Ce	41.7	44.0	55.3	44.2	42.5	46.6	37.6	44.8	44.7	43.8
Pr	4.7	5.6	-	4.3	5.7	6.4	10.3	6.3	4.6	5.4
Nd	19.8	20.5	26.0	16.0	18.5	19.2	21.5	22.3	17.3	20.0
Sm	3.1	3.3	-	3.6	4.3	2.9	1.8	1.4	2.7	3.4
Eu	0.2	a	-	-	-	-	-	-	-	-
Gd	1.9	1.9[a]	-	1.5	3.1	2.2	2.6	1.5	2.6	2.4
Tb	0.2	-	-	0.7	-	0.1	-	-	-	-
Dy	0.6	-	-	2.7	-	1.2	-	0.3	1.3	-
Ho	0.2	0.3	-	0.7	-	-	-	-	-	-
Er	-	-	-	0.7	-	0.3	-	0.2	1.7	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	0.1	0.2	-
Lu	-	-	-	-	-	-	-	0.1	-	-
Y/(Y+La)x100	(2.3)	(0.3)	(7.2)	(2.6)	-	-	(2.6)	(1.5)	(1.5)	-
Method	OS	CH	OS	XF	XF	XF	OS	OS	CH	XF
Σ = La+Ce+Pr	74.0	74.0	74.0	74.1	74.1	74.1	74.1	74.1	74.2	74.2
La-Nd	93.8	94.5	100.0	90.1	92.6	93.3	95.6	96.4	91.5	94.2
Sm-Ho	6.2	5.5	-	9.2	7.4	6.4	4.4	3.2	6.6	5.8
Er-Lu	-	-	-	0.7	-	0.3	-	0.4	1.9	-
RE_2O_3, wt.%	63.2	49.6	-	37.1	-	-	-	-	56.6	-
La/Nd	1.39	1.19	0.72	1.60	1.40	1.10	1.22	1.03	1.44	1.25
ThO_2, wt.%	6.34	-	17.0	-	-	-	-	8.61	6.00	-
U_3O_8, wt.%	-	-	-	-	-	-	-	0.12	-	-

Table 1-21. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)
(a) Eu + Gd calcd. as Gd; (b) Tb + Y calcd. as Y

	201	202	203	204	205	206	207a	207b	208	209
La	23.9	23.4	30.0	23.4	19.9	25.0	23.8	24.2	20.5	22.4
Ce	44.9	45.3	39.4	45.6	48.8	49.4	45.0	46.2	49.0	46.2
Pr	5.4	5.5	4.9	5.3	5.6	-	5.6	5.4	4.9	5.9
Nd	20.8	21.6	18.8	20.3	23.3	16.8	18.9	17.8	19.0	17.0
Sm	3.3	2.3	3.4	3.5	2.4	2.3	3.8	3.3	2.8	3.2
Eu	-	0.5	-	-	-	-	-	-	a	-
Gd	1.7	0.8	2.2	1.7	-	6.5	2.9	3.1	2.6[a]	3.4
Tb	-	0.1	1.3	-	-	-	-	-	b	0.1
Dy	-	0.3	-	-	-	-	-	-	1.0	1.4
Ho	-	0.2	-	-	-	-	-	-	0.1	-
Er	-	-	-	0.2	-	-	-	-	-	0.4
Tm	-	-	-	-	-	-	-	-	0.1	-
Yb	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	-	-	-	)2.6)	-	(4.5)	(9.2)	(9.1)	(1.9)[b]	-
Method	XF	XF	XF	OS	EP	INA	OS	OS	CH	XF
Σ = La+Ce+Pr	74.2	74.2	74.3	74.3	74.3	74.4	74.4	75.8	74.4	74.5
La-Nd	95.0	95.8	93.1	94.6	97.6	91.2	93.3	93.6	93.4	91.5
Sm-Ho	5.0	4.2	6.9	5.2	2.4	8.8	6.7	6.4	6.5	8.1
Er-Lu	-	-	-	0.2	-	-	-	-	0.1	0.4
RE_2O_3, wt.%	-	-	-	-	53.55	71.63	-	-	53.29	-
La/Nd	1.15	1.08	1.60	1.15	0.85	1.49	1.26	1.36	1.08	1.32
ThO_2, wt.%	-	-	-	9.63	-	1.94	21.3	19.5	16.30	-
U_3O_8, wt.%	-	-	-	0.13	-	-	-	-	-	-

Table 1-22. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	210	211	212	213	214	215	216a	216b	217	218
La	23.2	23.7	23.8	24.4	25.6	23.8	23.7	23.3	22.9	25.5
Ce	45.2	45.4	50.8	44.8	40.0	45.7	45.5	47.0	46.1	40.2
Pr	6.2	5.5	-	5.5	9.2	5.4	5.7	5.4	6.0	9.3
Nd	17.3	19.7	25.4	20.4	18.1	19.9	20.4	19.8	16.2	18.4
Sm	3.4	3.7	-	3.3	3.6	3.2	3.6	3.4	6.3	3.7
Eu	-	-	-	-	-	-	-	-	-	-
Gd	2.9	2.0	-	1.6	3.0	2.0	1.1	1.1	2.5	2.9
Tb	0.1	-	-	-	-	-	-	-	-	-
Dy	1.3	-	-	-	-	-	-	-	-	-
Ho	-	-	-	-	-	-	-	-	-	-
Er	0.4	-	-	-	0.4	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	0.1	-	-	-	-	-
Lu	-	-	-)	-	-	-	-	-	-	-
Y/(Y+La)x100	-	-	(8.4)	-	-	-	(1.0)	(1.0)	(7.2)	(5.5)
Method	XF	XF	OS	XF	OS	XF	OS	OS	EP	OS
Σ = La+Ce+Pr	74.6	74.6	74.6	74.7	74.8	74.9	74.9	75.7	75.0	75.0
La-Nd	91.9	94.3	100.0	95.1	92.9	94.8	95.3	95.5	91.2	93.4
Sm-Ho	7.7	5.7	-	4.9	6.6	5.2	4.7	4.5	8.8	6.6
Er-Lu	0.4	-	-	-	0.5	-	-	-	-	-
RE_2O_3, wt.%	-	-	-	-	45.7	-	-	-	60.3	-
La/Nd	1.34	1.20	0.94	1.20	1.41	1.20	1.16	1.18	1.41	1.39
ThO_2, wt.%	-	-	10.3	-	-	-	10.9	7.7	5.6	-
U_3O_8, wt.%	-	-	-	-	-	-	-	-	0.4	-

Table 1-23. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

(c) Tb + Dy + Y calcd. as Y

	219	220	221	222	223	224	225	226	227	228
La	23.8	21.8	20.3	25.5	20.9	18.9	22.9	21.9	21.0	24.0
Ce	45.6	47.1	49.6	40.6	48.7	51.6	47.4	46.5	47.3	46.2
Pr	5.6	6.2	5.2	9.0	5.6	4.7	4.9	6.8	6.9	5.0
Nd	19.8	18.9	20.1	21.3	15.3	15.9	16.2	17.0	17.7	19.2
Sm	3.2	2.7	1.6	2.0	5.2	3.4	2.6	3.3	3.2	3.3
Eu	-	-	-	0.2	-	0.1	-	0.3	-	-
Gd	2.0	2.0	2.9	1.2	4.3	2.6	5.5	1.8	2.0	2.3
Tb	-	-	-	-	c	0.3	-	0.3	0.2	-
Dy	-	1.1	0.1	-	c	1.6	0.5	1.3	1.2	-
Ho	-	-	-	-	-	-	-	0.1	0.2	-
Er	-	0.2	0.2	0.2	-	0.3	-	0.4	0.1	-
Tm	-	-	-	-	-	0.2	-	-	-	-
Yb	-	-	-	-	-	0.4	-	0.3	0.2	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	-	-	-	-	(2.8)[c]	(1.2)	(4.4)	-	-	(4.4)
Method	XF	XF	OS	CH	INA	XF	OS	XF	XF	XF
Σ = La+Ce+Pr	75.0	75.1	75.1	75.1	75.2	75.2	75.2	75.2	75.2	75.2
La-Nd	94.8	94.0	95.2	96.4	90.5	91.1	91.4	92.2	92.9	94.4
Sm-Ho	5.2	5.8	4.6	3.4	9.5	8.0	8.6	7.1	6.8	5.6
Er-Lu	-	0.2	0.2	0.2	-	0.9	-	0.7	0.3	-
RE_2O_3, wt.%	-	-	-	58.5	-	38.4	62.2	-	56.2	-
La/Nd	1.20	1.15	1.01	1.20	1.37	1.19	1.41	1.29	1.19	1.25
ThO_2, wt.%	-	-	-	-	-	-	5.6	-	-	-
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 1-24. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	229	230	231	232	233	234	235	236	237	238
La	22.6	24.3	23.6	21.9	23.6	21.4	24.8	23.2	20.5	21.9
Ce	46.9	45.8	46.9	47.6	41.8	48.7	45.5	47.0	50.2	47.7
Pr	5.7	5.2	4.8	5.9	10.0	5.3	5.1	5.2	4.8	5.9
Nd	20.0	18.6	21.7	17.0	18.8	19.2	19.8	21.4	16.8	16.9
Sm	2.4	3.8	3.0	2.5	1.8	3.5	3.0	1.4	2.8	2.5
Eu	0.1	0.2	-	0.1	-	-	-	0.1	-	0.1
Gd	1.3	1.9	-	2.1	3.7	1.9	1.8	1.1	2.6	2.1
Tb	0.2	-	-	0.3	-	-	-	0.2	0.5	0.3
Dy	0.6	-	-	1.4	-	-	-	0.3	1.0	1.4
Ho	-	-	-	0.3	-	-	-	0.1	0.2	0.3
Er	0.1	0.2	-	0.6	0.3	-	-	-	0.2	0.6
Tm	-	-	-	-	-	-	-	-	0.2	-
Yb	0.1	-	-	0.3	-	-	-	-	0.2	0.3
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	-	(3.1)	-	(12.8)	-	(6.7)	-	-	(1.0)	-
Method	XF	OS	EP	XF	OS	OS	XF	XF	XF	XF
Σ = La+Ce+Pr	75.2	75.3	75.3	75.4	75.4	75.4	75.4	75.4	75.5	75.5
La-Nd	95.2	93.9	97.0	92.4	94.2	94.6	95.2	96.8	92.3	92.4
Sm-Ho	4.6	5.9	3.0	6.7	5.5	5.4	4.8	3.2	7.1	6.7
Er-Lu	0.2	0.2	-	0.9	0.3	-	-	-	0.6	0.9
RE_2O_3, wt.%	-	-	66.53	-	57.0	-	-	44.6	43.4	-
La/Nd	1.13	1.31	1.09	1.29	1.26	1.11	1.25	1.08	1.22	1.30
ThO_2, wt.%	-	9.97	-	-	-	3.66	-	-	-	-
U_3O_8, wt.%	-	0.20	-	-	-	-	-	-	-	-

Table 1-25. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)
(a) Eu + Gd calcd. as Gd; (b) Tb + Y calcd. as Y

	239	240	241	242	243	244	245	246	247	248
La	22.3	22.0	25.4	19.7	20.3	24.8	25.3	25.7	21.1	21.4
Ce	49.8	47.7	45.0	47.6	49.3	45.8	45.2	46.0	48.6	47.4
Pr	3.4	5.8	5.1	8.3	6.0	5.1	5.2	4.1	6.2	7.1
Nd	18.7	19.3	19.6	20.7	21.89	19.0	20.1	15.3	17.1	20.0
Sm	3.1	4.8	2.9	3.7	2.6	3.4	2.4	2.7	3.2	2.5
Eu	-	-	-	-	-	-	a	-	0.1	-
Gd	1.7	-	2.0	-	-	1.9	1.3[a]	2.4	2.2	1.2
Tb	-	-	-	-	-	-	b	-	0.1	-
Dy	0.6	0.4	-	-	-	-	0.5	2.2	1.0	0.4
Ho	0.1		-	-	-	-	-	-	0.2	-
Er	0.2		-	-	-	-	-	1.3	0.1	-
Tm	-	-	-	-	-	-	-	-		-
Yb	0.1	-	-	-	-	-	-	0.3	0.1	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	-	(5.7)	-	-	-	-	(1.2)[b]	(2.6)	-	-
Method	EP	XF	XF	XF	-	XF	CH	-	XF	XF
Σ = La+Ce+Pr	75.5	75.5	75.5	75.6	75.6	75.7	75.7	75.8	75.9	75.9
La-Nd	94.2	94.8	95.1	96.3	97.4	94.7	95.8	91.1	93.0	95.9
Sm-Ho	5.5	5.2	4.9	3.7	2.6	5.3	4.2	7.3	6.8	4.1
Er-Lu	0.3	-	-	-	-	-	-	1.6	0.2	-
RE_2O_3, wt.%	48.32	-	-	-	-	-	63.03	-	-	56.0
La/Nd	1.19	1.14	1.30	0.95	0.93	1.31	1.26	1.68	1.23	1.07
ThO_2, wt.%	-	5.93	-	-	-	-	6.14	-	-	-
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 1-26. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)
(a) Eu + Gd calcd. as Gd; (b) Tb + Y calcd. as Y

	249	250	251	252	253	254	255	256	257	258
La	26.6	23.3	21.2	25.3	22.5	22.2	26.0	24.0	21.1	24.4
Ce	43.7	42.0	49.1	45.9	47.4	49.4	50.0	46.2	49.9	45.4
Pr	5.7	10.7	5.7	4.8	6.1	4.4	-	5.9	5.1	6.3
Nd	17.3	18.4	18.6	18.7	19.0	21.2	24.0	18.7	19.2	19.5
Sm	4.1	1.9	2.7	3.2	3.3	2.8	-	2.9	2.5	3.7
Eu	-	-	0.1	-	-	-	-	-	a	-
Gd	2.6	3.7	1.5	2.1	1.5	-	-	1.7	1.8[a]	-
Tb	-	-	0.3	-	-	-	-	-	b	-
Dy	-	-	0.7	-	-	-	-	0.5	0.3	0.7
Ho	-	-	0.1	-	-	-	-	-	-	-
Er	-	-	-	-	0.2	-	-	0.1	0.1	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(2.0)	(3.7)	-	-	-	-	(9.1)	(4.0)	(5.8)[b]	(4.6)
Method	CH	OS	XF	XF	OS	EP	OS	ID	CH	EP
Σ = La+Ce+Pr	76.0	76.0	76.0	76.0	76.0	76.0	76.0	76.1	76.1	76.1
La-Nd	93.3	94.4	94.6	94.7	95.0	97.2	100.00	94.8	95.3	95.6
Sm-Ho	6.7	5.6	5.4	5.3	4.8	2.8	-	5.1	4.6	4.4
Er-Lu	-	-	-	-	0.2	-	-	0.1	0.1	-
RE_2O_3, wt.%	-	-	-	-	-	52.13	-	46.8	63.75	-
La/Nd	1.54	1.27	1.14	1.35	1.18	1.05	1.08	1.28	1.10	1.25
ThO_2, wt.%	-	-	-	-	6.46	-	15.3	8.12	4.00	11.6
U_3O_8, wt.%	-	-	-	-	0.09	-	-	0.30	-	-

Table 1-27. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	259	260	261	262	263	264	265	266	267	268
La	23.7	24.3	23.7	25.7	25.9	22.1	25.7	26.9	26.4	25.5
Ce	47.6	46.8	47.4	45.7	46.4	49.7	46.0	44.4	45.2	51.0
Pr	4.9	5.1	5.1	4.9	4.1	4.6	4.8	5.2	4.9	-
Nd	13.4	18.7	19.0	19.0	15.5	18.4	18.4	18.5	18.8	23.5
Sm	6.9	3.6	2.9	3.2	2.7	2.4	2.9	3.0	3.2	-
Eu	-	-	-	-	-	0.2	-	-	-	-
Gd	3.5	1.5	1.9	1.5	2.4	1.2	2.2	2.0	1.5	-
Tb	-	-	-	-	-	0.2	-	-	-	-
Dy	-	-	-	-	1.4	0.7	-	-	-	-
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	1.3	0.2	-	-	-	-
Tm	-	-	-	-	-	0.1	-	-	-	-
Yb	-	-	-	-	0.3	0.2	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(6.4)	-	-	-	(2.6)	-	-	-	-	(8.0)
Method	EP	XF	XF	XF	CH	XF	XF	XF	XF	OS
Σ = La+Ce+Pr	76.2	76.2	76.2	76.3	76.4	76.4	76.5	76.5	76.5	76.5
La-Nd	89.6	94.9	95.2	95.3	91.9	94.8	94.9	95.0	95.3	100.0
Sm-Ho	10.4	5.1	4.8	4.7	6.5	4.7	5.1	5.0	4.7	-
Er-Lu	-	-	-	-	1.6	0.5	-	-	-	-
RE_2O_3, wt.%	60.2	-	-	-	62.4	-	-	-	-	-
La/Nd	1.77	1.30	1.25	1.35	1.67	1.20	1.40	1.45	1.40	1.09
ThO_2, wt.%	4.5	-	-	-	8.75	-	-	-	-	11.7
U_3O_8, wt.%	2.5	-	-	-	-	-	-	-	-	-

Table 1-28. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	269	270	271	273	273	274	275	276	277	278
La	19.2	25.6	23.2	21.7	19.3	21.0	23.1	25.2	26.2	23.3
Ce	51.5	45.9	48.1	52.3	53.4	49.3	47.8	47.1	42.1	46.4
Pr	5.9	5.1	5.3	2.7	4.0	6.5	5.9	4.5	8.5	7.1
Nd	16.8	17.6	19.6	18.0	18.6	16.0	18.4	19.0	19.3	19.6
Sm	3.8	3.0	1.4	2.9	3.0	2.4	2.1	2.4	2.3	2.0
Eu	-	-	0.1	-	-	0.1	-	-	-	0.2
Gd	2.1	2.8	1.2	1.6	1.1	1.3	1.8	1.8	1.6	0.6
Tb	b	-	0.2	-	-	0.2	0.2	-	-	0.1
Dy	0.7	-	0.7	0.5	0.4	1.3	0.6	-	-	0.4
Ho	-	-	0.2	0.1	-	0.3	-	-	-	0.1
Er	-	-	-	0.2	0.1	0.6	0.1	-	-	-
Tm	-	-	-	-	-	0.1	-	-	-	-
Yb	-	-	-	-	0.1	0.8	-	-	-	0.2
Lu	-	-	-	-	-	0.1	-	-	-	-
Y/(Y+La)x100	(0.9)[b]	-	-	-	-	-	(7.2)	(2.2)	(1.9)	-
Method	CH	XF	XF	EP	XF	XF	-	OS	OS	XF
Σ = La+Ce+Pr	76.6	76.6	76.6	76.7	76.7	76.8	76.8	76.8	76.8	76.8
La-Nd	93.4	94.2	96.2	94.7	95.3	92.8	95.2	95.8	96.1	96.4
Sm-Ho	6.6	5.8	3.8	5.1	4.5	5.6	4.7	4.2	3.9	3.4
Er-Lu	-	-	-	0.2	0.2	1.6	0.1	-	-	0.2
RE_2O_3, wt.%	-	-	55.1	49.05	68.3	-	-	-	-	-
La/Nd	1.14	1.45	1.18	1.21	1.04	1.31	1.26	1.33	1.36	1.19
ThO_2, wt.%	8.48	-	-	-	-	-	-	6.7	-	-
U_3O_8, wt.%	0.04	-	-	-	-	-	-	-	-	-

Table 1-29. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)
(a) Eu + Gd calcd. as Gd; (b) Tb + Y calcd. as Y

	279	280	281	282	283	284	285	286	287	288
La	22.0	25.2	28.0	23.3	21.5	24.3	26.3	28.3	23.8	23.1
Ce	50.7	51.6	42.9	51.9	52.8	46.8	45.5	46.8	46.8	48.0
Pr	4.1	-	6.0	1.7	2.6	5.8	5.1	1.8	6.3	5.8
Nd	20.3	23.2	13.9	14.7	17.2	17.3	17.5	18.3	18.3	18.4
Sm	2.0	-	4.2	3.1	3.1	2.7	3.2	4.4	2.4	2.1
Eu	a	-	0.7	0.1	0.1	a	-	-	-	-
Gd	0.7[a]	-	3.8	2.6	1.7	2.0[a]	2.4	0.4	1.6	1.8
Tb	b	-	-	-	-	b	-	-	0.1	0.2
Dy	0.2	-	-	1.9	0.6	0.4	-	-	0.7	0.5
Ho	-	-	0.1	-	0.1	0.3	-	-	-	-
Er	-	-	0.4	0.4	0.2	0.4	-	-	-	0.1
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	0.3	0.1	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(0.9)[b]	(7.2)	(2.4)	(10.1)	-	(8.7)[b]	-	(21.5)	-	-
Method	CH	OS	-	XF	EP	CH	XF	-	XF	XF
Σ = La+Ce+Pr	76.8	76.8	76.9	76.9	76.9	76.9	76.9	76.9	76.9	76.9
La-Nd	97.1	100.0	90.8	91.6	94.1	94.2	94.4	95.2	95.2	95.3
Sm-Ho	2.9	-	8.8	7.7	5.6	5.4	5.6	4.8	4.8	4.6
Er-Lu	-	-	0.4	0.7	0.3	0.4	-	-	-	0.1
RE_2O_3, wt.%	61.0	-	-	-	53.99	50.13	-	-	-	-
La/Nd	1.08	1.09	2.01	1.59	1.25	1.40	1.50	1.55	1.30	1.26
ThO_2, wt.%	7.23	9.7	-	-	-	5.77	-	-	-	-
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 1-30. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	289	290	291	292	293	294	295	296	297	298
La	22.8	26.4	22.3	26.6	25.9	25.0	24.1	24.1	25.9	22.5
Ce	48.3	42.1	48.1	46.9	46.2	52.1	47.9	48.3	46.3	51.1
Pr	5.8	8.4	6.6	3.6	5.0	-	5.2	4.8	5.0	3.6
Nd	18.9	19.2	16.2	14.8	18.5	22.9	12.7	17.2	18.5	18.7
Sm	1.6	2.2	2.6	1.9	2.9	-	3.7	2.8	2.8	1.8
Eu	-	-	0.2	-	-	-	0.2	-	-	0.3
Gd	2.0	1.5	1.7	3.3	1.5	-	2.8	2.8	1.5	1.3
Tb	-	-	0.2	0.5	-	-	0.3	-	-	-
Dy	0.2	-	1.1	2.0	-	-	1.9	-	-	0.7
Ho	-	-	0.2	0.2	-	-	0.3	-	-	-
Er	0.3	0.2	0.3	-	-	-	0.4	-	-	-
Tm	-	-	-	0.2	-	-	0.1	-	-	-
Yb	0.1	-	0.5	-	-	-	0.4	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(3.2)	-	-	(2.3)	-	(6.3)	-	-	-	-
Method	OS	OS	XF	XF	XF	OS	XF	XF	XF	-
Σ = La+Ce+Pr	76.9	76.9	77.0	77.1	77.1	77.1	77.2	77.2	77.2	77.2
La-Nd	95.8	96.1	93.2	91.9	95.6	100.0	89.9	94.4	95.7	95.9
Sm-Ho	3.8	3.7	6.0	7.9	4.4	-	9.2	5.6	4.3	4.1
Er-Lu	0.4	0.2	0.8	0.2	-	-	0.9	-	-	-
RE_2O_3, wt.%	-	51.15	-	-	-	-	-	-	-	-
La/Nd	1.21	1.38	1.38	1.80	1.40	1.09	1.90	1.40	1.40	1.20
ThO_2, wt.%	9.17	-	-	-	-	10.0	-	-	-	-
U_3O_8, wt.%	0.18	-	-	-	-	-	-	-	-	-

Table 1-31. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)
(a) Eu + Gd calcd. as Gd

	299	300	301	302	303	304	305	306	307	308
La	24.4	23.9	28.3	29.0	26.6	25.0	24.1	26.9	16.3	23.0
Ce	47.8	48.1	43.5	43.1	45.8	475.	48.4	46.3	55.3	48.7
Pr	5.1	5.3	5.5	5.2	5.0	5.0	5.1	4.4	6.0	5.9
Nd	18.1	18.4	18.9	19.6	18.3	15.5	14.4	17.3	17.5	18.2
Sm	2.7	3.3	3.8	1.8	2.8	5.0	5.4	2.9	3.0	1.5
Eu	-	-	-	0.3	-	-	-	-	a	-
Gd	1.9	1.0	-	0.9	1.5	2.0	2.6	2.2	1.9[a]	1.9
Tb	-	-	-	-	-	-	-	-	-	-
Dy	-	-	-	0.1	-	-	-	-	-	0.3
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	0.4
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	0.1
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	-	(0.9)	-	-	-	(1.4)	(1.7)	-	(2.0)	(3.2)
Method	XF	OS	XF	XF	XF	EP	EP	XF	CH	-
Σ = La+Ce+Pr	77.3	77.3	77.3	77.3	77.4	77.5	77.6	77.6	77.6	77.6
La-Nd	95.4	95.7	96.2	96.9	95.7	93.0	92.0	94.9	95.1	95.8
Sm-Ho	4.6	4.3	3.8	3.1	4.3	7.0	8.0	5.1	4.9	3.7
Er-Lu	-	-	-	-	-	-	-	-	-	0.5
RE_2O_3, wt.%	-	-	-	-	-	63.4	59.7	50.0	-	54.71
La/Nd	1.35	1.30	1.50	1.48	1.45	1.61	1.67	1.55	0.93	1.26
ThO_2, wt.%	-	9.3	-	-	-	4.1	5.6	-	-	7.64
U_3O_8, wt.%	-	-	-	-	-	0.1	0.2	-	-	0.29

Table 1-32. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd.)

	309a	309b	309c	310	311	312	313	314	315	316
La	22.3	24.5	23.2	25.2	24.6	25.7	26.9	23.3	26.9	20.0
Ce	41.6	47.4	52.9	48.3	48.2	47.0	46.6	51.3	40.3	52.8
Pr	9.1	6.2	5.5	4.2	4.9	5.1	4.3	3.3	10.7	5.1
Nd	20.1	19.4	16.3	16.2	17.3	17.8	17.9	15.2	18.5	22.1
Sm	3.3	1.8	1.7	3.0	3.3	3.0	2.9	3.1	1.4	-
Eu	-	0.2	0.1	0.2	-	-	-	0.1	-	-
Gd	2.6	-	0.2	1.3	1.7	1.4	1.4	1.8	2.0	-
Tb	-	-	-	0.2	-	-	-	-	-	b
Dy	1.0	0.3	0.1	0.9	-	-	-	1.7	-	-
Ho	-	0.1	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	0.2	-
Tm	-	0.1	-	0.2	-	-	-	-	-	-
Yb	-	-	-	0.3	-	-	-	0.2	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(2.8)	-	-	(1.0)	(4.4)	-	-	(6.5)	-	(15.1)[b]
Method	XF	XF	CH	XF	OS	XF	XF	XF	OS	CH
Σ = La+Ce+Pr	73.0	78.1	81.6	77.7	77.7	77.8	77.8	77.9	77.9	77.9
La-Nd	93.1	97.5	97.9	93.9	95.0	95.6	95.7	93.1	96.4	100.0
Sm-Ho	6.9	2.4	2.1	5.6	5.0	4.4	4.3	6.7	3.4	-
Er-Lu	-	0.1	-	0.5	-	-	-	0.2	0.2	-
RE_2O_3, wt.%	54.0	54.0	54.0	47.5	-	-	-	-	50.8	-
La/Nd	1.11	1.26	1.42	1.56	1.42	1.44	1.50	1.53	1.45	0.90
ThO_2, wt.%	2.39	2.39	2.39	-	11.0	-	-	-	-	-
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 1-33. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	317	318	319	320	321	322	323	324	325	326
La	23.8	22.3	23.1	26.2	30.1	26.8	23.9	26.7	24.7	25.6
Ce	51.9	51.5	48.9	47.1	42.6	40.5	51.9	46.2	47.0	47.4
Pr	2.3	4.2	6.0	4.7	5.3	10.7	2.3	5.2	6.4	5.1
Nd	15.6	16.6	17.3	18.1	18.3	18.5	15.5	17.8	17.9	18.9
Sm	2.8	2.7	2.3	2.5	3.5	1.4	2.8	2.5	1.7	3.0
Eu	0.1	0.1	0.1	-	-	-	0.1	-	0.1	-
Gd	2.3	1.8	1.4	1.4	-	2.1	2.3	1.6	1.3	-
Tb	-	-	0.2	-	-	-	-	-	-	-
Dy	1.0	0.6	0.5	-		-	1.0	-	0.5	-
Ho	-	-	-	-	0.2	-	-	-	-	-
Er	0.1	0.1	0.2	-		-	0.1	-	0.3	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	0.1	0.1	-	-	-	-	0.1	-	0.1	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(6.0)	(2.7)	-	-	(3.3)	(1.1)	(6.4)	-	(2.0)	-
Method	XF	XF	XF	XF	OS	OS	XF	XF	OS	XF
Σ = La+Ce+Pr	78.0	78.0	78.0	78.0	78.0	78.0	78.1	78.1	78.1	78.1
La-Nd	93.6	94.6	95.3	96.1	96.3	96.5	93.6	95.9	96.0	97.0
Sm-Ho	6.2	5.2	4.5	3.9	3.7	3.5	6.2	4.1	3.6	3.0
Er-Lu	0.2	0.2	0.2	-	-	-	0.2	-	0.4	-
RE_2O_3, wt.%	-	-	52.9	-	-	-	-	-	-	-
La/Nd	1.53	1.34	1.34	1.45	1.64	1.45	1.54	1.50	1.38	1.35
ThO_2, wt.%	18.7	7.57	-	-	0.18	-	-	-	1.04	-
U_3O_8, wt.%	-	-	-	-	-	-	-	-	1.38	-

Table 1-34. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)
(a) Eu + Gd calcd. as Gd; (b) Tb + Y calcd. as Y

	327	328	329	330	331	332	333	334	335	336
La	14.3	24.4	20.1	23.5	22.8	23.0	24.0	27.9	26.2	26.0
Ce	56.5	47.3	50.8	49.6	49.5	52.0	52.0	44.6	47.4	47.6
Pr	7.3	6.5	7.3	5.1	6.0	3.3	2.3	5.8	4.7	4.8
Nd	20.0	17.1	17.6	18.8	14.7	15.2	15.4	17.0	17.5	16.7
Sm	1.3	1.6	1.7	2.1	5.3	3.0	2.8	2.2	2.6	1.9
Eu	0.2	-	-	a	-	0.1	0.1	a	-	0.2
Gd	0.4	2.5	1.4	0.9[a]	1.7	2.3	2.1	1.1[a]	1.6	1.4
Tb	-	-	-	c	-	-	-	b	-	0.3
Dy	-	0.4	0.5	c	-	0.9	1.1	0.5	-	0.5
Ho	-	-	-	-	-	-	-	0.2	-	0.1
Er	-	0.1	0.4	-	-	0.1	0.1	0.4	-	0.3
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	0.1	0.2	-	-	0.1	0.1	0.3	-	0.2
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	-	(3.1)	(2.4)	(0.6)[c]	(5.4)	(6.1)	(6.1)	(2.4)[b]	-	(2.4)
Method		OS	XF	CH	EP	XF	XF	CH	XF	CH
Σ = La+Ce+Pr	78.1	78.2	78.2	78.2	78.3	78.3	78.3	78.3	78.3	78.4
La-Nd	98.1	95.3	95.8	97.0	93.0	93.5	93.7	95.3	95.8	95.1
Sm-Ho	1.9	4.5	3.6	3.0	7.0	6.3	6.1	4.0	4.2	4.4
Er-Lu	-	0.2	0.6	-	-	0.2	0.2	0.7	-	0.5
RE_2O_3, wt.%	-	-	-	64.6	61.3	-	-	60.84	-	61.8
La/Nd	0.72	1.43	1.14	1.25	1.55	1.51	1.56	1.64	1.50	1.56
ThO_2, wt.%	-	-	-	5.60	6.5	-	-	4.26	-	-
U_3O_8, wt.%	-	0.25	-	-	0.2	-	-	-	-	-

Table 1-35. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)
(a) Eu + Gd calcd. as Gd; (b) Tb + Y calcd. as Y

	337	338	339	340	341	342	343	344	345	346
La	24.6	32.2	25.1	25.3	27.8	26.3	23.2	27.2	24.1	26.6
Ce	48.8	40.0	48.4	49.0	46.3	47.5	49.1	51.3	52.2	47.2
Pr	5.0	6.2	4.9	4.2	4.4	4.7	6.2	-	2.4	4.9
Nd	16.9	17.3	18.4	13.0	16.1	17.5	19.6	21.5	15.7	16.1
Sm	2.9	2.7	2.5	2.7	2.1	2.6	1.3	-	2.6	2.4
Eu	-	0.1	-	0.2	0.2	-	0.1	-	-	a
Gd	1.8	0.4	0.7	1.6	1.5	1.4	0.5	-	2.0	1.6[a]
Tb	-	0.1	-	0.5	0.3	-	-	-	-	b
Dy	-	0.3	-	1.0	1.3	-	-	-	0.9	0.6
Ho	-	-	-	-	-	-	-	-	-	0.2
Er	-	0.7	-	0.9	-	-	-	-	-	0.4
Tm	-	-	-	0.4	-	-	-	-	-	-
Yb	-	-	-	0.8	-	-	-	-	0.1	-
Lu	-	-	-	0.4	-	-	-	-	-	-
Y/(Y+La)x100	(0.3)	(7.1)	(5.5)	(1.3)	(1.6)	-	-	(5.8)	(3.8)	(1.9)[b]
Method	XF	ICP	OS	XF	-	XF	XF	OS	XF	CH
Σ = La+Ce+Pr	78.4	78.4	78.4	78.5	78.5	78.5	78.5	78.5	78.7	78.7
La-Nd	95.3	95.7	96.8	91.5	94.6	96.0	98.1	100.0	94.4	94.8
Sm-Ho	4.7	3.6	3.2	6.0	5.4	4.0	1.9	-	5.5	4.8
Er-Lu	-	0.7	-	2.5	-	-	-	-	0.1	0.4
RE_2O_3, wt.%	-	65.1	-	42.5	61.21	-	-	-	-	58.48
La/Nd	1.46	1.86	1.36	1.95	1.73	1.50	1.18	1.27	1.54	1.65
ThO_2, wt.%	-	3.32	7.7	-	-	-	-	8.1	-	4.96
U_3O_8, wt.%	-	0.87	-	-	-	-	-	-	-	-

Table 1-36. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)
(a) Eu + Gd calcd. as Gd; (b) Tb + Y calcd. as Y

	347	348	349	350	351	352	353	354	355	356
La	20.3	27.8	24.5	26.1	25.2	27.0	28.5	19.3	24.2	27.7
Ce	52.4	45.6	52.8	47.9	48.1	41.9	44.0	54.3	52.4	46.7
Pr	6.0	5.4	1.5	4.8	5.5	9.9	6.4	5.3	2.3	4.5
Nd	16.7	13.5	14.9	16.6	17.6	17.8	14.3	14.5	15.5	16.1
Sm	1.9	3.0	3.0	1.9	1.5	1.5	3.3	2.6	2.6	2.1
Eu	-	0.7	-	a	-	-	0.6	0.2	0.1	a
Gd	2.2	3.5	1.9	1.6[a]	1.2	1.8	2.9	1.9	1.7	1.7[a]
Tb	-	-	-	b	0.2	-	-	0.2		b
Dy	0.3	-	1.2	0.5	0.6	-	-	1.2	1.0	1.2
Ho	-	0.1	-	0.1	0.1	-	-	0.1	-	-
Er	0.1	0.4	0.1	0.3	-	0.1	-	0.2	0.1	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	0.1	-	0.1	0.2	-	-	-	0.2	0.1	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	-	(2.4)	(4.8)	(2.8)[b]	-	-	(1.6)	-	(5.2)	(1.9)[b]
Method	XF	-	XF	CH	XF	OS	-	XF	XF	CH
Σ = La+Ce+Pr	78.7	78.8	78.8	78.8	78.8	78.8	78.9	78.9	78.9	78.9
La-Nd	95.4	92.3	93.7	95.4	96.4	96.6	93.2	93.4	94.4	95.0
Sm-Ho	4.4	7.3	6.1	4.1	3.6	3.3	6.8	6.2	5.4	5.0
Er-Lu	0.2	0.4	0.2	0.5	-	0.1	-	0.4	0.2	-
RE_2O_3, wt.%	-	-	-	61.69	-	59.7	-	-	-	61.21
La/Nd	1.22	2.06	1.64	1.57	1.43	1.52	1.99	1.33	1.56	1.72
ThO_2, wt.%	-	-	-	4.62	-	-	-	-	-	5.32
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 1-37. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)
(a) Eu + Gd calcd. as Gd; (b) Tb + Y calcd. as Y

	357	358	359	360	351	362	363	364	365	366
La	26.4	28.6	28.4	29.5	23.0	27.1	28.6	29.2	27.2	17.2
Ce	47.4	43.0	43.3	45.0	51.5	46.8	41.0	41.7	46.3	56.8
Pr	5.1	7.3	7.2	4.5	4.6	5.3	9.6	8.3	5.8	5.3
Nd	17.6	17.9	18.0	15.5	15.1	15.2	17.4	20.8	16.9	17.7
Sm	2.5	1.3	1.3	3.9	2.9	2.3	1.5	-	2.7	1.8
Eu	-	0.2	0.2	-	-	a	-	-	a	a
Gd	1.0	1.6	1.6	1.6	1.6	1.4[a]	1.9	-	1.1[a]	1.2[a]
Tb	-	-	-	-	-	b	-	-	b	-
Dy	-	-	-	-	-	0.6	-	-	-	-
Ho	-	-	-	-	1.2	0.3	-	-	-	-
Er	-	0.1	-	-	-	0.7	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	0.1	0.3	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	-	-	-	-	(5.0)	(2.4)[b]	(1.3)	-	(2.2)[b]	(1.6)
Method	XF	OS	OS	XF	XF	CH	OS	XF	CH	CH
Σ = La+Ce+Pr	78.9	78.9	78.9	79.0	79.1	79.2	79.2	79.2	79.3	79.3
La-Nd	96..5	96.8	96.9	94.5	94.2	94.4	96.6	100.0	96.2	97.0
Sm-Ho	3.5	3.1	3.1	5.5	5.7	4.6	3.4	-	3.8	3.0
Er-Lu	-	0.1	-	-	0.1	1.0	-	-	-	-
RE_2O_3, wt.%	-	60.0	-	-	-	39.69	-	-	62.08	55.1
La/Nd	1.50	1.60	1.58	1.90	1.52	1.78	1.64	1.40	1.61	0.97
ThO_2, wt.%	-	-	-	-	-	8.94	-	-	3.00	-
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 1-38. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	367	368	369	370	371	372	373	374	375	376
La	27.4	23.9	25.8	25.8	26.1	25.7	29.7	24.2	27.7	31.3
Ce	51.9	52.3	49.1	53.6	49.7	50.4	45.9	52.8	47.1	43.2
Pr	-	3.2	4.5	-	3.7	3.4	3.9	2.5	4.7	5.0
Nd	20.7	15.2	18.0	18.0	12.3	13.0	15.0	15.3	16.8	18.0
Sm	-	2.4	2.3	2.4	2.6	2.7	1.6	2.5	2.4	1.8
Eu	-	0.1	-	-	0.2	-	-	-	-	-
Gd	-	1.5	-	-	1.5	1.5	2.6	1.;8	1.3	0.7
Tb	-	-	-	-	0.4	0.4	0.2	-	-	-
Dy	-	1.4	0.3	0.2	1.3	1.1	1.1	0.8	-	-
Ho	-	-	-	-	0.2	0.2	-	-	-	-
Er	-	-	-	-	0.7	0.5	-	-	-	-
Tm	-	-	-	-	0.3	0.3	-	-	-	-
Yb	-	-	-	-	0.5	0.5	-	0.1	-	-
Lu	-	-	-	-	0.5	0.3	-	-	-	-
Y/(Y+La)x100	(6.3)	(4.5)	(2.7)	(2.6)	(1.2)	1.0	(1.2)	(3.6)	-	-
Method	OS	XF	EP	EP	XF	XF	XF	XF	XF	XF
Σ = La+Ce+Pr	79.3	79.4	79.4	79.4	79.5	79.5	79.5	79.5	79.5	79.5
La-Nd	100.00	94.6	97.4	97.4	91.8	92.5	94.5	94.8	96.3	97.5
Sm-Ho	-	5.4	2.6	2.6	6.2	5.9	5.5	5.1	3.7	2.5
Er-Lu	-	-	-	-	2.0	1.6	-	0.1	-	-
RE_2O_3, wt.%	-	-	57.65	59.06	48.8	49.4	48.3	-	-	-
La/Nd	1.32	1.57	1.43	1.43	2.12	1.98	1.98	1.58	1.65	1.74
ThO_2, wt.%	8.2	-	8.04	8.07	-	-	-	-	-	-
U_3O_8, wt.%	-	-	0.64*	0.91*	-	-	-	-	-	-

Table 1-39. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)
(a) Eu + Gd calcd. as Gd; (b) Tb + Y calcd. as Y; (c) Tb + Dy + Y calcd. as Y

	377	378	379	380	381	382	383	384	385	386
La	25.4	23.2	23.2	27.8	22.9	22.1	25.0	24.0	23.4	26.2
Ce	54.1	51.8	52.9	41.6	53.4	53.4	52.4	49.2	51.1	49.0
Pr	-	4.6	3.5	10.2	3.4	4.2	2.3	6.5	5.2	4.6
Nd	20.5	14.8	14.9	16.8	14.8	14.9	15.0	15.5	18.2	14.4
Sm	-	2.8	2.5	1.8	2.5	1.9	2.5	2.2	1.4	5.1
Eu	-	-	0.1	a	0.1	-	-	0.1	a	-
Gd	-	1.6	1.6	0.9[a]	1.2	1.4	1.8	1.0	0.7[a]	0.7
Tb	-	-	-	b	-	0.2	-	0.1	c	-
Dy	-	1.0	1.3	0.6	1.2	0.6	0.9	0.7	c	-
Ho	-	-	-	0.1	-	0.2	-	0.1	-	-
Er	-	-	-	0.1	0.4	0.2	-	0.3	-	-
Tm	-	-	-	-	-	0.2	-	-	-	-
Yb	-	0.2	-	0.1	0.1	0.7	0.1	0.3	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(8.9)	(5.4)	(3.7	(1.5)[b]	(4.6)	(0.6	(4.4)	-	(1.1)[c]	1.6)
Method	OS	XF	XF	CH	XF	XF	XF	XF	CH	EP
Σ = La+Ce+Pr	79.5	79.6	79.6	79.6	79.7	79.7	79.7	79.7	79.7	79.8
La-Nd	100.0	94.4	94.5	96.4	94.5	94.6	94.7	95.2	97.9	94.2
Sm-Ho	-	5.4	5.5	3.4	3.8	4.3	5.2	4.2	2.1	5.8
Er-Lu	-	0.2	-	0.2	0.5	1.1	0.1	0.6	-	-
RE_2O_3, wt.%	-	-	-	58.92	-	45.5	-	-	64.6	64.7
La/Nd	1.24	1.57	1.56	1.65	1.55	1.48	1.67	1.55	1.29	1.82
ThO_2, wt.%	12.2	-	-	7.07	-	-	-	-	5.6	0.7
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	1.3

Table 1-40. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

(a) Eu + Gd calcd. as Gd

	387	388	389	390	391	392	393	394	395	396
La	24.0	23.2	26.6	28.3	23.6	24.2	20.4	24.4	23.9	25.4
Ce	53.1	53.2	48.8	46.6	53.4	52.3	54.3	53.8	52.8	52.9
Pr	2.7	3.4	4.4	4.9	2.9	3.4	5.2	1.8	3.3	1.7
Nd	14.8	14.9	15.3	16.0	14.7	14.7	17.3	14.1	14.6	14.7
Sm	2.5	2.4	2.6	2.5	2.5	2.4	2.2	2.6	2.5	2.5
Eu	0.1	0.1	0.1	-	0.1	0.2	a	-	0.1	0.1
Gd	1.7	1.6	1.5	1.0	1.7	1.5	0.6[a]	1.7	1.6	1.8
Tb	-	-	0.1	-	-	-	-	-	-	-
Dy	1.0	1.0	0.5	0.7	1.0	1.3	-	1.4	1.1	0.8
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	0.1	-	-	0.1	-	-
Tm	-	-	0.1	-	-	-	-	-	-	-
Yb	0.1	0.2	-	-	-	-	-	0.1	0.1	0.1
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(3.9)	(5.5)	-	-	(4.4)	(4.0)	(0.9)	(4.2)	(4.6)	(3.3)
Method	XF	XF	XF	CH	XF	XF	CH	XF	XF	XF
Σ = La+Ce+Pr	79.8	79.8	79.8	79.8	79.9	79.9	79.9	80.0	80.0	80.0
La-Nd	94.6	94.7	95.1	95.8	94.6	94.6	97.2	94.1	94.6	94.7
Sm-Ho	5.3	5.1	4.8	4.2	5.3	5.4	2.8	5.7	5.3	5.2
Er-Lu	0.1	0.2	0.1	-	0.1	-	-	0.2	0.1	0.1
RE_2O_3, wt.%	-	-	-	67.2	-	-	-	-	-	-
La/Nd	1.62	1.56	1.74	1.77	1.61	1.65	1.18	1.73	1.64	1.73
ThO_2, wt.%	-	-	-	1.68	-	-	-	-	-	-
U_3O_8, wt.%	-	-	-	0.035	-	-	-	-	-	-

Table 1-41. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	397	398	399	400	401	402	403	404	405	406
La	15.5	26.8	24.5	28.4	23.1	23.5	25.9	24.2	25.0	27.0
Ce	42.5	44.1	55.5	46.6	53.8	51.2	49.9	54.0	53.7	44.0
Pr	22.0	9.1	-	5.1	3.2	5.4	4.3	2.0	1.5	9.2
Nd	15.6	17.2	20.0	14.4	14.5	15.1	17.0	14.1	14.9	17.2
Sm	3.0	1.3	-	1.5	2.4	2.2	2.8	2.6	2.4	1.2
Eu	-	-	-	0.1	-	0.1	-	-	-	-
Gd	1.4	1.4	-	-	1.9	1.6	-	1.6	1.7	1.4
Tb	-	-	-	-	-	0.1	-	-	-	-
Dy	-	-	-	1.4	0.9	0.6	0.1	1.3	0.7	-
Ho	-	0.1	-	0.9	-	0.1	-	-	-	-
Er	-	-	-	1.2	0.1	-	-	0.1	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	0.4	0.1	0.1	-	0.1	0.1	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(1.2)	-	(0.7)	-	(4.2)	-	(1.9)	(3.9)	(3.6)	(1.9)
Method	CH	OS	OS	OS	XF	XF	EP	XF	XF	OS
Σ = La+Ce+Pr	80.0	80.0	80.0	80.1	80.1	80.1	80.1	80.2	80.2	80.2
La-Nd	95.6	97.2	100.0	94.5	94.6	95.2	97.1	94.3	95.1	97.4
Sm-Ho	4.4	2.8	-	3.9	5.2	4.7	2.9	5.5	4.8	2.6
Er-Lu	-	-	-	1.6	0.2	0.1	-	0.2	0.1	-
RE_2O_3, wt.%	-	54.4	-	-	-	-	60.08	-	-	-
La/Nd	0.99	1.56	1.23	1.97	1.59	1.56	1.52	1.72	1.68	1.57
ThO_2, wt.%	-	-	13.7	0.2	-	-	8.27	-	-	-
U_3O_8, wt.%	-	-	-	-	-	-	0.82	-	-	-

Table 1-42. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	407	408	409	410	411	412	413	414	415	416
La	28.2	25.3	20.6	24.5	26.6	27.7	26.9	27.1	29.5	27.2
Ce	52.0	54.9	53.6	51.5	49.5	52.6	48.0	53.2	46.6	53.2
Pr	-	-	6.1	4.3	4.2	-	5.4	-	4.3	-
Nd	17.2	19.8	16.7	17.1	17.3	17.4	18.0	19.7	15.5	19.6
Sm	2.4	-	2.5	2.5	2.3	2.2	1.0	-	1.6	-
Eu	-	-	-	-	-	-	0.1	-	-	-
Gd	-	-	-	-	-	-	0.6	-	2.5	-
Tb	-	-	-	-	-	-	-	-	-	-
Dy	0.2	-	0.5	0.1	0.1	0.1	-	-	-	-
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(2.7)	(6.2)	(3.5)	(2.7)	(1.9)	(1.8)	-	(7.4)	-	(0.6)
Method	EP	OS	EP	EP	EP	EP	XF	OS	XF	OS
Σ = La+Ce+Pr	80.2	80.2	80.3	80.3	80.3	80.3	80.3	80.3	80.4	80.4
La-Nd	97.4	100.0	97.0	97.4	97.6	97.7	98.3	100.0	95.9	100.0
Sm-Ho	2.6	-	3.0	2.6	2.4	2.3	1.7	-	4.1	-
Er-Lu	-	-	-	-	-	-	-	-	-	-
RE_2O_3, wt.%	58.53	-	-	59.72	57.67	58.85	-	-	-	-
La/Nd	1.64	1.28	1.23	1.43	1.54	1.59	1.49	1.38	1.90	1.39
ThO_2, wt.%	7.59	9.1	-	8.91	7.35	7.16	-	7.5	-	-
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 1-43. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)
(a) Eu + Gd calcd. as Gd; (b) Tb + Y calcd. as Y; (c) Tb + Dy + Y calcd. as Y

	417	418	419	420	421	422	423	424	425	426
La	26.3	29.5	24.9	25.8	22.6	25.8	8.7	23.0	28.1	24.7
Ce	49.8	47.1	51.0	50.5	53.9	49.9	65.2	53.5	43.8	53.6
Pr	4.4	3.9	4.6	4.2	4.0	4.8	6.7	4.1	8.7	2.4
Nd	11.6	14.9	14.9	16.1	16.4	17.0	11.6	16.4	17.1	13.8
Sm	2.7	1.1	2.0	2.5	1.9	2.4	4.8	1.9	1.0	2.4
Eu	0.1	-	a	-	a	-	-	a	-	-
Gd	1.5	1.7	1.6[a]	-	1.2[a]	-	3.0	1.0[a]	1.3	2.0
Tb	0.5	0.2	b	-	-	-	-	c	-	-
Dy	1.1	1.2	0.4	0.9	-	0.9	-	c	-	1.0
Ho	0.5	0.2	0.1	-	-	-	-	-	-	-
Er	0.1	-	0.2	-	-	-	-	-	-	-
Tm	0.5	0.2	-	-	-	-	-	-	-	-
Yb	0.7	-	0.3	-	-	-	-	-	-	0.1
Lu	0.2	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(0.9)	(1.2)	(3.9)[b]	(1.9)	(1.1)	(2.2)	(0.15)	(2.8[c])	(1.2)	(4.6)
Method	XF	XF	CH	EP	CH	EP	XF	CH	OS	XF
Σ = La+Ce+Pr	80.5	80.5	80.5	80.5	80.5	80.5	80.6	80.6	80.6	80.7
La-Nd	92.1	95.4	95.4	96.6	96.9	97.5	92.2	97.0	97.7	94.5
Sm-Ho	6.4	4.4	4.1	3.4	3.1	3.3	7.8	2.9	2.3	5.4
Er-Lu	1.5	0.2	0.5	-	-	-	-	-	-	0.1
RE_2O_3, wt.%	49.2	48.2	61.76	60.38	56.3	59.71	50.6	53.45	-	-
La/Nd	2.27	1.98	1.67	1.60	1.38	1.52	0.75	1.40	1.64	1.79
ThO_2, wt.%	-	-	6.20	7.85	-	9.05	5.77	5.55	-	-
U_3O_8, wt.%	-	-	-	-	-	0.55	-	-	-	-

Table 1-44. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	427	428	429	430	431	432	433	434	435	436
La	25.1	24.6	19.5	25.7	24.3	24.6	28.4	24.9	22.7	26.3
Ce	51.5	51.9	55.2	49.9	56.5	51.2	47.8	51.4	52.0	49.2
Pr	4.1	4.2	6.1	5.2	-	5.1	4.7	4.6	6.2	5.4
Nd	16.5	16.5	17.0	17.0	19.2	15.0	16.2	16.6	17.2	17.6
Sm	2.5	2.7	2.2	2.2	-	1.9	1.9	2.4	1.9	0.9
Eu	-	-	-	-	-	0.2	-	-	-	0.1
Gd	-	-	-	-	-	1.0	1.0	-	-	0.5
Tb	-	-	-	-	-	-	-	-	-	-
Dy	0.3	0.1	-	-	-	1.6	-	0.1	-	-
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	0.4	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(3.0	(1.9)	-	(5.4)	(9.2)	-	-	(2.4)	-	(0.4)
Method	EP	EP	XF	EP	OS	XF	XF	EP	EP	XF
Σ = La+Ce+Pr	80.7	80.7	80.8	80.8	80.8	89.9	80.9	80.9	80.9	80.9
La-Nd	97.2	97.2	97.8	97.8	100.0	95.9	97.1	97.5	98.1	98.5
Sm-Ho	2.8	2.8	2.2	2.2	-	4.7	2.9	2.5	1.9	1.5
Er-Lu	-	-	-	-	-	0.4	-	-	-	-
RE_2O_3, wt.%	54.87	60.8	-	-	-	-	-	62.46	62.33	69.4
La/Nd	1.52	1.49	1.15	1.51	1.27	1.63	1.75	1.50	1.32	1.49
ThO_2, wt.%	10.89	8.44	-	2.45	7.5	-	-	8.71	1.79	-
U_3O_8, wt.%	-	-	-	-	-	-	-	0.48	-	-

Table 1-45. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)
(a) Eu + Gd calcd. as Gd; (b) Tb + Y calcd. as Y

	437	438	439	440	441	442	443	444	445	446
La	27.7	28.0	23.9	23.7	24.4	25.7	25.8	26.0	30.0	29.8
Ce	53.2	44.5	51.2	53.5	51.6	50.3	50.2	50.0	51.1	45.4
Pr	-	8.4	5.9	3.4	5.0	5.0	5.0	5.1	-	6.0
Nd	19.1	19.1	13.4	14.5	15.7	16.6	16.6	16.3	18.7	12.0
Sm	-	-	2.8	2.3	2.2	2.4	2.4	2.6	-	2.4
Eu	-	-	a	-	-	-	-	-	-	0.6
Gd	-	-	1.6[a]	1.0	0.8	-	-	-	-	2.9
Tb	-	-	b	-	-	-	-	-	-	-
Dy	-	-	1.2	1.1	0.3	-	-	-	-	-
Ho	-	-	-	-	-	-	-	-	-	0.2
Er	-	-	-	-	-	-	-	-	-	0.5
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	0.1	-	-	-	-	-	0.2
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(6.5)	-	(2.5)[b]	(3.6)	-	(6.5)	(5.2)	(6.6)	(8.0)	(6.2)
Method	OS	XF	CH	XF	-	EP	EP	EP	OS	-
Σ = La+Ce+Pr	80.9	80.9	80.6	80.6	81.0	81.0	81.0	81.1	81.1	81.2
La-Nd	100.0	100.0	94.4	95.1	96.7	97.6	97.6	97.4	99.8	93.2
Sm-Ho	-	-	5.6	4.4	3.3	2.4	2.4	2.6	-	6.1
Er-Lu	-	-	-	0.1	-	-	-	-	-	0.7
RE_2O_3, wt.%	-	-	62.75	-	-	-	-	-	-	-
La/Nd	1.45	1.47	1.78	1.63	1.55	1.55	1.55	1.60	1.60	2.48
ThO_2, wt.%	6.9	-	-	-	-	1.88	2.46	2.42	6.1	2.1
U_3O_8,wt.%	-	-	-	-	-	-	-	-	-	-

Table 1-46. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)
(a) Eu + Gd calcd. as Gd; (c) Tb _ Dy + Y calcd. as Y

	447	448	449	450	451	452	453	454	455	456
La	24.6	27.0	26.0	26.0	26.7	27.5	28.7	26.4	26.3	22.3
Ce	51.8	48.8	50.4	50.6	49.7	53.7	49.0	54.9	49.1	53.4
Pr	4.8	5.4	4.8	4.6	4.8	-	3.6	-	6.0	5.7
Nd	16.0	16.1	16.2	16.3	17.3	18.8	14.0	18.7	16.4	16.6
Sm	2.5	1.6	1.9	2.4	1.5	-	0.9	-	1.5	1.6
Eu	-	0.3	-	-	-	-	0.2	-	a	0.1
Gd	-	0.6	0.7	-	-	-	2.2	-	0.7[a]	0.2
Tb	-	0.1	-	-	-	-	0.2	-	c	-
Dy	0.3	0.1	-	0.1	-	-	1.2	-	c	0.1
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(2.8)	(0.3)	(1.6)	(1.8)	-	(7.5)	(0.7)	(5.7)	(1.0)[c]	-
Method	EP	AAS	OS	EP	EP	OS	XF	OS	CH	XF
Σ = La+Ce+Pr	81.2	81.2	81.2	81.2	81.2	81.2	81.3	81.3	81.4	81.4
La-Nd	97.2	97.3	97.4	97.5	98.5	100.0	95.3	100.0	97.8	98.0
Sm-Ho	2.8	2.7	2.6	2.5	1.5	-	4.7	-	2.2	2.0
Er-Lu	-	-	-	-	-	-	-	-	-	-
RE_2O_3, wt.%	59.55	69.88	-	61.40	68.56	-	49.8	-	60.5	54.0
La/Nd	1.54	1.68	1.60	1.60	1.54	1.46	2.05	1.41	1.60	1.34
ThO_2, wt.%	8.45	-	13.0	8.04	1.26	7.0	-	7.9	1.47	2.39
U_3O_8, wt.%	0.24	-	-	0.64	-	-	-	-	-	0.03

Table 1-47. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

(a) Eu + Gd calcd. as Gd

	457	458	459	460	46	462	463	464	465	466
La	22.8	23.4	30.2	31.5	22.6	22.2	31.3	25.0	21.4	23.7
Ce	52.7	52.3	51.3	50.0	47.9	48.3	47.1	52.4	54.7	53.2
Pr	6.0	5.8	-	-	11.1	11.1	3.2	4.2	5.5	4.8
Nd	16.2	16.5	18.5	18.5	13.0	13.1	14.6	15.8	16.0	13.6
Sm	1.5	1.0	-	-	2.2	2.3	0.9	2.4	1.4	2.0
Eu	-	0.2	-	-	-	-	0.2	-	a	-
Gd	0.5	0.5	-	-	2.9	3.0	1.6	-	1.0[a]	0.9
Tb	-	-	-	-	-	-	0.2	-	-	0.2
Dy	0.3	0.3	-	-	-	-	0.9	0.2	-	0.6
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	0.3	-	-	-	-	0.2
Tm	-	-	-	-	-	-	-	-	-	0.3
Yb	-	-	-	-	-	-	-	-	-	0.3
Lu	-	-	-	-	-	-	-	-	-	0.2
Y/(Y+La)x100	-	(0.6)	(3.1)	(5.2)	-	(2.5)	(0.9)	(2.2)	(1.1)	(0.4)
Method	XF	-	OS	OS	OS	OS	XF	EP	CH	XF
Σ = La+Ce+Pr	81.5	81.5	81.5	81.5	81.6	81.6	81.6	81.6	81.6	81.7
La-Nd	97.7	98.0	100.0	100.0	94.6	94.7	96.2	97.4	97.6	95.3
Sm-Ho	2.3	2.0	-	-	5.1	5.3	3.8	2.6	2.4	3.7
Er-Lu	-	-	-	-	0.3	-	-	-	-	1.0
RE_2O_3	61.0	68.93	-	-	59.8	-	50.4	60.68	-	46.2
La/Nd	1.41	1.42	1.63	1.70	1.74	1.69	2.14	1.58	1.34	1.74
ThO_2, wt.%	3.8	-	9.4	5.9	-	-	-	8.13	-	-
U_3O_8, wt.%	-	-	-	-	-	-	-	2.28	-	-

Table 1-48. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)
(a) Eu + Gd calcd. as Gd; (b) Tb + Y calcd. as Y

	467	468	469	470	471	472	473	474	475	476
La	27.6	22.9	26.8	29.6	29.8	27.2	26.7	23.2	22.7	27.6
Ce	50.8	53.0	50.2	46.3	46.3	50.5	51.0	53.9	53.7	50.3
Pr	3.5	6.2	5.1	6.3	6.1	4.6	4.6	5.3	6.0	4.5
Nd	13.9	14.5	16.0	13.2	13.7	15.4	15.5	15.0	15.2	15.8
Sm	1.9	2.1	1.0	2.0	2.0	2.2	2.1	1.4	1.4	1.8
Eu	-	a	0.2	0.5	0.2	-	-	-	-	-
Gd	2.3	0.8[a]	-	2.1	1.9	-	-	1.2	0.4	-
Tb	-	b	-	-	-	-	-	-	-	-
Dy	-	0.2	0.2	-	-	0.1	0.1	-	0.3	-
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	0.2	0.3	-	-	-	-	-	0.1	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	0.1	0.2	-	-	-	-	-	0.2	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(1.7)	(4.0)[b]	(2.9)	(1.9)	(1.9)	(2.2)	(2.0)	(1.1)	-	(0.8)
Method	OS	CH	XF	-	-	EP	EP	CH	XF	EP
Σ = La+Ce+Pr	81.9	82.1	82.1	82.2	82.2	82.3	82.3	82.4	82.4	82.4
La-Nd	95.8	96.6	98.1	95.4	95.9	97.7	97.8	97.4	97.6	98.2
Sm-Ho	4.2	3.1	1.4	4.6	4.1	2.3	2.2	2.6	2.1	1.8
Er-Lu	-	0.3	0.5	-	-	-	-	-	0.3	-
RE_2O_3	63.2	63.0	-	-	-	61.44	60.83	56.06	52.7	62.61
La/Nd	1.99	1.58	1.68	2.24	2.18	1.77	1.72	1.55	1.49	1.75
ThO_2, wt.%	4.6	5.46	-	2.6	1.8	8.45	8.33	-	-	6.42
U_3O_8, wt.%	trace	-	-	-	-	0.50	0.58	-	-	0.77

Table 1-49. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	477	478	479	480	481	482	483	484	485	486
La	22.0	21.7	30.7	28.7	27.1	27.9	22.9	28.0	27.0	34.7
Ce	57.0	54.7	45.2	50.0	51.4	50.1	49.8	49.8	51.4	38.6
Pr	3.5	6.1	6.8	4.0	4.2	4.7	10.1	5.1	4.6	9.7
Nd	10.4	15.1	11.9	13.8	14.9	16.4	12.5	15.6	15.3	17.0
Sm	1.8	1.2	1.0	1.4	2.2	0.9	2.2	1.5	1.2	-
Eu	-	0.4	0.2	-	-	-	-	-	-	-
Gd	4.9	0.6	0.2	1.4	-	-	2.3	-	0.5	-
Tb	-	-	-	0.4	-	-	-	-	-	-
Dy	0.2	0.2	0.4	0.1	0.2	-	-	-	-	-
Ho	-	-	-	-	-	-	-	-	-	-
Er	0.2	-	1.8	0.2	-	-	0.2	-	-	-
Tm	-	-	1.6	-	-	-	-	-	-	-
Yb	-	-	0.2	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(0.3)	(0.6)	-	(0.6)	(2.3)	-	-	-	(0.3)	-
Method	EP	-	XF	XF	EP	XF	XF	XF	OS	XF
Σ = La+Ce+Pr	82.5	82.5	82.7	82.7	82.7	82.7	82.8	82.9	83.0	83.0
La-Nd	92.9	97.6	94.6	96.5	97.6	99.1	95.3	98.5	98.3	100.0
Sm-Ho	6.9	2.4	1.8	3.3	2.4	0.9	4.5	1.5	1.7	-
Er-Lu	0.2	-	3.6	0.2	-	-	0.2	-	-	-
RE_2O_3	-	70.11	62.5	52.3	59.55	-	54.7	-	-	-
La/Nd	2.12	1.44	2.58	2.08	1.82	1.70	1.83	1.79	1.76	2.04
ThO_2, wt.%	-	-	-	-	-	7.47	-	-	6.7	-
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 1-50. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)
(a) Eu + Gd calcd. as Gd; (b) Tb + Y calcd. as Y; (c) Tb + Dy + Y calcd. as Y

	487	488	489	490	491	492	493	494	495	496
La	23.5	18.2	20.6	28.6	23.5	27.8	31.2	29.3	26.5	28.3
Ce	54.8	58.8	60.3	50.7	55.1	55.5	47.5	50.0	53.5	55.5
Pr	4.8	6.1	2.3	4.0	4.7	-	4.8	4.3	3.8	-
Nd	13.9	14.8	5.9	7.9	13.2	16.7	14.9	14.1	14.0	16.2
Sm	1.9	1.5	0.8	-	2.5	-	1.6	1.8	1.5	-
Eu	a	a	0.1	-	a	-	-	0.3	a	-
Gd	1.1[a]	0.6[a]	1.5	-	0.5[a]	-	-	0.2	0.7[a]	-
Tb	-	c	0.2	-	b	-	-	-	c	-
Dy	-	c	2.0	5.4	0.3	-	-	-	c	-
Ho	-	-	0.2	-	-	-	-	-	-	-
Er	-	-	0.9	1.7	0.2	-	-	-	-	-
Tm	-	-	0.1	-	-	-	-	-	-	-
Yb	-	-	4.7	1.7	-	-	-	-	-	-
Lu	-	-	0.4	-	-	-	-	-	-	-
Y/(Y+La)x100	(1.4)	(3.4)[c]	-	-	(0.9)[b]	(0.6)	-	-	(2.8)[c]	(0.4)
Method	CH	CH	XF	XF	CH	OS	XF	EP	CH	OS
Σ = La+Ce+Pr	83.1	83.1	83.2	83.3	83.3	83.3	83.5	83.6	83.8	83.8
La-Nd	97.0	97.9	89.1	91.2	96.5	100.0	98.4	97.7	97.8	100.0
Sm-Ho	3.0	2.1	4.8	5.4	3.3	-	1.6	2.3	2.2	-
Er-Lu	-	-	6.1	3.4	0.2	-	-	-	-	-
RE_2O_3	-	60.05	-	-	60.85	-	-	57.45	56.2	-
La/Nd	1.69	1.23	3.49	3.62	1.78	1.66	2.09	2.08	1.89	1.75
ThO_2, wt.%	-	7.95	-	-	4.15	8.4	-	-	2.78	8.7
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 1-51. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (contd.)

	497	498	499	500	501	502	503	504	505	506
La	24.7	27.5	31.21	27.7	24.1	27.3	26.5	28.2	31.7	33.9
Ce	53.8	51.3	48.4	56.5	55.0	53.2	52.9	56.5	48.9	42.5
Pr	5.4	5.2	4.6	-	5.3	3.9	5.1	-	4.3	8.8
Nd	13.5	15.0	14.2	15.8	13.1	13.5	14.3	15.3	14.4	12.1
Sm	1.6	0.6	1.5	-	1.5	1.8	0.7	-	0.7	1.7
Eu	a	-	-	-	0.1	-	0.1	-	-	0.1
Gd	0.8[a]	0.4	0.1	-	0.7	-	0.4	-	-	0.8
Tb	0.1	-	-	-	0.1	-	-	-	-	-
Dy	0.1	-	-	-	0.1	0.3	-	-	-	0.1
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(2.1)	(0.3)	(0.4)	(0.4)	(2.0)	(3.2)	-	(0.5)	-	(3.2)
Method	CH	-	-	OS	-	EP	-	OS	XF	XF
Σ = La+Ce+Pr	83.9	84.0	84.2	84.2	84.4	84.4	84.5	84.7	84.9	85.2
La-Nd	97.4	99.0	98.4	100.0	97.5	97.9	98.8	100.0	99.3	97.3
Sm-Ho	2.6	1.0	1.6	-	2.5	2.1	1.2	-	0.7	2.7
Er-Lu	-	-	-	-	-	-	-	-	-	-
RE_2O_3	59.01	69.36	56.63	-	59.01	48.57	70.84	-	-	68.6
La/Nd	1.83	1.83	2.20	1.75	1.84	2.02	1.85	1.84	2.20	2.80
ThO_2, wt.%	-	0.17	-	9.1	2.42	12.61	0.23	9.4	-	0.11
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 1-52. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	507	508	509	510	511	512	513	514	515	516
La	26.6	35.0	32.1	22.9	25.4	31.3	27.3	21.2	31.3	24.5
Ce	54.0	47.3	48.7	50.3	55.2	49.8	53.3	58.4	50.1	55.7
Pr	4.8	3.1	4.7	12.6	5.2	4.7	5.4	6.6	5.0	6.4
Nd	10.6	11.6	12.8	7.7	12.6	14.2	10.1	10.1	13.6	11.2
Sm	2.6	1.0	0.9	-	0.9	-	-	1.3	-	1.5
Eu	-	-	0.3	2.2	0.2	-	-	0.4	-	-
Gd	1.1	0.8	0.4	-	0.4	-	0.2	0.4	-	0.4
Tb	-	0.4	-	2.3	-	-	-	0.2	-	-
Dy	0.3	0.6	0.1	-	0.1	-	-	0.6	-	0.3
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	0.2	-	-	-	-	3.7	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	0.6	-	-
Lu	-	-	-	-	-	-	-	0.2	-	-
Y/(Y+La)x100	(1.5)	(0.3)	(0.5)	(1.4)	-	-	(0.15)	(0.3)	-	-
Method	CH	XF	-	OS	-	XF	XF	-	XF	-
Σ = La+Ce+Pr	85.4	85.4	85.5	85.8	85.8	85.8	86.0	86.2	86.4	86.6
La-Nd	96.0	97.0	98.3	93.5	98.4	100.0	96.1	96.3	100.0	97.8
Sm-Ho	4.0	2.8	1.7	4.5	1.6	-	0.2	2.9	-	2.2
Er-Lu	-	0.2	-	-	-	-	3.7	0.8	-	-
RE_2O_3	-	54.1	70.99	-	69.66	-	-	-	-	-
La/Nd	2.51	3.02	2.51	2.96	2.02	2.20	2.70	2.10	2.30	2.19
ThO_2, wt.%	6.25	-	-	-	-	-	-	-	-	-
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 1-53. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)
(a) Eu + Gd calcd. as Gd; (c) Tb + Dy + Y calcd. as Y

	517	518	519	520	521	522	523	524	525	526
La	27.5	28.1	29.5	30.5	30.5	25.7	32.1	25.1	24.9	27.3
Ce	54.4	54.2	53.2	52.1	50.9	56.8	51.2	57.5	58.5	56.8
Pr	4.9	4.5	4.3	4.5	5.8	4.7	4.0	5.1	4.7	4.1
Nd	11.1	12.1	11.9	9.7	10.3	12.0	11.4	11.1	10.7	10.3
Sm	1.1	1.1	1.1	1.4	1.4	0.5	1.1	0.9	0.8	0.8
Eu	-	-	-	-	-	a	-	-	a	-
Gd	0.3	-	-	1.2	0.8	0.3[a]	0.2	0.2	0.4[a]	0.3
Tb	-	-	-	-	-	c	-	-	c	-
Dy	0.4	-	-	0.4	0.3	c	-	0.1	c	0.3
Ho	-	-	-	-	-	-	-	-	-	-
Er	0.1	-	-	0.1	-	-	-	-	-	0.1
Tm	-	-	-	-	-	-	-	-	-	-
Yb	0.2	-	-	0.1	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	-	-	-	(3.6)	(2.7)	(0.4)[c]	-	-	(5.6)[c]	-
Method	-	OS	OS	EP	XF	CH	XF	XF	CH	-
Σ = La+Ce+Pr	86.8	86.8	87.0	87.1	87.2	87.2	87.3	87.7	88.1	88.2
La-Nd	97.9	98.9	98.9	96.8	97.5	99.2	98.7	98.8	98.8	98.5
Sm-Ho	1.8	1.1	1.1	3.0	2.5	0.8	1.3	1.2	1.2	1.4
Er-Lu	0.3	-	-	0.2	-	-	-	-	-	0.1
RE_2O_3	-	62.6	-	-	63.1	-	-	-	-	-
La/Nd	2.48	2.32	2.48	3.14	2.96	2.14	2.82	2.26	2.33	2.65
ThO_2, wt.%	-	0.2	2.8	-	4.5	-	-	-	-	-
U_3O_8, wt.%	-	-	0.003	-	-	-	-	-	-	-

Table 1-54. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	527	528	529	530	531	532	533	534	535	536
La	39.3	35.6	40.2	35.2	38.9	40.3	37.0	40.8	36.8	29.1
Ce	45.0	49.4	44.4	50.0	46.1	44.4	48.5	43.9	48.6	56.8
Pr	4.0	3.4	3.9	3.3	3.6	3.9	3.1	4.1	3.5	3.1
Nd	10.7	11.0	9.6	11.1	9.6	9.6	9.9	10.2	10.3	8.2
Sm	1.0	0.6	0.7	0.4	-	0.5	1.0	1.0	0.6	1.0
Eu	-	-	0.1	-	0.4	0.1	-	-	0.1	0.1
Gd	-	-	0.6	-	1.4	0.6	0.1	-	-	0.7
Tb	-	-	0.1	-	-	0.1	-	-	-	0.1
Dy	-	-	0.3	-	-	0.4	0.3	-	-	0.5
Ho	-	-	-	-	-	-	0.1	-	-	-
Er	-	-	-	-	-	-	-	-	0.1	0.2
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	0.1	-	-	0.1	-	-	-	0.2
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	-	(0.3)	(0.9)	-	(1.1)	(0.9)	-	(2.0)	(0.1)	(4.3)
Method	-	EP	-	-	-	-	EP	OS	OS	XF
Σ = La+Ce+Pr	88.3	88.4	88.5	88.5	88.6	88.6	88.6	88.8	88.9	89.0
La-Nd	99.0	99.4	98.1	99.6	98.2	98.	98.5	99.0	99.2	97.2
Sm-Ho	1.0	0.6	1.8	0.4	1.8	1.7	1.5	1.0	0.7	2.4
Er-Lu	-	-	0.1	-	-	0.1	-	-	0.1	0.4
RE_2O_3	-	62.92	65.20	-	-	9.2	59.24	-	68.1	-
La/Nd	3.67	3.24	4.19	3.17	4.05	4.2	3.74	4.00	3.57	3.55
ThO_2, wt.%	-	3.23	-	-	1.8	-	11.6	-	0.08	-
U_3O_8, wt.%	-	-	-	-	-	-	0.4	-	-	-

Table 1-55. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)
(a) Eu + Gd calcd. as Gd; (c) Tb + Dy + Y calcd. as Y

	537	538	539	540	541	542	543	544	545	546
La	34.7	25.8	35.5	37.6	24.3	29.7	39.5	39.4	32.8	35.2
Ce	51.0	61.1	49.4	45.2	59.9	55.0	46.4	46.3	52.6	50.8
Pr	3.3	2.2	4.2	6.3	5.0	4.5	3.4	3.8	4.2	3.7
Nd	9.8	9.2	9.6	10.9	8.1	9.8	9.9	8.5	9.5	8.9
Sm	0.9	1.2	1.1	-	1.1	0.4	0.8	-	0.4	0.6
Eu	-	a	-	-	-	-	-	0.6	-	0.3
Gd	0.3	0.5[a]	0.2	-	0.6	0.4	-	1.3	0.4	0.5
Tb	-	c	-	-	-	-	-	-	-	-
Dy	-	c	-	-	0.3	0.2	-	-	0.1	-
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	0.4	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	0.3	-	-	0.1	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	-	(0.8)[c]	(0.7)	-	(1.6)	(0.3)	-	(1.7)	(0.2)	(0.2)
Method	EP	CH	-	XF	CH	-	XF	-	-	-
Σ = La+Ce+Pr	89.0	89.1	89.1	89.1	89.2	89.2	89.3	89.5	89.6	89.7
La-Nd	98.8	98.3	98.7	100.0	97.3	99.0	99.2	98.0	99.1	98.6
Sm-Ho	1.2	1.7	1.3	-	2.0	1.0	0.8	1.9	0.9	1.4
Er-Lu	-	-	-	-	0.7	-	-	0.1	-	-
RE_2O_3	-	63.9	-	-	63.2	-	-	-	69.96	70.36
La/Nd	3.54	2.80	3.70	3.45	3.00	3.03	3.99	4.64	3.45	3.96
ThO_2, wt.%	-	5.07	-	-	3.1	-	-	-	0.29	-
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 1-56. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd.)

	547	548	549	550	551	552	553	554	555	556
La	35.3	44.9	21.9	37.8	36.9	36.8	37.7	39.5	33.2	37.9
Ce	50.9	44.9	65.0	48.7	49.4	49.1	48.9	47.2	53.1	49.5
Pr	3.5	-	3.0	3.5	3.7	4.2	3.5	3.5	3.9	3.1
Nd	9.8	10.2	9.0	9.2	9.6	9.4	9.4	8.5	9.1	9.0
Sm	0.5	-	0.7	0.8	0.2	0.5	0.5	0.7	0.4	0.5
Eu	-	-	-	-	-	-	-	0.2	-	-
Gd	-	-	0.4	-	-	-	-	0.3	0.2	-
Tb	-	-	-	-	-	-	-	-	-	-
Dy	-	-	-	-	0.2	-	-	0.1	0.1	-
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	-	(2.0)	-	-	(1.3)	-	-	(0.5)	-	-
Method	XF	OS	XF	-	EP	XF	XF	-	-	XF
Σ = La+Ce+Pr	89.7	89.8	89.9	90.0	90.0	90.1	90.1	90.2	90.2	90.5
La-Nd	99.5	100.0	98.9	99.2	99.6	99.5	99.5	98.7	99.3	99.5
Sm-Ho	0.5	-	1.1	0.8	0.4	0.5	0.5	1.3	0.7	0.5
Er-Lu	-	-	-	-	-	-	-	-	-	-
RE_2O_3	-	-	-	-	-	-	-	-	-	-
La/Nd	3.60	4.40	2.43	4.11	3.84	3.91	4.01	4.65	3.65	4.21
ThO_2, wt.%	3.0	-	-	-	-	-	-	-	-	-
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 1-57. Monazite-(Ce) from igneous and metamorphic rocks, atomic percent (cont'd)

	557	558	559	560	561	562	563	564	565
La	38.4	35.4	33.2	32.4	37.4	30.8	35.6	39.1	40.4
Ce	48.9	52.2	54.4	56.0	50.1	58.2	50.2	50.8	47.0
Pr	3.6	3.4	3.4	2.7	3.8	2.6	5.9	2.0	4.7
Nd	8.4	8.2	8.5	8.5	8.7	8.0	7.3	6.6	6.6
Sm	0.2	0.5	0.3	0.1	-	0.1	0.7	0.2	-
Eu	-	-	-	-	-	-	-	-	-
Gd	0.4	-	0.1	0.3	-	0.3	0.3	0.5	1.3
Tb	-	-	-	-	-	-	-	-	-
Dy	0.1	0.3	0.1	-	-	-	-	0.3	-
Ho	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	0.3	-
Tm	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	0.2	-
Lu	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(0.2)	(0.6)	-	-	-	-	-	-	(4.1)
Method	-	EP	XF	XF	XF	XF	CH	XF	EP
Σ = La+Ce+Pr	90.9	91.0	91.0	91.1	91.3	91.6	91.7	91.9	92.1
La-Nd	99.3	99.2	99.5	99.6	100.0	99.6	99.0	98.5	98.7
Sm-Ho	0.7	0.8	0.5	0.4	-	0.4	1.0	1.0	1.3
Er-Lu	-	-	-	-	-	-	-	0.5	-
RE_2O_3	69.95	-	-	-	-	-	70.3	-	35.24
La/Nd	4.57	4.32	3.91	3.81	4.30	3.85	4.88	5.92	6.12
ThO_2, wt.%	0.40	-	-	-	0.7	-	-	-	11.34
U_3O_8, wt.%	-	-	-	-	-	-	-	-	15.64

Table 2-1. Monazite-(Ce) from placers, atomic percent
(b) Tb + Y calcd. as Y

	1	2	3	4	5	6	7	8	9	10
La	12.7	16.4	19.1	19.2	16.6	28.0	20.0	19.5	18.3	17.8
Ce	41.3	41.5	37.1	40.2	40.3	29.3	37.9	41.7	41.1	44.5
Pr	5.1	4.7	7.3	4.9	8.0	7.6	7.4	4.5	8.1	5.7
Nd	32.7	24.8	28.7	14.2	24.0	28.2	24.7	26.1	23.5	17.8
Sm	7.4	7.2	6.9	-	3.3	4.7	5.7	6.3	3.3	-
Eu	-	-	-	-	-	-	-	-	-	-
Gd	-	5.4	-	-	7.8	-	3.1	1.9	0.7	-
Tb	-	-	-	b	-	-	-	-	-	b
Dy	0.8	-	0.9	8.2	-	2.2	0.4	-	-	5.3
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	5.4	-	-	0.8	-	-	2.8
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	5.5	-	-	-	-	-	2.8
Lu	-	-	-	2.4	-	-	-	-	-	3.3
Y/(Y+La)x100	(2.5)	(5.4)	(6.7)	(2.7)[b]	(6.8)	(11.3)	-	(3.5)	(4.9)	(3.2)[b]
Method	EP	OS	EP	CH	OS	EP	XF	OS	OS	CH
Σ = La+Ce+Pr	59.1	62.6	63.5	64.3	64.9	64.9	65.3	65.7	67.5	68.0
La-Nd	91.8	87.4	92.2	78.5	88.9	93.1	90.0	91.8	91.0	85.8
Sm-Ho	8.2	12.6	7.8	8.2	11.1	6.9	9.2	8.2	4.0	5.3
Er-Lu	-	-	-	13.3	-	-	0.8	-	-	8.9
RE_2O_3	-	59.2	-	54.0	-	-	-	60.6	-	55.34
La/Nd	0.39	0.66	0.67	1.35	0.69	0.99	0.81	0.75	0.78	1.00
ThO_2, wt.%	6.6	6.49	9.2	1.14	-	5.9	0.67	6.67	-	1.01
U_3O_8, wt.%	-	0.50	-	0.41	-	-	-	0.40	-	0.41

Table 2-2. Monazite-(Ce) from placers, atomic percent (cont'd)

	11a	11b	11c	11d	11e	11f	12	13	14	15
La	20.4	25.5	26.7	27.7	28.3	28.8	17.9	16.2	18.2	16.8
Ce	42.8	45.7	48.5	48.9	49.7	50.3	45.2	44.2	44.6	47.0
Pr	4.8	4.9	4.5	4.8	4.3	4.7	5.1	8.0	5.6	5.0
Nd	22.2	17.2	15.0	13.1	12.7	11.9	25.2	23.2	24.0	24.5
Sm	5.8	2.9	2.0	2.4	1.9	1.5	5.9	2.8	6.4	5.9
Eu	-	-	-	-	-	-	-	-	-	-
Gd	4.0	3.8	3.3	3.1	3.1	2.8	-	5.6	-	-
Tb	-	-	-	-	-	-	-	-	-	-
Dy	-	-	-	-	-	-	0.7	-	1.2	0.8
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(3.5)	(3.5)	(1.6)	(1.2)	(1.1)	-	(3.6)	(4.1)	(4.1)	(4.8)
Method	XF	XF	XF	XF	XF	XF	EP	OS	EP	EP
Σ = La+Ce+Pr	68.0	76.1	79.7	81.4	82.3	83.8	68.2	68.4	68.4	68.8
La-Nd	90.2	93.3	94.7	94.5	95.0	95.7	93.4	91.6	92.4	93.3
Sm-Ho	9.8	6.7	5.3	5.5	5.0	4.3	6.6	8.4	7.6	6.7
Er-Lu	-	-	-	-	-	-	-	-	-	-
RE_2O_3										
La/Nd	0.92	1.48	1.78	2.11	2.23	2.42	0.71	0.70	0.76	0.69
ThO_2, wt.%	-	-	-	-	1.01	-	8.2	-	-	7.4
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 2-3. Monazite-(Ce) from placers, atomic percent (cont'd)

	16	17	18	19	20	21	22	23	24	25
La	19.0	20.5	17.0	20.3	17.3	15.7	15.3	18.5	12.4	19.4
Ce	45.2	41.1	43.9	43.5	46.8	49.3	48.7	45.9	55.2	45.8
Pr	4.6	7.4	8.3	5.6	5.3	4.5	5.5	5.2	2.0	4.5
Nd	24.9	22.0	22.6	21.6	24.6	22.8	23.7	17.9	17.9	24.7
Sm	5.0	3.3	3.1	5.4	4.6	6.6	5.9	4.8	9.6	3.7
Eu	-	-	-	-	-	-	-	0.2	1.0	-
Gd	-	5.7	4.1	2.0	-	-	-	6.2	1.8	-
Tb	-	-	-	-	-	-	-	0.2	-	-
Dy	1.3	-	-	1.6	1.4	1.1	0.9	0.8	0.1	1.9
Ho	-	-	-	-	-	-	-	0.1	-	-
Er	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	0.2	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(8.3)	(5.6)	(5.4)	(5.9)	(7.0)	(1.0)	(0.5)	(4.6)	(1.3)	(9.6)
Method	EP	OS	OS	OS	EP	EP	EP	-	XF	EP
Σ = La+Ce+Pr	68.8	69.0	69.2	69.4	69.4	69.5	69.5	69.6	69.6	69.7
La-Nd	93.7	91.0	91.8	91.0	94.0	92.3	93.2	87.5	87.5	94.4
Sm-Ho	6.3	9.0	7.2	9.0	6.0	7.7	6.8	12.3	12.5	5.6
Er-Lu	-	-	-	-	-	-	-	0.2	-	-
RE_2O_3	-	-	-	50.0	-	-	-	-	-	-
La/Nd	0.76	0.93	0.75	0.94	0.70	0.69	0.65	1.03	0.69	0.79
ThO_2, wt.%	6.4	-	-	6.09	14.4	5.7	7.3	-	-	10.3
U_3O_8, wt.%	-	-	-	5.43	-	-	-	-	-	-

Table 2-4. Monazite-(Ce) from placers, atomic percent (cont'd)

	26	27	28	29	30	31	32	33	34	35
La	19.0	15.4	16.5	20.0	17.2	19.6	17.6	21.3	21.4	21.4
Ce	43.9	48.9	48.7	43.9	47.0	44.7	47.8	43.5	45.1	45.4
Pr	6.8	5.7	4.8	6.1	5.9	5.8	4.9	5.7	4.6	4.5
Nd	25.7	22.8	24.4	24.6	23.0	25.0	24.2	22.9	21.2	21.5
Sm	4.3	6.0	4.3	4.0	6.0	3.6	4.6	5.2	4.6	5.3
Eu	-	-	-	-	-	-	-	-	-	-
Gd	-	-	-	-	-	-	-	-	3.1	2.0
Tb	-	-	-	-	-	-	-	-	-	-
Dy	0.3	1.2	1.3	1.4	0.9	1.3	0.9	1.4	-	-
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(3.3)	(2.2)	(4.5)	(7.6)	(5.6)	(6.7)	(4.1)	(3.6)	(4.6)	(3.5)
Method	EP	EP	EP	EP	EP	EP	EP	EP	OS	OS
Σ = La+Ce+Pr	69.7	70.0	70.0	70.0	70.1	70.1	70.3	70.5	71.1	71.3
La-Nd	95.4	92.8	94.4	94.6	93.1	95.1	94.5	93.4	92.3	92.8
Sm-Ho	4.6	7.2	5.6	5.4	6.9	4.9	5.5	6.6	7.7	7.2
Er-Lu	-	-	-	-	-	-	-	-	-	-
RE_2O_3	-	-	-	-	-	-	-	-	60.5	60.5
La/Nd	0.74	0.68	0.68	0.81	0.75	0.78	0.73	0.93	1.01	1.00
ThO_2, wt.%	5.5	7.8	6.3	13.4	11.0	10.7	8.8	10.9	6.33	6.09
U_3O_8, wt.%	-	-	-	-	-	-	-	-	0.41	5.43

Table 2-5. Monazite-(Ce) from placers, atomic percent (cont'd)

	36	37	38	39	40	41	42	43	44	45
La	18.1	22.2	17.7	15.4	19.0	17.9	20.3	17.0	20.3	17.4
Ce	48.2	43.2	48.9	48.1	47.9	48.9	45.9	49.5	45.5	49.8
Pr	5.0	5.9	4.9	8.1	4.7	4.8	5.6	5.5	6.2	4.8
Nd	22.5	23.9	22.9	16.6	23.2	23.8	23.2	21.3	22.1	23.0
Sm	4.4	4.1	4.6	8.0	4.1	3.7	4.4	6.0	5.2	4.2
Eu	-	-	-	-	-	-	-	-	-	-
Gd	-	-	-	3.8	-	-	-	-	-	-
Tb	-	-	-	-	-	-	-	-	-	-
Dy	1.8	0.7	1.0	-	1.1	0.9	0.6	0.7	0.7	0.8
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(6.2)	(4.2)	(4.3)	(6.2)	(4.7)	(3.9)	(4.1)	(0.9)	(3.9)	(2.8)
Method	EP	EP	EP	CH	EP	EP	EP	EP	EP	EP
Σ = La+Ce+Pr	71.3	71.3	71.5	71.6	71.6	71.6	71.8	72.0	72.0	72.0
La-Nd	93.8	95.2	94.4	88.2	94.8	95.4	95.0	93.3	94.1	95.0
Sm-Ho	6.2	4.8	5.6	11.8	5.2	4.6	5.0	6.7	5.9	5.0
Er-Lu	-	-	-	-	-	-	-	-	-	-
RE_2O_3	-	-	-	63.35	-	-	-	-	-	-
La/Nd	0.81	0.93	0.77	0.93	0.82	0.75	0.88	0.80	0.92	0.75
ThO_2, wt.%	13.15	11.2	16.39	2.85	11.2	11.2	5.4	12.3	4.3	6.8
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 2-6. Monazite-(Ce) from placers, atomic percent (cont'd)

	46	47	48	49	50	51	52	53	54	55
La	19.4	19.3	17.5	19.6	17.6	22.9	18.9	19.9	20.6	21.0
Ce	48.1	48.7	50.2	48.5	50.6	45.4	49.5	46.4	46.3	46.8
Pr	4.6	4.4	4.8	4.4	4.5	4.6	4.5	6.7	6.3	5.5
Nd	23.9	22.9	19.9	23.7	22.4	20.9	23.7	23.2	21.2	18.4
Sm	3.1	3.3	6.2	2.9	4.1	4.2	2.8	3.5	4.9	4.5
Eu	-	-	-	-	-	-		-	-	0.1
Gd	-	-	-	-	-	2.0		-	-	1.9
Tb	-	-	-	-	-	-	-	-	-	0.2
Dy	1.4	1.4	1.4	0.9	0.8	-	0.6	0.3	0.7	1.0
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	0.4
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	0.2
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(2.1)	(8.7)	(5.1)	(3.6)	(3.1)	(4.2)	(2.6)	(1.6)	(4.2)	(3.1)
Method	EP	EP	EP	EP	EP	OS	EP	EP	EP	-
Σ = La+Ce+Pr	72.1	72.4	72.5	72.5	72.7	72.9	72.9	73.0	73.2	73.3
La-Nd	96.0	95.3	92.4	96.2	95.1	93.8	96.6	96.2	94.4	91.7
Sm-Ho	4.5	4.7	7.6	3.8	4.9	6.2	3.4	3.8	5.6	7.7
Er-Lu	-	-	-	-	-	-	-	-	-	0.6
RE_2O_3	-	-	-	-	-	58.5	-	-	-	-
La/Nd	0.82	0.84	0.88	0.83	0.79	1.10	0.80	0.86	0.97	1.14
ThO_2, wt.%	9.45	9.2	6.4	10.8	8.0	7.0	4.5	5.5	0.55	-
U_3O_8, wt.%	-	-	-	-	-	0.32	-	-	-	-

Table 2-7. Monazite-(Ce) from placers, atomic percent (cont'd)

	56	57	58	59	60	61	62	63	64	65
La	18.8	19.9	23.4	18.9	20.6	21.6	19.0	17.6	17.3	27.6
Ce	49.4	48.0	45.4	48.6	48.1	47.0	48.7	51.2	51.8	39.9
Pr	5.1	5.4	4.6	5.9	4.9	5.0	5.9	4.8	4.5	6.2
Nd	21.4	22.1	20.4	22.3	20.8	21.9	22.1	22.2	23.0	14.9
Sm	4.6	-	4.2	4.3	5.1	3.6	3.6	3.4	2.8	4.7
Eu	-	-	-	-	-	-	-	-	-	-
Gd	-	-	2.0	-	-	-	-	-	-	3.4
Tb	-	-	-	-	-	-	-	-	-	-
Dy	0.7	4.6	-	-	0.5	0.9	0.7	0.8	0.6	3.3
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(2.7)	(7.6)	(4.3)	-	(2.1)	(2.77)	(3.9)	(3.5)	(2.9)	(13.3)
Method	EP	EP	OS	XF	EP	EP	EP	EP	EP	OS
Σ = La+Ce+Pr	73.3	73.3	73.4	73.4	73.6	73.6	73.6	73.6	73.6	73.7
La-Nd	94.7	95.4	93.8	95.7	94.4	95.5	95.7	95.8	96.6	88.6
Sm-Ho	5.3	4.6	6.2	4.3	5.6	4.5	4.3	4.2	3.4	11.4
Er-Lu	-	-	-	-	-	-	-	-	-	-
RE_2O_3	-	-	59.0	-	-	-	-	-	-	-
La/Nd	0.88	0.90	1.15	0.85	0.98	0.99	0.86	0.79	0.75	1.85
ThO_2, wt.%	0.95	2.3	7.07	-	9.2	9.2	7.3	9.7	7.8	-
U_3O_8, wt.%	-	-	0.07	-	-	-	-	-	-	-

Table 2-8. Monazite-(Ce) from placers, atomic percent (cont'd)

	66	67	68	69	70	71	72	73	74	75
La	20.4	23.9	21.6	18.1	19.7	23.6	23.4	22.9	24.1	20.9
Ce	48.3	45.4	47.6	51.2	49.0	46.3	46.0	46.0	45.4	48.1
Pr	5.0	4.5	4.6	4.5	5.1	4.0	4.6	5.1	4.5	5.0
Nd	23.6	20.4	21.2	21.2	21.9	22.0	20.6	20.8	21.1	22.1
Sm	2.2	3.4	3.4	3.8	3.6	3.2	3.4	3.4	3.4	3.2
Eu	-	0.9	-	-	-	-	-	0.2	0.2	-
Gd	-	1.5	1.6	-	-	-	2.0	1.6	1.5	-
Tb	-	-	-	-	-	-	-	-	-	-
Dy	0.5	-	-	1.2	0.7	0.9	-	-	-	0.7
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(1.0)	(2.5)	(4.4)	(6..4)	(2.4)	(5.6)	(4.2)	(3.3)	(3.0)	(3.3)
Method	EP	OS	OS	EP	EP	EP	OS	OS	OS	EP
Σ = La+Ce+Pr	73.7	73.8	73.8	73.8	73.8	73.9	74.0	74.0	74.0	74.0
La-Nd	97.3	94.2	95.0	95.0	95.7	95.9	94.6	94.8	95.1	96.1
Sm-Ho	2.7	5.8	5.0	5.0	4.3	4.1	5.4	5.2	4.9	3.9
Er-Lu	-	-	-	-	-	-	-	-	-	-
RE_2O_3	-	-	-	-	-	-	-	-	-	-
La/Nd	0.86	1.17	1.02	0.85	0.90	1.07	1.14	1.10	1.14	0.95
ThO_2, wt.%	13.5	2.00	-	8.8	7.15	8.4	-	6.24	-	4.2
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 2-9. Monazite-(Ce) from placers, atomic percent (cont'd)

	76	77	78	79	80	81	82	83	84	85
La	19.5	23.5	18.3	22.8	20.3	23.5	18.9	21.6	18.4	19.9
Ce	50.0	44.2	50.6	45.3	48.7	45.9	50.0	47.5	49.5	51.3
Pr	4.6	6.5	5.3	6.1	5.3	4.9	5.5	5.4	6.6	3.3
Nd	21.6	21.8	22.2	22.5	21.6	21.9	19.6	21.4	21.6	21.9
Sm	2.9	3.6	3.1	3.0	3.2	3.3	4.5	2.2	3.2	2.7
Eu	-	-	-	-	-	-	-	-	-	-
Gd	-	-	-	-	-	-	-	-	-	-
Tb	-	-	-	-	-	-	-	-	-	-
Dy	1.4	0.4	0.3	0.3	0.9	0.5	1.5	0.9	0.7	0.9
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(6.4)	(3.0)	(1.2)	(7.3)	(4.5)	(1.0)	(8.4)	(6.0)	(5.7)	(8.8)
Method	EP	EP	EP	EP	EP	EP	EP	EP	EP	EP
Σ = La+Ce+Pr	74.1	74.2	74.2	74.2	74.3	74.3	74.4	74.5	74.5	74.5
La-Nd	95.7	96.0	96.4	96.7	95.9	96.2	94.0	95.9	96.1	96.4
Sm-Ho	4.3	4.0	3.4	3.3	4.1	3.8	6.0	4.1	3.9	3.6
Er-Lu	-	-	-	-	-	-	-	-	-	-
RE_2O_3	-	-	-	-	-	-	-	-	-	-
La/Nd	0.90	1.08	0.82	1.01	0.94	1.07	0.96	1.01	0.85	0.91
ThO_2, wt.%	6.9	8.2	8.8	9.1	10.1	7.2	15.6	9.7	5.9	9.7
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 2-10. Monazite-(Ce) from placers, atomic percent (cont'd)

	86	87	88	89	90	91	92	93	94	95
La	19.2	20.9	19.3	24.4	19.6	18.9	23.0	20.4	20.1	21.7
Ce	50.8	48.6	50.7	45.8	50.5	51.7	46.7	49.5	49.7	47.4
Pr	4.5	5.1	4.6	4.5	4.6	4.3	5.3	5.1	5.2	5.9
Nd	22.0	21.9	22.1	21.0	21.9	20.9	18.8	21.5	21.67	21.7
Sm	2.6	2.8	2.8	3.4	2.9	3.3	3.1	2.9	2.7	3.0
Eu	-	-	-	0.2	-	-	0.1	-	-	-
Gd	-	-	-	0.7	-	-	1.8	-	-	-
Tb	-	-	-	-	-	-	0.2	-	-	-
Dy	0.9	0.7	0.5	-	0.5	0.9	0.7	0.6	0.7	0.3
Ho	-	-	-	-	-	-	0.1	-	-	-
Er	-	-	-	-	-	-	0.2	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(0.9)	(3.8)	(1.6)	(3.3)	(3.9)	(4.8)	(3.0)	(3.2)	(3.7)	(3.7)
Method	EP	EP	EP	OS	EP	EP	-	EP	EP	EP
Σ = La+Ce+Pr	74.5	74.6	74.6	74.7	74.7	74.9	75.0	75.0	75.0	75.0
La-Nd	96.5	96.5	96.7	95.7	96.6	95.8	93.8	96.5	96.6	96.7
Sm-Ho	3.5	3.5	3.3	4.3	3.4	4.2	6.0	3.5	3.4	3.3
Er-Lu	-	-	-	-	-	-	0.2	-	-	-
RE_2O_3	-	-	-	58.3	-	-	-	-	-	-
La/Nd	0.87	0.95	0.87	1.16	0.89	0.90	1.22	0.95	0.93	1.00
ThO_2, wt.%	5.0	7.8	11.5	7.5	8.2	5.4	-	7.9	9.3	6.0
U_3O_8, wt.%	-	-	-	0.3	-	-	-	-	-	-

Table 2-11. Monazite-(Ce) from placers, atomic percent (cont'd)

	96	97	98	99	100	101	102	103	104	105
La	20.5	23.4	21.2	23.6	22.1	23.7	22.8	22.1	26.0	21.6
Ce	49.8	46.3	49.4	47.2	47.8	47.1	46.9	48.7	44.3	48.5
Pr	4.8	5.5	4.6	4.5	5.4	4.6	5.7	4.6	5.2	5.4
Nd	20.5	19.7	21.0	20.6	20.7	19.6	20.6	21.5	19.2	20.9
Sm	3.5	3.8	2.7	3.4	3.2	3.4	3.1	2.6	2.8	3.0
Eu	-	-	-	-	-	-	-	-	-	-
Gd	-	-	-	0.7	-	1.6	0.9	-	1.7	-
Tb	-	-	-	-	-	-	-	-	0.1	-
Dy	0.9	1.3	1.1	-	0.8	-	-	0.5	0.7	0.6
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(5.0	-	(4.0)	(3.3)	(3.7)	(3.1)	(0.7)	(1.4)	(2.4)	(2.6)
Method	EP	-	EP	OS	EP	OS	OS	EP	CH	EP
Σ = La+Ce+Pr	75.1	75.2	75.2	75.3	75.3	75.4	75.4	75.4	75.5	75.5
La-Nd	95.6	94.9	96.2	95.9	96.0	95.0	96.0	96.9	94.7	96.4
Sm-Ho	4.4	5.1	3.8	4.1	4.0	5.0	4.0	3.1	5.3	3.6
Er-Lu	-	-	-	-	-	-	-	-	-	-
RE_2O_3	-	-	-	62.6	-	61.45	-	-	-	-
La/Nd	1.00	1.19	1.01	1.15	1.07	1.21	1.11	1.03	1.35	1.03
ThO_2, wt.%	9.8	-	8.2	4.44	8.6	4.91	12.4	11.6	-	9.7
U_3O_8, wt.%	-	-	-	0.23	-	0.26	-	-	-	-

Table 2-12. Monazite-(Ce) from placers, atomic percent (cont'd)

	106	107	108	109	110	111	112	113	114	115
La	26.7	20.8	19.7	18.1	22.4	22.1	24.9	24.4	22.7	21.2
Ce	44.5	49.2	50.9	52.7	48.1	49.6	45.4	47.7	49.4	49.9
Pr	4.5	5.8	5.2	5.0	5.4	4.3	5.5	4.3	4.3	5.4
Nd	19.2	19.9	20.5	20.7	20.3	19.0	18.4	16.0	17.9	19.2
Sm	2.9	2.4	2.7	3.0	3.5	3.8	3.7	3.0	2.9	3.3
Eu	-	0.2	-	-	-	-	-	0.1	0.2	-
Gd	1.5	1.0	-	-	-	-	-	1.9	1.7	-
Tb	-	-	-	-	-	-		0.1	0.2	-
Dy	0.7	0.6	1.0	0.5	0.3	1.2	1.6	0.9	0.6	1.0
Ho	-	-	-	-	-	-		0.1	-	-
Er	-	0.1	-	-	-	-	-	0.5	0.1	-
Tm	-	-	-	-	-	-	-	0.5	-	-
Yb	-	-	-	-	-	-	-	0.4	-	-
Lu	-	-	-	-	-	-	-	0.1	-	-
Y/(Y+Ln)x100	-	(2.4)	(5.0)	(1.2)	(1.7)	(4.5)	-	(4.4)	(3.4)	(3.2)
Method	XF	-	EP	EP	EP	EP	OS	-	XF	EP
Σ = La+Ce+Pr	75.7	75.8	75.8	75.8	75.9	76.0	75.8	76.4	76.4	76.5
La-Nd	94.9	95.7	96.3	96.5	96.2	95.0	94.2	92.4	94.3	95.7
Sm-Ho	5.1	4.2	3.7	3.5	3.8	5.0	5.3	6.1	5.6	4.3
Er-Lu	-	0.1	-	-	-	-	-	1.5	0.1	-
RE_2O_3	-	51.21	-	-	-	-	-	-	60.32	-
La/Nd	1.39	1.05	0.96	0.87	1.10	1.16	1.35	1.53	1.27	1.10
ThO_2, wt.%	-	3.85	11.0	6.8	3.1	10.5	10.3	-	7.4	4.6
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 2-13. Monazite-(Ce) from placers, atomic percent (cont'd)

	116	117	118	119	120	121	122	123	124	125
La	25.8	23.7	19.8	20.0	25.2	21.5	23.7	21.3	19.6	21.2
Ce	45.1	47.1	52.4	50.7	46.6	49.2	47.7	51.8	52.9	49.7
Pr	5.6	5.2	4.4	6.0	4.9	6.0	5.4	3.7	4.4	6.2
Nd	19.3	19.6	20.5	18.9	19.1	18.3	18.0	19.6	20.2	17.8
Sm	3.5	3.1	2.3	2.4	3.0	3.3	3.5	2.0	2.4	4.0
Eu	-	-	-	0.2	-	-	-	0.1	-	-
Gd	-	1.3	-	1.0	1.2	-	-	1.2	-	-
Tb	-	-	-	-	-	-	-	-	-	-
Dy		-	0.6	0.6	-	0.7		0.3	0.5	1.1
Ho	0.7	-	-	-	-	-	1.7	-	-	-
Er		-		0.2	-	-		-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(2.9)	(2.3)	(1.6)	(3.0)	(4.8)	(3.8)	(12.2)	-	(2.2)	(9.8)
Method	OS	OS	EP	-	OS	EP	OS	XF	EP	EP
Σ = La+Ce+Pr	76.5	76.0	76.6	76.7	76.7	76.7	76.8	76.8	76.9	77.1
La-Nd	95.8	95.6	97.1	95.6	95.8	95.0	94.8	96.4	97.1	94.9
Sm-Ho	4.2	4.4	2.9	4.2	4.2	4.0	5.2	3.6	2.9	5.1
Er-Lu	-	-	-	0.2	-	-	-	-	-	-
RE_2O_3	-	-		51.31	-	-	-	62.37	-	-
La/Nd	1.34	1.21	0.97	1.07	1.32	1.17	1.32	1.09	0.97	1.19
ThO_2, wt.%	7.35	11.0	7.5	2.85	7.2	4.2	6.2	6.06	5.6	12.1
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 2-14. Monazite-(Ce) from placers, atomic percent (contd.)

	126	127	128	129	130	131	132	133	134	135
La	23.1	27.1	25.0	20.4	24.4	27.5	24.7	22.7	23.7	26.5
Ce	49.4	45.6	47.9	53.3	49.2	45.9	49.5	52.1	50.6	47.4
Pr	4.8	4.7	5.2	4.4	4.7	5.0	4.3	3.9	4.5	4.9
Nd	18.2	17.8	17.6	18.8	17.3	17.4	19.5	18.1	17.3	18.0
Sm	2.5	3.8	2.5	2.4	2.3	4.2	1.8	2.4	2.3	2.5
Eu	0.2	-	-	-	0.3	-	-	-	-	-
Gd	1.4	-	1.4	-	1.3	-	-	-	1.1	0.7
Tb	0.1	-	-	-	0.1	-	-	-	0.1	-
Dy	0.3	1.0	0.1	0.7	0.3	-	0.2	0.8	0.3	-
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	0.2	-	0.1	-	-	-	0.1	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	0.1	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(2.2)	(4.4)	(3.5)	(3.3)	(2.5)	-	(2.1)	(3.0)	(1.5)	(2.6)
Method	XF	OS	-	EP	XF	OS	EP	EP	XF	OS
Σ = La+Ce+Pr	77.3	77.4	78.1	78.1	78.3	78.4	78.5	78.7	78.8	78.8
La-Nd	95.5	95.2	95.7	96.9	95.6	95.8	98.0	96.8	96.1	96.8
Sm-Ho	4.5	4.8	4.0	3.1	4.3	4.2	2.0	3.2	3.8	3.2
Er-Lu	-	-	0.3	-	0.1	-	-	-	0.1	-
RE_2O_3	58.8	-	-	-	63.42	-	-	-	58.64	-
La/Nd	1.27	1.52	1.42	1.09	1.41	1.58	1.27	1.25	1.37	1.47
ThO_2, wt.%	6.4	5.20	-	6.8	7.0	-	9.2	4.7	6.5	12.2
U_3O_8, wt.%	-	-	-	-	-	6.1	-	-	-	-

Table 2-15. Monazite-(Ce) from placers, atomic percent (cont'd)

	136	137	138	139	140	141	142	143	144	145
La	26.9	24.1	19.2	24.7	22.9	25.6	24.5	18.5	25.9	27.2
Ce	49.4	50.6	56.0	50.9	52.5	50.2	51.1	55.3	50.0	49.7
Pr	4.4	4.3	4.3	4.2	4.5	4.3	4.5	6.5	4.7	3.8
Nd	16.6	16.6	18.1	15.9	16.3	15.6	16.1	15.8	16.7	12.4
Sm	2.4	2.5	1.8	2.2	3.3	2.3	2.1	3.6	1.6	1.2
Eu	-	0.3	-	0.3	-	0.2	0.1	-		0.1
Gd	0.3	1.1	-	1.3	-	1.3	0.9	-	1.0	5.5
Tb	-	0.1	-	0.1	-	0.1	0.1	-		-
Dy	-	0.3	0.6	0.3	0.5	0.3	0.5	0.3		0.1
Ho	-	-	-	-	-	-	-	-		-
Er	-	0.1	-	0.1	-	0.1	0.1	-	0.1	-
Tm	-	-	-	-	-	-	-	-		-
Yb	-	-	-	-	-	-	-	-		-
Lu	-	-	-	-	-	-	-	-		-
Y/(Y+La)x100	(2.2)	(2.2)	(0.7)	(2.2)	(4.7)	(2.5)	(1.5)	(4.6)	(0.9)	(0.9)
Method	XF	XF	EP	XF	EP	XF	XF	EP	OS	XF
Σ = La+Ce+Pr	80.7	79.0	79.5	79.8	79.9	80.1	80.1	80.3	80.6	80.7
La-Nd	97.3	95.6	97.6	95.7	96.2	95.7	96.2	96.1	97.3	93.1
Sm-Ho	2.7	4.3	2.4	4.2	3.8	4.2	3.7	3.9	2.6	6.9
Er-Lu	-	0.1	-	0.1	-	0.1	0.1	-	0.1	-
RE_2O_3	-	58.77	-	58.22	-	58.03	58.60	-	-	62.51
La/Nd	1.62	1.45	1.06	1.55	1.40	1.64	1.52	1.17	1.55	2.19
ThO_2, wt.%	-	6.6	3.6	7.3	11.4	7.9	8.4	3.3	8.1	7.5
U_3O_8, wt.%	-	-	-	-	-	-	-	-	0.3	-

Table 2-16. Monazite-(Ce) from placers, atomic percent (cont'd)

	146	147	148	149	150	151
La	20.1	22.2	20.1	26.4	24.4	30.1
Ce	53.9	51.3	56.9	51.7	56.0	52.4
Pr	6.8	7.4	4.4	4.2	5.3	3.9
Nd	12.2	16.0	15.8	14.6	13.7	12.1
Sm	5.1	2.5	2.5	1.8	0.6	0.9
Eu	-	-	-	-	-	0.1
Gd	-	-	-	0.8	-	0.3
Tb	-	-	-	0.1	-	0.1
Dy	1.9	0.6	0.3	0.3	-	-
Ho	-	-	-	-	-	-
Er	-	-	-	0.1	-	0.1
Tm	-	-	-	-	-	-
Yb	-	-	-	-	-	-
Lu	-	-	-	-	-	-
Y/(Y+La)x100	(5.2)	(3.2)	(0.8)	(1.7)	-	(0.5)
Method	EP	EP	EP	XF	EP	XF
Σ = La+Ce+Pr	80.8	80.9	81.4	82.3	85.7	86.4
La-Nd	93.0	96.9	97.2	96.9	99.4	98.5
Sm-Ho	7.0	3.1	2.8	3.0	0.6	1.4
Er-Lu	-	-	-	0.1	-	0.1
RE_2O_3	-	-	-	58.24	68.90	61.86
La/Nd	1.65	1.39	1.27	1.81	1.78	2.49
ThO_2, wt.%	11.7	6.3	5.75	8.1	1.28	6.6
U_3O_8, wt.%	-	-	-	-	-	-

Table 3-1. Dark Monazite(Ce), atomic percent (cont'd)

	1	2	3	4	5	6	7	8	9	10
La	10.5	11.4	18.5	14.0	15.3	16.4	15.7	19.6	15.8	17.8
Ce	40.2	41.4	33.3	42.9	44.0	43.8	44.4	42.3	44.4	44.2
Pr	6.4	6.8	9.1	6.1	6.1	5.5	6.0	4.2	6.0	5.7
Nd	32..0	28.5	25.5	28.4	25.5	23.6	24.9	25.6	25.1	25.9
Sm	7.6	6.5	5.4	6.0	5.2	5.0	5.3	5.1	5.1	4.5
Eu	0.9	1.2	1.7	0.7	0.9	0.8	0.9	1.0	0.9	0.6
Gd	2.4	3.8	6.1	1.9	3.0	4.9	2.8	1.5	2.7	1.3
Tb	-	-	-	-	-	-	-	0.2	-	-
Dy	-	0.4	0.4	-	-	-	-	0.3	-	-
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	0.2	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(1.3)	(1.4)	-	(1.3)	(2.5)	(1.0)	(2.5)	(0.6)	(2.6)	(1.2)
Method	OS	XF	OS	OS	XF	XF	XF	XF	XF	OS
Σ = La+Ce+Pr	57.1	59.6	60.9	63.0	65.4	65.7	66.1	66.1	66.2	67.7
La-Nd	89.1	88.1	86.4	91.4	90.9	89.3	91.0	91.7	91.3	93.6
Sm-Ho	10.9	11.9	13.6	8.6	9.1	10.7	9.0	8.1	8.7	6.4
Er-Lu	-	-	-	-	-	-	-	0.2	-	-
RE_2O_3	70.70	67.45	55.70	72.72	-	-	-	66.32	-	67.55
La/Nd	0.33	0.40	0.73	0.49	0.60	0.69	0.63	0.77	0.63	0.69
ThO_2, wt.%	0.75	0.32	0.001	0.35	-	-	-	0.54	-	1.0
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	-

Table 3-2. Dark Monazite(Ce), atomic percent (cont'd)

	11	12	13	14	15	16	17	18	19	20
La	18.2	17.9	19.8	21.3	17.9	20.3	21.2	23.3	19.9	19.5
Ce	44.5	44.0	44.9	44.1	47.9	44.7	44.8	43.0	46.7	46.5
Pr	5.2	7.4	5.7	5.2	5.0	5.9	5.3	5.1	4.8	5.6
Nd	25.7	24.5	24.7	24.3	23.9	23.9	23.2	22.6	22.8	23.5
Sm	3.7	3.1	2.8	3.1	3.1	3.4	3.6	3.4	2.9	3.2
Eu	0.6	0.6	0.5	0.4	0.3	0.5	0.5	0.6	0.4	0.5
Gd	2.1	1.9	1.6	1.6	1.5	1.3	1.4	2.0	1.5	1.2
Tb	-	-	-	-	-	-	-	-	-	-
Dy	-	0.3	-	-	0.4	-	-	-	-	-
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-
Tm	-	0.3	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(1.2)	(1.6)	(1.1)	(1.4)	(4.6)	(1.2)	(1.2)	(1.5)	(1.4)	(0.8)
Method	OS	-	OS	OS	XF	OS	OS	OS	OS	OS
Σ = La+Ce+Pr	67.9	69.3	70.4	70.6	70.8	70.9	71.3	71.4	71.4	71.6
La-Nd	93.6	93.8	95.1	94.9	94.7	94.8	94.5	94.0	94.2	95.1
Sm-Ho	6.4	5.9	4.9	5.1	5.3	5.2	5.5	6.0	4.8	4.9
Er-Lu	-	0.3	-	-	-	-	-	-	-	-
RE_2O_3	61.4	52.75	71.8	55.08	56.4	69.95	71.96	60.99	55.56	65.02
La/Nd	0.71	0.73	0.80	0.88	0.75	0.85	0.91	1.03	0.87	0.83
ThO_2, wt.%	0.53	0.66	0.70	0.59	-	0.65	0.68	3.2	0.58	0.60
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	

Table 3-3. Dark Monazite(Ce), atomic percent (cont'd)

	21	22	23	24	25	26	27	28	29	30
La	19.6	20.5	23.0	20.3	19.7	19.8	17.6	24.7	22.0	21.4
Ce	46.6	46.2	43.5	46.2	47.1	47.5	48.9	42.4	45.5	46.1
Pr	5.4	5.0	5.4	5.5	5.6	5.5	6.4	5.8	5.5	5.5
Nd	23.5	23.4	22.2	22.1	20.3	21.6	21.1	19.9	22.1	22.5
Sm	3.1	3.0	3.3	3.4	3.5	3.2	2.9	4.7	2.7	2.7
Eu	0.4	0.4	0.5	0.6	0.6	0.6	0.5	0.1	0.4	0.4
Gd	1.4	1.5	2.1	1.9	2.0	1.8	2.2	2.4	1.8	1.4
Tb	-	-	-	-	0.2	-	-	-	-	-
Dy	-	-	-	-	0.7	-	0.4	-	-	-
Ho	-	-	-	-	0.1	-	-	-	-	-
Er	-	-	-	-	0.2	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(0.8)	(1.35)	(3.5)	(1.4)	(1.7)	(1.2)	(1.4)	(5.6)	(1.0)	(1.3)
Method	OS	OS	OS	OS	-	OS	-	OS	OS	OS
Σ = La+Ce+Pr	71.6	71.7	71.9	72.0	72.4	72.8	72.9	72.9	73.0	73.0
La-Nd	95.1	95.1	94.1	94.1	92.7	94.4	94.0	92.8	95.1	95.5
Sm-Ho	4.9	4.9	5.9	5.9	7.1	5.6	6.0	7.2	4.9	4.5
Er-Lu	-	-	-	-	0.2	-	-	-	-	-
RE_2O_3	64.90	54.57	49.8	60.07	-	61.47	46.36	65.21	70.69	56.85
La/Nd	0.83	0.88	1.04	0.92	0.97	0.92	0.83	1.24	1.00	0.95
ThO_2, wt.%	1.02	0.59	0.57	0.5	-	0.5	0.06	9.6	0.70	0.82
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	

Table 3-4. Dark Monazite(Ce), atomic percent (cont'd)

	31	32	33	34	35	36	37	38	39	40
La	21.6	22.0	21.7	21.9	17.2	22.0	17.3	23.6	23.9	21.1
Ce	46.4	46.2	46.9	48.8	51.4	47.5	51.6	46.1	47.5	49.2
Pr	5.3	5.2	5.5	3.4	5.7	4.9	5.7	5.4	4.9	6.3
Nd	21.8	21.8	20.5	20.6	18.6	21.3	18.8	19.3	19.9	18.6
Sm	3.2	2.9	3.4	2.7	4.2	2.6	4.2	3.1	2.2	2.0
Eu	0.4	0.5	0.5	0.8	0.3	0.4	0.3	0.5	0.4	0.5
Gd	1.3	1.4	1.5	1.1	2.1	1.3	2.1	1.5	1.2	2.0
Tb	-	-	-	0.2	0.1	-	-	0.2	-	-
Dy	-	-	-	0.3	0.4	-	-	0.3	-	0.2
Ho	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	0.2	-	-	-	-	-	0.1
Tm	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(1.1)	(1.1)	(1.2)	(0.8)	(1.7)	(1.3)	(1.6	(1.7)	(1.2)	(0.5)
Method	OS	OS	OS	XF	-	OS	OS	CH	-	XF
Σ = La+Ce+Pr	73.3	73.4	74.1	74.1	74.3	74.4	74.6	75.1	76.3	76.6
La-Nd	95.1	95.2	94.6	94.7	92.9	95.7	93.4	94.4	96.2	95.2
Sm-Ho	4.9	4.8	5.4	5.1	7.1	4.3	6.6	5.6	3.8	4.7
Er-Lu	-	-	-	0.2	-	-	-	-	-	0.1
RE_2O_3	58.70	63.21	62.26	66.82	-	50.82	44.74	-	56.85	68.45
La/Nd	0.99	1.01	1.06	1.06	0.92	1.03	0.92	1.22	1.20	1.13
ThO_2, wt.%	0.70	0.83	0.70	0.53	-	0.58	1.3	-	0.78	0.66
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-	

Table 3-5. Dark Monazite(Ce), atomic percent (cont'd)

	41	42	43	44	45	46	47
La	24.3	22.1	25.3	29.1	31.7	26.3	21.3
Ce	47.7	52.4	50.2	48.1	48.3	57.9	63.5
Pr	5.0	4.1	4.5	4.8	2.9	2.6	7.0
Nd	20.1	17.7	16.3	17.0	13.8	2.8	-
Sm	2.3	1.4	2.2	0.8	1.6	3.8	5.2
Eu	0.6	0.7	0.4	0.2	0.3	0.3	0.4
Gd	-	1.3	1.1	-	0.9	4.6	2.6
Tb	-	0.1	-	-	0.1	0.1	-
Dy	-	-	-	-	0.3	1.5	-
Ho	-	-	-	-	-	-	-
Er	-	0.2	-	-	0.1	0.1	-
Tm	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-
Y/(Y+La)x100	(1.3)	(0.7)	(0.8)	-	(1.9)	(1.7)	(2.0)
Method	OS	XF	OS	-	XF	-	-
Σ = La+Ce+Pr	77.0	78.6	80.0	82.0	82.9	86.8	91.8
La-Nd	97.1	96.3	96.3	99.0	96.7	89.6	91.8
Sm-Ho	2.9	3.5	3.7	1.0	3.2	10.3	8.2
Er-Lu	-	0.2	-	-	0.1	0.1	-
RE_2O_3	59.32	62.46	60.04	69.88	66.09	-	-
La/Nd	1.21	1.25	1.55	1.71	2.30	9.39	-
ThO_2, wt.%	0.78	1.40	-	-	0.36	0.06	1.3
U_3O_8, wt.%	-	-	-	-	-	-	-

Table 4-1. Monazite-(La)(1-3), monazite-(Nd)(4-8), and gasparite-(Ce)(9), atomic percent

	1	2	3	4	5	6	7	8	9
La	35.1	44.5	41.7	5.7	8.2	3.6	12.8	24.4	22.1
Ce	12.8	33.4	37.9	29.9	15.2	28.9	30.3	27.0	51.4
Pr	8.9	3.3	11.3	4.6	17.1	9.4	-	8.8	7.0
Nd	30.0	18.5	9.1	39.0	54.6	43.0	34.3	30.9	19.5
Sm	5.2	0.3	-	12.4	2.9	12.1	13.8	5.0	-
Eu	1.8	-	-	2.1	0.3	-	0.8	-	-
Gd	3.8	-	-	4.9	1.7	3.0	5.7	2.9	-
Tb	0.3	-	-	0.4	-	-	0.7	-	-
Dy	1.6	-	-	0.7	-	-	1.5	1.0	-
Ho	-	-	-	-	-	-	-	-	-
Er	0.5	-	-	0.3	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	0.1	-	-
Lu	-	-	-	-	-	-	-	-	-
Y/(Y+La)x100	(2.7)	-	-	(1.7)	-	-	(2.7)	-	-
Method	EP	CH	XF	XF	-	EP	OS	-	EP
Σ = La+Ce+Pr	56.8	81.2	90.9	40.2	40.5	41.9	43.1	60.2	80.5
La-Nd	86.8	99.7	100.0	79.2	95.1	84.9	77.4	91.1	100.0
Sm-Ho	12.7	0.3	-	20.5	4.9	15.1	22.5	8.9	-
Er-Lu	0.5	-	-	0.3	-	-	0.1	-	-
RE_2O_3	-	67.34	-	68.03	-	70.19	-	69.6	55.31
La/Nd	1.17	2.41	4.58	0.15	0.15	0.08	0.37	0.79	1.13
ThO_2, wt.%	-	-	-	0.12	-	-	-	-	1.95
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-

Table 5-1. Cheralite, atomic percent

	1	2
La	19.5	18.3
Ce	45.1	48.1
Pr	4.4	5.9
Nd	21.5	22.9
Sm	6.3	4.8
Eu	0.9	-
Gd	1.5	-
Tb	0.2	-
Dy	0.2	-
Ho	-	-
Er	-	-
Tm	0.4	-
Yb	-	-
Lu	-	-
Y/(Y+La)x100	(0.4)	-
Method	EP	XF
Σ = La+Ce+Pr	69.0	72.3
La-Nd	90.5	95.2
Sm-Ho	9.1	4.8
Er-Lu	0.4	-
RE_2O_3	27.25	-
La/Nd	0.91	0.80
ThO_2, wt.%	31.64	-
U_3O_8, wt.%	4.33	-

Table 6-1. Huttonite, atomic percent

	1	2	3	4	5	6	7
La	-	17.9	14.9	18.6	16.4	20.2	19.7
Ce	-	52.4	56.2	48.4	58.9	60.2	71.3
Pr	-	-	-	5.9	4.2	-	-
Nd	-	29.7	28.9	22.5	20.5	19.6	9.0
Sm	-	-	-	4.6	-	-	-
Eu	-	-	-	-	-	-	-
Gd	11.0	-	-	-	-	-	-
Tb	5.2	-	-	-	-	-	-
Dy	25.3	-	-	-	-	-	-
Ho	5.0	-	-	-	-	-	-
Er	24.7	-	-	-	-	-	-
Tm	2.4	-	-	-	-	-	-
Yb	24.0	-	-	-	-	-	-
Lu	2.4	-	-	-	-	-	-
Y/(Y+La)x100	(40.2	-	-	-	-	-	-
Method	OS	EP	EP	XF	EP	EP	EP
Σ = La+Ce+Pr	0.0	70.3	71.1	72.9	79.5	80.4	91.0
La-Nd	0.0	100.0	100.0	95.4	100.0	100.0	100.0
Sm-Ho	46.5	-	-	4.6	-	-	-
Er-Lu	53.5	-	-	-	-	-	-
RE_2O_3	5.5	11.7	13.6	24.61	16.7	4.5	20.5
La/Nd	-	0.60	0.52	0.83	0.80	1.03	2.18
ThO_2, wt.%	43.2	64.0	63.6	40.56	58.3	69.9	56.4
U_3O_8	2.44	0.83	<0.47	1.63	<0.47	1.04	<0.47
SiO_2,wt.%	17.2	13.5	10.4	10.05	11.1	12.8	8.1
P_2O_5,wt.%	0.7	7.1	8.9	10.00	10.5	7.4	11.2

Table 7-1. Average composition of monazite-(Ce), Tables 1-3, atomic percent

	A	B	C	D	E	F	G
La	21.2	24.2	25.2	29.7	28.3	20.5	21.5
Ce	45.4	48.1	43.5	51.8	49.3	46.0	48.2
Pr	5.8	5.3	8.5	4.3	4.8	5.4	5.3
Nd	19.3	17.5	20.2	12.5	1.2	22.0	21.0
Sm	5.1	2.7	2.1	1.3	1.7	3.5	2.0
Eu	-	-	0.1	-	-	0.6	-
Gd	2.5	1.4	0.2	0.1	0.4	1.9	0.8
Tb	0.1	0.1	0.1	-	-	-	-
Dy	0.4	0.5	0.1	-	0.1	0.1	0.3
Ho	-	-	-	-	0.1	-	-
Er	0.1	0.1	-	0.3	0.1	-	-
Tm	-	-	-	-	-	-	-
Yb	0.1	0.1	-	-	-	-	-
Lu	-	-	-	-	-	-	-
100Y/(Y+Ln)	(3.8)	(3.3)	(2.6)	(4.4)	(0.8)	(1.55)	(4.0)
no detns.	138	120	24	6	6	44	145
Σ=La+Ce+Pr	72.4	77.6	77.2	85.8	82.4	71.9	75.0
La-Nd	91.7	95.1	97.4	98.3	97.6	93.9	96.0
Sm-Ho	8.1	4.7	2.6	1.4	2.3	6.1	4.0
Er-Lu	0.2	0.2	-	0.3	0.1	-	-
RE_2O_3	58.9	56.5	55.3	-	-	61.6	-
no. detns.	17	79	20	-	-	38	-
ThO_2, wt.%	9.0	6.3	6.0	-	2.1	0.9	7.9
no detns.	80	71	3	-	8	37	130
U_3O_8, wt.%	1.18	0.62	-	-	-	-	1.16
no detns.	20	18	-	-	-	-	13

Key to Table 7

A-E - from Table 1:
A=av. of 117 analyses from granitic pegmatites;
B=av. of 187 from granites, granodiorites, and quartz monzonites;
C=av. of 44 from gneisses;
D=av. of 13 from alkalic rocks and alkalic pegmatite
E=av. of 25 from carbonatites
F=av. of 46 dark monazites from Table 3;
G=av. of 151 from placers (Table 2)

Note: The averages for R.E. compositions do not include data from analyses in which La, Ce, Pr, or Nd were not determined. However, determinations of Y/(Y+Ln) and for ThO_2 or U_3O_8 from such analyses were used in calculating the averages above.

The averages for U_3O_8 are considered to be uncertain. For example, for A, the average of 1.18% becomes 0.40% if the highest determination (15.64% is omitted; the average for G of 1.16% becomes 0.33% if the two highest determinations (5.43, 6.1%) are omitted.

Table 8-1. Previously published average compositions of monazites, atomic percent

	1	2	3	4	5	6	7	8	
La	20.6	18.0	21.3	21.7	24.2	24.0	31.3	23.9	
Ce	44.2	45.7	48.8	49.4	42.4	46.6	51.2	46.0	
Pr	5.7	7.1	5.6	5.7	8.3	5.4	4.3	5.5	
Nd	20.0	16.8	18.5	18.6	20.8	18.2	11.2	18.8	
Sm	5.1	3.7	2.3	2.3	2.0	3.1	0.7	3.7	
Eu	0.1	0.2	0.1	-	-	-	-	-	
Gd	3.8	2.8	1.3	1.7	2.1	1.9	0.3	1.7	
Tb	0.1	0.3	0.2	0.1	-	-	-	-	
Dy	0.2	3.3	1.2	0.3	-	0.7	0.4	0.2	
Ho	-	0.3	0.2	0.1	-	-	-	-	
Er	0.1	1.0	-	0.1	0.2	0.1	0.4	0.1	
Tm	-	-	0.3	-	-	-	-	-	
Yb	0.1	0.8	-	-	-	-	0.2	0.1	
Lu	-	-	-	-	-	-	-	-	
Y/(Y+Ln)x100	(4.9)	-	-	-	-	(3.6)	(0.7)	-	
Method	-	-	-	-	-	-	-	-	
Σ = La+Ce+Pr	70.5	70.8	75.7	76.8	74.9	76.0	86.8	75.4	
La-Nd	90.5	87.6	94.2	95.4	95.7	94.2	98.0	94.2	
Sm-Ho	9.3	10.6	5.3	4.5	4.1	5.7	1.4	5.6	
Er-Lu	0.2	1.8	0.5	0.1	0.2	0.1	0.6	0.2	
RE_2O_3	-	-	-	-	-	-	-	-	
La/Nd	1.03	1.07	1.15	1.17	1.17	1.32	2.79	1.28	
ThO_2, wt.%									
U_3O_8, wt.%	-	-	-	-	-	-	-	-	-

Table 9a. Locality and Rock Type Index - Monazite-(Ce)

Table 1. Analyses	Author	Date	Locality	Rock Type
1	Shukolyukov et al.	1979	Alakurtti, N. Karelia, U.S.S.R.	
2	Shukolyukov et al.	1979	N. Karelia, U.S.S.R.	
3	Shukolyukov et al.	1979	Chkalov, N. Karelia U.S.S.R.	
4	Zhirov et al.	1961	Alakurtti, N. Karelia	granite pegmatite
5	Shukolyukov et al.	1979	Chkalov, N. Karelia, U.S.S.R.	
6	Heinrich et al.	1960	Brown Derby mine, Gunnison Co., Colo.	granite pegmatite
7	Mittelfehldt and Miller	1983	Sweetwater pluton, Calif.	pegmatite
8	Andersen	1986	Fen district, Norway	carbonatite
9	Kalita	1961	Kapraovo, Karelia U.S.S.R.	granite pegmatite
10	Heinrich et al.	1960	Brown Derby mine, Gunnison Co., Colo.	granite pegmatite
11	Rapp and Wilson	1986	Raade, Norway	pegmatite
12	Heinrich et al.	1960	Brown Derby mine Gunnison Co., Colo.	pegmatite
13	Shukolyukov et al.	1979	Chernaya Salma, Karelia, U.S.S.R.	
14	Murata et al.	1957	Jamestown, Colo.	aplite-pegmatite zone
15	Zhang and Tao	1986	Bayan Obo, China	aegirine-type ore
16	Ivantishin et al.	1964	Ukrainian Shield	granite
17	McCarty	1935	New Mexico	
18	Kalita	1961	Kaita, Karelia	granite pegmatite
19	Vainshtein et al.	1956b	Karelia	granite pegmatite
20	Kornetova and Kazakova	1982	Siberia	pegmatite pegmatite
21	Kalita	1961	Alakurtti, Karelia U.S.S.R.	granite pegmatite
22	Kalita	1959	N.W. Karelia	granite pegmatite
23	Ivantishin et al.	1964	Ukrainian Shield	granite gneiss
24	Semenor and Khomyakov	1981	N. Karelia	
25	Kalita	1969	eastern Baltic Shield	granite pegmatite
26	quoted by Vlasov	1964	Chernaya Salma, Karelia	granite pegmatite
27	Sahama and Vahatalo	1941	Luikohlahti, Karelia	granite pegmatite
28	Kornetova and Osolodkina	1966	Siberia	granite pegmatite

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 1. Analyses	Author	Date	Locality	Rock Type
29	Leonova and Nikitin	1962	Karelia	granite pegmatite
30	Vainshtein et al.	1956b	Chernaya Salma, Karelia	granite pegmatite
31	Hugo	1970	Styr Kraal, S. Africa	
32	Shukolyukov et al.	1979	Temryuk, Karelia, U.S.S.R.	
33	Kalita	1961	Neblogera, Karelia	granite pegmatite
34	Zhirov et al.	1961	N. Karelia	granite pegmatite
35	Zayats and Kuts	1964	Dniepr region, Ukraine	biotite gneiss
36	Murata et al.	1957	Grans, Sao Paulo, Brazil	granite pegmatite; inner part of crystal 37
37	Murata et al.	1957	Grans, Sao Paulo, Brazil	granite pegmatite; outer part of crystal 36
38	Ivantishin et al.	1964	Ukraine	granite pegmatite
39	Kalita	1961	Nuoleinnieme, Karelia	granite pegmatite
40	Sahama and Vahatalo	1939	Impilahti, Karelia	
41	Shukolyukov et al.	1979	Given, Karelia	
42	Vainshtein et al.	1955	Karelia	pegmatite
43	Murata et al.	1953	Crabtree Creek, N. Carolina	
44	Lee and Bastron	1967	Mt. Wheeler area, Nevada	granodiorite-quartz monzonite
45	Vainshtein et al.	1956b	Mozambique	pegmatite
46	Ivantishin et al.	1964	Ukrainian Shield	granite pegmatite
47	Ivantishin et al.	1964	Kirovgrad-Zhitomir	granite
48	Zagats and Kuts	1964	Gnilopyat River Basin, Ukraine	Archean garnet-biotite gneiss
49	Semenov	1963	S. Asia	spodumene pegmatite
50	Khomyakov	1964	W. Tannu-Ola, U.S.S.R.	calcite vein
51	McCarty	1935	not known	
52	McCarty	1935	Cleveland Co., N.C., USA	
53	Shukolyukov et al.	1979	Glukhovets, U.S.S.R.	
54	Hugo	1970	Debares, S. Africa	
55	Lee and Bastron	1967	Mt. Wheeler area, Nevada	granodiorite-quartz monzite
56	Lee and Bastron	1967	Mt. Wheeler area, Nevada	granodiorite-quartz monzite
57	Orsa et al.	1967	Ukraine	garnet-muscovite pegmatite

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 1. Analyses	Author	Date	Locality	Rock Type
58	Heinrich et al.	1960	Petaca, N. Mexico	granite pegmatite
59	Zayats and Kuts	1964	Ukraine	Archean biotite gneiss
60	McCarty	1935	McDowell Co., N.C.	
61	Vainshtein et al.	1955	Brazil	
62	Lee and Bastron	1967	Mt. Wheeler area, Nevada	granodiorite-quartz monozite
63	Ivantishin et al.	1964	Ukraine	granite pegmatite
64	Ivantishin et al	1964	Ukraine	gneiss
65	Shukolyukov et al	1979	not known	
66	quoted by Vlasov	1964	Mongolia	alkali hydro-thermalite
67	Mannucci et al.	1986	Val Vigazzo, Italy	pegmatite
68	Mohr	1984	North Carolina	core of zoned porphyroblast
69	Mohr	1984	North Carolina	rim of zoned porphyroblast
70	Vainshtein et al.	1956b	Hittero, Norway	
71	Zhirov et al.	1961	Impilahti, Karelia, U.S.S.R.	granite pegmatite
72	Zhang and Tao	1986	Bayan Obo, China	main ore
73	Zagats and Kuts	1964	Gnilopat river basin Ukraine	Archean biotite gneiss
74	Fujii	1961	Fukushima Pref., Japan	
75	Zhirov et al.	1961	Kupchinit, Karelia	granite pegmatite
76	Popernalok	1961	Popernalore, Karelia	granite pegmatite
77	Zhang and Tao	1986	East ore, Bayan Obo, China	dolomite
78	Zhirov et al.	1961	Tedino, Karelia	granite pegmatite
79	Murata et al.	1953	Petaca, N. Mexico	granite pegmatite
80	Shmakin and Shirgaevo	1970	Gutero, Biryasin area, Siberia	pegmatite
81	Vainshtein et al.	1956b	Kurumkan, E. Siberia	cordierite gneiss
82	Ivantishin et al.	1964	Ukraine	gneiss
83	Vainshtein et al.	1956b	Pysstinoc, Siberia	quartzite
84	Heinrich et al.	1960	Chaffee Co., Colo.	granite pegmatite
85	Murata et al.	1959	Gramma, Sao Paulo, Brazil	granite pegmatite
86	Sahama and Vahatalo	1941	Turku, Finland	granite
87	Lee and Bastron	1967	Mt. Wheeler area, Nev.	granodiorite-quartz monozite
88	Heinrich et al.	1960	Petaca, N. Mexico	granite pegmatite

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 1. Analyses	Author	Date	Locality	Rock Type
89	Pluhar	1979	Takua Pa, S. Thailand	granite pegmatite
90	Lee and Bastron	1967	Mt. Wheeler area, Nev.	granodiorite-quartz monzonite
91	Vainshein et al.	1956b	Zhezholev, Ukraine	
92	McCarty	1935	Arendel, Norway	
93	Shukolyukov et al.	1978	Eki Varaki, N. Karelia, U.S.S.R.	
94	Ivantishin et al.	1964	Chudnov-Berdesinskii Ukraine	granite
95	Murata et al.	1959	Pemba, Minas Gerais, Brazil	granite pegmatite
96	Lee and Bastron	1967	Mt. Wheeler area, Nevada	granodiorite-quartz monzonite
97	Konetova	1963	Siberia	granite pegmatite
98	Ivantishin et al.	1964	Ukraine	gneiss
99	Amli	1975	Troland, Norway	granite pegmatite
100	Vainshein et al.	1956b	Arendal, Norway	pegmatite
101	Murata et al.	1953	Amelia, Va.	granite pegmatite
102	Heinrich et al.	1960	Pocos, N. Mexico	granite pegmatite
103	Zayats and Kuts	1964	Gnilopyat river basin, Ukraine	garnet-biotite gneiss
104	Murata et al.	1959	Ferros, Minas Gerais, Brazil	granite pegmatite
105	Ivantishin et al.	1964	Kirovgrad-Zhitomir, Ukraine	granite
106	Shukolyukov et al.	1979	Nova Pavlova, Karelia, U.S.S.R.	
107	Vainshtein et al.	1956b	Gnilopyat river, Ukraine	pegmatite
108	Lyakhovich	1962	E. Sayan	granite
109	Leonova and Nikitin	1962	Chkalov, Karelia	granite pegmatite
110	Vainshtein et al.	1956b	Zhalzhosk, Ukraine	gneissic granite
111	Heinrich et al.	1960	Chaffee Co., Colo.	granite pegmatite
112	Bernstein	1982	N. Carolina	quartz vein in slate
113	quoted by Vlasov	1964	European S.S.R.	alkali granite
114	Ivantishin et al.	1964	Kirovgrad-Zhitomir Ukraine	granite
115	Murata et al.	1959	Minas Gerais, Brazil	granite pegmatite

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 1. Analyses	Author	Date	Locality	Rock Type
116	Leonora and Nikitin	1962	Chkalov, Karelia U.S.S.R.	granite pegmatite
117	Shmakin and Shiryeeva	1970	Moma, Siberia	pegmatite
118	Kalita	1969	East Baltic shield U.S.S.R.	granite pegmatite
119	Heinrich et al.	1960	Petaca, N. Mexico	granite pegmatite
120	Kostin and Volzhenkova	1965	not stated	quartz-oligoclase vein in gabbro
121	Murata et al.	1953	Portland, Conn.	granite pegmatite
122	Zhirov et al.	1961	Tedina, Karelia, U.S.S.R.	granite pegmatite
123	Heinrich et al.	1960	Park Co., Colo.	granite pegmatite
124	Marchenko	1967	S.E. Ukraine	biotite gneiss
125	Heinrich et al.	1960	Park Co., Colo.	granite pegmatite
126	Wyllie	1950	Normanville district, Australia	pegmatite
127	Lyckhovich	1962	Talitsk massif, Gornyi Altai	biotite granite
128	Vainshtein et al.	1956b	Arendal, Norway	
129	Lyakhovich and Barinskii	1961	Kurokhol massif W. Tuva	granite
130	Fishman et al.	1968	Sol'ner massif Polar Urals	granite
131	Lee and Bastron	1967	Mt. Wheeler area, Nevada	granodiorite-quartz monzonite
132	Heinrich et al.	1960	Petaca, N. Mexico	granite pegmatite
133	Heinrich et al.	1960	Petaca, N. Mexico	granite pegmatite
134	Zhang and Tao	1986	East ore, Bayan Obo China	
135	Vainshtein et al.	1956b	Tedino, Karelia, U.S.S.R.	
136	Pavlenko et al.	1959	Uzuntaig massif, E. Tuva	granosyenite
137	Fishman et al.	1968	source of the Bolshaya Pobk river, U.S.S.R.	
138	Hugo	1970	Kroma Puts, S. Africa	pegmatitic granodiorite
139	Kucha	1980	Bogatyne area, Lower Silesia, Poland	
140	Murata et al.	1959	Sao Bento, Rio Grande do Norte, Brazil	granite pegmatite
141	Lee and Bastron	1967	Mt. Wheeler area, Nevada	granodiorite-quartz monozite
142	Komov et al.	1974	Polar Urals	hydrothermal quartz vein

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 1 Analyses	Author	Date	Locality	Rock Type
143	Murata et al.	1953	Hollis, N. Carolina	quartz monzonite pegmatite
144	Komov et al.	1974	Pamirs, Siberia	albitized quartzite
145	Vainshtein et al.	1956b	Kiev dist., Ukraine	kaolinized granite
146	Bukanov and Shvetsova	1966	Near-Polar Urals	quartz vein
147 (av. of 10)	Vainshtein et al.	1956a	Borshchevoch ridge Transbaikal	
148	Zayats and Kuts	1964	Pobozhs, Ukraine	garnet-biotite gneiss
149	Zhang and Tao	1986	Bayan Obo, China	riebeckite-type ore
150	Zayats and Kuts	1964	Azov region, U.S.S.R.	biotite gneiss
151	Bel'kov	1979	Kola Peninsula, U.S.S.R.	metasomatic granite
152	Marchenko	1967	S.E. Ukraine	biotite-garnet pegmatite
153	Shukolyukov et al.	1979	not given	
154 (same as 146?)	Komov et al.	1974	Polar Urals	quartz vein
155	Graeser and Schwander	1987	Italy	pegmatite vein in gneiss
156	Povilaitis and Varshal	1959	Kuu massif, Kazakstan	metasomatic feldspar rock
157	Ivantishin et al	1964	Ukraine	gneiss
158	Haapala et al.	1969	Puumala, Finland	biotite vein in Precambrian granite
159	Zhirov et al.	1961	Chkalov, Karelia, U.S.S.R.	granite pegmatite
160	Bukahov and Shvetsova	1966	near-Polar Urals	quartz vein
161 (av. of 5)	Choong	1971	Malaysia	
162	Ivantishin et al.	1964	Ukraine	Kirovgrad-Zhitomir granite
163	Ivantishin et al.	1964	Ukraine	gneiss
164	Pavlenko et al.	1959	Ilektag massif, E. Tuva	biotite granite
165	Shmakin and Shiryaeva	1970	Gutaro-Biryagin area, Siberia	pegmatite
166	Znamenskii et al.	1967	Myakulski river, E. Sayan	2-mica granite
167	Lee and Bastron	1967	Mt. Wheeler area, Nevada	granodiorite-quartz monozite
168	Mineev	1963	Tarbagatan, Kazakhstan	exocontact metasomatites
169	Mineev	1963	Tarbagatan, Kazakhstan	exocontact metasomatites
170	Murata et al.	1959	Uba, Minas Gerais, Brazil	granite pegmatite
171	Bearth	1934	Perdotech, Switzerland	Alpine cleft
172	Bel'kov	1979	Kola Peninsula, U.S.S.R.	leucocratic granite

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 1 Analyses	Author	Date	Locality	Rock Type
173	Lee and Bastron	1967	Mt. Wheeler, Nevada	granodiorite-quartz monozite
174	Lee and Bastron	1967	Mt. Wheeler area, Nevada	granodiorite-quartz monozite
175	Vainshtein et al.	1956b	Azov region, U.S.S.R.	pegmatite
176	Ivantishin et al.	1964	Chudnov-Berdesinskii, Ukraine	granite
177	Lyakhovich	1962	Kuu massif, Kazakhstan	granite
178	L'vov	1965	Borisovskii massif Kochkar, Urals	pegmatite
179	Trace	1960	Hicks Dome, Illinois	cherty residuum overlying limestone
180	Lee and Bastron	1967	Mt. Wheeler area, Nevada	granodiorite-quartz-monozite
181	Kovalenko et al.	1971	Buge-Gaziyan, Mongolia	microclinite
182	Vainshtein et al.	1956b	Temryuk, Azov region, U.S.S.R.	
183	Mannucci et al.	1986	Val Vigezzo, Italy	pegmatite
184	Leonova and Nikitin	1962	Perti Vokera, Karelia U.S.S.R.	granite pegmatite
185	Kapustin	1985	Novipoltov massif, U.S.S.R.	carbonatite
186	Zayats and Kuts	1964	Gnilopyat river basin Ukraine	biotite gneiss
187	Zayats and Kuts	1964	Gnilopyat river basin Ukraine	garnet-biotite gneiss
188	Lee and Bastron	1967	Mt. Wheeler area, Nevada	granodiorite-quartz monozite
189	Povilaitis and Varshal	1959	Kuu massif, Kazakhstan	metasomatic feldspar rock
190	Semenov and Khomyakov	1981	India	strongly magnetic
191	Lee and Bastron	1967	Mt. Wheeler area, Nevada	granodiorite-quartz monozite
192	Kirillov and Ryzhova	1968	Karelia, U.S.S.R.	sulfatian carbonatite
193	Murata et al.	1959	Nazarene, Minas Gerais, Brazil	granite pegmatite
194	L'vov and Zhangurov	1963	Borisovskii massif, Urals	pegmatite
195	Vainshtein et al.	1956b	Hittero, Norway	pegmatite
196	Znamenskii et al.	1967	Tickhaya river, E. Sayan	biotite granite
197	Ivantishin et al.	1964	Ukraine	gneiss
198	Kuts	1966	Azov region, U.S.S.R.	xenoliths in granite
199	Marchenko	1967	S.E. Ukraine	garnet-biotite pegmatite
200	Vainshtein et al.	1956b	Yuzhakova, Ukraine	granite
201	Vainshtein et al.	1956b	Torgevitsy, Ukraine	granite
202	Lyakhovich	1962	E. Sayan	granite
203	Pavlenko et al.	1959	Milzei massif, E. Tuva	alaskite

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 1 Analyses	Author	Date	Locality	Rock Type
204	Kuts	1966	Belmichaya, Azov region U.S.S.R.	
205	White and Nelen	1987	Foote mine, N. Carolina	pegmatite
206	Mittelfehldt and Miller	1983	Sweetwater Wash. pluton, Calif.	granite
207a	Murata et al.	1958	Juiz de Fera, Minas Gerais, Brazil	granite pegmatite outer part of crystal
207b	Murata et al.	1958	Juiz de Fera, Minas Gerais, Brazil	granite pegmatite inner part of crystal
208	Bel'kov	1979	Kola Peninsula, U.S.S.R.	metasomatic granite
209	Znamenskii et al.	1967	E. Sayan	biotite granite
210	Znamenskii et al.	1967	E. Sayan	biotite granite
211	Vainshtein et al.	1956b	Kalchik river, Ukraine	pegmatite
212	Murata et al.	195?)	Juiz de Fera, Minas Gerais, Brazil	granite pegmatite
213	Vainshtein et al.	1956b	Temryuk, Azov region, U.S.S.R.	pegmatite
214	Zayats and Kuts	1964	Pabuzhe, Ukraine	Archean biotite gneiss
215	Vainshtein et al.	1955	Torgeritsy, Ukraine	granite
216a,b (same species; collected separately)	Murata et al.	1957	Shelby district, N. Car.	quartz monozite
217	Mannucci et al.	1981	Alps, Italy	pegmatite
218	Ivantishin et al.	1964	Ukraine	Proterozoic gneiss
219 (same as 215?)	Vainshtein et al.	1955	Zhelzheskii, Ukraine	gneissic granite
220	Znamenskii et al.	1967	Tiskhaya river, E. Sayan	biotite granite
221	Kuts	1966	Berda river, Azov region, U.S.S.R.	aplitic granite
222	Zayats and Kuts	1964	Sluch river basin, Azov region	Proterozoic biotite gneiss
223	Fujii	1961	Ishikawa-Che, Fukushima Prefecture, Japan	
224	L'vov	1965	Borisovskii massif, Urals	kyanite schist
225	Leonova and Nikitin	1962	Lake Laakensko, Karelia, U.S.S.R.	granite pegmatite
226	Lyakhovich	1962	E. Sayan	biotite granite

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 1 Analyses	Author	Date	Locality	Rock Type
227	Yalovenko and Yur'ova	1964	Lazovatka, Ukraine	granite
228	Vainshtein et al.	1955	Brazil	granite
229	Lyakhovich	1962	Eldzhurtin massif, Caucasus	biotite granite
230	Kuts	1966	Torgevitsy, Ukraine	pegmatite
231	Anderson	1986	Fen district, Norway	carbonatite
232	Semenov	1963	Ras-Iz, Polar Urals	plagiogranite pegmatite
233	Zayats and Kuts	1964	Slyuch river basin, Ukraine	garnet-biotite gneiss
234	Murata et al.	1957	Yucca Valley, Calif.	granite pegmatite
235	Vainshtein et al.	1955	Torgevitsy, Ukraine	pegmatite
236	Lyakhovich	1962	Korovischin massif, Gornyi Altai	granite
237	L'vov	1968	Varlamoff massif, Urals	granite
238	Lyakovich	1968	Urals	quartz vein
239	Jefferies	1985	Carnmenellis pluton, Cornwall, England	biotite granite
240	Wyllie	1950	Cooglegong, W. Australia	pegmatite
241	Vainshtein et al.	1956b	Temryuk, Azov region, U.S.S.R.	
242	Vainshtein et al.	1956b	Blyunov mine, Urals	pegmatite
243	Zhang and Tao	1986	Bayun Obo, China	main magnetic ore
244	Vainshtein et al.	1956b	Kiev dist., U.S.S.R.	granite
245	Bel'kov	1979	Kola Peninsula, U.S.S.R.	metasomatic granite
246	Yurk et al.; quoted by Lazarenko et al.	1980	Ukraine	aplitic granite
247	Lyakhovich	1962	Ukraine	biotite granite
248	Yalovenko nd Yur'ova	1967	Rovno, Ukraine	pegmatite granite
249	Shmakin and Shiryaeva	1970	Gutero-Biryasin area, Siberia	
250	Ivantishin et al.	1964	Ukraine	gneiss
251	Lyakhovich	1962	Talitsk massif, Gornyi Altai	biotite granite
252	Vainshtein et al.	1956b	Fukushima, Japan	
253	Kuts	1966	Temryuk, Azov region U.S.S.R.	pegmatite
254	Anderson	1986	Fen dist., Norway	carbonatite
255	Murata et al.	1959	Juiz de Fera, Minas Gerais, Brazil	granite pegmatite
256	Charey	1986	Cornwall, England	granite
257	Povilaitis and Varshal	1969	Kuu massif, Kazakhstan	quartz-scheelite vein in serpentinite

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 1 Analyses	Author	Date	Locality	Rock Type
258	Pluhar	1979	Phukat, S. Thailand	granite pegmatite
259	Mannucci et al.	1986	Alps, Italy	pegmatite
260	Vainshtein et al	1956b	Tamryuk, Azov region U.S.S.R.	
261	Vainshtein et al.	1955	Ostropel, Ukraine	granite
262	Vainshtein et al.	1956b	Krutocheg, Urals	granite
263	Marchenko	1967	S.E. Ukraine	aplitic biotite granite
264	Lyakhevich	1968	Kazakhstan	biotite granite
265	Vainshtein et al.	1955	Noiro-Shaitaken, Urals	two-mica granite
266	Vainshtein et al.	1955	Krivoi reg., Ukraine	
267	Vainshtein et al.	1956b	Krutocheg, Urals	granite
268	Murata et al.	1959	Juiz de Fera, Minas Gerais, Brazil	granite pegmatite
269	Kornetova	1963	Siberia	granite pegmatite
270	Vainshtein et al.	1956b	Buzivka, Ukraine	kaolinized granite
271	Lyakhovich	1962	Talitsk massif, Gornyi Altai	biotite granite
272	Jefferies	1985	Carnmenellis pluton, Cornwall, England	biotite granite
273	Kapustin	1966	Vuorijarvi, Karelia U.S.S.R.	carbonatite
274	Lyakhovich	1962	Kochkar massif, Urals	granite
275	Kuts, quoted by Lazarenko et al.	1980	Berda, Ukraine	aplitic granite
276	Murata et al.	1957	Shelby dist., N. Carolina	sillimanite schist
277	Ivantishin et al.	1964	Ukraine	gneiss
278	Lyakhovich	1962	E. Sayan	granite
279	Povilaitis and Varshal	1969	Kuu massif, Kazakhstan	quartz-wolframite vein in greisen
280	Murata et al.	1959	Juiz de Fera, Minas Gerais, Brazil	granite pegmatite
281	Komov et al.	1974	Polar Urals	quartz vein
282	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	granite
283	Jefferies	1985	Carnmenellis pluton Cornwall, England	biotite granite
284	Bel'kov	1979	Kola Peninsula, U.S.S.R.	granodiorite-tonalite
285	Vainshtein et al.	1956b	Kirovgrad, Ukraine	granite
286	Khamrabaev and Azimov	1986	Aktau massif, W. Uzbekistan	granite pegmatite
287	Zhirov et al.	1961	Kheto-Lambthe, Karelia, U.S.S.R.	granite pegmatite

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 1 Analyses	Author	Date	Locality	Rock Type
288	Lyakhovich	1962	Ekaterinov massif, Ukraine	biotite granite
289	Kuts	1966	Anatolskii, Azov region U.S.S.R.	granite
290	Zayats and Kuts	1964	Gnilopyat river basin Ukraine	Archean biotite granite
291	Lyakhovich	1968	E. Sayan	biotite granite
292	L'vov and Zhangurov	1968	Dzebyk region, E. Urals	biotite gneiss
293 (av.of 6)	Vainshtein et al.	1956a	Borshchevoch Ridge, Transbaikal	gneissic granite
294	Murata et al.	1959	Ferros, Minas Gerais, Brazil	granite pegmatite
295	Lyakhovich	1962	Kochkar massif, Urals	pegmatite
296	Vainshtein et al.	1955	Badeiba, Transvaal	pegmatite
297	Vainshtein et al.	1956b	Temryak, Azov region, U.S.S.R.	pegmatite
298	Lyakhovich and Kasaeva	1968	Kabaride-Balkarsk A.S.S.R.	Precambrian granite
299	Vainshtein et al.	1955	Korea	pegmatite
300	Murata et al.	1953	Shelby dist., N. Carolina	quartz monzonite pegmatite
301	Pavlenko et al.	1966	Milzei massif, E. Tuva	biotite granite
302	Lyakhovich and Barinskii	1961	Edygai massif, W. Tuva	quartz vein
303	Vainshtein et al.	1956b	Temryuk, Azov region U.S.S.R.	pegmatite
304	Mannucci et al.	1986	Alps, Italy	fissure
305	Mannucci et al.	1986	Alps, Italy	pegmatite
306	Gavrilova and Turanskaya	1958	Kirovgrad, Ukraine	granite
307	Orsa et al.	1967	Middle Dniepr region Ukraine	pegmatite granite
308	Lazarenko et al.	1980	Ekaterinava, Ukraine	
309a,b,c 3 analyses of 1 sample	Ploshko and Knyazaeva	1965	Urushten complex, Caucasus	
310	L'vov	1965	Demerinskii massif, Urals	granite gneiss
311	Murata et al.	1957	Chesterfield, Va.	granite
312-313	Vainshtein et al.	1956b	Gorevka, Ukraine	
314	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	granite
315	Zayats and Kuts	1964	Gnilopyat river basin Ukraine	Archean biotite gneiss
316	Nadashovskii et al.	1969	Far Eastern, U.S.S.R.	alkali granite
317-318	Vainshtein et al.	1956b	Gorovka, Ukraine	granite
319	Lyakhovich	1962	Murzinsk massif, Urals	granite
320	Vainshtein et al.	1955	Ostrope, Austria	pegmatite
321	Wylie	1950	Olary, S. Australia	gold mine

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 1 Analyses	Author	Date	Locality	Rock Type
322	Ivantishin et al.	1964	Chudnov-Berdesinskii, Ukraine	granite
323	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	biotite granite
324	Vainshtein et al.	1956b	Suberov, Ukraine	
325	Kuts	1966	Anatolisk, Azov region U.S.S.R.	granite
326	Vainshtein et al.	1956b	Kurumkan, E. Siberia	
327	Zhang and Tao	1986	East ore, Bayan Obo, China	
328	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	biotite granite
329	Semenov	1963	Transbaikal	granite
330	Povilaitis and Varshal	1967	Kuu massif, Kazakhstan	quartz vein
331	Mannucci et al.	1986	Alps, Italy	pegmatite
332	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	biotite granite
333	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	biotite granite
334	Bel'kov	1979	Kola Peninsula, U.S.S.R.	alkali granite
335	Vainshtein et al.	1956b	Zasentriskoi, E. Siberia	
336	Belolipetskii and Elina	1967	not given	alkali granite
337	Pinkney and Wood, quoted by Semenov	1963	Van Reinsdorf, S. Africa	hydrothermal granite
338	Bermanec et al.	1988	Yugoslavia	hydrothermal vein vein in syenite
339	Murata et al.	1957	Shelby dist., N. Carolina	biotite schist
340	L'vov	1965	Samarskii massif, Urals	granite
341	Batieva	1976	Kola Peninsula, U.S.S.R.	alkali granite
342	Vainshtein et al.	1956b	Pastinnec, E. Siberia	
343	Khonyakov	1964	Tannu-Ola	quartz syenite
344	Murata et al.	1959	San Rafael, Rio Grande do Norte, Brazil	granite
345	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	biotite granite
346	Bel'kov	1979	Polar Urals	alkali granite
347	Kapustin	1966	Nama Vara, Karelia, U.S.S.R.	
348	Komov et al.	1974	Polar Urals	quartz vein
349	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	biotite granite
350	Bel'kov	1979	Polar Urals	alkali granite
351	Lyakhovich	1962	Transbaikal	biotite granite
352	Zayats and Kuts	1964	basin of Sluch river, Ukraine	Proterozoic garnet-biotite gneiss
353	Komov et al.	1974	Polar Urals	quartz vein
354	Lyakhovich	1968	Gornyi Altai	pegmatite

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 1 Analyses	Author	Date	Locality	Rock Type
355	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	biotite granite
356	Bel'kov	1979	alkali granite, Kola Peninsula	alkali granite
357	Vainshtein et al.	1956b	Temryuk, Azov region, U.S.S.R.	pegmatite
358	Zayats and Kuts	1969	Sluck river basin, Ukraine	biotite gneiss
359 same as 358?	Ivantishin et al.	1964	Ukraine	Lower Proterozoic gneiss
360	Vainshtein et al.	1956a	Borshchevoch ridge, Transbaikal	granite
361	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	biotite granite
362	Bel'kov	1979	Kola Peninsula, U.S.S.R.	metasomatic granite
363	Ivantishin et al.	1964	Ukraine	gneiss
364	Borovskii and Gerasimovskii	1945	Urusika river, Siberia	granite pegmatite
365	Bel'kov	1979	Kola Peninsula, U.S.S.R.	alkali granite
366	Orsa et al.	1967	Middle Dniepr region, Ukraine	pegmatite granite
367	Murata et al.	1959	Mar de Espinha, Minas Gerais, Brazil	granite pegmatite
368	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	biotite granite
369,370	Jefferies	1985	Cornwall, England	biotite granite
371-372	L'vov	1965	Samarskii massif, Urals	granite
373	L'vov and Zhangurov	1968	Dzhabyk region, E. Urals	granite
374	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	biotite granite
375	Vainshtein et al.	1956b	Zasentiske, E. Siberia	
376	Van Wambeke	1977	Karonge deposit, Burundi Republic	
377	Murata et al.	1959	Mar de Espinha, Minas Gerais, Brazil	granite pegmatite
378,379	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	biotite granite
380	Bel'kov	1979	Kola Peninsula, U.S.S.R.	metasomatic granite
381	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	biotite granite
382	L'vov	1965	Varlamoffski massif, Urals	granite
383	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	biotite granite
384	Lyakhovich	1962	Ukraine	biotite granite

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 1 Analyses	Author	Date	Locality	Rock Type
385	Povilaitis and Varshal	1959	Kuu massif, Kazakhstan	metasomatic albite-quartz replacement of granite
386	Mannucci et al.	1986	Rauris, Italy	fissure
387,388	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	biotite granite
389	Zhirov et al.	1961	Eki Varaka, N. Karelia U.S.S.R.	granite pegmatite
390	Kupriyanova et al.	1964	European S.S.R.	quartz-fluorite molybdenite vein
391,392	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	biotite granite
393	Orsa et al.	1967	Zaporozh'ye, Ukraine	plagiomigmatite
394-396	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	biotite granite
397	Shiryaeva	1971	Mamsk region, Siberia	muscovite pegmatite
398	Kuts	1966	Ingulets region, Ukraine	gneiss
399	Murata et al.	1959	Consicao de Meto, Ventre, Minas Gerais, Brazil	granite pegmatite
400	McKie	1962	Kangankunde, Malawi	carbonatite
401	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	biotite granite
402	Lyakovich	1968	Kazakhstan	biotite granite
403	Jefferies	1985	Cornwall, England	biotite granite
404,405	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	biotite granite
406	Ivantishin et al.	1964	Ukraine	gneiss
407	Jefferies et al.	1985	Cornwall, England	biotite granite
408	Murata et al.	1959	Mar de Espinha, Minas Gerais, Brazil	granite pegmatite
409	Pluhar	1979	Takua Pa, S. Thailand	granite pegmatite
410-412	Jefferies et al.	1985	Cornwall, England	biotite granite
413	Semenov and Barinskii	1958	Tennet, Yakutia	pegmatite of alkaline growth
414	Murata et al.	1959	Mar de Espinha, Minas Gerais, Brazil	granite pegmatite
415	Vainshtein et al.	1955	Aldan	pegmatite
416	Murata et al.	1959	Juiz de Fera, Minas Gerais, Brazil	schist wall rock of pegmatite
417	L'vov	1965	Varlamoff massif, Urals	granite
418	L'vov and Zhangurov	1968	Dzhabyk region, E. Urals	granite
419	Bel'kov	1979	Kola Peninsula	metasomatic granite
420	Jefferies	1985	Cornwall, England	biotite granite
421	Orsa et al.	1967	Middle Dniepr region, Ukraine	granite
422	Jefferies	1985	Cornwall, England	biotite granite

Table 9a. Locality Index - Monazite-(Ce) (contd.)

Table 1 Analyses	Author	Date	Locality	Rock Type
423	Kukharenko et al.	1961, 1965	Namo Vara, Karelia	sulfatian carbonatite
424	Povilaitis and Varshal	1959	Kuu massif, Kazakhstan	
425	Ivantishin et al.	1964	Ukraine	gneiss
426	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	biotite granite
427-428	Jefferies	1985	Cornwall, England	biotite granite
429	Vainshtein et al.	1956b	Il'men Mts., Urals	pegmatite
430	Shlyukova	1986	Khibina massif, Kola Peninsula, U.S.S.R.	pegmatite
431	Murata et al.	1959	Mar de Espinha, Minas Gerais, Brazil	granite pegmatite
432	Lyakhovich	1968	Kazakhstan	granite
433 av. of 8	Vainshtein et al.	1956a	Borshchevoch ridge, Transbaikal	granite
434	Vainshtein et al.	1956b	Il'men Mts., Urals	pegmatite
435	Andersen	1986	Fen dist., Norway	carbonatite
436	Proshchenko	1967	E. Siberia	albitite
437	Murata et al.	1959	Mar de Espinha, Minas Gerais, Brazil	granite pegmatite
438	Borovskii and Gerasimovskii	1945	Elizavetinsk, Urals	granite pegmatite
439	Kovalenko et al.	1971	Ink-Khairken, Mongolia	microclinite
440	Aleksiev and Tsvetkova	1962	Rila Mts., Bulgaria	biotite granite
441	Semenov and Khomyakov	1981	India	weakly magnetic
442-444	Shlyukova	1981	Khibina massif, Kola Peninsula, U.S.S.R.	
445	Murata et al.	1959	Mar de Espinha, Minas Gerais, Brazil	schist wall rock of granite pegmatite (#431)
446	Komov et al.	1974	Pamirs, Siberia	quartz-carbonate vein
447	Jefferies	1985	Cornwall, England	biotite granite
448	Papunen and Lindsjo	1972	Korsnas, Finland	skarn, lead deposit
449	Murata et al.	1957	Hollis, N. Carolina	quartz monzonite dike
450	Jefferies	1985	Cornwall, England	biotite granite
451	Anderson	1986	Fen dist., Norway	carbonatite
452	Murata et al.	1959	Mar de Espinha, Minas Gerais, Brazil	carbonatite
453	L'vov and Zhangurov	1968	Dzhabyk region, E. Urals	
454	Murata et al.	1959	Mar de Espinha, Minas Gerais, Brazil	carbonatite
455	Povilaitis and Varshal	1959	Kuu massif, Kazakhstan	granite
456	Ploshko	1961	Malaya Laba river, Caucasus, U.S.S.R.	talc-actinolite rock

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 1 Analyses	Author	Date	Locality	Rock Type
457	Yalovenko and Yur'eva	1967	Roches, Ukraine	granite
458	Zhang and Tao	1986	Bayan Obo, China	main ore
459	Murata et al.	1959	Juiz de Feros Minas Gerais, Brazil	granite pegmatite
460	Murata et al.	1959	Mar de Espinha, Minas Gerais, Brazil	granite pegmatite
461	Zayats and Kuts	1964	Ukraine	Archean biotite gneiss
462 (same as 461?)	Ivantishin et al.	1964	Ukraine	gneiss
463	L'vov and Zhangurov	1968	Dzhabyk region, E. Urals	granite
464	Jefferies	1986	Cornwall, England	biotite granite
465	Orsa et al.	1967	Zaporzhge, Ukraine	plagiogranite
466	L'vov	1965	Demarinskii massif, Urals	granite
467	Leonova and Nikitin	1962	Karelia, U.S.S.R.	granite pegmatite
468	Povilaitis and Varshal	1959	Kuu massif, Kazakhstan	metasomatic feldspar rock
469	Semenov	1963	Magadcherea, U.S.S.R.	pegmatite
470	Komov et al.	1974	Polar Urals	quartz vein
471	Komov et al.	1974	Pamirs, Siberia	dolomitized quartzite
472-473	Jefferies	1985	Cornwall, England	biotite granite
474	Vladykin et al.	1982	Mongolia	arfvedsonite granite
475	Lyakhovich	1967	Azov region, U.S.S.R.	
476	Jefferies	1985	Cornwall, England	biotite granite
477	Kretsev and Zamoryanskaya	1986	not given	
478	Zhang and Tao	1986	Bayan Obo, China	main ore
479	Meliksetyan	1963	Megri pluton, Armyan S.S.R.	syenite
480	L'vov and Zhangurov	1968	Sucundu region, E. Urals	granite
481	Jefferies	1985	Cornwall, England	biotite granite
482	Vainshtein et al.	1955	central Asia	quartz vein
483	Zayats and Kuts	1964	Pobuzhe, Ukraine	garnet-biotite gneiss
484	Vainshtein et al.	1956b	Pyat Palsen, Aldan	graphite granite
485	Murata et al.	1959	Shelby dist., N. Carolina	biotite gneiss
486	Borovskii and Gerasimovskii	1945	Andermanskii, Uriskiken river, Siberia	granite
487	Orsa et al.	1967	Middle Dniepr region, Ukraine	plagiomigmatite
488	Povilaitis and Varshal	1959	Kuu massif, Kazakhstan	vein granite
489	Mineev et al.	1962	Vishnevye Mts., Urals	alteration product of chevkinite, fenite
490	Es'kova and Ganzeev	1964	Urals	fenitized granite pegmatite

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 1 Analyses	Author	Date	Locality	Rock Type
491	Povilaitis and Varshal	1959	Kuu massif, Kazakhstan	quartz-wolframite vein in gneiss
492	Murata et al.	1959	San Rafael, Rio Grande do Norte, Brazil	pegmatite
493	Vainshtein et al.	1961	E. Sayan	carbonatite
494	Murata et al.	1957	Mt. Pass, Calif.	carbonatite
495	Povilaitis and Varshal	1959	Kuu massif, Kazakhstan	vein granite
496	Murata et al.	1959	Sabinopolis, Brazil	granite pegmatite
497	Vinogradov and Elina	1968	N.W. Kola Peninsula, U.S.S.R.	granite
498	Zhang and Tao	1986	East Ore Bayan Obo, China	aegirine type
499	Kuznetsova et al.	1980	northern Siberia	dolomite-ankerite carbonatite
500	Murata et al.	1959	Sabinopolis, Brazil	granite pegmatite
501	Dubrovskii	1968	Yuroeisk complex, Kola Peninsula	granite
502	Jefferies	1985	Cornwall, England	biotite granite
503	Zhang and Tao	1986	East ore zone, Bayan Obo, China	late stage vein
504	Murata et al.	1959	Sabinopolis, Brazil	granite pegmatite
505	Vainshtein et al.	1955	Urals	pegmatite
506	Serdyuchenko et al.	1967	Byelorussia	Precambrian biotite gneiss
507	Chistyakova and Kazakova	1968	Kazakhstan	granite pegmatite
508	L'vov and Zhangurov	1968	Chelyabin dist., E. Urals	granite
509	Zhang and Tao	1986	Bayan Obo, China	
510	Ivantishin et al.	1964	Ukraine	gneiss
511	Zhang and Tao	1986	Bayan Obo, China	
512	Vainshtein et al.	1961	E. Sayan	carbonatite
513	Kalenor et al.	1963	Far Eastern U.S.S.R.	pseudomorph after loparite in hydrothermally altered syenite
514	Zhang and Tao	1986	Bayan Obo, China	late stage vein
515	Kapustin	1966	E. Sayan	carbonatite
516	Mineev	1968	N.W. Tarbagatau, Kazakhstan	pegmatite
517	Mineev	1968	N.W. Tarbagatau, Kazakhstan	biotite apogranite
518	Chistov	1965	E. Siberia	carbonatite
519	Murata et al. Jaffe	1953 1955	Mt. Pass, Calif.	carbonatite
520	Vetoshkina et al.	1980	Ploska Mt., Kola Peninsula, U.S.S.R.	amazonite pegmatite

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 1 Analyses	Author	Date	Locality	Rock Type
521	Semenov et al.	1967	Tarbagatau, Kazakhstan	quartz-fluorite pegmatite
522	Povilaitis and Varshal	1959	Kuu massif, Kazakhstan	granite
523	Zuev and Kosterin	1961	Central Asia	hydrothermal
av. of 4				
524	Lyakhovich	1968	Kazakhstan	biotite granite
525	Povilaitis and Varshal	1959	Kuu massif, Kazakhstan	granite
526	Mineev	1968	N.W. Tarbagatau, Kazakhstan	biotite apogranite
527	quoted by Vlasov	1964	Mongolia	alkali hydrothermalite
528	Michael	1988	Bishop tuff, Calif.	inclusion in pyroxene
529	Zhang and Tao	1986	Bayan Obo, China	
530	Semenov et al.	1978	Tamil Nadu, India	carbonatite
531	Komov et al.	1974	Pamirs	quartzite
532	Zhang and Tao	1986	Bayan Obo, China	aegirine-type ore
same as 529?				
533	Jobbins et al.	1977	Sri Lanka	gem
534	Murata et al.	1957	Magnet Cove, Ark.	aplite-pyrite dike in carbonatite
535	Bloomfield and Garson	1965	Kangankunde Hill, Malawi	carbonatite
	Holt	1965		
536	Semenov	1963	Kazakhstan	greisen
537	Plaksenko et al.	1982	Shiryaeva pluton, U.S.S.R.	gabbro-dolerite
538	Povilaitis and	1959	Kuu massif, Kazakhstan	granite
539	Kuznetsova et al.	1980	N. Siberia	dolomite-ankerite carbonatite
540	Borovskii and Gerasimovskii	1945	Kounrad deposit, Balkhesh	granite
541	Marchenko	1967	S.E. Ukraine	hydrothermal gneissic xenolith in syenite
542	Zhang and Tao	1986	Bayan Obo, China	late-stage vein
543	Pavlenko et al.	1959	Dugdin massif, E. Tuva	pegmatite schlieren in granosyenite
544	Komov et al.	1974	Polar Urals	quartz vein
545	Zhang and Tao	1986	East ore, Bayan Obo, China	banded layer
546	Zhang and Tao	1986	Bayan Obo, China	
547	Vainshtein et al.	1955	Kazakhstan	hydrothermally altered pegmatite
548	Rose et al.	1958	Magnet Cove, Arkansas	carbonatite
549	Lyakhovich	1962	Eldzhurtin massif, N. Caucasus	
550	quoted by Vlasov	1964	Kounrad, Kazakhstan	

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 1 Analyses	Author	Date	Locality	Rock Type
551	Pluhar	1979	Phuket, S. Thailand	granite pegmatite
552	Vainshtein et al.	1955	Vishnevye Mts., Urals	carbonate vein
553	Vainshtein et al.	1955	Central Kazakstan	quartz vein
554	Zhang and Tao	1986	Bayan Obo, China	
555	Es'kova and Ganzeev	1969	Vishnevye Mts., Urals	dolomite vein in ultramafic rock
556	Vainshtein et al.	1955	Kazakhstan	hydrothermally altered pegmatite
557	Zhang and Tao	1986	Bayan Obo, China	dolomite type, main ore
558	Pluhar	1979	Phuket, S. Thailand	granite pegmatite
559	Es'kova and Ganzeev	1964	Vishnevye Mts., Urals	alkalic muscovite-corundum pegmatite
560	Es'kova and Ganzeev	1964	Vishnevye Mts., Urals	albitite in miaskite
561	Heinrich and Levinson	1961	Ravalli Co., Mont.	carbonatite
562	Zhabin and Svyazhin	1962	Vishnevye Mts., Urals	albitite
563	Somina and Bulakh	1966	E. Sayan	carbonatite
564	Es'kova and Ganzeev	1964	Vishnevye Mts., Urals	alkali pegmatite
565	Gramaccioli and Segelstad	1978	Piani, Italy	pegmatite
Table 2				
1	Pluhar	1979	Ranang Prov., S. Thailand	
2	Flinter et al.	1963	Johore State, Malaysia	
3	Pluhar	1979	Phang Nge Prov., S. Thailand	
4	Nekrasov	1972	Kular region, Far Eastern U.S.S.R.	SiO_2 12.04; P_2O_5 24.08%
5	McCarty	1935	China	
6	Pluhar	1979	Phuket Prov., S. Thailand	
7	Li and Grebennikova	1962	Siberia	
8	Flinter et al.	1963	Parak, Malaysia	
9	McCarty	1935	India	
10	Nekrasov	1972	Kular region, Far Eastern	SiO_2 12.04; P_2O_5 24.08%
11a-f	Richartz	1961	Brazil black sand (separated into magnetic fractions; listed in order of increasing magnetism	
12	Pluhar	1979	Ranang Prov., S. Thailand	
13	McCarty	1935	India	
14,15,16	Pluhar	1979	Ranang Prov., S. Thailand	
17	McCarty	1935	Idaho	
18	McCarty	1935	Florida	
19	Flinter et al.	1963	Kadah State, Malaysia	
20-22	Pluhar	1979	Ranang Prov., S. Thailand	

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 2 Analyses	Author	Date	Locality	Rock Type
23	Hedrick	1988	Florida	
24	Zemel	1936	Aldan, U.S.S.R.	gold placer
25	Pluhar	1979	Ranang Prov., S. Thailand	
26	Pluhar	1979	Phang Nge Prov., S. Thailand	
27-28	Pluhar	1979	Ranang Prov., S. Thailand	
29	Pluhar	1979	Phang Nge Prov., S. Thailand	
30-33	Pluhar	1979	Ranang Prov., S. Thailand	
34	Flinter	1963	Silian, Malaysia	
35	Flinter	1963	Trong Parak, Malaysia	
36-38	Pluhar	1979	Ranang Prov., S. Thailand	
39	Lazinski	1969	Baltic Sea coast	black sand
40-43	Pluhar	1979	Ranang Prov., S. Thailand	
44	Pluhar	1979	Phang Nge Prov.	
45-50	Pluhar	1979	Ranang Prov., S. Thailand	
51	Flinter et al.	1963	Kanper Perak, Malaysia	
52	Pluhar	1979	Ranang Prov., S. Thailand	
53-54	Pluhar	1979	Phang Nge Prov., S. Thailand	
55	Hedrick	1988	E. Australia	
56-57	Pluhar	1979	Ranang Prov., S. Thailand	
58	Flinter et al.	1963	Serenban, Malaysia	
59	Kosterin et al.	1962	Maritime Prov., Far Eastern, U.S.S.R.	
60	Pluhar	1979	Phuket Prov., S. Thailand	
61-64	Pluhar	1979	Ranang Prov., S. Thailand	
65	Trace	1960	Hardin Co., Ill.	cherty residuum overlying limestone
66	Pluhar	1979	Ranang Prov., S. Thailand	
67	Flinter et al.	1963	Semeling, Kedah State Malaysia	
68	Flinter et al.	1963	Batu Gugel, Perak State Malaysia	
69-71	Pluhar	1979	Ranang Prov., S. Thailand	
72	Flinter et al.	1963	Pertang, Perak State Malaysia	
73	Flinter et al.	1963	Bider, Perak State Malaysia	
74	Flinter et al.	1963	Petaling, Salanger State Malaysia	
75	Pluhar	1979	Ranang Prov., S. Thailand	
76	Pluhar	1979	Ranang Prov., S. Thailand	
77	Pluhar	1979	Phang Nge Prov., S. Thailand	
78	Pluhar	1979	Ranang Prov., S. Thailand	
79	Pluhar	1979	Phang Nge Prov., S. Thailand	
80-81	Pluhar	1979	Ranang Prov., S. Thailand	

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 2 Analyses	Author	Date	Locality	Rock Type
82	Pluhar	1979	Phang Nge Prov., S. Thailand	
83	Pluhar	1979	Ranang Prov., S. Thailand	
84	Pluhar	1979	Phang Nge Prov., S. Thailand	
85	Pluhar	1979	Ranang Prov., S. Thailand	
86-88	Pluhar	1979	Ranang Prov., S. Thailand	
89	Flinter et al.	1963	Selangor State, Malaysia	
90-91	Pluhar	1979	Ranang Prov., S. Thailand	
92	Soong	1978	Taiwan	
93	Pluhar	1979	Phukat Prov., S. Thailand	
94	Pluhar	1979	Ranang Prov., S. Thailand	
95	Pluhar	1979	Phang Nge Prov., S. Thailand	
96	Pluhar	1979	Phang Nge Prov., S. Thailand	
97	Pluhar	1979	Ranung Prov., S. Thailand	
98	Hedrick	1988	India	
99	Flinter et al.	1963	Sunghai, Perak State, Malaysia	
100	Pluhar	1979	Ranung Prov., S. Thailand	
101	Flinter et al.	1963	Pulau Besur, Malacca State, Malaysia	
102	Murata et al.	1953	Travancore, India	
103	Pluhar	1979	Ranung Prov., S. Thailand	
104	Hwang et al.	1981	Australia	
105	Pluhar	1979	Ranung Prov., S. Thailand	
106	Semenov and Turanskaya quoted by Vlasov, v. 2, p. 283	1964	Korea	
107	Chen et al.	1973	Taiwan	
108-110	Pluhar	1979	Ranang Prov., S. Thailand	
111	Pluhar	1979	Phang Nge Prov., S. Thailand	
112	Wylie	1950	Scottsdale dist., Tasmania	
113	Hedrick	1988	China	
114	Rosenblum	1974	Liberia	
115	Pluhar	1979	Phuket Prov., S. Thailand	
116	Wylie	1950	Byron Bay, N.S. Wales, Australia	a split of
117	Murata et al.	1957	Byron Bay, N.S. Wales,	same sample
118	Pluhar	1979	Ranang Prov., S. Thailand	
119	Chen et al.	1973	Taiwan	
120	Murata et al.	1953	Pacific Grove, Calif.	
121	Pluhar	1979	Ranang Prov., S. Thailand	
122	Wylie	1950	Stannum, N.S. Wales, Australia	alluvial
123	Smirnov	1969	Riphaen sediments, Middle Dniester area, Ukraine	
124	Pluhar	1979	Ranang Prov., S. Thailand	
125	Pluhar	1979	Phang Nge Prov., S. Thailand	
126	Rosenblum	1974	Liberia	
127	Wylie	1950	Cape Everard, Victoria Australia	beach sand

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 2 Analyses	Author	Date	Locality	Rock Type
128	Hedrick	1988	W. Australia	
129	Pluhar	1979	Ranang Prov., S. Thailand	
130	Rosenblum	1974	Liberia	
131	Wylie	1950	King Island, Australia	beach sand
132	Pluhar	1979	Ranang Prov., S. Thailand	
133	Pluhar	1979	Phuket Prov., S. Thailand	
134	Rosenblum	1974	Liberia	
135	Murata et al.	1953	Pacific Grove, Calif.	
136	Heinrich et al.	1960	Pacific Grove, Calif.	split of 135
137	Rosenblum	1974	Liberia	
138	Pluhar	1979	Phuket Prov., S. Thailand	
139	Rosenblum	1974	Liberia	
140	Pluhar	1979	Ranang Prov., S. Thailand	
141-142	Rosenblum	1974	Liberia	
143	Pluhar	1979	Phong Nge Prov., S. Thailand	
144	Hammond	1946	Travancore, India	beach sand
145	Rosenblum	1974	Liberia	
146	Pluhar	1979	Phang Nge Prov., S. Thailand	
147	Pluhar	1979	Phuket Prov., S. Thailand	
148	Pluhar	1979	Ranang Prov., S. Thailand	
149	Rosenblum	1974	Liberia	
150	Styles and Young	1983	Afu Hills, Nigeria	
151	Rosenblum	1974	Liberia	
Table 3.				
1	Rosenblum and Mosier	1983	Kivu, Zaire	
2	Nekrasova and Nekrasov	1983	Indigirka river, N.E. Yakutia	
3	Kosterin et al.	1962	Maritime Prov., E. Siberia	cassiterite placer
4	Rosenblum and Mosier	1983	Kivu, Zaire	
5-7	Donnot et al.	1973	Brittany, France	gray, Paleozoic schist
8	Nekrasova and Nekrasov	1983	Indigirka river, N.E. Yakutia	
9	Donnot et al.	1973	Brittany, France	gray, Paleozoic schist
10	Rosenblum and Mosier	1983	Kivu, Zaire	
11	Rosenblum and Mosier	1983	France	
12	Chen, Li, and Wu	1973	Taiwan	
13	Rosenblum and Moser	1983	Livengood, Alaska	
14	Rosenblum and Moser	1983	Taiwan	
15	Serdyuchenko and Kochetkov	1974	Timan, U.S.S.R.	Riphaen shale
16-17	Rosenblum and Mosier	1983	Kivu, Zaire	
18	Rosenblum and Mosier	1983	Ruby, Alaska	
19	Rosenblum and Mosier	1983	S.W. Taiwan	
20	Rosenblum and Mosier	1983	Eagle, Alaska	

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 3 Analyses	Author	Date	Locality	Rock Type
21	Rosenblum and Mosier	1983	Teller, Alaska	
22	Rosenblum and Mosier	1983	S.W. Taiwan	
23	Rosenblum and Mosier	1983	Montana	
24	Rosenblum and Mosier	1983	Rio San Juan, Peru	
25	Soong	1978	Taiwan	
26	Rosenblum and Mosier	1983	Rio Morro, Peru	
27	Chen, Li, and Wu	1973	Taiwan	
28-29	Rosenblum and Mosier	1983	Taiwan	
30	Rosenblum and Mosier	1983	Tanana, Alaska	
31	Rosenblum and Mosier	1983	Livengood, Alaska	
32	Rosenblum and Mosier	1983	Talkeetna, Alaska	
33	Rosenblum and Mosier	1983	Livengood, Alaska	
34	Nekrasova and Nekrasov	1983	Obrivisty river, N.E. Yakutia	
35	Soong	1978	Taiwan	
36	Rosenblum and Mosier	1983	Taiwan	
37	Soong quoted by Rosenblum and Mosier	1983	S.W. Taiwan	
same as 35?				
38	Huang et al.	1980	Taiwan	
39	Rosenblum and Mosier	1982	Tanana, Alaska	
40	Nekrasova and Nekrasov	1983	Sclar river, N.E. Yakutia	
41	Rosenblum and Mosier	1983	Tanana, Alaska	
42	Nekrasova and Nekrasov	1983	Dzhatuk river, N.E. Yakutia	
43	Rosenblum and Mosier	1983	Ophir, Alaska	
44	Soong	1978	Taiwan	
45	Nekrasova and Nekrasov	1983	Vera river, N.E. Yakutia	
46	Vaquero Nazabal	1978	Spain	
47	Soong	1978	Taiwan	
Table 4.				
1	Maksimovic and Panto	1983	Liverici, Yugoslavia	bauxite
2	Semenov	1969	Ilimaussaq, Greenland	alkalic rock
3	Borovskii and Gerasimovskii	1945	Balkhash	granite
4	Nekrasova and Nekrasov	1983	Uruselekh river, Siberia	dark monozite
5	Proshchenko quoted by Vlasov, v. 1, p. 243	1964	N. Yakutia	alkali granite pegmatite
6	Graeser and Schwander	1987	Italy	pegmatite vein in gneiss
7	Shukolyukov et al.	1979	Alakurtti, N. Karelia U.S.S.R.	
8	Maksimovic and Panto	1980	Greece	Marmora bauxite deposit
9	Graeser and Schwander	1987	Italy	pegmatite vein in gneiss

Table 9a. Locality and Rock Type Index - Monazite-(Ce) (contd.)

Table 5 Analyses	Author	Date	Locality	Rock Type
1	Bowles et al.	1980	Kuttakhuzhi, Travancore India	kaolinized pegmatite
2	Pavlenko et al.	1959	Bayankul massif, E. Tuva	amazonite pegmatite
Table 6.				
1	Kosterin and Zuev	1962	not given	veinlet in granophyre
2-3	Kucha	1980	Bogatyn area, Lower Silesia, Poland	huttonite-monazite
4	Pavlenko et al.	1965	S.E. Siberia	"eerphosphor-huttonite", amazonite pegmatite,
5	Kucha	1980	Bogatyn area, Lower Silesia, Poland	huttonite-monazite
6	Kucha	1980	Bogatyn area, Lower Silesia, Poland	huttonite-monazite
7	Kucha	1980	Bogatyn area, Lower Silesia, Poland	huttonite-monazite

Table 9b. Locality Index - Monazite-(Ce)

Country	Table	Analyses
Africa		
Burundi Republic	1	376
Liberia	2	114, 126, 130, 134, 137, 139, 141, 142, 145, 149, 151
Malawi	1	400, 535
Mozambique	1	45
Nigeria	2	150
South Africa	1	31, 54, 138, 296, 337
Zaire	3	1, 4, 10, 16, 17, 18, 21
Asia		
"South Asia"	1	49
China	1	15, 72, 77, 134, 149, 243, 327, 458, 478, 498, 503, 509 511, 514, 529, 532, 542, 546, 554, 557
	2	5, 113
India	1	190, 441, 530
	2	9, 13, 98, 102, 144
Japan	1	74, 223, 252
Korea	1	299
	2	106
Malaysia	1	161
	2	2, 8, 19, 34, 35, 51, 58, 67, 68, 72-74, 89, 99, 101
Mongolia	1	66, 181, 437, 474, 527
Sri Lanka	1	533
Taiwan	2	92, 107, 119
	3	12, 14, 19, 22, 25, 27-29, 35-38, 44, 47
Thailand	1	89, 258, 409, 551, 558
	2	1, 3, 6, 12, 14, 15, 16, 20-22, 25-33, 36-38, 40-50 52-54, 56, 57, 60-64, 66, 69-71, 75-88, 90, 91, 93-97, 100, 103, 105, 108-111, 115, 118, 121, 124, 125 129, 132, 133, 138, 140, 143, 146-148
U.S.S.R.		
"Siberia"	1	20, 28, 80, 83, 97, 117, 165, 249, 269, 364, 397
	2	7
	3	13, 36, 44, 47
"Central Asia	1	482, 523
"East Siberia, "Far Eastern U.S.S.R.", "Maritime Province"		
	1	81, 316, 326, 335, 342, 375, 436, 513, 518
	2	4, 10, 59
	3	3
"N. Siberia"	1	499, 539
Aldan	1	415, 484
	2	24
Balkhash	1	540
Gornyi Altai	1	127, 236, 251, 271, 354, 543
Kabaridi-Balkarsk A.S.S.R.	1	298
Kazakhstan	1	156, 168, 169, 177, 189, 257, 264, 279, 330, 385, 402 424, 432, 455, 468, 488, 491, 495, 507, 516, 517 521, 522, 524-526, 536, 538, 547, 550, 553, 556
Pamirs	1	144, 446, 471, 544
Polar Urals	1	130, 142, 146, 154, 160, 232, 281, 346, 348, 350, 353 470, 471, 544
Sayan	1	108, 166, 196, 202, 209, 210, 220, 226, 278, 291, 493 512, 515, 563

Table 9b. Locality Index - Monazite-(Ce)

Asia (contd.)

Country	Table	Analyses
U.S.S.R.		
Tannu-Ola	1	50, 343
Timan	3	15
Transbaikal	1	147, 293, 329, 351, 360, 433
Tuva	1	129, 136, 164, 203, 301, 302, 543
Urals	1	178, 194, 224, 237, 238, 242, 262, 265, 267, 274, 292, 295, 310, 319, 340, 371-373, 382, 417, 418, 429, 434, 438, 453, 463, 466, 480, 489, 490, 505, 508, 552, 555, 559, 560, 562, 564
Uzbekistan	1	286
Yakutia	1	413
	3	2, 8, 34, 40, 42, 45

Australia

"Australia"	1	126
	2	131
"East Australia"	2	55, 104
"South Australia"	1	321
New South Wales	1	116, 117, 122
Tasmania	2	112
Victoria	2	127
West Australia	1	240
	2	128

Europe

Austria	1	320
Bulgaria	1	282, 314, 323, 328, 332, 333, 345, 349, 355, 361, 368, 374, 378, 379, 381, 383, 387, 388, 391, 392, 394-396, 401, 404, 405, 426, 440
England	1	239, 256, 272, 283, 369, 370, 403, 407, 410-412, 420, 422, 427, 428, 447, 450, 464, 472, 473, 476, 481, 502
Finland	1	86, 158, 448
France	3	5-7, 9, 11
Italy	1	67, 155, 183, 217, 259, 304, 305, 331, 386, 565
Norway	1	8, 11, 70, 92, 99, 100, 128, 195, 231, 254, 435, 451
Poland	1	139
Spain	3	46
Switzerland	1	171
"U.S.S.R."	1	53, 113, 137, 185, 390, 469, 537
Azov region	1	150, 175, 182, 198, 204, 213, 221, 222, 241, 253, 260, 289, 297, 303, 325, 357, 475
Baltic region	1	25, 118
	2	39
Armenia	1	479
Byelorussia	1	506
Caucasus	1	229, 309a, b, c, 456, 549
Karelia and Kola Peninsula		
	1	1-5, 9, 13, 18, 19, 21, 22, 24, 26, 27, 29, 30, 32-34, 39-42, 71, 75, 76, 78, 93, 106, 109, 116, 122, 135, 151,159, 172, 184, 192, 208, 225, 245, 273, 284, 287, 334, 341, 347, 356, 362, 365, 380, 389, 415, 419, 423, 430, 442-444, 467, 497, 501, 520

Table 9b. Locality Index - Monazite-(Ce)

Asia (contd.)

Country	Table	Analyses
Ukraine	1	16, 23, 35, 38, 46-48, 57, 59, 63, 64, 73, 82, 91, 94, 98, 103, 105, 107, 110, 114, 124, 145, 148, 152, 157, 162, 163, 176, 186, 187, 197, 199-201, 211, 214, 215, 218, 219, 225, 227, 230, 233, 235, 244, 246-248, 250, 261, 263, 266, 270, 275, 277, 285, 288, 290, 306-308, 312, 313, 315, 317, 318, 322, 324, 352, 358, 359, 363, 366, 384, 393, 398, 406, 421, 425, 451, 457, 462, 465, 483, 487, 510, 541
	2	123
Yugoslavia	1	338

North America

United States:		
Alaska	3	13, 18, 20, 21, 30-33, 39, 41, 43
Arkansas	1	534, 538
California	1	7, 206, 234, 494, 519, 528
	2	120, 135, 136
Connecticut	1	121
Florida	2	18, 23
Idaho	2	17
Illinois	1	179
	2	65
Montana	1	561
	3	23
Nevada	1	44, 55, 56, 62, 87, 90, 96, 131, 141, 167, 173, 174, 180, 188, 191
New Mexico	1	17, 58, 79, 88, 102, 119, 132, 133
North Carolina	1	43, 52, 60, 68, 69, 112, 143, 205, 216a,b, 276, 300, 339, 449, 485
Virginia	1	101, 311

South America

Country	Table	Analyses
Brazil	1	36, 37, 61, 85, 95, 104, 115, 140, 170, 193, 207a,b, 212, 228, 255, 268, 280, 294, 344, 367, 377, 399, 408, 414, 416, 431, 437, 445, 452, 454, 459, 460, 492, 496, 500, 504
	2	11a-11f
Peru	3	24, 26

No Locality Given

	1	51, 65, 120, 153, 336, 477

15 Aug 91

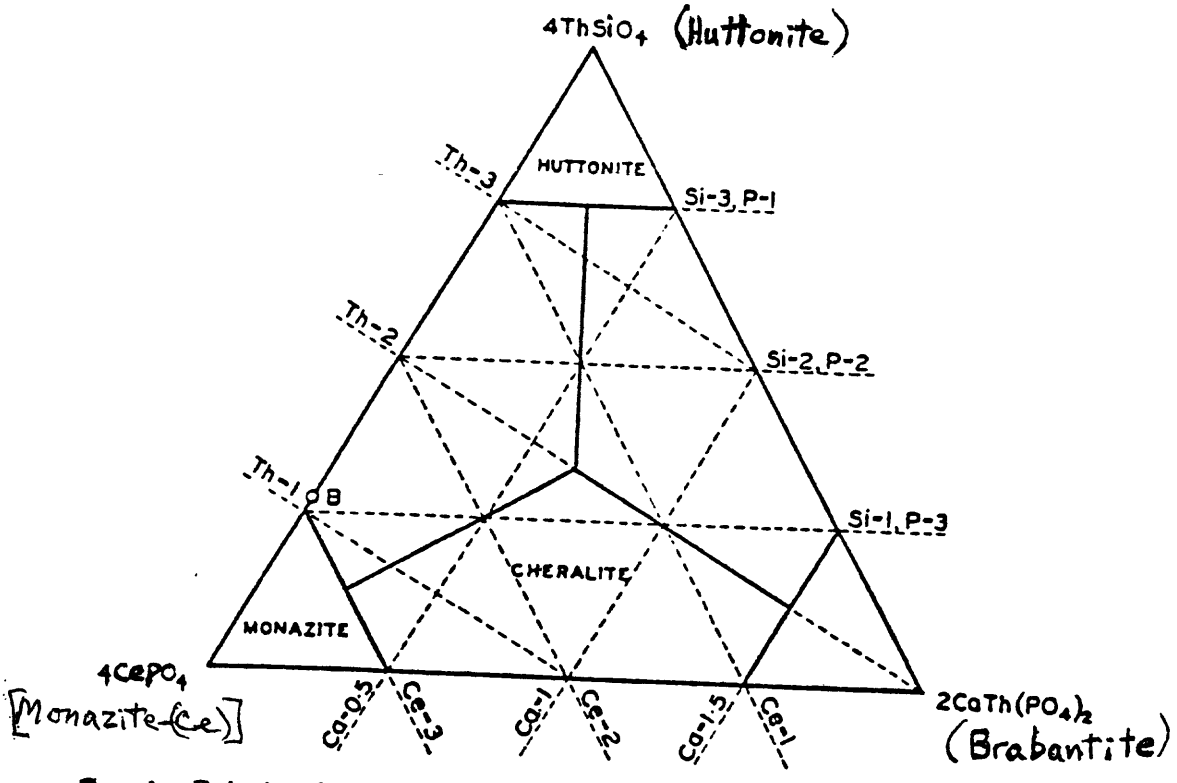
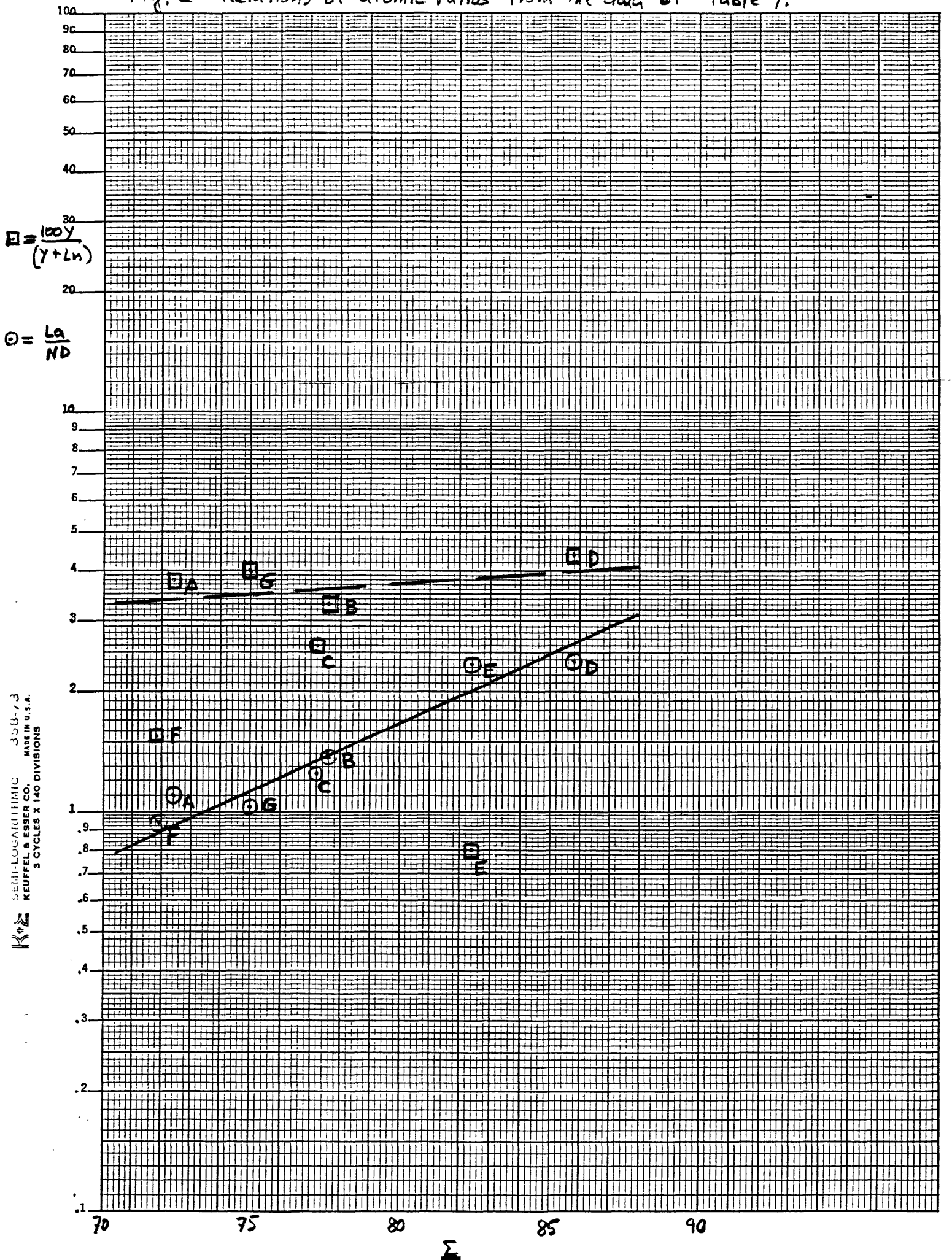


FIG. 1. Relationships in the monoclinic system $CePO_4$–$CaTh(PO_4)_2$–$ThSiO_4$, modified from Bowie and Horne (1953).

Fig. 2 Relations of atomic ratios from the data of Table 7.

(as of Feb. 90)



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