The Distribution of Rare-Earth Elements in Minerals of the Monazite Family

U.S. GEOLOGICAL SURVEY BULLETIN 2140

AVAILABILITY OF BOOKS AND MAPS OF THE U.S. GEOLOGICAL SURVEY

Instructions on ordering publications of the U.S. Geological Survey, along with prices of the last offerings, are given in the current-year issues of the monthly catalog "New Publications of the U.S. Geological Survey." Prices of available U.S. Geological Survey publications released prior to the current year are listed in the most recent annual "Price and Availability List." Publications that may be listed in various U.S. Geological Survey catalogs (**see back inside cover**) but not listed in the most recent annual "Price and Availability List" may no longer be available.

Reports released through the NTIS may be obtained by writing to the National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161; please include NTIS report number with inquiry.

Order U.S. Geological Survey publications **by mail** or **over the counter** from the offices listed below.

BY MAIL

Books

Professional Papers, Bulletins, Water-Supply Papers, Techniques of Water-Resources Investigations, Circulars, publications of general interest (such as leaflets, pamphlets, booklets), single copies of Earthquakes & Volcanoes, Preliminary Determination of Epicenters, and some miscellaneous reports, including some of the foregoing series that have gone out of print at the Superintendent of Documents, are obtainable by mail from

U.S. Geological Survey, Information Services
Box 25286, Federal Center
Denver, CO 80225

Subscriptions to periodicals (Earthquakes & Volcanoes and Preliminary Determination of Epicenters) can be obtained ONLY from the

Superintendent of Documents
Government Printing Office
Washington, DC 20402

(Check or money order must be payable to Superintendent of Documents.)

Maps

For maps, address mail orders to

U.S. Geological Survey, Information Services
Box 25286, Federal Center
Denver, CO 80225

Residents of Alaska may order maps from

U.S. Geological Survey, Earth Science Information Center
101 Twelfth Ave., Box 12
Fairbanks, AK 99701

OVER THE COUNTER

Books and Maps

Books and maps of the U.S. Geological Survey are available over the counter at the following U.S. Geological Survey offices, all of which are authorized agents of the Superintendent of Documents.

- **ANCHORAGE, Alaska**–Rm. 101, 4230 University Dr.
- **LAKEWOOD, Colorado**–Federal Center, Bldg. 810
- **MENLO PARK, California**–Bldg. 3, Rm. 3128, 345 Middlefield Rd.
- **RESTON, Virginia**–USGS National Center, Rm. 1C402, 12201 Sunrise Valley Dr.
- **SALT LAKE CITY, Utah**–Federal Bldg., Rm. 8105, 125 South State St.
- **SPOKANE, Washington**–U.S. Post Office Bldg., Rm. 135, West 904 Riverside Ave.
- **WASHINGTON, D.C.**–Main Interior Bldg., Rm. 2650, 18th and C Sts., NW.

Maps Only

Maps may be purchased over the counter at the following U.S. Geological Survey offices:

- **FAIRBANKS, Alaska**–New Federal Bldg, 101 Twelfth Ave.
- **ROLLA, Missouri**–1400 Independence Rd.
- **STENNIS SPACE CENTER, Mississippi**–Bldg. 3101

The Distribution of Rare-Earth Elements in Minerals of the Monazite Family

By Sam Rosenblum *and* Michael Fleischer

U.S. GEOLOGICAL SURVEY BULLETIN 2140

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON, D.C. : 1995

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

Gordon P. Eaton, Director

For sale by U.S. Geological Survey, Map Distribution
Box 25286, MS 306, Federal Center
Denver, CO 80225

Library of Congress Cataloging-in-Publication Data

Rosenblum, Sam.
The distribution of rare-earth elements in minerals of the monazite family / by Sam Rosenblum and Michael Fleischer.
p. cm.—(U.S. Geological Survey bulletin ; 2140)
Includes bibliographical references.
Supt. of Docs. no.: I 19.3:2140
1. Monazite. 2. Earths, Rare. I. Fleischer, Michael, 1908– II. Title. III. Series.
QE75.B9 no. 2140
[QE391.M75]
557.3 s—dc20 95–32912
[549'.72] CIP

CONTENTS

FIGURES

TABLES

THE DISTRIBUTION OF RARE-EARTH ELEMENTS IN MINERALS OF THE MONAZITE FAMILY

By Sam Rosenblum[1] *and* Michael Fleischer[2]

ABSTRACT

Minerals of the monazite structural group include phosphates (predominant), arsenates, and silicates that have the general formula ABO_4, where A=Bi, Ca, Ce, La, Nd, Th, U, Fe, Pb, Y and B=P^{+5}, As^{+5}, Al^{+3}, and (or) Si^{+4}. Monazite-family minerals contain essential PO_4 and the light rare-earth elements lanthanum, cerium, and neodymium; they contain minor amounts of other light rare-earth elements and heavy rare-earth elements. Monazite-(Ce) is the predominant species.

Tables 2–4 contain analyses of 772 monazites wherein the 14 naturally occurring rare-earth elements are given in atomic percentages. In addition, a derived atomic percentage for yttrium is given, and values are shown for sigma (Σ) (the sum of La+Ce+Pr), for La-Nd, Sm-Ho, and Er-Lu sums, for weight percentages of RE_2O_3 (RE is the sum of rare-earth elements), ThO_2, and U_3O_8, and for La/Nd. Eighteen analyses for other varieties of monazite, gasparite-(Ce), cheralite, and huttonite are given in tables 5–7. The average compositions of monazite-(Ce) from various sources are given in tables 8 and 9. Analyses of monazite-(Ce) are crossreferenced by author and location in tables 10 and 11.

INTRODUCTION

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, Fe, Pb, and Y and B=As^{+5}, P^{+5}, Al^{+3}, and (or) Si^{+4}. The presently known 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)	$(Ce,La,Nd)(P,Si)O_4$
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; hence, it will not be considered further here. Brabantite has been reported to contain 3.05 percent RE_2O_3 (Wang, 1978) (RE is the sum of rare-earth elements), but individual lanthanides were not determined.

The relationships of monazite, cheralite, huttonite, and brabantite are shown in figure 1.

Within the monazite group, the monazite family consists of minerals containing light rare-earth elements (mainly lanthanum, cerium, and neodymium) as essential cations and phosphate as the essential anion. Nonessential thorium, as well as minor amounts of calcium, iron, uranium, and lead, may substitute for as much as 25 percent of the rare-earth elements; and silicon, as well as minor amounts of aluminum, may substitute for as much as 25 percent of the phosphorus, as indicated in Bowie and Horne (1953, fig. 1).

If the cerium content of monazite-(Ce) is exceeded by another rare-earth element or if normally minor elements exceed 10 percent, then the analysis represents an unusual variety (see table 5). Thus, the high uranium content (15.64 percent) of a single analysis as described in the headnote of table 8 would allow a varietal name of monazite-(Ce,U) or uranian monazite-(Ce), according to the system proposed by Levinson (1966) and Bayliss and Levinson (1988).

BACKGROUND INFORMATION

The distribution of the lanthanides and yttrium in monazite family minerals has been the subject of many papers. Monazite was recognized long ago to be a mineral that concentrates the light lanthanides, in accordance with their

[1]U.S. Geological Survey, retired; 12165 W. Ohio Place, Lakewood, Colorado 80228.

[2]Smithsonian Institution, Washington, D.C. 20560.

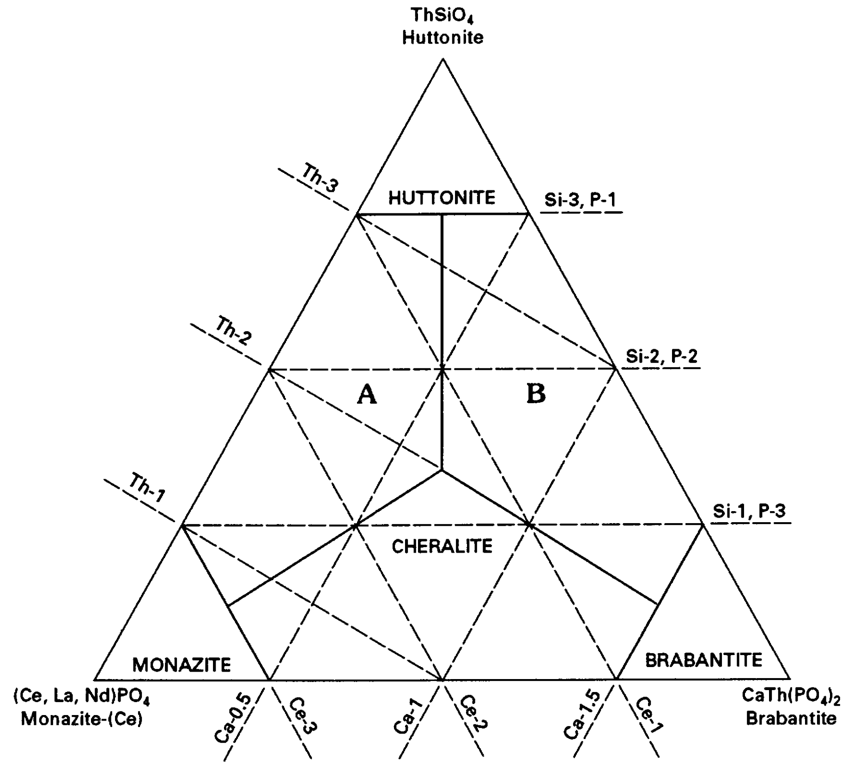

Figure 1. Relations in the monoclinic system (Ce, La, Nd)PO_4-$CaTh(PO_4)_2$-$ThSiO_4$. Modified from Bowie and Horne (1953).

occupancy of positions with co-ordination number ten (10). The considerable effect resulting from the geologic environment of formation on the distribution of the lanthanides was not recognized, however, 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 rare-earth element minerals) in specific rock types include those by Holt (1965) (carbonatites), Marchenko (1967) (gneisses and migmatites), Heinrich and Wells (1980) (several associations), and Clark (1984) (several associations). In addition, papers by Ploshko (1961) and Marchenko and Goncharova (1964) discuss formation of monazite by pneumatolytic and hydrothermal processes. Rosenblum and Mosier (1983) described a dark monazite that is neoblastically formed in carbonaceous shale at temperatures of as much as 300°C in contact-metamorphic zones; other investigators preferred low-grade regional metamorphism for the origin of this variety of monazite.

Finally, we note that some papers dwell on the physical-chemical reasons for fractionation of rare-earth elements found in rocks and minerals. Balashov and Pozharitskaya (1968) indicated that decrease in temperature and change of alkalinity are the main factors determining the composition of rare-earth elements in minerals of carbonatites, but that the distribution of rare-earth elements between coexisting minerals is determined by their crystal chemistry. Wells (1977) condensed a survey of geochemical literature to illustrate the various factors that control partitioning of chemically similar light rare-earth elements. These factors include (1) ionic radius, (2) crystal structure, (3) basicity, (4) oxidation state, and (5) stability of complexes.

COMPUTATION OF ATOMIC PERCENTAGES FROM ANALYSES

The literature is replete with mineral analyses done by a number of different methods and reported in metal or oxide percentages, parts per million, parts per billion, counts per second, and other units. Comparing such data from article to article is usually difficult; thus, a need became apparent for comparable dimensionless data. We recommend that chemical analyses of minerals, reported in any units, be converted into atomic percentages to allow easy comparison of any and all data.

Atomic percentages are calculated by dividing the reported analytical value (in any units) of each element by the atomic weight of the element to obtain an atomic proportion. Each atomic proportion, multiplied by 100 percent and divided by the sum of all the atomic proportions, yields the atomic percent for the element. The sum of all atomic percentages should equal 100 percent.

Table 1. Computation of atomic percentages and their use in deriving chondrite-normalized ratios.
[Chondrite atomic percentages were computed from abundances in Evensen and others (1978, p. 1203). Leaders (--) indicate no value reported]

Element	Weight percent	Atomic proportion	Atomic percentage	Chondrite atomic percentage	Chondrite-normalized ratio
La	24.2	0.17420	24.60	10.14	2.43
Ce	48.1	0.34325	48.47	26.21	1.85
Pr	5.3	0.03761	5.31	3.94	1.35
Nd	17.5	0.12130	17.13	18.92	0.91
Sm	2.7	0.01796	2.54	5.89	0.43
Eu	--	--	--	2.20	--
Gd	1.4	0.00890	1.26	7.48	0.17
Tb	0.1	0.00063	0.09	1.36	0.07
Dy	0.5	0.00308	0.43	9.00	0.05
Ho	--	--	--	1.98	--
Er	0.1	0.00060	0.08	5.71	0.01
Tm	--	--	--	0.84	--
Yb	0.1	0.00058	0.08	5.49	0.01
Lu	--	--	--	0.84	--
Total	100.00	0.70811	99.99	100.00	

In addition to allowing rapid comparisons of analytical data, atomic percentages of such data may be converted into chondrite-normalized ratios (CNR) by simply dividing these values by the atomic percentages of the same elements in chondrites. In table 1, the fifth column shows the atomic percentages of the 14 lanthanides in the average chondrite (Evensen and others, 1978), and in the sixth column are the chondrite-normalized ratios of the lanthanides in the example.

DESCRIPTIONS OF TABLES AND DISCUSSION

This report is an update of Fleischer and Altschuler (1969) and includes a compilation of all available determinations, as of 1988 (with only two exceptions), of the rare-earth elements (lanthanides and yttrium) in minerals of the monazite structural group, 790 in all. Monazite-(Ce) is the overwhelmingly dominant mineral, accounting for 772 of the analyzed samples.

In tables 2–7, atomic percentages of the lanthanides are listed in order of increasing sigma (Σ) (the sum of the atomic percentages of La+Ce+Pr). Also given is the ratio of the atomic percentage of yttrium to the sum of the atomic percentages of yttrium and all lanthanides [100Y/(Y+Ln)]. This value was computed from the weight percentages of the reported lanthanides and yttrium and is shown in parentheses to indicate that it is not directly comparable to the atomic percentages for the 14 lanthanides (which are summed to 100 percent, excluding yttrium). In addition, the weight percentages of ThO_2 and U_3O_8 in the analyzed samples are given where available.

The averages tabulated in tables 8 and 9 show the effect of the type of geological occurrence on the distribution of rare-earth elements in monazite-(Ce)—namely, the general increase of the light lanthanides and the decrease of yttrium from granitic pegmatites to granitic rocks to alkalic rocks and carbonatites. These generally antithetic relations may not be used, however, with any precision to determine provenance. We note that total rare-earth oxide contents increase in monazite from gneisses to granitic rocks to granitic pegmatites to metamorphosed black shales, for the rock types for which averages could be calculated.

From the data of table 8, we plotted points on log-normal graph paper (see fig. 2) for La/Nd (circles) versus sigma and 100Y/(Y+Ln) (squares) versus sigma. For the La/Nd, a straight line was easily drawn from the points for monazites from metamorphosed black shales (F) and granitic pegmatites (A) to those from carbonatites (E) and alkalic rocks (D). Why this trend line indicates a log-normal distribution of the light rare-earth elements is not apparent at this time; however, it is apparent from the moderate rise in the trend line for the circled points that the content of light rare-earth elements increases as sigma increases. An opposite relation for the squared points is expected, but we hesitate to draw a trend line between squared points A and E, considering the divergence of points D and F. Perhaps more data are needed to better define this relation.

If a trend line is drawn between squared points A and D, to show the distribution of heavy rare-earth elements (represented by the yttrium content) in monazites, then we might speculate that heavy rare-earth elements apparently remain static with increasing sigma. In addition, monazites from strongly metamorphosed rocks (C), carbonatites (E), and black shales (F) apparently are depleted in heavy rare-earth elements. The heavy rare-earth element distribution in mon-

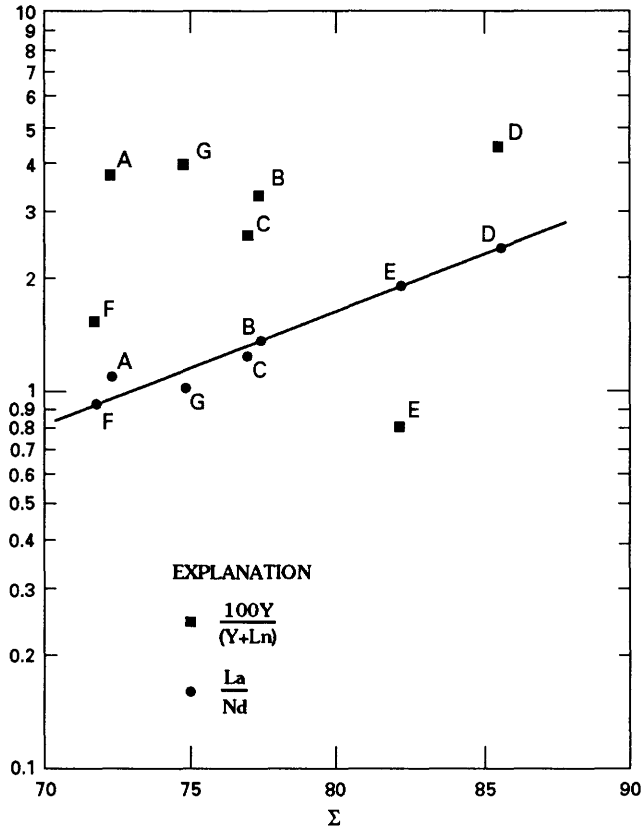

Figure 2. Relations of atomic ratios from the data of table 8. Points A–G are discussed in text.

azites from placers (G) lying between squared points A (granitic pegmatite) and B (granitic rocks) indicates sources in the calc-alkaline series, obviously a mixture of pegmatitic and granitic rocks.

The range of composition for rare-earth elements in monazite is relatively less than that in minerals of low rare-earth element content. Also, the variation in the amounts of rare-earth elements in monazite is far less satisfactory as a guide to type of host rock than is true for either apatite (Fleischer and Altschuler, 1969, 1986) or titanite (Fleischer, 1978).

We infer from tables 2 and 3 that the compositions of monazite-(Ce) in granitic rocks and in gneisses are not notably different. Rosenblum and Mosier (1983) showed, however, that the average composition of dark monazites (table 8, column F) is distinct from that of yellow monazites of different genesis, especially in their high europium and low thorium contents.

Table 10 lists authors, localities and sources for monazite analyses in tables 2–7. Table 11 gives localities for monazite-(Ce) analyses in tables 2–4.

EXPLANATION OF TABLES 2–9

The compositions in these tables are given in atomic percentages of the elements, and the sum of the lanthanides in each columns is 100 percent. The ratio 100Y/(Y+Ln) is also an atomic ratio. Footnotes in tables 2 and 3 indicate if any of the following calculations were done:

Footnote 1	Tb+Y calculated as Y
Footnote 2	Eu+Gd calculated as Gd
Footnote 3	Tb+Dy+Y calculated as Y

A leader (-) indicates either not reported or less than 0.1 atomic percent. The entry "Method" gives the analytical method used, with the following abbreviations:

AAS	Atomic absorption spectrophotometry
CH	Chromatography
EP	Electron microprobe
ICP	Inductively coupled plasma
INA	Instrumental neutron activation
OS	Optical spectrography
XF	X-ray fluorescence

The following sums are reported:

La-Nd	Sum of La+Ce+Pr+Nd
Sm-Ho	Sum of Sm+Eu+Gd+Tb+Dy+Ho
Er-Lu	Sum of Er+Tm+Yb+Lu

RE_2O_3, ThO_2, and U_3O_8 are in weight percent, as reported by references author (s). La/Nd is the ratio of atomic percentage of La divided by the atomic percentage of Nd.

Acknowledgments.—The writers wish to express their gratitude to the following members of the U.S. Geological Survey for help in improving this paper: Mary Woodruff, for generating table 10, keypunching the initial draft, and checking the computations; Margo Johnson, whose computer expertise was vital in getting this report into final copy form for review; and Edward C.T. Chao, Eugene E. Foord, Andrew E. Grosz (retired), William C. Overstreet (retired), and G.B. Sidder for useful reviews.

Table 2. Monazite-(Ce) from igneous and metamorphic rocks.
[Atomic percent except RE_2O_3, ThO_2, and U_3O_8, which are in weight percent]

	1	2	3	4	5	6	7	8	9	10	11	12
La	11.9	21.5	20.3	9.9	21.3	8.6	13.7	10.3	12.4	10.4	10.3	10.4
Ce	35.4	29.7	32.3	35.2	32.8	39.8	41.7	39.3	37.3	42.1	41.9	41.9
Pr	-	-	-	8.4	-	5.8	-	6.6	8.4	5.8	6.2	6.1
Nd	31.9	23.8	30.4	26.1	28.0	24.1	26.0	38.0	24.2	28.5	24.4	26.6
Sm	12.7	6.0	8.9	11.3	5.3	16.3	9.2	5.8	9.7	10.1	10.1	11.1
Eu	0.8	0.6	0.7	-	0.6	-	-	-	0.2	-	0.5	-
Gd	5.4	4.7	3.3	7.7	4.2	5.4	9.4	-	5.6	3.1	6.6	3.9
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	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(2.6)	(33.7)	(4.5)	-	(23.1)	(4.7)	(8.9)	-	-	(5.3)	(4.0)	(4.6)
Method	OS	OS	OS	XF	OS	XF	INA	EP	XF	XF	INA	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	58.4	58.4
La-Nd	79.2	75.0	83.0	79.6	82.1	78.3	81.4	94.2	82.3	86.8	82.8	85.0
Sm-Ho	20.8	17.5	16.4	20.4	14.4	21.7	18.6	5.8	17.4	13.2	17.2	15.0
Er-Lu	-	7.5	0.6	-	3.5	-	-	-	-	-	-	-
RE_2O_3	-	-	-	-	-	-	60.12	68.96	-	-	66.48	-
La/Nd	0.37	0.90	0.67	0.38	0.76	0.36	0.53	0.27	0.51	0.36	0.42	0.39
ThO_2	-	-	-	-	-	4.1	6.18	0.20	-	3.8	1.21	4.0
U_3O_8	-	-	-	-	-	-	-	-	-	-	0.26	0.1

	13	14	15	16	17	18	19	20	21	22	23	24
La	24.2	13.7	7.9	11.9	16.6	16.2	19.0	14.2	15.3	19.0	20.9	16.6
Ce	35.9	40.9	47.3	40.1	36.9	38.3	37.9	40.6	38.6	36.4	30.8	40.7
Pr	-	6.0	5.4	9.0	7.8	7.1	5.0	7.1	8.1	6.8	10.7	5.4
Nd	28.1	33.2	36.1	31.1	27.0	20.3	19.9	21.1	20.8	22.1	35.3	14.6
Sm	6.1	4.3	2.3	5.1	3.4	10.2	11.0	8.7	10.5	9.2	1.1	9.7
Eu	0.4	-	0.4	0.3	-	0.2	-	-	-	-	-	-
Gd	2.9	1.9	0.4	2.5	8.3	5.3	7.2	5.2	5.1	4.7	1.2	10.3
Tb	0.4	-	-	-	-	0.7	-	0.6	0.5	0.4	-	-
Dy	1.5	-	0.2	-	-	1.1	-	1.8	0.7	1.0	-	2.4
Ho	-	-	-	-	-	0.2	-	0.1	0.2	0.2	-	0.2
Er	0.2	-	-	-	-	0.2	-	0.2	0.2	0.2	-	-
Tm	-	-	-	-	-	-	-	0.1	-	-	-	0.1
Yb	0.3	-	-	-	-	0.2	-	0.2	-	-	-	-
Lu	-	-	-	-	-	-	-	0.1	-	-	-	-
100Y/(Y+Ln)	(3.7)	(4.2)	(0.3)	(4.6)	(5.0)	-	-	-	-	-	(1.2)	(5.3)
Method	OS	OS	-	OS	OS	XF	XF	XF	XF	XF	OS	-
Σ=La+Ce+Pr	60.1	60.6	60.6	61.0	61.3	61.6	61.9	61.9	62.0	62.2	62.4	62.7
La-Nd	88.2	93.8	96.7	92.1	88.3	81.9	81.8	83.0	82.8	84.3	97.7	77.3
Sm-Ho	11.3	6.2	3.3	7.9	11.7	17.7	18.2	16.4	17.0	15.5	2.3	22.6
Er-Lu	0.5	-	-	-	-	0.4	-	0.6	0.2	0.2	-	0.1
RE_2O_3	-	-	69.36	-	-	-	-	53.26	-	-	-	-
La/Nd	0.86	0.41	0.22	0.38	0.61	0.80	0.95	0.67	0.74	0.86	0.59	1.14
ThO_2	-	-	0.17	-	-	-	-	13.00	5.47	-	-	-
U_3O_8	-	-	-	-	-	-	-	-	-	-	-	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	25	26	27	28	29	30	31	32	33	34	35	36
La	15.2	19.3	21.7	9.1	13.6	19.5	14.4	24.1	18.5	17.6	25.4	15.1
Ce	38.3	38.4	35.3	47.7	45.7	38.9	44.3	39.8	39.9	39.6	29.2	43.3
Pr	9.2	5.1	6.1	6.5	4.2	5.1	5.2	-	5.6	7.1	10.0	6.5
Nd	20.6	19.7	20.3	25.1	14.7	20.5	24.8	28.9	15.5	22.3	33.0	26.2
Sm	10.3	11.2	6.4	7.7	12.7	12.1	4.7	4.7	4.5	6.0	1.0	6.2
Eu	-	-	-	-	-	-	-	0.5	0.2	0.1	-	-
Gd	4.9	6.3	6.2	3.5	8.5	3.9	5.2	1.2	4.5	5.0	1.1	2.7
Tb	0.4	-	-	[1]	-	-	0.4	0.2	0.7	0.3	-	-
Dy	0.7	-	2.7	0.3	0.6	-	0.6	0.5	3.5	1.6	-	-
Ho	0.2	-	-	-	-	-	-	-	0.9	-	-	-
Er	0.2	-	1.3	0.1	-	-	-	-	2.4	0.3	0.3	-
Tm	-	-	-	-	-	-	-	-	0.3	-	-	-
Yb	-	-	-	-	-	-	0.4	0.1	3.0	0.1	-	-
Lu	-	-	-	-	-	-	-	-	0.5	-	-	-
100Y/(Y+Ln)	-	-	(2.2)	(6.7)[1]	(2.9)	-	(8.1)	(1.6)	-	-	-	(7.8)
Method	-	-	XF	CH	OS	-	XF	OS	XF	XF	OS	OS
Σ=La+Ce+Pr	62.7	62.8	63.1	63.3	63.5	63.5	63.9	63.9	64.0	64.3	64.6	64.9
La-Nd	83.3	82.5	83.4	88.4	78.2	84.0	88.7	92.8	79.5	86.6	97.6	91.1
Sm-Ho	16.5	17.5	15.3	11.5	21.8	16.0	10.9	7.1	14.3	13.0	2.1	8.9
Er-Lu	0.2	-	1.3	0.1	-	-	0.4	0.1	6.2	0.4	0.3	-
RE_2O_3	-	-	-	55.2	59.2	-	64.5	-	-	-	54.8	-
La/Nd	0.74	0.98	1.07	0.36	0.93	0.95	0.58	0.83	1.19	0.79	0.77	0.58
ThO_2	-	-	9.0	5.53	8.3	-	4.36	-	-	-	-	16.3
U_3O_8	-	-	-	-	-	-	0.34	-	-	-	-	-

	37	38	39	40	41	42	43	44	45	46	47	48
La	15.6	19.8	17.3	22.9	25.3	19.8	20.0	21.1	18.2	21.8	20.2	21.8
Ce	43.5	36.0	41.4	34.0	39.7	39.7	40.2	35.1	41.5	35.1	37.9	37.0
Pr	6.7	9.1	6.3	8.1	-	5.7	5.0	9.2	6.3	9.1	8.2	7.5
Nd	25.3	27.5	19.5	20.9	28.6	22.0	22.1	22.2	24.3	24.8	27.7	29.2
Sm	6.0	5.7	6.6	7.4	3.5	12.8	8.3	6.4	5.8	6.0	4.4	1.5
Eu	-	-	0.5	-	0.8	-	-	0.1	-	0.2	-	-
Gd	2.9	1.9	3.3	4.9	1.4	-	4.4	3.6	3.9	3.0	1.6	2.1
Tb	-	-	0.5	-	-	-	-	0.4	-	-	-	-
Dy	-	-	1.8	1.2	0.5	-	-	1.5	-	-	-	-
Ho	-	-	0.4	-	-	-	-	0.3	-	-	-	-
Er	-	-	1.8	0.6	0.1	-	-	-	-	-	-	0.5
Tm	-	-	0.2	-	-	-	-	-	-	-	-	-
Yb	-	-	0.4	-	0.1	-	-	0.1	-	-	-	0.1
Lu	-	-	-	-	-	-	-	-	-	-	-	0.3
100Y/(Y+Ln)	(8.3)	(2.6)	-	-	(1.7)	-	(7.4)	(6.2)	-	(3.1)	(0.8)	-
Method	OS	OS	XF	XF	OS	XF	OS	OS	XF	OS	OS	OS
Σ=La+Ce+Pr	65.8	64.9	65.0	65.0	65.0	65.2	65.2	65.4	66.0	66.0	66.3	66.3
La-Nd	91.1	92.4	84.5	85.9	93.6	87.2	87.3	87.6	90.3	90.8	94.0	95.5
Sm-Ho	8.9	7.6	13.1	13.5	6.2	12.8	12.7	12.3	9.7	9.2	6.0	3.6
Er-Lu	-	-	2.4	0.6	0.2	-	-	0.1	-	-	-	0.9
RE_2O_3	-	-	-	-	-	-	-	51.6	-	-	-	47.0
La/Nd	0.62	0.72	0.89	1.10	0.89	0.90	0.91	0.95	0.75	0.88	0.73	0.75
ThO_2	15.5	-	-	-	-	-	12.1	9.89	-	-	-	-
U_3O_8	-	-	-	-	-	-	-	-	-	-	-	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	49	50	51	52	53	54	55	56	57	58	59	60
La	15.7	15.3	16.8	17.2	26.8	16.6	21.8	22.6	14.9	17.1	20.3	17.6
Ce	45.6	43.4	42.2	41.2	40.1	46.3	38.8	39.0	47.5	45.7	38.7	43.5
Pr	5.1	7.7	7.6	8.4	-	4.2	6.8	5.8	5.1	5.0	8.8	7.1
Nd	12.9	26.6	24.9	23.9	25.3	21.9	20.5	20.6	20.4	21.1	24.1	23.2
Sm	9.8	4.0	3.3	3.4	4.2	3.7	6.0	5.7	6.0	8.3	3.8	3.2
Eu	0.2	0.4	-	-	0.7	-	0.1	0.1	[2]	-	-	-
Gd	6.9	1.7	5.2	5.9	1.5	5.8	3.5	3.8	4.1[2]	2.8	3.9	5.4
Tb	0.9	0.2	-	-	-	0.3	0.5	0.5	0.3	-	-	-
Dy	1.5	0.4	-	-	0.9	0.7	1.5	1.5	1.4	-	-	-
Ho	0.2	-	-	-	-	-	0.2	0.3	0.1	-	-	-
Er	0.4	0.1	-	-	0.2	0.1	-	-	0.2	-	0.4	-
Tm	-	-	-	-	-	-	0.1	-	-	-	-	-
Yb	0.7	0.2	-	-	0.3	0.4	0.2	0.1	-	-	-	-
Lu	0.1	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(20.7)	-	(4.8)	(6.6)	(3.3)	(8.4)	(6.7)	(5.3)	(8.1)	(2.0)	-	(5.0)
Method	XF	XF	OS	OS	OS	XF	OS	OS	CH	XF	OS	OS
S=La+Ce+Pr	66.4	66.4	66.6	66.8	66.9	67.1	67.4	67.4	67.5	67.8	67.8	68.2
La-Nd	79.3	93.0	91.5	90.7	92.2	89.0	87.9	88.0	87.9	88.9	91.9	91.4
Sm-Ho	19.5	6.7	8.5	9.3	7.3	10.5	11.8	11.9	11.9	11.1	7.7	8.6
Er-Lu	1.2	0.3	-	-	0.5	0.5	0.3	0.1	0.2	-	0.4	-
RE_2O_3	-	65.0	-	-	-	60.63	73.1	56.2	-	-	58.5	-
La/Nd	1.22	0.58	0.67	0.72	1.06	0.76	1.06	1.10	0.73	0.81	0.84	0.76
ThO_2	-	-	-	-	-	7.01	8.90	14.8	-	10.7	-	-
U_3O_8	-	-	-	-	-	0.34	-	-	-	-	-	-
	61	62	63	64	65	66	67	68	69	70	71	72
La	21.0	23.4	18.3	22.5	23.3	18.2	19.0	22.7	24.9	20.9	15.4	18.3
Ce	41.9	38.8	38.7	38.4	45.3	43.3	43.4	42.0	41.6	41.7	46.2	43.4
Pr	5.4	6.2	11.5	7.6	-	7.2	6.4	4.1	4.1	6.2	7.3	7.2
Nd	21.0	20.4	24.9	27.8	23.6	27.5	18.1	21.6	21.0	22.0	23.0	27.3
Sm	4.8	5.3	4.9	1.5	3.4	3.8	9.5	3.5	3.3	5.7	4.3	3.8
Eu	-	0.1	-	-	0.3	-	-	-	-	-	-	-
Gd	5.9	2.9	1.7	2.2	1.8	-	3.6	6.1	5.1	3.5	1.9	-
Tb	-	0.5	-	-	0.4	-	-	-	-	-	0.1	-
Dy	-	1.9	-	-	1.4	-	-	-	-	-	0.9	-
Ho	-	0.3	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	0.2	-	-	-	-	-	0.3	-
Tm	-	0.1	-	-	-	-	-	-	-	-	0.3	-
Yb	-	0.1	-	-	0.3	-	-	-	-	-	0.3	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	-	(6.3)	(2.0)	(3.7)	(4.9)	-	(8.3)	(2.6)	(5.3)	-	-	-
Method	XF	OS	OS	OS	OS	-	EP	EP	EP	XF	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	68.9	68.9
La-Nd	89.3	88.8	93.4	96.3	92.2	96.2	86.9	90.4	91.6	90.8	91.9	96.2
Sm-Ho	10.7	11.0	6.6	3.7	7.3	3.8	13.1	9.6	8.4	9.2	7.2	3.8
Er-Lu	-	0.2	-	-	0.5	-	-	-	-	-	0.9	-
RE_2O_3	-	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	0.67	0.67
ThO_2	-	12.1	-	-	-	-	18.5	-	-	-	-	-
U_3O_8	-	-	-	-	-	-	0.6	-	-	-	-	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	73	74	75	76	77	78	79	80	81	82	83	84
La	24.5	14.3	16.7	17.4	18.5	19.0	22.3	14.3	22.0	24.8	21.9	16.5
Ce	35.4	46.9	44.9	45.9	43.5	43.3	42.4	50.7	41.7	35.7	41.8	47.8
Pr	9.1	8.0	7.6	6.0	7.3	7.2	4.8	4.5	5.8	9.0	5.9	5.3
Nd	25.1	18.4	21.6	19.0	27.5	20.0	21.1	22.8	23.1	25.2	21.9	22.7
Sm	2.2	7.2	4.1	4.6	3.2	4.2	6.5	4.3	4.4	2.2	4.8	6.0
Eu	-	-	-	0.1	-	0.2	-	-	-	-	-	-
Gd	3.0	5.2	3.3	2.8	-	3.7	2.9	3.1	3.0	3.1	3.7	1.7
Tb	-	[1]	0.3	0.4	-	0.4	-	-	-	-	-	-
Dy	-	-	1.2	1.5	-	1.3	-	-	-	-	-	-
Ho	-	-	0.1	0.3	-	0.1	-	0.3	-	-	-	-
Er	0.4	-	0.1	0.2	-	0.3	-	-	-	-	-	-
Tm	-	-	-	0.2	-	-	-	-	-	-	-	-
Yb	0.1	-	0.1	1.5	-	0.3	-	-	-	-	-	-
Lu	0.2	-	-	0.1	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	-	(2.7)[1]	-	(4.0)	-	-	(4.6)	(4.0)	-	(5.4)	-	(5.1)
Method	OS	CH,INA	XF	XF	-	XF	OS	CH	XF	OS	XF	XF
Σ=La+Ce+Pr	69.0	69.2	69.2	69.3	69.3	69.5	69.5	69.5	69.5	69.5	69.6	69.6
La-Nd	94.1	87.6	90.8	88.3	96.8	89.5	90.6	92.3	92.6	94.7	91.5	92.3
Sm-Ho	5.2	12.4	9.0	9.7	3.2	9.9	9.4	7.7	7.4	5.3	8.5	7.7
Er-Lu	0.7	-	0.2	2.0	-	0.6	-	-	-	-	-	-
RE_2O_3	50.9	-	-	-	-	-	-	-	-	-	-	-
La/Nd	0.98	0.78	0.77	0.92	0.67	0.95	1.06	0.63	0.95	0.98	1.00	0.73
ThO_2	-	-	-	-	-	-	10.7	-	-	-	-	10.1
U_3O_8	-	-	-	-	-	-	-	-	-	-	-	-
	85	86	87	88	89	90	91	92	93	94	95	96
La	18.1	24.4	22.5	17.4	17.5	17.9	21.9	17.4	28.6	21.8	19.6	22.2
Ce	51.5	37.8	39.9	47.1	45.9	46.6	41.8	44.4	41.2	39.7	50.3	40.8
Pr	-	7.5	7.3	5.2	6.3	5.3	6.1	8.0	-	8.4	-	7.0
Nd	30.4	19.2	19.9	20.1	24.3	21.8	21.9	22.5	24.5	25.9	30.1	17.4
Sm	-	4.2	5.1	7.5	5.4	6.1	5.0	3.1	3.4	2.0	-	6.6
Eu	-	-	0.1	-	-	-	-	-	0.4	-	-	0.1
Gd	-	5.1	2.7	2.7	-	2.3	3.3	4.6	1.4	2.2	-	3.4
Tb	-	-	0.4	-	-	-	-	-	-	-	-	0.4
Dy	-	1.2	1.81	-	0.6	-	-	-	0.4	-	-	1.6
Ho	-	-	0.2	-	-	-	-	-	-	-	-	0.2
Er	-	0.6	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	0.1
Yb	-	-	-	-	-	-	-	-	0.1	-	-	0.2
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(9.3)	-	(5.8)	(1.5)	(3.0)	(1.2)	-	(6.0)	(2.0)	(2.9)	(8.3)	(7.2)
Method	OS	XF	OS	XF	EP	XF	XF	OS	OS	OS	OS	OS
Σ=La+Ce+Pr	69.6	69.7	69.7	69.7	69.7	69.8	69.8	69.8	69.8	69.9	69.9	70.0
La-Nd	100.0	88.9	89.6	89.8	94.0	91.6	91.7	92.3	94.3	95.8	100.0	87.4
Sm-Ho	-	10.5	10.3	10.2	6.0	8.4	8.3	7.7	5.6	4.2	-	12.3
Er-Lu	-	0.6	0.1	-	-	-	-	-	0.1	-	-	0.3
RE_2O_3	-	-	61.8	-	-	-	-	-	-	-	-	70.7
La/Nd	0.60	1.27	1.13	0.87	0.72	0.82	1.00	0.77	1.17	0.84	0.65	1.28
ThO_2	11.4	2.0	14.3	11.2	3.3	9.5	-	-	-	-	5.3	12.2
U_3O_8	-	-	-	-	-	0.1	-	-	-	-	-	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	97	98	99	100	101	102	103	104	105	106	107	108
La	20.8	19.6	15.9	20.8	20.3	15.9	22.4	17.9	23.0	28.5	22.4	20.4
Ce	43.1	40.5	46.1	44.0	44.5	48.8	39.4	52.3	36.9	41.8	42.5	43.8
Pr	6.1	9.9	8.1	5.4	5.4	5.5	8.4	-	10.4	-	5.6	6.3
Nd	19.2	22.9	24.7	20.8	22.2	22.8	25.5	29.8	21.6	24.0	22.4	25.8
Sm	4.7	3.5	3.5	5.6	5.8	6.0	2.0	-	6.0	3.5	4.9	1.8
Eu	-	-	-	-	-	-	-	-	-	0.8	-	0.2
Gd	3.5	3.6	1.0	3.4	1.8	1.0	2.1	-	2.1	1.0	2.2	1.2
Tb	[1]	-	-	-	-	-	-	-	-	-	-	0.2
Dy	1.1	-	0.3	-	-	-	-	-	-	0.3	-	0.3
Ho	0.9	-	0.2	-	-	-	-	-	-	-	-	-
Er	0.6	-	0.1	-	-	-	0.2	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	0.1	-	-	-	-	-	-	0.1	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(5.4)[1]	(4.1)	(2.1)	-	(3.3)	(1.0)	-	(1.9)	(4.2)	(1.6)	-	-
Method	CH	OS	EP	XF	OS	XF	OS	OS	OS	OS	XF	XF
Σ=La+Ce+Pr	70.0	70.0	70.1	70.2	70.2	70.2	70.2	70.2	70.3	70.3	70.5	70.5
La-Nd	89.2	92.9	94.8	91.0	92.4	93.0	95.7	100.0	91.9	94.3	92.9	96.3
Sm-Ho	10.2	7.1	5.0	9.0	7.6	7.0	4.1	-	8.1	5.6	7.1	3.7
Er-Lu	0.6	-	0.2	-	-	-	0.2	-	-	0.1	-	-
RE_2O_3	-	-	71.6	-	-	-	54.0	-	-	-	-	52.3
La/Nd	1.08	0.85	0.64	1.00	0.91	0.70	0.88	0.60	1.06	1.19	1.00	0.79
ThO_2	7.37	-	-	-	15.5	9.9	-	8.0	-	-	-	-
U_3O_8	0.08	-	-	-	-	0.1	-	-	-	-	-	-

	109	110	111	112	113	114	115	116	117	118	119	120
La	18.7	22.3	15.6	21.2	16.5	19.0	18.3	11.3	21.3	11.4	18.9	32.5
Ce	48.1	42.1	49.3	48.1	45.7	42.6	52.4	55.3	42.6	55.4	46.8	33.6
Pr	3.8	6.2	5.7	1.4	8.5	9.1	-	4.2	6.9	4.1	5.2	4.9
Nd	20.2	21.6	22.4	22.2	22.4	23.6	29.3	16.2	23.7	16.2	20.7	20.1
Sm	3.6	4.8	5.4	4.2	3.4	3.8	-	9.0	2.8	9.0	5.9	3.5
Eu	-	-	-	-	0.3	-	-	-	-	-	-	-
Gd	4.7	3.0	1.6	2.5	1.6	1.9	-	4.0	2.3	3.9	2.5	4.4
Tb	-	-	-	-	0.2	-	-	-	-	-	-	-
Dy	0.9	-	-	-	0.6	-	-	-	-	-	-	1.0
Ho	-	-	-	-	-	-	-	-	0.4	-	-	-
Er	-	-	-	-	0.3	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	0.5	-	-	-	-	-	-	-
Lu	-	-	-	0.4	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(12.8)	-	(4.8)	(1.8)	(7.2)	(1.5)	(7.5)	(4.3)	(4.0)	-	(3.2)	(7.2)
Method	OS	XF	XF	EP	-	OS	OS	OS	CH	-	XF	-
Σ=La+Ce+Pr	70.6	70.6	70.6	70.7	70.7	70.7	70.7	70.8	70.8	70.9	70.9	71.0
La-Nd	90.8	92.2	93.0	92.9	93.1	94.3	100.00	87.0	94.5	87.1	91.6	91.1
Sm-Ho	9.2	7.8	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	57.4	-	-	69.1	-	-	-	59.9	-	-	-	-
La/Nd	0.93	1.03	0.70	0.95	0.74	0.81	0.62	0.70	0.90	0.70	0.91	1.62
ThO_2	8.3	-	9.2	-	-	-	5.7	7.35	-	-	7.7	-
U_3O_8	0.30	-	-	-	-	-	-	0.24	-	-	-	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	121	122	123	124	125	126	127	128	129	130	131	132
La	24.3	19.6	17.7	22.9	15.5	21.2	21.4	22.6	20.3	24.3	24.1	19.7
Ce	42.1	44.8	47.5	43.4	49.9	44.0	43.4	43.4	44.4	43.3	38.3	46.2
Pr	4.7	6.7	5.9	4.9	5.8	6.0	6.4	5.3	6.6	3.7	9.0	5.5
Nd	17.7	19.1	22.5	19.9	22.0	23.0	23.6	18.9	20.6	21.0	19.9	20.5
Sm	7.6	4.2	5.2	3.5	5.7	4.3	2.6	6.0	3.5	2.8	4.5	6.2
Eu	-	0.2	-	-	-	-	0.2	-	0.2	0.3	0.1	-
Gd	3.6	3.6	1.2	2.6	1.1	-	1.3	3.8	2.1	2.2	2.0	1.9
Tb	-	0.3	-	-	-	-	0.2	-	0.3	0.3	0.3	-
Dy	-	1.2	-	1.3	-	-	0.4	-	1.2	1.1	1.4	-
Ho	-	0.1	-	-	-	1.5	0.1	-	0.2	-	0.3	-
Er	-	0.1	-	1.3	-	-	0.2	-	0.3	0.3	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	0.1	-	0.2	-	-	0.2	-	0.3	0.7	0.1	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(4.6)	(5.0)	(6.3)	(2.9)	(6.9)	(8.6)	-	-	-	-	(5.4)	(2.4)
Method	OS	XF	XF	CH	XF	OS	XF	XF	XF	-	OS	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	71.4	71.4
La-Nd	88.8	90.2	93.6	91.1	93.2	94.2	94.8	90.2	91.9	92.3	91.3	91.9
Sm-Ho	11.2	9.6	6.4	7.4	6.8	5.8	4.8	9.8	7.5	6.7	0.1	-
Er-Lu	-	0.2	-	1.5	-	-	0.4	-	0.6	1.0	8.6	8.1
RE_2O_3	-	-	-	52.4	-	-	49.2	-	59.8	-	36.3	-
La/Nd	1.37	1.03	0.79	1.15	0.70	0.92	0.91	1.20	0.99	1.16	1.21	0.96
ThO_2	1.59	-	7.1	7.80	7.3	19.4	-	-	-	-	7.65	10.4
U_3O_8	-	-	-	-	0.1	-	-	-	-	-	-	0.1

	133	134	135	136	137	138	139	140	141	142	143	144
La	18.9	20.0	25.0	26.5	19.5	17.9	14.9	13.5	24.7	19.6	20.7	26.1
Ce	46.9	44.9	41.3	40.4	46.4	50.1	52.9	58.4	39.6	46.5	45.6	41.1
Pr	5.6	6.5	5.2	4.9	5.9	3.9	4.1	-	7.7	5.9	5.8	4.9
Nd	20.7	25.6	19.2	19.5	21.2	17.4	19.4	28.1	19.0	21.2	18.9	21.6
Sm	6.1	1.8	5.6	4.1	4.1	3.4	4.6	-	4.4	4.0	5.0	2.6
Eu	-	-	-	-	0.4	-	2.4	-	0.1	0.4	-	0.5
Gd	1.8	1.2	3.7	2.7	2.0	5.1	1.7	-	2.2	2.0	4.0	2.6
Tb	-	-	-	-	0.1	0.5	-	-	0.4	0.1	-	-
Dy	-	-	-	1.9	0.4	0.9	-	-	1.6	0.3	-	-
Ho	-	-	-	-	-	-	-	-	0.2	-	-	0.1
Er	-	-	-	-	-	0.1	-	-	-	-	-	0.3
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	0.7	-	-	0.1	-	-	0.2
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(1.9)	-	-	-	-	(12.4)	-	(6.6)	(5.5)	-	(6.4)	(5.3)
Method	XF	-	XF	XF	-	XF	EP	OS	OS	-	OS	-
Σ=La+Ce+Pr	71.4	71.4	71.5	71.8	71.8	71.9	71.9	71.9	72.0	72.0	72.1	72.1
La-Nd	92.1	97.0	90.7	91.3	93.0	89.3	91.3	100.0	91.0	93.2	91.0	93.7
Sm-Ho	7.9	3.0	9.3	8.7	7.0	9.9	8.7	-	8.9	6.8	9.0	5.8
Er-Lu	-	-	-	-	-	0.8	-	-	0.1	-	-	0.5
RE_2O_3	-	-	-	-	-	56.29	47.2	-	59.0	-	-	-
La/Nd	0.91	0.78	1.30	1.36	0.92	1.03	0.77	0.48	1.30	0.92	1.10	1.21
ThO_2	11.8	-	-	-	-	8.35	25.4	2.6	10.2	-	17.5	3.6
U_3O_8	-	-	-	-	-	0.56	-	-	-	-	-	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	145	146	147	148	149	150	151	152	153	154	155	156
La	23.6	18.6	22.0	21.6	19.3	23.2	19.8	24.7	27.7	18.7	20.9	17.0
Ce	43.3	47.0	45.0	41.4	47.0	45.7	46.6	41.9	39.7	47.0	44.6	51.0
Pr	5.3	6.6	5.2	9.2	5.9	3.3	5.9	5.7	4.9	6.6	6.8	4.4
Nd	19.7	20.3	20.9	22.8	24.2	24.8	17.5	18.8	19.3	20.3	20.8	18.0
Sm	5.1	3.6	4.6	2.7	0.4	1.4	4.1	3.6	3.8	3.6	4.3	3.5
Eu	-	0.3	-	-	0.7	-	[2]	-	-	0.3	-	[2]
Gd	3.0	2.6	2.3	2.1	0	1.6	3.4[2]	2.3	2.9[2]	2.5	2.6	2.8[2]
Tb	-	0.2	-	-	0.3	-	[1]	-	[1]	0.2	-	[1]
Dy	-	0.6	-	-	-	-	0.9	1.4	0.6	0.6	-	1.8
Ho	-	0.2	-	-	-	-	0.4	-	0.2	0.2	-	0.1
Er	-	-	-	0.2	-	-	1.0	1.4	0.4	-	-	0.7
Tm	-	-	-	-	-	-	-	-	0.2	-	-	0.1
Yb	-	-	-	-	-	-	0.4	0.2	0.3	-	-	0.6
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	-	-	-	-	-	(3.5)	(4.9)[1]	(1.5)	(5.3)[1]	-	-	(12.8)[1]
Method	XF	-	XF	OS	-	OS	CH	CH	CH	-	EP	CH
Σ=La+Ce+Pr	72.2	72.2	72.2	72.2	72.2	72.2	72.3	72.3	72.3	72.3	72.3	72.4
La-Nd	91.9	92.5	93.1	95.0	96.4	97.0	89.8	91.1	91.6	92.6	93.1	90.4
Sm-Ho	8.1	7.5	6.9	4.8	3.6	3.0	8.8	7.3	7.5	7.4	6.9	8.2
Er-Lu	-	-	-	0.2	-	-	1.4	1.6	0.9	-	-	1.4
RE_2O_3	-	-	-	52.8	67.89	57.1	52.42	58.0	55.14	-	68.92	55.6
La/Nd	1.20	0.92	1.05	0.95	0.80	0.94	1.13	1.31	1.44	0.92	1.00	0.94
ThO_2	-	-	-	-	-	4.10	8.52	5.50	8.50	-	-	8.0
U_3O_8	-	-	-	-	-	0.08	-	-	-	-	-	-
	157	158	159	160	161	162	163	164	165	166	167	168
La	21.5	23.9	22.4	19.3	22.7	22.7	24.6	24.4	25.0	21.7	27.4	21.1
Ce	41.6	42.5	44.2	47.3	45.3	39.0	39.4	43.1	42.4	45.2	41.0	45.9
Pr	9.3	6.1	6.0	6.0	4.6	11.1	8.8	5.5	5.6	6.2	4.9	6.3
Nd	23.0	22.7	18.1	21.3	21.6	20.6	23.9	22.1	24.8	18.3	18.9	22.8
Sm	2.6	2.9	4.0	3.4	4.0	5.1	2.0	4.9	1.2	3.7	3.3	2.4
Eu	-	-	0.2	0.2	-	0.2	0.1	-	-	-	0.1	-
Gd	2.0	1.9	2.7	1.8	1.8	1.3	1.2	-	1.0	3.2	2.5	0.7
Tb	-	-	0.3	0.2	-	-	-	-	-	0.1	0.3	0.2
Dy	-	-	1.1	0.5	-	-	-	-	-	1.3	1.2	0.5
Ho	-	-	0.1	-	-	-	-	-	-	-	0.3	-
Er	-	-	0.4	-	-	-	-	-	-	0.3	-	0.1
Tm	-	-	0.3	-	-	-	-	-	-	-	-	-
Yb	-	-	0.1	-	-	-	-	-	-	-	0.1	-
Lu	-	-	0.1	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(1.8)	(0.9)	(3.5)	-	(4.6)	(1.2)	(1.8)	-	(1.4)	-	(5.7)	-
Method	OS	-	XF	-	XF	OS	OS	XF	CH	XF	OS	-
Σ=La+Ce+Pr	72.4	72.5	72.6	72.6	72.6	72.8	72.8	73.0	73.0	73.1	73.3	73.3
La-Nd	95.4	95.2	90.7	93.9	94.2	93.4	96.7	95.1	97.8	91.4	92.2	96.1
Sm-Ho	4.6	4.8	8.4	6.1	5.8	6.6	3.3	4.9	2.2	8.3	7.7	3.8
Er-Lu	-	-	0.9	-	-	-	-	-	-	0.3	0.1	0.1
RE_2O_3	-	-	-	-	-	-	-	-	-	-	63.8	-
La/Nd	0.93	1.05	1.24	0.91	1.05	1.10	1.03	1.10	1.01	1.19	1.45	0.92
ThO_2	-	5.7	-	-	-	-	-	-	-	-	6.46	-
U_3O_8	-	0.1	-	-	-	-	-	-	-	-	-	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	169	170	171	172	173	174	175	176	177	178	179	180
La	21.6	21.0	19.3	22.4	24.4	27.3	24.8	23.8	20.2	21.9	27.6	24.3
Ce	45.3	52.3	47.8	45.5	41.0	41.6	43.5	40.9	47.1	47.0	39.9	45.0
Pr	6.4	-	6.3	5.5	8.1	4.6	5.2	8.9	6.3	4.8	6.2	4.4
Nd	23.7	26.7	18.7	19.0	18.0	20.0	20.7	21.5	24.4	13.7	14.9	16.0
Sm	1.8	-	3.6	3.6	4.1	3.1	3.7	2.0	0.8	3.5	4.7	3.8
Eu	-	-	-	[2]	0.1	0.2	-	-	0.1	0.2	-	[2]
Gd	0.6	-	2.9	2.3[2]	2.2	1.9	2.1	2.9	0.7	2.5	3.4	3.7[2]
Tb	-	-	-	[1]	0.3	0.2	-	-	0.2	0.6	-	[1]
Dy	0.4	-	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	0.2	-	-	0.6	-	-	-	-	-	1.1	-	0.4
Tm	-	-	-	-	-	-	-	-	-	0.6	-	-
Yb	-	-	-	-	0.1	-	-	-	-	1.1	-	0.6
Lu	-	-	-	-	-	-	-	-	-	0.8	-	-
100Y/(Y+Ln)	-	(10.3)	(3.1)	(7.4)[1]	(5.1)	(2..3)	-	(1.5)	-	(1.6)	(13.3)	(0.5)[1]
Method	-	OS	XF	CH	OS	OS	XF	XF	XF	XF	OS	CH
Σ=La+Ce+Pr	73.3	73.3	73.4	73.4	73.5	73.5	73.5	73.6	73.6	73.7	73.7	73.7
La-Nd	97.0	100.0	92.1	92.4	91.5	93.5	94.2	95.1	98.0	87.4	88.6	89.7
Sm-Ho	2.8	-	7.9	7.0	8.4	6.5	5.8	4.9	2.0	9.0	11.4	9.3
Er-Lu	0.2	-	-	0.6	0.1	-	-	-	-	3.6	-	1.0
RE_2O_3	-	-	-	43.65	75.5	66.1	-	-	53.8	44.8	-	45.4
La/Nd	0.91	0.79	1.03	1.18	1.36	1.37	1.20	1.11	0.83	1.60	1.85	1.52
ThO_2	-	6.3	3.0	9.41	11.5	5.92	-	-	-	-	4.4	8.62
U_3O_8	-	-	-	-	-	-	-	-	-	-	-	-

	181	182	183	184	185	186	187	188	189	190	191	192
La	19.1	24.8	22.5	23.5	18.2	24.0	26.2	28.2	19.8	21.5	27.6	24.4
Ce	48.2	43.5	45.5	45.6	49.5	40.9	37.5	40.8	48.9	46.9	41.7	44.0
Pr	6.4	5.4	5.8	4.7	6.1	8.9	10.2	5.0	5.3	5.6	4.7	5.6
Nd	20.1	20.7	10.2	18.6	20.2	21.3	21.4	18.5	18.7	19.1	19.8	20.5
Sm	3.7	3.9	11.8	3.4	2.0	1.9	1.8	3.4	3.9	3.8	3.1	3.3
Eu	[2]	-	-	-	0.2	-	-	0.1	[2]	0.1	0.2	[2]
Gd	1.7[2]	1.7	4.2	3.5	2.3	2.8	2.6	2.2	2.3[2]	2.2	1.9	1.9[2]
Tb	[1]	-	-	-	0.2	-	-	0.3	[1]	0.2	0.2	-
Dy	0.8	-	-	0.7	0.8	-	-	1.1	0.6	0.4	0.6	-
Ho	-	-	-	-	0.1	-	-	0.3	0.1	-	0.2	0.3
Er	-	-	-	-	0.2	0.2	0.3	-	0.2	0.1	-	-
Tm	-	-	-	-	-	-	-	-	0.1	-	-	-
Yb	-	-	-	-	0.2	-	-	0.1	0.1	0.1	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(3.9)[1]	-	(8.4)	(6.8)	-	-	-	(4.3)	(6.1)[1]	-	(2.3)	(0.3)
Method	CH	XF	EP	OS	-	OS	OS	OS	CH	-	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	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	93.8	94.5
Sm-Ho	6.2	5.6	16.0	7.6	5.6	4.7	4.4	7.4	6.9	6.7	6.2	5.5
Er-Lu	-	-	-	-	0.4	0.2	0.3	0.1	0.4	0.2	-	-
RE_2O_3	58.8	-	46.3	60.6	-	56.8	57.15	65.9	55.6	-	63.2	49.6
La/Nd	0.95	1.20	2.21	1.26	0.90	1.13	1.22	1.52	1.06	1.13	1.39	1.19
ThO_2	-	-	19.5	7.1	-	-	-	6.44	8.0	-	6.34	-
U_3O_8	-	-	1.6	-	-	-	-	-	-	-	-	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	193	194	195	196	197	198	199	200	201	202	203	204
La	18.7	25.6	25.9	21.1	26.2	23.0	24.9	25.0	23.9	23.4	30.0	23.4
Ce	55.3	44.2	42.5	46.6	37.6	44.8	44.7	43.8	44.9	45.3	39.4	45.6
Pr	-	4.3	5.7	6.4	10.3	6.3	4.6	5.4	5.4	5.5	4.9	5.3
Nd	26.0	16.0	18.5	19.2	21.5	22.3	17.3	20.0	20.8	21.6	18.8	20.3
Sm	-	3.6	4.3	2.9	1.8	1.4	2.7	3.4	3.3	2.3	3.4	3.5
Eu	-	-	-	-	-	-	-	-	-	0.5	-	-
Gd	-	1.5	3.1	2.2	2.6	1.5	2.6	2.4	1.7	0.8	2.2	1.7
Tb	-	0.7	-	0.1	-	-	-	-	-	0.1	1.3	-
Dy	-	2.7	-	1.2	-	0.3	1.3	-	-	0.3	-	-
Ho	-	0.7	-	-	-	-	-	-	-	0.2	-	-
Er	-	0.7	-	0.3	-	0.2	1.7	-	-	-	-	0.2
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	0.1	0.2	-	-	-	-	-
Lu	-	-	-	-	-	0.1	-	-	-	-	-	-
100Y/(Y+Ln)	(7.2)	(2..6)	-	-	(2..6)	(1.5)	(1.5)	-	-	-	-	(2.6)
Method	OS	XF	XF	XF	OS	OS	CH	XF	XF	XF	XF	OS
Σ=La+Ce+Pr	74.0	74.1	74.1	74.1	74.1	74.1	74.2	74.2	74.2	74.2	74.3	74.3
La-Nd	100.0	90.1	92.6	93.3	95.6	96.4	91.5	94.2	95.0	95.8	93.1	94.6
Sm-Ho	-	9.2	7.4	6.4	4.4	3.2	6.6	5.8	5.0	4.2	6.9	5.2
Er-Lu	-	0.7	-	0.3	-	0.4	1.9	-	-	-	-	0.2
RE_2O_3	-	37.1	-	-	-	-	56.6	-	-	-	-	-
La/Nd	0.72	1.60	1.40	1.10	1.22	1.03	1.44	1.25	1.15	1.08	1.60	1.15
ThO_2	17.0	-	-	-	-	8.61	6.00	-	-	-	-	9.63
U_3O_8	-	-	-	-	-	0.12	-	-	-	-	-	0.13

	205	206	207a	207b	208	209	210	211	212	213	214	215
La	19.9	25.0	23.8	24.2	20.5	22.4	23.2	23.7	23.8	24.4	25.6	23.8
Ce	48.8	49.4	45.0	46.2	49.0	46.2	45.2	45.4	50.8	44.8	40.0	45.7
Pr	5.6	-	5.6	5.4	4.9	5.9	6.2	5.5	-	5.5	9.2	5.4
Nd	23.3	16.8	18.9	17.8	19.0	17.0	17.3	19.7	25.4	20.4	18.1	19.9
Sm	2.4	2.3	3.8	3.3	2.8	3.2	3.4	3.7	-	3.3	3.6	3.2
Eu	-	-	-	-	[2]	-	-	-	-	-	-	-
Gd	-	6.5	2.9	3.1	2.6[2]	3.4	2.9	2.0	-	1.6	3.0	2.0
Tb	-	-	-	-	[1]	0.1	0.1	-	-	-	-	-
Dy	-	-	-	-	1.0	1.4	1.3	-	-	-	-	-
Ho	-	-	-	-	0.1	-	-	-	-	-	-	-
Er	-	-	-	-	-	0.4	0.4	-	-	-	0.4	-
Tm	-	-	-	-	0.1	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-	0.1	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	-	(4.5)	(9.2)	(9.1)	(1.9)[1]	-	-	-	(8.4)	-	-	-
Method	EP	INA	OS	OS	CH	XF	XF	XF	OS	XF	OS	XF
Σ=La+Ce+Pr	74.3	74.4	74.4	75.8	74.4	74.5	74.6	74.6	74.6	74.7	74.8	74.9
La-Nd	97.6	91.2	93.3	93.6	93.4	91.5	91.9	94.3	100.0	95.1	92.9	94.8
Sm-Ho	2.4	8.8	6.7	6.4	6.5	8.1	7.7	5.7	-	4.9	6.6	5.2
Er-Lu	-	-	-	-	0.1	0.4	0.4	-	-	-	0.5	-
RE_2O_3	53.55	71.63	-	-	53.29	-	-	-	-	-	45.7	-
La/Nd	0.85	1.49	1.26	1.36	1.08	1.32	1.34	1.20	0.94	1.20	1.41	1.20
ThO_2	-	1.94	21.3	19.5	16.30	-	-	-	10.3	-	-	-
U_3O_8	-	-	-	-	-	-	-	-	-	-	-	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	216a	216b	217	218	219	220	221	222	223	224	225	226
La	23.7	23.3	22.9	25.5	23.8	21.8	20.3	25.5	20.9	18.9	22.9	21.9
Ce	45.5	47.0	46.1	40.2	45.6	47.1	49.6	40.6	48.7	51.6	47.4	46.5
Pr	5.7	5.4	6.0	9.3	5.6	6.2	5.2	9.0	5.6	4.7	4.9	6.8
Nd	20.4	19.8	16.2	18.4	19.8	18.9	20.1	21.3	15.3	15.9	16.2	17.0
Sm	3.6	3.4	6.3	3.7	3.2	2.7	1.6	2.0	5.2	3.4	2.6	3.3
Eu	-	-	-	-	-	-	-	0.2	-	0.1	-	0.3
Gd	1.1	1.1	2.5	2.9	2.0	2.0	2.9	1.2	4.3	2.6	5.5	1.8
Tb	-	-	-	-	-	-	-	-	[3]	0.3	-	0.3
Dy	-	-	-	-	-	1.1	0.1	-	[3]	1.6	0.5	1.3
Ho	-	-	-	-	-	-	-	-	-	-	-	0.1
Er	-	-	-	-	-	0.2	0.2	0.2	-	0.3	-	0.4
Tm	-	-	-	-	-	-	-	-	-	0.2	-	-
Yb	-	-	-	-	-	-	-	-	-	0.4	-	0.3
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(1.0)	(1.0)	(7.2)	(5.5)	-	-	-	-	(2.8)[3]	(1.2)	(4.4)	-
Method	OS	OS	EP	OS	XF	XF	OS	CH	INA	XF	OS	XF
Σ=La+Ce+Pr	74.9	75.7	75.0	75.0	75.0	75.1	75.1	75.1	75.2	75.2	75.2	75.2
La-Nd	95.3	95.5	91.2	93.4	94.8	94.0	95.2	96.4	90.5	91.1	91.4	92.2
Sm-Ho	4.7	4.5	8.8	6.6	5.2	5.8	4.6	3.4	9.5	8.0	8.6	7.1
Er-Lu	-	-	-	-	-	0.2	0.2	0.2	-	0.9	-	0.7
RE_2O_3	-	-	60.3	-	-	-	-	58.5	-	38.4	62.2	-
La/Nd	1.16	1.18	1.41	1.39	1.20	1.15	1.01	1.20	1.37	1.19	1.41	1.29
ThO_2	10.9	7.7	5.6	-	-	-	-	-	-	-	5.6	-
U_3O_8	-	-	0.4	-	-	-	-	-	-	-	-	-
	227	228	229	230	231	232	233	234	235	236	237	238
La	21.0	24.0	22.6	24.3	23.6	21.9	23.6	21.4	24.8	23.2	20.5	21.9
Ce	47.3	46.2	46.9	45.8	46.9	47.6	41.8	48.7	45.5	47.0	50.2	47.7
Pr	6.9	5.0	5.7	5.2	4.8	5.9	10.0	5.3	5.1	5.2	4.8	5.9
Nd	17.7	19.2	20.0	18.6	21.7	17.0	18.8	19.2	19.8	21.4	16.8	16.9
Sm	3.2	3.3	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	2.0	2.3	1.3	1.9	-	2.1	3.7	1.9	1.8	1.1	2.6	2.1
Tb	0.2	-	0.2	-	-	0.3	-	-	-	0.2	0.5	0.3
Dy	1.2	-	0.6	-	-	1.4	-	-	-	0.3	1.0	1.4
Ho	0.2	-	-	-	-	0.3	-	-	-	0.1	0.2	0.3
Er	0.1	-	0.1	0.2	-	0.6	0.3	-	-	-	0.2	0.6
Tm	-	-	-	-	-	-	-	-	-	-	0.2	-
Yb	0.2	-	0.1	-	-	0.3	-	-	-	-	0.2	0.3
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	-	(4.4)	-	(3.1)	-	(12.8)	-	(6.7)	-	-	(1.0)	-
Method	XF	XF	XF	OS	EP	XF	OS	OS	XF	XF	XF	XF
Σ=La+Ce+Pr	75.2	75.2	75.2	75.3	75.3	75.4	75.4	75.4	75.4	75.4	75.5	75.5
La-Nd	92.9	94.4	95.2	93.9	97.0	92.4	94.2	94.6	95.2	96.8	92.3	92.4
Sm-Ho	6.8	5.6	4.6	5.9	3.0	6.7	5.5	5.4	4.8	3.2	7.1	6.7
Er-Lu	0.3	-	0.2	0.2	-	0.9	0.3	-	-	-	0.6	0.9
RE_2O_3	56.2	-	-	-	66.53	-	57.0	-	-	44.6	43.4	-
La/Nd	1.19	1.25	1.13	1.31	1.09	1.29	1.26	1.11	1.25	1.08	1.22	1.30
ThO_2	-	-	-	9.97	-	-	-	3.66	-	-	-	-
U_3O_8	-	-	-	0.20	-	-	-	-	-	-	-	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	239	240	241	242	243	244	245	246	247	248	249	250
La	22.3	22.0	25.4	19.7	20.3	24.8	25.3	25.7	21.1	21.4	26.6	23.3
Ce	49.8	47.7	45.0	47.6	49.3	45.8	45.2	46.0	48.6	47.4	43.7	42.0
Pr	3.4	5.8	5.1	8.3	6.0	5.1	5.2	4.1	6.2	7.1	5.7	10.7
Nd	18.7	19.3	19.6	20.7	21.89	19.0	20.1	15.3	17.1	20.0	17.3	18.4
Sm	3.1	4.8	2.9	3.7	2.6	3.4	2.4	2.7	3.2	2.5	4.1	1.9
Eu	-	-	-	-	-	-	[2]	-	0.1	-	-	-
Gd	1.7	-	2.0	-	-	1.9	1.3[2]	2.4	2.2	1.2	2.6	3.7
Tb	-	-	-	-	-	-	[1]	-	0.1	-	-	-
Dy	0.6	-	-	-	-	-	0.5	2.2	1.0	0.4	-	-
Ho	0.1	0.4	-	-	-	-	-	-	0.2	-	-	-
Er	0.2	-	-	-	-	-	-	1.3	0.1	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	0.1	-	-	-	-	-	-	0.3	0.1	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	-	(5.7)	-	-	-	-	(1.2)[1]	(2.6)	-	-	(2.0)	(3.7)
Method	EP	XF	XF	XF	-	XF	CH	-	XF	XF	CH	OS
Σ=La+Ce+Pr	75.5	75.5	75.5	75.6	75.6	75.7	75.7	75.8	75.9	75.9	76.0	76.0
La-Nd	94.2	94.8	95.1	96.3	97.4	94.7	95.8	91.1	93.0	95.9	93.3	94.4
Sm-Ho	5.5	5.2	4.9	3.7	2.6	5.3	4.2	7.3	6.8	4.1	6.7	5.6
Er-Lu	0.3	-	-	-	-	-	-	1.6	0.2	-	-	-
RE_2O_3	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	1.54	1.27
ThO_2	-	5.93	-	-	-	-	6.14	-	-	-	-	-
U_3O_8	-	-	-	-	-	-	-	-	-	-	-	-

	251	252	253	254	255	256	257	258	259	260	261	262
La	21.2	25.3	22.5	22.2	26.0	24.0	21.1	24.4	23.7	24.3	23.7	25.7
Ce	49.1	45.9	47.4	49.4	50.0	46.2	49.9	45.4	47.6	46.8	47.4	45.7
Pr	5.7	4.8	6.1	4.4	-	5.9	5.1	6.3	4.9	5.1	5.1	4.9
Nd	18.6	18.7	19.0	21.2	24.0	18.7	19.2	19.5	13.4	18.7	19.0	19.0
Sm	2.7	3.2	3.3	2.8	-	2.9	2.5	3.7	6.9	3.6	2.9	3.2
Eu	0.1	-	-	-	-	-	[2]	-	-	-	-	-
Gd	1.5	2.1	1.5	-	-	1.7	1.8[2]	-	3.5	1.5	1.9	1.5
Tb	0.3	-	-	-	-	-	[1]	-	-	-	-	-
Dy	0.7	-	-	-	-	0.5	0.3	0.7	-	-	-	-
Ho	0.1	-	-	-	-	-	-	-	-	-	-	-
Er	-	-	0.2	-	-	0.1	0.1	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	-	-	-	-	(9.1)	(4.0)	(5.8)[1]	(4.6)	(6.4)	-	-	-
Method	XF	XF	OS	EP	OS	ID	CH	EP	EP	XF	XF	XF
Σ=La+Ce+Pr	76.0	76.0	76.0	76.0	76.0	76.1	76.1	76.1	76.2	76.2	76.2	76.3
La-Nd	94.6	94.7	95.0	97.2	100.00	94.8	95.3	95.6	89.6	94.9	95.2	95.3
Sm-Ho	5.4	5.3	4.8	2.8	-	5.1	4.6	4.4	10.4	5.1	4.8	4.7
Er-Lu	-	-	0.2	-	-	0.1	0.1	-	-	-	-	-
RE_2O_3	-	-	-	52.13	-	46.8	63.75	-	60.2	-	-	-
La/Nd	1.14	1.35	1.18	1.05	1.08	1.28	1.10	1.25	1.77	1.30	1.25	1.35
ThO_2	-	-	6.46	-	15.3	8.12	4.00	11.6	4.5	-	-	-
U_3O_8	-	-	0.09	-	-	0.30	-	-	2.5	-	-	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	263	264	265	266	267	268	269	270	271	273	273	274
La	25.9	22.1	25.7	26.9	26.4	25.5	19.2	25.6	23.2	21.7	19.3	21.0
Ce	46.4	49.7	46.0	44.4	45.2	51.0	51.5	45.9	48.1	52.3	53.4	49.3
Pr	4.1	4.6	4.8	5.2	4.9	-	5.9	5.1	5.3	2.7	4.0	6.5
Nd	15.5	18.4	18.4	18.5	18.8	23.5	16.8	17.6	19.6	18.0	18.6	16.0
Sm	2.7	2.4	2.9	3.0	3.2	-	3.8	3.0	1.4	2.9	3.0	2.4
Eu	-	0.2	-	-	-	-	-	-	0.1	-	-	0.1
Gd	2.4	1.2	2.2	2.0	1.5	-	2.1	2.8	1.2	1.6	1.1	1.3
Tb	-	0.2	-	-	-	-	[1]	-	0.2	-	-	0.2
Dy	1.4	0.7	-	-	-	-	0.7	-	0.7	0.5	0.4	1.3
Ho	-	-	-	-	-	-	-	-	0.2	0.1	-	0.3
Er	1.3	0.2	-	-	-	-	-	-	-	0.2	0.1	0.6
Tm	-	0.1	-	-	-	-	-	-	-	-	-	0.1
Yb	0.3	0.2	-	-	-	-	-	-	-	-	0.1	0.8
Lu	-	-	-	-	-	-	-	-	-	-	-	0.1
100Y/(Y+Ln)	(2.6)	-	-	-	-	(8.0)	(0.9)[1]	-	-	-	-	-
Method	CH	XF	XF	XF	XF	OS	CH	XF	XF	EP	XF	XF
Σ=La+Ce+Pr	76.4	76.4	76.5	76.5	76.5	76.5	76.6	76.6	76.6	76.7	76.7	76.8
La-Nd	91.9	94.8	94.9	95.0	95.3	100.0	93.4	94.2	96.2	94.7	95.3	92.8
Sm-Ho	6.5	4.7	5.1	5.0	4.7	-	6.6	5.8	3.8	5.1	4.5	5.6
Er-Lu	1.6	0.5	-	-	-	-	-	-	-	0.2	0.2	1.6
RE_2O_3	62.4	-	-	-	-	-	-	-	55.1	49.05	68.3	-
La/Nd	1.67	1.20	1.40	1.45	1.40	1.09	1.14	1.45	1.18	1.21	1.04	1.31
ThO_2	8.75	-	-	-	-	11.7	8.48	-	-	-	-	-
U_3O_8	-	-	-	-	-	-	0.04	-	-	-	-	-
	275	276	277	278	279	280	281	282	283	284	285	286
La	23.1	25.2	26.2	23.3	22.0	25.2	28.0	23.3	21.5	24.3	26.3	28.3
Ce	47.8	47.1	42.1	46.4	50.7	51.6	42.9	51.9	52.8	46.8	45.5	46.8
Pr	5.9	4.5	8.5	7.1	4.1	-	6.0	1.7	2.6	5.8	5.1	1.8
Nd	18.4	19.0	19.3	19.6	20.3	23.2	13.9	14.7	17.2	17.3	17.5	18.3
Sm	2.1	2.4	2.3	2.0	2.0	-	4.2	3.1	3.1	2.7	3.2	4.4
Eu	-	-	-	0.2	[2]	-	0.7	0.1	0.1	[2]	-	-
Gd	1.8	1.8	1.6	0.6	0.7[2]	-	3.8	2.6	1.7	2.0[2]	2.4	0.4
Tb	0.2	-	-	0.1	[1]	-	-	-	-	[1]	-	-
Dy	0.6	-	-	0.4	0.2	-	-	1.9	0.6	0.4	-	-
Ho	-	-	-	0.1	-	-	0.1	-	0.1	0.3	-	-
Er	0.1	-	-	-	-	-	0.4	0.4	0.2	0.4	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	0.2	-	-	-	0.3	0.1	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(7.2)	(2.2)	(1.9)	-	(0.9)[1]	(7.2)	(2.4)	(10.1)	-	(8.7)[1]	-	(21.5)
Method	-	OS	OS	XF	CH	OS	-	XF	EP	CH	XF	-
Σ=La+Ce+Pr	76.8	76.8	76.8	76.8	76.8	76.8	76.9	76.9	76.9	76.9	76.9	76.9
La-Nd	95.2	95.8	96.1	96.4	97.1	100.0	90.8	91.6	94.1	94.2	94.4	95.2
Sm-Ho	4.7	4.2	3.9	3.4	2.9	-	8.8	7.7	5.6	5.4	5.6	4.8
Er-Lu	0.1	-	-	0.2	-	-	0.4	0.7	0.3	0.4	-	-
RE_2O_3	-	-	-	-	61.0	-	-	-	53.99	50.13	-	-
La/Nd	1.26	1.33	1.36	1.19	1.08	1.09	2.01	1.59	1.25	1.40	1.50	1.55
ThO_2	-	6.7	-	-	7.23	9.7	-	-	-	5.77	-	-
U_3O_8	-	-	-	-	-	-	-	-	-	-	-	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	287	288	289	290	291	292	293	294	295	296	297	298
La	23.8	23.1	22.8	26.4	22.3	26.6	25.9	25.0	24.1	24.1	25.9	22.5
Ce	46.8	48.0	48.3	42.1	48.1	46.9	46.2	52.1	47.9	48.3	46.3	51.1
Pr	6.3	5.8	5.8	8.4	6.6	3.6	5.0	-	5.2	4.8	5.0	3.6
Nd	18.3	18.4	18.9	19.2	16.2	14.8	18.5	22.9	12.7	17.2	18.5	18.7
Sm	2.4	2.1	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	1.6	1.8	2.0	1.5	1.7	3.3	1.5	-	2.8	2.8	1.5	1.3
Tb	0.1	0.2	-	-	0.2	0.5	-	-	0.3	-	-	-
Dy	0.7	0.5	0.2	-	1.1	2.0	-	-	1.9	-	-	0.7
Ho	-	-	-	-	0.2	0.2	-	-	0.3	-	-	-
Er	-	0.1	0.3	0.2	0.3	-	-	-	0.4	-	-	-
Tm	-	-	-	-	-	0.2	-	-	0.1	-	-	-
Yb	-	-	0.1	-	0.5	-	-	-	0.4	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	-	-	(3.2)	-	-	(2.3)	-	(6.3)	-	-	-	-
Method	XF	XF	OS	OS	XF	XF	XF	OS	XF	XF	XF	-
Σ=La+Ce+Pr	76.9	76.9	76.9	76.9	77.0	77.1	77.1	77.1	77.2	77.2	77.2	77.2
La-Nd	95.2	95.3	95.8	96.1	93.2	91.9	95.6	100.0	89.9	94.4	95.7	95.9
Sm-Ho	4.8	4.6	3.8	3.7	6.0	7.9	4.4	-	9.2	5.6	4.3	4.1
Er-Lu	-	0.1	0.4	0.2	0.8	0.2	-	-	0.9	-	-	-
RE_2O_3	-	-	-	51.15	-	-	-	-	-	-	-	-
La/Nd	1.30	1.26	1.21	1.38	1.38	1.80	1.40	1.09	1.90	1.40	1.40	1.20
ThO_2	-	-	9.17	-	-	-	-	10.0	-	-	-	-
U_3O_8	-	-	0.18	-	-	-	-	-	-	-	-	-
	299	**300**	**301**	**302**	**303**	**304**	**305**	**306**	**307**	**308**	**309a**	**309b**
La	24.4	23.9	28.3	29.0	26.6	25.0	24.1	26.9	16.3	23.0	22.3	24.5
Ce	47.8	48.1	43.5	43.1	45.8	475.	48.4	46.3	55.3	48.7	41.6	47.4
Pr	5.1	5.3	5.5	5.2	5.0	5.0	5.1	4.4	6.0	5.9	9.1	6.2
Nd	18.1	18.4	18.9	19.6	18.3	15.5	14.4	17.3	17.5	18.2	20.1	19.4
Sm	2.7	3.3	3.8	1.8	2.8	5.0	5.4	2.9	3.0	1.5	3.3	1.8
Eu	-	-	-	0.3	-	-	-	-	[2]	-	-	0.2
Gd	1.9	1.0	-	0.9	1.5	2.0	2.6	2.2	1.9[2]	1.9	2.6	-
Tb	-	-	-	-	-	-	-	-	-	-	-	-
Dy	-	-	-	0.1	-	-	-	-	-	0.3	1.0	0.3
Ho	-	-	-	-	-	-	-	-	-	-	-	0.1
Er	-	-	-	-	-	-	-	-	-	0.4	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	0.1
Yb	-	-	-	-	-	-	-	-	-	0.1	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	-	(0.9)	-	-	-	(1.4)	(1.7)	-	(2.0)	(3.2)	(2.8)	-
Method	XF	OS	XF	XF	XF	EP	EP	XF	CH	-	XF	XF
Σ=La+Ce+Pr	77.3	77.3	77.3	77.3	77.4	77.5	77.6	77.6	77.6	77.6	73.0	78.1
La-Nd	95.4	95.7	96.2	96.9	95.7	93.0	92.0	94.9	95.1	95.8	93.1	97.5
Sm-Ho	4.6	4.3	3.8	3.1	4.3	7.0	8.0	5.1	4.9	3.7	6.9	2.4
Er-Lu	-	-	-	-	-	-	-	-	-	0.5	-	0.1
RE_2O_3	-	-	-	-	-	63.4	59.7	50.0	-	54.71	54.0	54.0
La/Nd	1.35	1.30	1.50	1.48	1.45	1.61	1.67	1.55	0.93	1.26	1.11	1.26
ThO_2	-	9.3	-	-	-	4.1	5.6	-	-	7.64	2.39	2.39
U_3O_8	-	-	-	-	-	0.1	0.2	-	-	0.29	-	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	309c	310	311	312	313	314	315	316	317	318	319	320
La	23.2	25.2	24.6	25.7	26.9	23.3	26.9	20.0	23.8	22.3	23.1	26.2
Ce	52.9	48.3	48.2	47.0	46.6	51.3	40.3	52.8	51.9	51.5	48.9	47.1
Pr	5.5	4.2	4.9	5.1	4.3	3.3	10.7	5.1	2.3	4.2	6.0	4.7
Nd	16.3	16.2	17.3	17.8	17.9	15.2	18.5	22.1	15.6	16.6	17.3	18.1
Sm	1.7	3.0	3.3	3.0	2.9	3.1	1.4	-	2.8	2.7	2.3	2.5
Eu	0.1	0.2	-	-	-	0.1	-	-	0.1	0.1	0.1	-
Gd	0.2	1.3	1.7	1.4	1.4	1.8	2.0	-	2.3	1.8	1.4	1.4
Tb	-	0.2	-	-	-	-	-	[1]	-	-	0.2	-
Dy	0.1	0.9	-	-	-	1.7	-	-	1.0	0.6	0.5	-
Ho	-	-	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	0.2	-	0.1	0.1	0.2	-
Tm	-	0.2	-	-	-	-	-	-	-	-	-	-
Yb	-	0.3	-	-	-	0.2	-	-	0.1	0.1	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	-	(1.0)	(4.4)	-	-	(6.5)	-	(15.1)[1]	(6.0)	(2.7)	-	-
Method	CH	XF	OS	XF	XF	XF	OS	CH	XF	XF	XF	XF
Σ=La+Ce+Pr	81.6	77.7	77.7	77.8	77.8	77.9	77.9	77.9	78.0	78.0	78.0	78.0
La-Nd	97.9	93.9	95.0	95.6	95.7	93.1	96.4	100.0	93.6	94.6	95.3	96.1
Sm-Ho	2.1	5.6	5.0	4.4	4.3	6.7	3.4	-	6.2	5.2	4.5	3.9
Er-Lu	-	0.5	-	-	-	0.2	0.2	-	0.2	0.2	0.2	-
RE_2O_3	54.0	47.5	-	-	-	-	50.8	-	-	-	52.9	-
La/Nd	1.42	1.56	1.42	1.44	1.50	1.53	1.45	0.90	1.53	1.34	1.34	1.45
ThO_2	2.39	-	11.0	-	-	-	-	-	18.7	7.57	-	-
U_3O_8	-	-	-	-	-	-	-	-	-	-	-	-
	321	**322**	**323**	**324**	**325**	**326**	**327**	**328**	**329**	**330**	**331**	**332**
La	30.1	26.8	23.9	26.7	24.7	25.6	14.3	24.4	20.1	23.5	22.8	23.0
Ce	42.6	40.5	51.9	46.2	47.0	47.4	56.5	47.3	50.8	49.6	49.5	52.0
Pr	5.3	10.7	2.3	5.2	6.4	5.1	7.3	6.5	7.3	5.1	6.0	3.3
Nd	18.3	18.5	15.5	17.8	17.9	18.9	20.0	17.1	17.6	18.8	14.7	15.2
Sm	3.5	1.4	2.8	2.5	1.7	3.0	1.3	1.6	1.7	2.1	5.3	3.0
Eu	-	-	0.1	-	0.1	-	0.2	-	-	[2]	-	0.1
Gd	-	2.1	2.3	1.6	1.3	-	0.4	2.5	1.4	0.9[2]	1.7	2.3
Tb	-	-	-	-	-	-	-	-	-	[3]	-	-
Dy	-	1.0	-	0.5	-	-	-	0.4	0.5	[3]	-	0.9
Ho	0.2	-	-	-	-	-	-	-	-	-	-	-
Er	-	-	0.1	-	0.3	-	-	0.1	0.4	-	-	0.1
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	0.1	-	0.1	-	-	0.1	0.2	-	-	0.1
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(3.3)	(1.1)	(6.4)	-	(2.0)	-	-	(3.1)	(2.4)	(0.6)[3]	(5.4)	(6.1)
Method	OS	OS	XF	XF	OS	XF	-	OS	XF	CH	EP	XF
Σ=La+Ce+Pr	78.0	78.0	78.1	78.1	78.1	78.1	78.1	78.2	78.2	78.2	78.3	78.3
La-Nd	96.3	96.5	93.6	95.9	96.0	97.0	98.1	95.3	95.8	97.0	93.0	93.5
Sm-Ho	3.7	3.5	6.2	4.1	3.6	3.0	1.9	4.5	3.6	3.0	7.0	6.3
Er-Lu	-	-	0.2	-	0.4	-	-	0.2	0.6	-	-	0.2
RE_2O_3	-	-	-	-	-	-	-	-	-	64.6	61.3	-
La/Nd	1.64	1.45	1.54	1.50	1.38	1.35	0.72	1.43	1.14	1.25	1.55	1.51
ThO_2	0.18	-	-	-	1.04	-	-	-	-	5.60	6.5	-
U_3O_8	-	-	-	-	1.38	-	-	0.25	-	-	0.2	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	333	334	335	336	337	338	339	340	341	342	343	344
La	24.0	27.9	26.2	26.0	24.6	32.2	25.1	25.3	27.8	26.3	23.2	27.2
Ce	52.0	44.6	47.4	47.6	48.8	40.0	48.4	49.0	46.3	47.5	49.1	51.3
Pr	2.3	5.8	4.7	4.8	5.0	6.2	4.9	4.2	4.4	4.7	6.2	-
Nd	15.4	17.0	17.5	16.7	16.9	17.3	18.4	13.0	16.1	17.5	19.6	21.5
Sm	2.8	2.2	2.6	1.9	2.9	2.7	2.5	2.7	2.1	2.6	1.3	-
Eu	0.1	[2]	-	0.2	-	0.1	-	0.2	0.2	-	0.1	-
Gd	2.1	1.1[2]	1.6	1.4	1.8	0.4	0.7	1.6	1.5	1.4	0.5	-
Tb	-	[1]	-	0.3	-	0.1	-	0.5	0.3	-	-	-
Dy	1.1	0.5	-	0.5	-	0.3	-	1.0	1.3	-	-	-
Ho	-	0.2	-	0.1	-	-	-	-	-	-	-	-
Er	0.1	0.4	-	0.3	-	0.7	-	0.9	-	-	-	-
Tm	-	-	-	-	-	-	-	0.4	-	-	-	-
Yb	0.1	0.3	-	0.2	-	-	-	0.8	-	-	-	-
Lu	-	-	-	-	-	-	-	0.4	-	-	-	-
100Y/(Y+Ln)	(6.1)	(2.4)[1]	-	(2.4)	(0.3)	(7.1)	(5.5)	(1.3)	(1.6)	-	-	(5.8)
Method	XF	CH	XF	CH	XF	ICP	OS	XF	-	XF	XF	OS
Σ=La+Ce+Pr	78.3	78.3	78.3	78.4	78.4	78.4	78.4	78.5	78.5	78.5	78.5	78.5
La-Nd	93.7	95.3	95.8	95.1	95.3	95.7	96.8	91.5	94.6	96.0	98.1	100.0
Sm-Ho	6.1	4.0	4.2	4.4	4.7	3.6	3.2	6.0	5.4	4.0	1.9	-
Er-Lu	0.2	0.7	-	0.5	-	0.7	-	2.5	-	-	-	-
RE_2O_3	-	60.84	-	61.8	-	65.1	-	42.5	61.21	-	-	-
La/Nd	1.56	1.64	1.50	1.56	1.46	1.86	1.36	1.95	1.73	1.50	1.18	1.27
ThO_2	-	4.26	-	-	-	3.32	7.7	-	-	-	-	8.1
U_3O_8	-	-	-	-	-	0.87	-	-	-	-	-	-
	345	346	347	348	349	350	351	352	353	354	355	356
La	24.1	26.6	20.3	27.8	24.5	26.1	25.2	27.0	28.5	19.3	24.2	27.7
Ce	52.2	47.2	52.4	45.6	52.8	47.9	48.1	41.9	44.0	54.3	52.4	46.7
Pr	2.4	4.9	6.0	5.4	1.5	4.8	5.5	9.9	6.4	5.3	2.3	4.5
Nd	15.7	16.1	16.7	13.5	14.9	16.6	17.6	17.8	14.3	14.5	15.5	16.1
Sm	2.6	2.4	1.9	3.0	3.0	1.9	1.5	1.5	3.3	2.6	2.6	2.1
Eu	-	[2]	-	0.7	-	[2]	-	-	0.6	0.2	0.1	[2]
Gd	2.0	1.6[2]	2.2	3.5	1.9	1.6[2]	1.2	1.8	2.9	1.9	1.7	1.7[2]
Tb	-	[1]	-	-	-	[1]	0.2	-	-	0.2	-	[1]
Dy	0.9	0.6	0.3	-	1.2	0.5	0.6	-	-	1.2	1.0	1.2
Ho	-	0.2	-	0.1	-	0.1	0.1	-	-	0.1	-	-
Er	-	0.4	0.1	0.4	0.1	0.3	-	0.1	-	0.2	0.1	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	0.1	-	0.1	-	0.1	0.2	-	-	-	0.2	0.1	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(3.8)	(1.9)[1]	-	(2.4)	(4.8)	(2.8)[1]	-	-	(1.6)	-	(5.2)	(1.9)[1]
Method	XF	CH	XF	-	XF	CH	XF	OS	-	XF	XF	CH
Σ=La+Ce+Pr	78.7	78.7	78.7	78.8	78.8	78.8	78.8	78.8	78.9	78.9	78.9	78.9
La-Nd	94.4	94.8	95.4	92.3	93.7	95.4	96.4	96.6	93.2	93.4	94.4	95.0
Sm-Ho	5.5	4.8	4.4	7.3	6.1	4.1	3.6	3.3	6.8	6.2	5.4	5.0
Er-Lu	0.1	0.4	0.2	0.4	0.2	0.5	-	0.1	-	0.4	0.2	-
RE_2O_3	-	58.48	-	-	-	61.69	-	59.7	-	-	-	61.21
La/Nd	1.54	1.65	1.22	2.06	1.64	1.57	1.43	1.52	1.99	1.33	1.56	1.72
ThO_2	-	4.96	-	-	-	4.62	-	-	-	-	-	5.32
U_3O_8	-	-	-	-	-	-	-	-	-	-	-	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	357	358	359	360	361	362	363	364	365	366	367	368
La	26.4	28.6	28.4	29.5	23.0	27.1	28.6	29.2	27.2	17.2	27.4	23.9
Ce	47.4	43.0	43.3	45.0	51.5	46.8	41.0	41.7	46.3	56.8	51.9	52.3
Pr	5.1	7.3	7.2	4.5	4.6	5.3	9.6	8.3	5.8	5.3	-	3.2
Nd	17.6	17.9	18.0	15.5	15.1	15.2	17.4	20.8	16.9	17.7	20.7	15.2
Sm	2.5	1.3	1.3	3.9	2.9	2.3	1.5	-	2.7	1.8	-	2.4
Eu	-	0.2	0.2	-	-	[2]	-	-	[2]	[2]	-	0.1
Gd	1.0	1.6	1.6	1.6	1.6	1.4[2]	1.9	-	1.1[2]	1.2[2]	-	1.5
Tb	-	-	-	-	-	[1]	-	-	[1]	-	-	-
Dy	-	-	-	-	-	0.6	-	-	-	-	-	1.4
Ho	-	-	-	-	1.2	0.3	-	-	-	-	-	-
Er	-	0.1	-	-	-	0.7	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	0.1	0.3	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	-	-	-	-	(5.0)	(2.4)[1]	(1.3)	-	(2.2)[1]	(1.6)	(6.3)	(4.5)
Method	XF	OS	OS	XF	XF	CH	OS	XF	CH	CH	OS	XF
Σ=La+Ce+Pr	78.9	78.9	78.9	79.0	79.1	79.2	79.2	79.2	79.3	79.3	79.3	79.4
La-Nd	96.5	96.8	96.9	94.5	94.2	94.4	96.6	100.0	96.2	97.0	100.00	94.6
Sm-Ho	3.5	3.1	3.1	5.5	5.7	4.6	3.4	-	3.8	3.0	-	5.4
Er-Lu	-	0.1	-	-	0.1	1.0	-	-	-	-	-	-
RE_2O_3	-	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	1.32	1.57
ThO_2	-	-	-	-	-	8.94	-	-	3.00	-	8.2	-
U_3O_8	-	-	-	-	-	-	-	-	-	-	-	-

	369	370	371	372	373	374	375	376	377	378	379	380
La	25.8	25.8	26.1	25.7	29.7	24.2	27.7	31.3	25.4	23.2	23.2	27.8
Ce	49.1	53.6	49.7	50.4	45.9	52.8	47.1	43.2	54.1	51.8	52.9	41.6
Pr	4.5	-	3.7	3.4	3.9	2.5	4.7	5.0	-	4.6	3.5	10.2
Nd	18.0	18.0	12.3	13.0	15.0	15.3	16.8	18.0	20.5	14.8	14.9	16.8
Sm	2.3	2.4	2.6	2.7	1.6	2.5	2.4	1.8	-	2.8	2.5	1.8
Eu	-	-	0.2	-	-	-	-	-	-	-	0.1	[2]
Gd	-	-	1.5	1.5	2.6	1.8	1.3	0.7	-	1.6	1.6	0.9[2]
Tb	-	-	0.4	0.4	0.2	-	-	-	-	-	-	[1]
Dy	0.3	0.2	1.3	1.1	1.1	0.8	-	-	-	1.0	1.3	0.6
Ho	-	-	0.2	0.2	-	-	-	-	-	-	-	0.1
Er	-	-	0.7	0.5	-	-	-	-	-	-	-	0.1
Tm	-	-	0.3	0.3	-	-	-	-	-	-	-	-
Yb	-	-	0.5	0.5	-	0.1	-	-	-	0.2	-	0.1
Lu	-	-	0.5	0.3	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(2.7)	(2.6)	(1.2)	(1.0)	(1.2)	(3.6)	-	-	(8.9)	(5.4)	(3.7	(1.5)[1]
Method	EP	EP	XF	XF	XF	XF	XF	XF	OS	XF	XF	CH
Σ=La+Ce+Pr	79.4	79.4	79.5	79.5	79.5	79.5	79.5	79.5	79.5	79.6	79.6	79.6
La-Nd	97.4	97.4	91.8	92.5	94.5	94.8	96.3	97.5	100.0	94.4	94.5	96.4
Sm-Ho	2.6	2.6	6.2	5.9	5.5	5.1	3.7	2.5	-	5.4	5.5	3.4
Er-Lu	-	-	2.0	1.6	-	0.1	-	-	-	0.2	-	0.2
RE_2O_3	57.65	59.06	48.8	49.4	48.3	-	-	-	-	-	-	58.92
La/Nd	1.43	1.43	2.12	1.98	1.98	1.58	1.65	1.74	1.24	1.57	1.56	1.65
ThO_2	8.04	8.07	-	-	-	-	-	-	12.2	-	-	7.07
U_3O_8	0.64	0.91	-	-	-	-	-	-	-	-	-	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	381	382	383	384	385	386	387	388	389	390	391	392
La	22.9	22.1	25.0	24.0	23.4	26.2	24.0	23.2	26.6	28.3	23.6	24.2
Ce	53.4	53.4	52.4	49.2	51.1	49.0	53.1	53.2	48.8	46.6	53.4	52.3
Pr	3.4	4.2	2.3	6.5	5.2	4.6	2.7	3.4	4.4	4.9	2.9	3.4
Nd	14.8	14.9	15.0	15.5	18.2	14.4	14.8	14.9	15.3	16.0	14.7	14.7
Sm	2.5	1.9	2.5	2.2	1.4	5.1	2.5	2.4	2.6	2.5	2.5	2.4
Eu	0.1	-	-	0.1	[2]	-	0.1	0.1	0.1	-	0.1	0.2
Gd	1.2	1.4	1.8	1.0	0.7[2]	0.7	1.7	1.6	1.5	1.0	1.7	1.5
Tb	-	0.2	-	0.1	[3]	-	-	-	0.1	-	-	-
Dy	1.2	0.6	0.9	0.7	[3]	-	1.0	1.0	0.5	0.7	1.0	1.3
Ho	-	0.2	-	0.1	-	-	-	-	-	-	-	-
Er	0.4	0.2	-	0.3	-	-	-	-	-	-	0.1	-
Tm	-	0.2	-	-	-	-	-	-	0.1	-	-	-
Yb	0.1	0.7	0.1	0.3	-	-	0.1	0.2	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(4.6)	(0.6)	(4.4)	-	(1.1)[3]	(1.6)	(3.9)	(5.5)	-	-	(4.4)	(4.0)
Method	XF	XF	XF	XF	CH	EP	XF	XF	XF	CH	XF	XF
Σ=La+Ce+Pr	79.7	79.7	79.7	79.7	79.7	79.8	79.8	79.8	79.8	79.8	79.9	79.9
La-Nd	94.5	94.6	94.7	95.2	97.9	94.2	94.6	94.7	95.1	95.8	94.6	94.6
Sm-Ho	5.0	4.3	5.2	4.2	2.1	5.8	5.3	5.1	4.8	4.2	5.3	5.4
Er-Lu	0.5	1.1	0.1	0.6	-	-	0.1	0.2	0.1	-	0.1	-
RE_2O_3	-	45.5	-	-	64.6	64.7	-	-	-	67.2	-	-
La/Nd	1.55	1.48	1.67	1.55	1.29	1.82	1.62	1.56	1.74	1.77	1.61	1.65
ThO_2	-	-	-	-	5.6	0.7	-	-	-	1.68	-	-
U_3O_8	-	-	-	-	-	1.3	-	-	-	0.035	-	-
	393	394	395	396	397	398	399	400	401	402	403	404
La	20.4	24.4	23.9	25.4	15.5	26.8	24.5	28.4	23.1	23.5	25.9	24.2
Ce	54.3	53.8	52.8	52.9	42.5	44.1	55.5	46.6	53.8	51.2	49.9	54.0
Pr	5.2	1.8	3.3	1.7	22.0	9.1	-	5.1	3.2	5.4	4.3	2.0
Nd	17.3	14.1	14.6	14.7	15.6	17.2	20.0	14.4	14.5	15.1	17.0	14.1
Sm	2.2	2.6	2.5	2.5	3.0	1.3	-	1.5	2.4	2.2	2.8	2.6
Eu	[2]	-	0.1	0.1	-	-	-	0.1	-	0.1	-	-
Gd	0.6[2]	1.7	1.6	1.8	1.4	1.4	-	-	1.9	1.6	-	1.6
Tb	-	-	-	-	-	-	-	-	-	0.1	-	-
Dy	-	1.4	1.1	0.8	-	-	-	1.4	0.9	0.6	0.1	1.3
Ho	-	-	-	-	-	0.1	-	0.9	-	0.1	-	-
Er	-	0.1	-	-	-	-	-	1.2	0.1	-	-	0.1
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	0.1	0.1	0.1	-	-	-	0.4	0.1	0.1	-	0.1
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(0.9)	(4.2)	(4.6)	(3.3)	(1.2)	-	(0.7)	-	(4.2)	-	(1.9)	(3.9)
Method	CH	XF	XF	XF	CH	OS	OS	OS	XF	XF	EP	XF
Σ=La+Ce+Pr	79.9	80.0	80.0	80.0	80.0	80.0	80.0	80.1	80.1	80.1	80.1	80.2
La-Nd	97.2	94.1	94.6	94.7	95.6	97.2	100.0	94.5	94.6	95.2	97.1	94.3
Sm-Ho	2.8	5.7	5.3	5.2	4.4	2.8	-	3.9	5.2	4.7	2.9	5.5
Er-Lu	-	0.2	0.1	0.1	-	-	-	1.6	0.2	0.1	-	0.2
RE_2O_3	-	-	-	-	-	54.4	-	-	-	-	60.08	-
La/Nd	1.18	1.73	1.64	1.73	0.99	1.56	1.23	1.97	1.59	1.56	1.52	1.72
ThO_2	-	-	-	-	-	-	13.7	0.2	-	-	8.27	-
U_3O_8	-	-	-	-	-	-	-	-	-	-	0.82	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	405	406	407	408	409	410	411	412	413	414	415	416
La	25.0	27.0	28.2	25.3	20.6	24.5	26.6	27.7	26.9	27.1	29.5	27.2
Ce	53.7	44.0	52.0	54.9	53.6	51.5	49.5	52.6	48.0	53.2	46.6	53.2
Pr	1.5	9.2	-	-	6.1	4.3	4.2	-	5.4	-	4.3	-
Nd	14.9	17.2	17.2	19.8	16.7	17.1	17.3	17.4	18.0	19.7	15.5	19.6
Sm	2.4	1.2	2.4	-	2.5	2.5	2.3	2.2	1.0	-	1.6	-
Eu	-	-	-	-	-	-	-	-	0.1	-	-	-
Gd	1.7	1.4	-	-	-	-	-	-	0.6	-	2.5	-
Tb	-	-	-	-	-	-	-	-	-	-	-	-
Dy	0.7	-	0.2	-	0.5	0.1	0.1	0.1	-	-	-	-
Ho	-	-	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	0.1	-	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(3.6)	(1.9)	(2.7)	(6.2)	(3.5)	(2.7)	(1.9)	(1.8)	-	(7.4)	-	(0.6)
Method	XF	OS	EP	OS	EP	EP	EP	EP	XF	OS	XF	OS
Σ=La+Ce+Pr	80.2	80.2	80.2	80.2	80.3	80.3	80.3	80.3	80.3	80.3	80.4	80.4
La-Nd	95.1	97.4	97.4	100.0	97.0	97.4	97.6	97.7	98.	100.0	95.9	100.0
Sm-Ho	4.8	2.6	2.6	-	3.0	2.6	2.4	2.3	1.7	-	4.1	-
Er-Lu	0.1	-	-	-	-	-	-	-	-	-	-	-
RE_2O_3	-	-	58.53	-	-	59.72	57.67	58.85	-	-	-	-
La/Nd	1.68	1.57	1.64	1.28	1.23	1.43	1.54	1.59	1.49	1.38	1.90	1.39
ThO_2	-	-	7.59	9.1	-	8.91	7.35	7.16	-	7.5	-	-
U_3O_8	-	-	-	-	-	-	-	-	-	-	-	-

	417	418	419	420	421	422	423	424	425	426	427	428
La	26.3	29.5	24.9	25.8	22.6	25.8	8.7	23.0	28.1	24.7	25.1	24.6
Ce	49.8	47.1	51.0	50.5	53.9	49.9	65.2	53.5	43.8	53.6	51.5	51.9
Pr	4.4	3.9	4.6	4.2	4.0	4.8	6.7	4.1	8.7	2.4	4.1	4.2
Nd	11.6	14.9	14.9	16.1	16.4	17.0	11.6	16.4	17.1	13.8	16.5	16.5
Sm	2.7	1.1	2.0	2.5	1.9	2.4	4.8	1.9	1.0	2.4	2.5	2.7
Eu	0.1	-	[2]	-	[2]	-	-	[2]	-	-	-	-
Gd	1.5	1.7	1.6[2]	-	1.2[2]	-	3.0	1.0[2]	1.3	2.0	-	-
Tb	0.5	0.2	[1]	-	-	-	-	[3]	-	-	-	-
Dy	1.1	1.2	0.4	0.9	-	0.1	-	[3]	-	1.0	0.3	0.1
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	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(0.9)	(1.2)	(3.9)[1]	(1.9)	(1.1)	(2.2)	(0.15)	(2.8[3])	(1.2)	(4.6)	(3.0)	(1.9)
Method	XF	XF	CH	EP	CH	EP	XF	CH	OS	XF	EP	EP
Σ=La+Ce+Pr	80.5	80.5	80.5	80.5	80.5	80.5	80.6	80.6	80.6	80.7	80.7	80.7
La-Nd	92.1	95.4	95.4	96.6	96.9	97.5	92.2	97.0	97.7	94.5	97.2	97.2
Sm-Ho	6.4	4.4	4.1	3.4	3.1	2.5	7.8	2.9	2.3	5.4	2.8	2.8
Er-Lu	1.5	0.2	0.5	-	-	-	-	-	-	0.1	-	-
RE_2O_3	49.2	48.2	61.76	60.38	56.3	59.71	50.6	53.45	-	-	54.87	60.8
La/Nd	2.27	1.98	1.67	1.60	1.38	1.52	0.75	1.40	1.64	1.79	1.52	1.49
ThO_2	-	-	6.20	7.85	-	9.05	5.77	5.55	-	-	10.89	8.44
U_3O_8	-	-	-	-	-	0.55	-	-	-	-	-	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	429	430	431	432	433	434	435	436	437	438	439	440
La	19.5	25.7	24.3	24.6	28.4	24.9	22.7	26.3	27.7	28.0	23.9	23.7
Ce	55.2	49.9	56.5	51.2	47.8	51.4	52.0	49.2	53.2	44.5	51.2	53.9
Pr	6.1	5.2	-	5.1	4.7	4.6	6.2	5.4	-	8.4	5.9	3.4
Nd	17.0	17.0	19.2	14.0	16.2	16.6	17.2	17.6	19.1	19.1	13.4	14.5
Sm	2.2	2.2	-	1.9	1.9	2.4	1.9	0.9	-	-	2.8	2.3
Eu	-	-	-	0.2	-	-	-	0.1	-	-	[2]	-
Gd	-	-	-	1.0	1.0	-	-	0.5	-	-	1.6[2]	1.0
Tb	-	-	-	-	-	-	-	-	-	-	[1]	-
Dy	-	-	-	1.6	-	0.1	-	-	-	-	1.2	1.1
Ho	-	-	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	0.4	-	-	-	-	-	-	-	0.1
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	-	(5.4)	(9.2)	-	-	(2.4)	-	(0.4)	(6.5)	-	(2.5)[1]	(3.6)
Method	XF	EP	OS	XF	XF	EP	EP	XF	OS	XF	CH	XF
Σ=La+Ce+Pr	80.8	80.8	80.8	80.9	80.9	80.9	80.9	80.9	80.9	80.9	81.0	81.0
La-Nd	97.8	97.8	100.0	94.9	97.1	97.5	98.1	98.5	100.0	100.0	94.4	95.1
Sm-Ho	2.2	2.2	-	4.7	2.9	2.5	1.9	1.5	-	-	5.6	4.4
Er-Lu	-	-	-	0.4	-	-	-	-	-	-	-	0.1
RE_2O_3	-	-	-	-	-	62.46	62.33	69.4	-	-	62.75	-
La/Nd	1.15	1.51	1.27	1.76	1.75	1.50	1.32	1.49	1.45	1.47	1.78	1.63
ThO_2	-	2.45	7.5	-	-	8.71	1.79	-	6.9	-	-	-
U_3O_8	-	-	-	-	-	0.48	-	-	-	-	-	-

	441	442	443	444	445	446	447	448	449	450	451	452
La	24.4	25.7	25.8	26.0	30.0	29.8	24.6	27.0	26.0	26.0	26.7	27.5
Ce	51.6	50.3	50.2	50.0	51.1	45.4	51.8	48.8	50.4	50.6	49.7	53.7
Pr	5.0	5.0	5.0	5.1	-	6.0	4.8	5.4	4.8	4.6	4.8	-
Nd	15.7	16.6	16.6	16.3	18.9	12.0	16.0	16.1	16.2	16.3	17.3	18.8
Sm	2.2	2.4	2.4	2.6	-	2.4	2.5	1.6	1.9	2.4	1.5	-
Eu	-	-	-	-	-	0.6	-	0.3	-	-	-	-
Gd	0.8	-	-	-	-	2.9	-	0.6	0.7	-	-	-
Tb	-	-	-	-	-	-	-	0.1	-	-	-	-
Dy	0.3	-	-	-	-	-	0.3	0.1	-	0.1	-	-
Ho	-	-	-	-	-	0.2	-	-	-	-	-	-
Er	-	-	-	-	-	0.5	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	0.2	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	-	(6.5)	(5.2)	(6.6)	(8.0)	(6.2)	(2.8)	(0.3)	(1.6)	(1.8)	-	(7.5)
Method	-	EP	EP	EP	OS	-	EP	AAS	OS	EP	EP	OS
Σ=La+Ce+Pr	81.0	81.0	81.0	81.1	81.1	81.2	81.2	81.2	81.2	81.2	81.2	81.2
La-Nd	96.7	97.6	97.6	97.4	100.0	93.2	97.2	97.3	97.4	97.5	98.5	100.0
Sm-Ho	3.3	2.4	2.4	2.6	-	6.1	2.8	2.7	2.6	2.5	1.5	-
Er-Lu	-	-	-	-	-	0.7	-	-	-	-	-	-
RE_2O_3	-	-	-	-	-	-	59.55	69.88	-	61.40	68.56	-
La/Nd	1.55	1.55	1.55	1.60	1.59	2.48	1.54	1.68	1.60	1.60	1.54	1.46
ThO_2	-	1.88	2.46	2.42	6.1	2.1	8.45	-	13.0	8.04	1.26	7.0
U_3O_8	-	-	-	-	-	-	0.24	-	-	0.64	-	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	453	454	455	456	457	458	459	460	461	462	463	464
La	28.7	26.4	26.3	22.3	22.8	23.4	30.2	31.5	22.6	22.2	31.3	25.0
Ce	49.0	54.9	49.1	53.4	52.7	52.3	51.3	50.0	47.9	48.3	47.1	52.4
Pr	3.6	-	6.0	5.7	6.0	5.8	-	-	11.1	11.1	3.2	4.2
Nd	14.0	18.7	16.4	16.6	16.2	16.5	18.5	18.5	13.0	13.1	14.6	15.8
Sm	0.9	-	1.5	1.6	1.5	1.0	-	-	2.2	2.3	0.9	2.4
Eu	0.2	-	[2]	0.1	-	0.2	-	-	-	-	0.2	-
Gd	2.2	-	0.7[2]	0.2	0.5	0.5	-	-	2.9	3.0	1.6	-
Tb	0.2	-	[3]	-	-	-	-	-	-	-	0.2	-
Dy	1.2	-	[3]	0.1	0.3	0.3	-	-	-	-	0.9	0.2
Ho	-	-	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	0.3	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(0.7)	(5.7)	(1.0)[3]	-	-	(0.6)	(3.1)	(5.2)	-	(2.5)	(0.9)	(2.2)
Method	XF	OS	CH	XF	XF	-	OS	OS	OS	OS	XF	EP
Σ=La+Ce+Pr	81.3	81.3	81.4	81.4	81.5	81.5	81.5	81.5	81.6	81.6	81.6	81.6
La-Nd	95.3	100.0	97.8	98.0	97.7	98.0	100.0	100.0	94.6	94.7	96.2	97.4
Sm-Ho	4.7	-	2.2	2.0	2.3	2.0	-	-	5.1	5.3	3.8	2.6
Er-Lu	-	-	-	-	-	-	-	-	0.3	-	-	-
RE_2O_3	49.8	-	60.5	54.0	61.0	68.93	-	-	59.8	-	50.4	60.68
La/Nd	2.05	1.41	1.60	1.34	1.41	1.42	1.63	1.70	1.74	1.69	2.14	1.58
ThO_2	-	7.9	1.47	2.39	3.8	-	9.4	5.9	-	-	-	8.13
U_3O_8	-	-	-	0.03	-	-	-	-	-	-	-	2.28
	465	466	467	468	469	470	471	472	473	474	475	476
La	21.4	23.7	27.6	22.9	26.8	29.6	29.8	27.2	26.7	23.2	22.7	27.6
Ce	54.7	53.2	50.8	53.0	50.2	46.3	46.3	50.5	51.0	53.9	53.7	50.3
Pr	5.5	4.8	3.5	6.2	5.1	6.3	6.1	4.6	4.6	5.3	6.0	4.5
Nd	16.0	13.6	13.9	14.5	16.0	13.2	13.7	15.4	15.5	15.0	15.2	15.8
Sm	1.4	2.0	1.9	2.1	1.0	2.0	2.0	2.2	2.1	1.4	1.4	1.8
Eu	[2]	-	-	[2]	0.2	0.5	0.2	-	-	-	-	-
Gd	1.0[2]	0.9	2.3	0.8[2]	-	2.1	1.9	-	-	1.2	0.4	-
Tb	-	0.2	-	[1]	-	-	-	-	-	-	-	-
Dy	-	0.6	-	0.2	0.2	-	-	0.1	0.1	-	0.3	-
Ho	-	-	-	-	-	-	-	-	-	-	-	-
Er	-	0.2	-	0.2	0.3	-	-	-	-	-	0.1	-
Tm	-	0.3	-	-	-	-	-	-	-	-	-	-
Yb	-	0.3	-	0.1	0.2	-	-	-	-	-	0.2	-
Lu	-	0.2	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(1.1)	(0.4)	(1.7)	(4.0)[1]	(2.9)	(1.9)	(1.9)	(2.2)	(2.0)	(1.1)	-	(0.8)
Method	CH	XF	OS	CH	XF	-	-	EP	EP	CH	XF	EP
Σ=La+Ce+Pr	81.6	81.7	81.9	82.1	82.1	82.2	82.2	82.3	82.3	82.4	82.4	82.4
La-Nd	97.6	95.3	95.8	96.6	98.1	95.4	95.9	97.7	97.8	97.4	97.6	98.2
Sm-Ho	2.4	3.7	4.2	3.1	1.4	4.6	4.1	2.3	2.2	2.6	2.1	1.8
Er-Lu	-	1.0	-	0.3	0.5	-	-	-	-	-	0.3	-
RE_2O_3	-	46.2	63.2	63.0	-	-	-	61.44	60.83	56.06	52.7	62.61
La/Nd	1.34	1.74	1.99	1.58	1.68	2.24	2.18	1.77	1.72	1.55	1.49	1.75
ThO_2	-	-	4.6	5.46	-	2.6	1.8	8.45	8.33	-	-	6.42
U_3O_8	-	-	trace	-	-	-	-	0.50	0.58	-	-	0.77

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	477	478	479	480	481	482	483	484	485	486	487	488
La	22.0	21.7	30.7	28.7	27.1	27.9	22.9	28.0	27.0	34.7	23.5	18.2
Ce	57.0	54.7	45.2	50.0	51.4	50.1	49.8	49.8	51.4	38.6	54.8	58.8
Pr	3.5	6.1	6.8	4.0	4.2	4.7	10.1	5.1	4.6	9.7	4.8	6.1
Nd	10.4	15.1	11.9	13.8	14.9	16.4	12.5	15.6	15.3	17.0	13.9	14.8
Sm	1.8	1.2	1.0	1.4	2.2	0.9	2.2	1.5	1.2	-	1.9	1.5
Eu	-	0.4	0.2	-	-	-	-	-	-	-	[2]	[2]
Gd	4.9	0.6	0.2	1.4	-	-	2.3	-	0.5	-	1.1[2]	0.6[2]
Tb	-	-	-	0.4	-	-	-	-	-	-	-	[3]
Dy	0.2	0.2	0.4	0.1	0.2	-	-	-	-	-	-	[3]
Ho	-	-	-	-	-	-	-	-	-	-	-	-
Er	0.2	-	1.8	0.2	-	-	0.2	-	-	-	-	-
Tm	-	-	1.6	-	-	-	-	-	-	-	-	-
Yb	-	-	0.2	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(0.3)	(0.6)	-	(0.6)	(2.3)	-	-	-	(0.3)	-	(1.4)	(3.4)[3]
Method	EP	-	XF	XF	EP	XF	XF	XF	OS	XF	CH	CH
Σ=La+Ce+Pr	82.5	82.5	82.7	82.7	82.7	82.7	82.8	82.9	83.0	83.0	83.1	83.1
La-Nd	92.9	97.6	94.6	96.5	97.6	99.1	95.3	98.5	98.3	100.0	97.0	97.9
Sm-Ho	6.9	2.4	1.8	3.3	2.4	0.9	4.5	1.5	1.7	-	3.0	2.1
Er-Lu	0.2	-	3.6	0.2	-	-	0.2	-	-	-	-	-
RE_2O_3	-	70.11	62.5	52.3	59.55	-	54.7	-	-	-	-	60.05
La/Nd	2.12	1.44	2.58	2.08	1.82	1.70	1.83	1.79	1.76	2.04	1.69	1.23
ThO_2	-	-	-	-	-	7.47	-	-	6.7	-	-	7.95
U_3O_8	-	-	-	-	-	-	-	-	-	-	-	-

	489	490	491	492	493	494	495	496	497	498	499	500
La	20.6	28.6	23.5	27.8	31.2	29.3	26.5	28.3	24.7	27.5	31.21	27.7
Ce	60.3	50.7	55.1	55.5	47.5	50.0	53.5	55.5	53.8	51.3	48.4	56.5
Pr	2.3	4.0	4.7	-	4.8	4.3	3.8	-	5.4	5.2	4.6	-
Nd	5.9	7.9	13.2	16.7	14.9	14.1	14.0	16.2	13.5	15.0	14.2	15.8
Sm	0.8	-	2.5	-	1.6	1.8	1.5	-	1.6	0.6	1.5	-
Eu	0.1	-	[2]	-	-	0.3	[2]	-	[2]	-	-	-
Gd	1.5	-	0.5[2]	-	-	0.2	0.7[2]	-	0.8[2]	0.4	0.1	-
Tb	0.2	-	[1]	-	-	-	[3]	-	0.1	-	-	-
Dy	2.0	5.4	0.3	-	-	-	[3]	-	0.1	-	-	-
Ho	0.2	-	-	-	-	-	-	-	-	-	-	-
Er	0.9	1.7	0.2	-	-	-	-	-	-	-	-	-
Tm	0.1	-	-	-	-	-	-	-	-	-	-	-
Yb	4.7	1.7	-	-	-	-	-	-	-	-	-	-
Lu	0.4	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	-	-	(0.9)[1]	(0.6)	-	-	(2.8)[3]	(0.4)	(2.1)	(0.3)	(0.4)	(0.4)
Method	XF	XF	CH	OS	XF	EP	CH	OS	CH	-	-	OS
Σ=La+Ce+Pr	83.2	83.3	83.3	83.3	83.5	83.6	83.8	83.8	83.9	84.0	84.2	84.2
La-Nd	89.1	91.2	96.5	100.0	98.4	97.7	97.8	100.0	97.4	99.0	98.4	100.0
Sm-Ho	4.8	5.4	3.3	-	1.6	2.3	2.2	-	2.6	1.0	1.6	-
Er-Lu	6.1	3.4	0.2	-	-	-	-	-	-	-	-	-
RE_2O_3	-	-	60.85	-	-	57.45	56.2	-	59.01	69.36	56.63	-
La/Nd	3.49	3.62	1.78	1.66	2.09	2.08	1.89	1.75	1.83	1.83	2.20	1.75
ThO_2	-	-	4.15	8.4	-	-	2.78	8.7	-	0.17	-	9.1
U_3O_8	-	-	-	-	-	-	-	-	-	-	-	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	501	502	503	504	505	506	507	508	509	510	511	512
La	24.1	27.3	26.5	28.2	31.7	33.9	26.6	35.0	32.1	22.9	25.4	31.3
Ce	55.0	53.2	52.9	56.5	48.9	42.5	54.0	47.3	48.7	50.3	55.2	49.8
Pr	5.3	3.9	5.1	-	4.3	8.8	4.8	3.1	4.7	12.6	5.2	4.7
Nd	13.1	13.5	14.3	15.3	14.4	12.1	10.6	11.6	12.8	7.7	12.6	14.2
Sm	1.5	1.8	0.7	-	0.7	1.7	2.6	1.0	0.9	-	0.9	-
Eu	0.1	-	0.1	-	-	0.1	-	-	0.3	2.2	0.2	-
Gd	0.7	-	0.4	-	-	0.8	1.1	0.8	0.4	-	0.4	-
Tb	0.1	-	-	-	-	-	-	0.4	-	2.3	-	-
Dy	0.1	0.3	-	-	-	0.1	0.3	0.6	0.1	-	0.1	-
Ho	-	-	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	0.2	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(2.0)	(3.2)	-	(0.5)	-	(3.2)	(1.5)	(0.3)	(0.5)	(1.4)	-	-
Method	-	EP	-	OS	XF	XF	CH	XF	-	OS	-	XF
Σ=La+Ce+Pr	84.4	84.4	84.5	84.7	84.9	85.2	85.4	85.4	85.5	85.8	85.8	85.8
La-Nd	97.5	97.9	98.8	100.0	99.3	97.3	96.0	97.0	98.3	93.5	98.4	100.0
Sm-Ho	2.5	2.1	1.2	-	0.7	2.7	4.0	2.8	1.7	4.5	1.6	-
Er-Lu	-	-	-	-	-	-	-	0.2	-	-	-	-
RE_2O_3	59.01	48.57	70.84	-	-	68.6	-	54.1	70.99	-	69.66	-
La/Nd	1.84	2.02	1.85	1.84	2.20	2.80	2.51	3.02	2.51	2.97	2.02	2.20
ThO_2	2.42	12.61	0.23	9.4	-	0.11	6.25	-	-	-	-	-
U_3O_8	-	-	-	-	-	-	-	-	-	-	-	-
	513	514	515	516	517	518	519	520	521	522	523	524
La	27.3	21.2	31.3	24.5	27.5	28.1	29.5	30.5	30.5	25.7	32.1	25.1
Ce	53.3	58.4	50.1	55.7	54.4	54.2	53.2	52.1	50.9	56.8	51.2	57.5
Pr	5.4	6.6	5.0	6.4	4.9	4.5	4.3	4.5	5.8	4.7	4.0	5.1
Nd	10.1	10.1	13.6	11.2	11.1	12.1	11.9	9.7	10.3	12.0	11.4	11.1
Sm	-	1.3	-	1.5	1.1	1.1	1.1	1.4	1.4	0.5	1.1	0.9
Eu	-	0.4	-	-	-	-	-	-	-	[2]	-	-
Gd	0.2	0.4	-	0.4	0.3	-	-	1.2	0.8	0.3[2]	0.2	0.2
Tb	-	0.2	-	-	-	-	-	-	-	[3]	-	-
Dy	-	0.6	-	0.3	0.4	-	-	0.4	0.3	[3]	-	0.1
Ho	-	-	-	-	-	-	-	-	-	-	-	-
Er	3.7	-	-	-	0.1	-	-	0.1	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	0.6	-	-	0.2	-	-	0.1	-	-	-	-
Lu	-	0.2	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(0.15)	(0.3)	-	-	-	-	-	(3.6)	(2.7)	(0.4)[3]	-	-
Method	XF	-	XF	-	-	OS	OS	EP	XF	CH	XF	XF
Σ=La+Ce+Pr	86.0	86.2	86.4	86.6	86.8	86.8	87.0	87.1	87.2	87.2	87.3	87.7
La-Nd	96.1	96.3	100.0	97.8	97.9	98.9	98.9	96.8	97.5	99.2	98.7	98.8
Sm-Ho	0.2	2.9	-	2.2	1.8	1.1	1.1	3.0	2.5	0.8	1.3	1.2
Er-Lu	3.7	0.8	-	-	0.3	-	-	0.2	-	-	-	-
RE_2O_3	-	-	-	-	-	62.6	-	-	63.1	-	-	-
La/Nd	2.70	2.10	2.30	2.19	2.48	2.32	2.48	3.14	2.96	2.14	2.82	2.26
ThO_2	-	-	-	-	-	0.2	2.8	-	4.5	-	-	-
U_3O_8	-	-	-	-	-	-	0.003	-	-	-	-	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	525	526	527	528	529	530	531	532	533	534	535	536
La	24.9	27.3	39.3	35.6	40.2	35.2	38.9	40.3	37.0	40.8	36.8	29.1
Ce	58.5	56.8	45.0	49.4	44.4	50.0	46.1	44.4	48.5	43.9	48.6	56.8
Pr	4.7	4.1	4.0	3.4	3.9	3.3	3.6	3.9	3.1	4.1	3.5	3.1
Nd	10.7	10.3	10.7	11.0	9.6	11.1	9.6	9.6	9.9	10.2	10.3	8.2
Sm	0.8	0.8	1.0	0.6	0.7	0.4	-	0.5	1.0	1.0	0.6	1.0
Eu	[2]	-	-	-	0.1	-	0.4	0.1	-	-	0.1	0.1
Gd	0.4[2]	0.3	-	-	0.6	-	1.4	0.6	0.1	-	-	0.7
Tb	[3]	-	-	-	0.1	-	-	0.1	-	-	-	0.1
Dy	[3]	0.3	-	-	0.3	-	-	0.4	0.3	-	-	0.5
Ho	-	-	-	-	-	-	-	-	0.1	-	-	-
Er	-	0.1	-	-	-	-	-	-	-	-	0.1	0.2
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	0.1	-	-	0.1	-	-	-	0.2
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(5.6)[3]	-	-	(0.3)	(0.9)	-	(1.1)	(0.9)	-	(2.0)	(0.1)	(4.3)
Method	CH	-	-	EP	-	-	-	-	EP	OS	OS	XF
Σ=La+Ce+Pr	88.1	88.2	88.3	88.4	88.5	88.5	88.6	88.6	88.6	88.8	88.9	89.0
La-Nd	98.8	98.5	99.0	99.4	98.1	99.6	98.2	98.	98.5	99.0	99.2	97.2
Sm-Ho	1.2	1.4	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	-	-	0.1	0.4
RE_2O_3	-	-	-	62.92	65.20	-	-	9.2	59.24	-	68.1	-
La/Nd	2.33	2.65	3.67	3.24	4.19	3.17	4.05	4.2	3.74	4.00	3.57	3.55
ThO_2	-	-	-	3.23	-	-	1.8	-	11.6	-	0.08	-
U_3O_8	-	-	-	-	-	-	-	-	0.4	-	-	-
	537	538	539	540	541	542	543	544	545	546	547	548
La	34.7	25.8	35.5	37.6	24.3	29.7	39.5	39.4	32.8	35.2	35.3	44.9
Ce	51.0	61.1	49.4	45.2	59.9	55.0	46.4	46.3	52.6	50.8	50.9	44.9
Pr	3.3	2.2	4.2	6.3	5.0	4.5	3.4	3.8	4.2	3.7	3.5	-
Nd	9.8	9.2	9.6	10.9	8.1	9.8	9.9	8.5	9.5	8.9	9.8	10.2
Sm	0.9	1.2	1.1	-	1.1	0.4	0.8	-	0.4	0.6	0.5	-
Eu	-	[2]	-	-	-	-	-	0.6	-	0.3	-	-
Gd	0.3	0.5[2]	0.2	-	0.6	0.4	-	1.3	0.4	0.5	-	-
Tb	-	[3]	-	-	-	-	-	-	-	-	-	-
Dy	-	[3]	-	-	0.3	0.2	-	-	0.1	-	-	-
Ho	-	-	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	0.4	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	0.3	-	-	0.1	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	-	(0.8)[3]	(0.7)	-	(1.6)	(0.3)	-	(1.7)	(0.2)	(0.2)	-	(2.0)
Method	EP	CH	-	XF	CH	-	XF	-	-	-	XF	OS
Σ=La+Ce+Pr	89.0	89.1	89.1	89.1	89.2	89.2	89.3	89.5	89.6	89.7	89.7	89.8
La-Nd	98.8	98.3	98.7	100.0	97.3	99.0	99.2	98.0	99.1	98.6	99.5	100.0
Sm-Ho	1.2	1.7	1.3	-	2.0	1.0	0.8	1.9	0.9	1.4	0.5	-
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	3.60	4.40
ThO_2	-	5.07	-	-	3.1	-	-	-	0.29	-	3.0	-
U_3O_8	-	-	-	-	-	-	-	-	-	-	-	-

Table 2. Monazite-(Ce) from igneous and metamorphic rocks—Continued.

	549	550	551	552	553	554	555	556	557
La	21.9	37.8	36.9	36.8	37.7	39.5	33.2	37.9	38.4
Ce	65.0	48.7	49.4	49.1	48.9	47.2	53.1	49.5	48.9
Pr	3.0	3.5	3.7	4.2	3.5	3.5	3.9	3.1	3.6
Nd	9.0	9.2	9.6	9.4	9.4	8.5	9.1	9.0	8.4
Sm	0.7	0.8	0.2	0.5	0.5	0.7	0.4	0.5	0.2
Eu	-	-	-	-	-	0.2	-	-	-
Gd	0.4	-	-	-	-	0.3	0.2	-	0.4
Tb	-	-	-	-	-	-	-	-	-
Dy	-	-	0.2	-	-	0.1	0.1	-	0.1
Ho	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	-	-	(1.3)	-	-	(0.5)	-	-	(0.2)
Method	XF	-	EP	XF	XF	-	-	XF	-
Σ=La+Ce+Pr	89.9	90.0	90.0	90.1	90.1	90.2	90.2	90.5	90.9
La-Nd	98.9	99.2	99.6	99.5	99.5	98.7	99.3	99.5	99.3
Sm-Ho	1.1	0.8	0.4	0.5	0.5	1.3	0.7	0.5	0.7
Er-Lu	-	-	-	-	-	-	-	-	-
RE_2O_3	-	-	-	-	-	-	-	-	69.95
La/Nd	2.43	4.11	3.84	3.91	4.01	4.65	3.65	4.21	4.57
ThO_2	-	-	-	-	-	-	-	-	0.40
U_3O_8	-	-	-	-	-	-	-	-	-

	558	559	560	561	562	563	564	565
La	35.4	33.2	32.4	37.4	30.8	35.6	39.1	40.4
Ce	52.2	54.4	56.0	50.1	58.2	50.2	50.8	47.0
Pr	3.4	3.4	2.7	3.8	2.6	5.9	2.0	4.7
Nd	8.2	8.5	8.5	8.7	8.0	7.3	6.6	6.6
Sm	0.5	0.3	0.1	-	0.1	0.7	0.2	-
Eu	-	-	-	-	-	-	-	-
Gd	-	0.1	0.3	-	0.3	0.3	0.5	1.3
Tb	-	-	-	-	-	-	-	-
Dy	0.3	0.1	-	-	-	-	0.3	-
Ho	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	0.3	-
Tm	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	0.2	-
Lu	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(0.6)	-	-	-	-	-	-	(4.1)
Method	EP	XF	XF	XF	XF	CH	XF	EP
Σ=La+Ce+Pr	91.0	91.0	91.1	91.3	91.6	91.7	91.9	92.1
La-Nd	99.2	99.5	99.6	100.0	99.6	99.0	98.5	98.7
Sm-Ho	0.8	0.5	0.4	-	0.4	1.0	1.0	1.3
Er-Lu	-	-	-	-	-	-	0.5	-
RE_2O_3	-	-	-	-	-	70.3	-	35.24
La/Nd	4.32	3.91	3.81	4.30	3.85	4.88	5.92	6.12
ThO_2	-	-	-	0.7	-	-	-	11.34
U_3O_8	-	-	-	-	-	-	-	15.64

[1]Tb+Y calculated as Y.
[2]Eu+Gd calculated as Gd.
[3]Tb+Dy+Y calculated as Y.

Table 3. Monazite-(Ce) from placers.
[Atomic percent except RE_2O_3, ThO_2 , and U_3O_8, which are in weight percent]

	1	2	3	4	5	6	7	8	9	10	11a	11b
La	12.7	16.4	19.1	19.2	16.6	28.0	20.0	19.5	18.3	17.8	20.4	25.5
Ce	41.3	41.5	37.1	40.2	40.3	29.3	37.9	41.7	41.1	44.5	42.8	45.7
Pr	5.1	4.7	7.3	4.9	8.0	7.6	7.4	4.5	8.1	5.7	4.8	4.9
Nd	32.7	24.8	28.7	14.2	24.0	28.2	24.7	26.1	23.5	17.8	22.2	17.2
Sm	7.4	7.2	6.9	-	3.3	4.7	5.7	6.3	3.3	-	5.8	2.9
Eu	-	-	-	-	-	-	-	-	-	-	-	-
Gd	-	5.4	-	-	7.8	-	3.1	1.9	5.7	-	4.0	3.8
Tb	-	-	-	[1]	-	-	-	-	-	[1]	-	-
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	-	-
100Y/(Y+Ln)	(2.5)	(5.4)	(6.7)	(2.7)[1]	(6.8)	(11.3)	-	(3.5)	(4.9)	(3.2)[1]	(3.5)	(3.5)
Method	EP	OS	EP	CH	OS	EP	XF	OS	OS	CH	XF	XF
Σ=La+Ce+Pr	59.1	62.6	63.5	64.3	64.9	64.9	65.3	65.7	67.5	68.0	68.0	76.1
La-Nd	91.8	87.4	92.2	78.5	88.9	93.1	90.0	91.8	91.0	85.8	90.2	93.3
Sm-Ho	8.2	12.6	7.8	8.2	11.1	6.9	9.2	8.2	9.0	5.3	9.8	6.7
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	0.92	1.48
ThO_2	6.6	6.49	9.2	1.14	-	5.9	0.67	6.67	-	1.01	-	-
U_3O_8	-	0.50	-	0.41	-	-	-	0.40	-	0.41	-	-
	11c	11d	11e	11f	12	13	14	15	16	17	18	19
La	26.7	27.7	28.3	28.8	17.9	16.2	18.2	16.8	19.0	20.5	17.0	20.3
Ce	48.5	48.9	49.7	50.3	45.2	44.2	44.6	47.0	45.2	41.1	43.9	43.5
Pr	4.5	4.8	4.3	4.7	5.1	8.0	5.6	5.0	4.6	7.4	8.3	5.6
Nd	15.0	13.1	12.7	11.9	25.2	23.2	24.0	24.5	24.9	22.0	22.6	21.6
Sm	2.0	2.4	1.9	1.5	5.9	2.8	6.4	5.9	5.0	3.3	3.1	5.4
Eu	-	-	-	-	-	-	-	-	-	-	-	-
Gd	3.3	3.1	3.1	2.8	-	5.6	-	-	-	5.7	4.1	2.0
Tb	-	-	-	-	-	-	-	-	-	-	-	-
Dy	-	-	-	-	0.7	-	1.2	0.8	1.3	-	-	1.6
Ho	-	-	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(1.6)	(1.2)	(1.1)	-	(3.6)	(4.1)	(4.1)	(4.8)	(8.3)	(5.6)	(5.4)	(5.9)
Method	XF	XF	XF	XF	EP	OS	EP	EP	EP	OS	OS	OS
Σ=La+Ce+Pr	79.7	81.4	82.3	83.8	68.2	68.4	68.4	68.8	68.8	69.0	69.2	69.4
La-Nd	94.7	94.5	95.0	95.7	93.4	91.6	92.4	93.3	93.7	91.0	91.8	91.0
Sm-Ho	5.3	5.5	5.0	4.3	6.6	8.4	7.6	6.7	6.3	9.0	7.2	9.0
Er-Lu	-	-	-	-	-	-	-	-	-	-	-	-
RE_2O_3	-		-		-		-		-	-	-	50.0
La/Nd	1.78	2.11	2.23	2.42	0.71	0.70	0.76	0.69	0.76	0.93	0.75	0.94
ThO_2	-	-	1.01	-	8.2	-	-	7.4	6.4	-	-	6.09
U_3O_8	-	-	-	-	-	-	-	-	-	-	-	5.43

Table 3. Monazite-(Ce) from placers—Continued.

	20	21	22	23	24	25	26	27	28	29	30	31
La	17.3	15.7	15.3	18.5	12.4	19.4	19.0	15.4	16.5	20.0	17.2	19.6
Ce	46.8	49.3	48.7	45.9	55.2	45.8	43.9	48.9	48.7	43.9	47.0	44.7
Pr	5.3	4.5	5.5	5.2	2.0	4.5	6.8	5.7	4.8	6.1	5.9	5.8
Nd	24.6	22.8	23.7	17.9	17.9	24.7	25.7	22.8	24.4	24.6	23.0	25.0
Sm	4.6	6.6	5.9	4.8	9.6	3.7	4.3	6.0	4.3	4.0	6.0	3.6
Eu	-	-	-	0.2	1.0	-	-	-	-	-	-	-
Gd	-	-	-	6.2	1.8	-	-	-	-	-	-	-
Tb	-	-	-	0.2	-	-	-	-	-	-	-	-
Dy	1.4	1.1	0.9	0.8	0.1	1.9	0.3	1.2	1.3	1.4	0.9	1.3
Ho	-	-	-	0.1	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	0.2	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(7.0)	(1.0)	(0.5)	(4.6)	(1.3)	(9.6)	(3.3)	(2.2)	(4.5)	(7.6)	(5.6)	(6.7)
Method	EP	EP	EP	-	XF	EP	EP	EP	EP	EP	EP	EP
Σ=La+Ce+Pr	69.4	69.5	69.5	69.6	69.6	69.7	69.7	70.0	70.0	70.0	70.1	70.1
La-Nd	94.0	92.3	93.2	87.5	87.5	94.4	95.4	92.8	94.4	94.6	93.1	95.1
Sm-Ho	6.0	7.7	6.8	12.3	12.5	5.6	4.6	7.2	5.6	5.4	6.9	4.9
Er-Lu	-	-	-	0.2	-	-	-	-	-	-	-	-
RE_2O_3	-	-	-	-	-	-	-	-	-	-	-	-
La/Nd	0.70	0.69	0.65	1.03	0.69	0.79	0.74	0.68	0.68	0.81	0.75	0.78
ThO_2	14.4	5.7	7.3	-	-	10.3	5.5	7.8	6.3	13.4	11.0	10.7
U_3O_8	-	-	-	-	-	-	-	-	-	-	-	-

	32	33	34	35	36	37	38	39	40	41	42	43
La	17.6	21.3	21.4	21.4	18.1	22.2	17.7	15.4	19.0	17.9	20.3	17.0
Ce	47.8	43.5	45.1	45.4	48.2	43.2	48.9	48.1	47.9	48.9	45.9	49.5
Pr	4.9	5.7	4.6	4.5	5.0	5.9	4.9	8.1	4.7	4.8	5.6	5.5
Nd	24.2	22.9	21.2	21.5	22.5	23.9	22.9	16.6	23.2	23.8	23.2	21.3
Sm	4.6	5.2	4.6	5.3	4.4	4.1	4.6	8.0	4.1	3.7	4.4	6.0
Eu	-	-	-	-	-	-	-	-	-	-	-	-
Gd	-	-	3.1	2.0	-	-	-	3.8	-	-	-	-
Tb	-	-	-	-	-	-	-	-	-	-	-	-
Dy	0.9	1.4	-	-	1.8	0.7	1.0	-	1.1	0.9	0.6	0.7
Ho	-	-	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(4.1)	(3.6)	(4.6)	(3.5)	(6.2)	(4.2)	(4.3)	(6.2)	(4.7)	(3.9)	(4.1)	(0.9)
Method	EP	EP	OS	OS	EP	EP	EP	CH	EP	EP	EP	EP
Σ=La+Ce+Pr	70.3	70.5	71.1	71.3	71.3	71.3	71.5	71.6	71.6	71.6	71.8	72.0
La-Nd	94.5	93.4	92.3	92.8	93.8	95.2	94.4	88.2	94.8	95.4	95.0	93.3
Sm-Ho	5.5	6.6	7.7	7.2	6.2	4.8	5.6	11.8	5.2	4.6	5.0	6.7
Er-Lu	-	-	-	-	-	-	-	-	-	-	-	-
RE_2O_3	-	-	60.5	60.5	-	-	-	63.35	-	-	-	-
La/Nd	0.73	0.93	1.01	1.00	0.81	0.93	0.77	0.93	0.82	0.75	0.88	0.80
ThO_2	8.8	10.9	6.33	6.09	13.15	11.2	16.39	2.85	11.2	11.2	5.4	12.3
U_3O_8	-	-	0.41	5.43	-	-	-	-	-	-	-	-

Table 3. Monazite-(Ce) from placers—Continued.

	44	45	46	47	48	49	50	51	52	53	54	55
La	20.3	17.4	19.4	19.3	17.5	19.6	17.6	22.9	18.9	19.9	20.6	21.0
Ce	45.5	49.8	48.1	48.7	50.2	48.5	50.6	45.4	49.5	46.4	46.3	46.8
Pr	6.2	4.8	4.6	4.4	4.8	4.4	4.5	4.6	4.5	6.7	6.3	5.5
Nd	22.1	23.0	23.9	22.9	19.9	23.7	22.4	20.9	23.7	23.2	21.2	18.4
Sm	5.2	4.2	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	0.7	0.8	0.9	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	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(3.9)	(2.8)	(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	EP	EP	OS	EP	EP	EP	-
Σ=La+Ce+Pr	72.0	72.0	72.1	72.4	72.5	72.5	72.7	72.9	72.9	73.0	73.2	73.3
La-Nd	94.1	95.0	96.0	95.3	92.4	96.2	95.1	93.8	96.6	96.2	94.4	91.7
Sm-Ho	5.9	5.0	4.0	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	0.92	0.75	0.82	0.84	0.88	0.83	0.79	1.10	0.80	0.86	0.97	1.14
ThO_2	4.3	6.8	9.45	9.2	6.4	10.8	8.0	7.0	4.5	5.5	0.55	-
U_3O_8	-	-	-	-	-	-	-	0.32	-	-	-	-

	56	57	58	59	60	61	62	63	64	65	66	67
La	18.8	19.9	23.4	18.9	20.6	21.6	19.0	17.6	17.3	27.6	20.4	23.9
Ce	49.4	48.0	45.4	48.6	48.1	47.0	48.7	51.2	51.8	39.9	48.3	45.4
Pr	5.1	5.4	4.6	5.9	4.9	5.0	5.9	4.8	4.5	6.2	5.0	4.5
Nd	21.4	22.1	20.4	22.3	20.8	21.9	22.1	22.2	23.0	14.9	23.6	20.4
Sm	4.6	-	4.2	4.3	5.1	3.6	3.6	3.4	2.8	4.7	2.2	3.4
Eu	-	-	-	-	-	-	-	-	-	-	-	0.9
Gd	-	-	2.0	-	-	-	-	-	-	3.4	-	1.5
Tb	-	-	-	-	-	-	-	-	-	-	-	-
Dy	0.7	4.6	-	-	0.5	0.9	0.7	0.8	0.6	3.3	0.5	-
Ho	-	-	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(2.7)	(7.6)	(4.3)	-	(2.1)	(2.77)	(3.9)	(3.5)	(2.9)	(13.3)	(1.0)	(2.5)
Method	EP	EP	OS	XF	EP	EP	EP	EP	EP	OS	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	73.7	73.8
La-Nd	94.7	95.4	93.8	95.7	94.4	95.5	95.7	95.8	96.6	88.6	97.3	94.2
Sm-Ho	5.3	4.6	6.2	4.3	5.6	4.5	4.3	4.2	3.4	11.4	2.7	5.8
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	0.86	1.17
ThO_2	0.95	2.3	7.07	-	9.2	9.2	7.3	9.7	7.8	-	13.5	2.00
U_3O_8	-	-	0.07	-	-	-	-	-	-	-	-	-

Table 3. Monazite-(Ce) from placers—Continued.

	68	69	70	71	72	73	74	75	76	77	78	79
La	21.6	18.1	19.7	23.6	23.4	22.9	24.1	20.9	19.5	23.5	18.3	22.8
Ce	47.6	51.2	49.0	46.3	46.0	46.0	45.4	48.1	50.0	44.2	50.6	45.3
Pr	4.6	4.5	5.1	4.0	4.6	5.1	4.5	5.0	4.6	6.5	5.3	6.1
Nd	21.2	21.2	21.9	22.0	20.6	20.8	21.1	22.1	21.6	21.8	22.2	22.5
Sm	3.4	3.8	3.6	3.2	3.4	3.4	3.4	3.2	2.9	3.6	3.1	3.0
Eu	-	-	-	-	-	0.2	0.2	-	-	-	-	-
Gd	1.6	-	-	-	2.0	1.6	1.5	-	-	-	-	-
Tb	-	-	-	-	-	-	-	-	-	-	-	-
Dy	-	1.2	0.7	0.9	-	-	-	0.7	1.4	0.4	0.3	0.3
Ho	-	-	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(4.4)	(6..4)	(2.4)	(5.6)	(4.2)	(3.3)	(3.0)	(3.3)	(6.4)	(3.0)	(1.2)	(7.3)
Method	OS	EP	EP	EP	OS	OS	OS	EP	EP	EP	EP	EP
Σ=La+Ce+Pr	73.8	73.8	73.8	73.9	74.0	74.0	74.0	74.0	74.1	74.2	74.2	74.2
La-Nd	95.0	95.0	95.7	95.9	94.6	94.8	95.1	96.1	95.7	96.0	96.4	96.7
Sm-Ho	5.0	5.0	4.3	4.1	5.4	5.2	4.9	3.9	4.3	4.0	3.4	3.3
Er-Lu	-	-	-	-	-	-	-	-	-	-	-	-
RE_2O_3	-	-	-	-	-	-	-	-	-	-	-	-
La/Nd	1.02	0.85	0.90	1.07	1.14	1.10	1.14	0.95	0.90	1.08	0.82	1.01
ThO_2	-	8.8	7.15	8.4	-	6.24	-	4.2	6.9	8.2	8.8	9.1
U_3O_8	-	-	-	-	-	-	-	-	-	-	-	-

	80	81	82	83	84	85	86	87	88	89	90	91
La	20.3	23.5	18.9	21.6	18.4	19.9	19.2	20.9	19.3	24.4	19.6	18.9
Ce	48.7	45.9	50.0	47.5	49.5	51.3	50.8	48.6	50.7	45.8	50.5	51.7
Pr	5.3	4.9	5.5	5.4	6.6	3.3	4.5	5.1	4.6	4.5	4.6	4.3
Nd	21.6	21.9	19.6	21.4	21.6	21.9	22.0	21.9	22.1	21.0	21.9	20.9
Sm	3.2	3.3	4.5	2.2	3.2	2.7	2.6	2.8	2.8	3.4	2.9	3.3
Eu	-	-	-	-	-	-	-	-	-	0.2	-	-
Gd	-	-	-	-	-	-	-	-	-	0.7	-	-
Tb	-	-	-	-	-	-	-	-	-	-	-	-
Dy	0.9	0.5	1.5	0.9	0.7	0.9	0.9	0.7	0.5	-	0.5	0.9
Ho	-	-	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(4.5)	(1.0)	(8.4)	(6.0)	(5.7)	(8.8)	(0.9)	(3.8)	(1.6)	(3.3)	(3.9)	(4.8)
Method	EP	EP	EP	EP	EP	EP	EP	EP	EP	OS	EP	EP
Σ=La+Ce+Pr	74.3	74.3	74.4	74.5	74.5	74.5	74.5	74.6	74.6	74.7	74.7	74.9
La-Nd	95.9	96.2	94.0	95.9	96.1	96.4	96.5	96.5	96.7	95.7	96.6	95.8
Sm-Ho	4.1	3.8	6.0	4.1	3.9	3.6	3.5	3.5	3.3	4.3	3.4	4.2
Er-Lu	-	-	-	-	-	-	-	-	-	-	-	-
RE_2O_3	-	-	-	-	-	-	-	-	-	58.3	-	-
La/Nd	0.94	1.07	0.96	1.01	0.85	0.91	0.87	0.95	0.87	1.16	0.89	0.90
ThO_2	10.1	7.2	15.6	9.7	5.9	9.7	5.0	7.8	11.5	7.5	8.2	5.4
U_3O_8	-	-	-	-	-	-	-	-	-	0.3	-	-

Table 3. Monazite-(Ce) from placers—Continued.

	92	93	94	95	96	97	98	99	100	101	102	103
La	23.0	20.4	20.1	21.7	20.5	23.4	21.2	23.6	22.1	23.7	22.8	22.1
Ce	46.7	49.5	49.7	47.4	49.8	46.3	49.4	47.2	47.8	47.1	46.9	48.7
Pr	5.3	5.1	5.2	5.9	4.8	5.5	4.6	4.5	5.4	4.6	5.7	4.6
Nd	18.8	21.5	21.67	21.7	20.5	19.7	21.0	20.6	20.7	19.6	20.6	21.5
Sm	3.1	2.9	2.7	3.0	3.5	3.8	2.7	3.4	3.2	3.4	3.1	2.6
Eu	0.1	-	-	-	-	-	-	-	-	-	-	-
Gd	1.8	-	-	-	-	-	-	0.7	-	1.6	0.9	-
Tb	0.2	-	-	-	-	-	-	-	-	-	-	-
Dy	0.7	0.6	0.7	0.3	0.9	1.3	1.1	-	0.8	-	-	0.5
Ho	0.1	-	-	-	-	-	-	-	-	-	-	-
Er	0.2	-	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(3.0)	(3.2)	(3.7)	(3.7)	(5.0)	-	(4.0)	(3.3)	(3.7)	(3.1)	(0.7)	(1.4)
Method	-	EP	EP	EP	EP	-	EP	OS	EP	OS	OS	EP
Σ=La+Ce+Pr	75.0	75.0	75.0	75.0	75.1	75.2	75.2	75.3	75.3	75.4	75.4	75.4
La-Nd	93.8	96.5	96.6	96.7	95.6	94.9	96.2	95.9	96.0	95.0	96.0	96.9
Sm-Ho	6.0	3.5	3.4	3.3	4.4	5.1	3.8	4.1	4.0	5.0	4.0	3.1
Er-Lu	0.2	-	-	-	-	-	-	-	-	-	-	-
RE_2O_3	-	-	-	-	-	-	-	62.6	-	61.45	-	-
La/Nd	1.22	0.95	0.93	1.00	1.00	1.19	1.01	1.15	1.07	1.21	1.11	1.03
ThO_2	-	7.9	9.3	6.0	9.8	-	8.2	4.44	8.6	4.91	12.4	11.6
U_3O_8	-	-	-	-	-	-	-	0.23	-	0.26	-	-
	104	105	106	107	108	109	110	111	112	113	114	115
La	26.0	21.6	26.7	20.8	19.7	18.1	22.4	22.1	24.9	24.4	22.7	21.2
Ce	44.3	48.5	44.5	49.2	50.9	52.7	48.1	49.6	45.9	47.7	49.4	49.9
Pr	5.2	5.4	4.5	5.8	5.2	5.0	5.4	4.3	5.5	4.3	4.3	5.4
Nd	19.2	20.9	19.2	19.9	20.5	20.7	20.3	19.0	18.4	16.0	17.9	19.2
Sm	2.8	3.0	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	1.7	-	1.5	1.0	-	-	-	-	-	1.9	1.7	-
Tb	0.1	-	-	-	-	-	-	-	-	0.1	0.2	-
Dy	0.7	0.6	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	-	-
100Y/(Y+Ln)	(2.4)	(2.6)	-	(2.4)	(5.0)	(1.2)	(1.7)	(4.5)	-	(4.4)	(3.4)	(3.2)
Method	CH	EP	XF	-	EP	EP	EP	EP	OS	-	XF	EP
Σ=La+Ce+Pr	75.5	75.5	75.7	75.8	75.8	75.8	75.9	76.0	76.3	76.4	76.4	76.5
La-Nd	94.7	96.4	94.9	95.7	96.3	96.5	96.2	95.0	94.7	92.4	94.3	95.7
Sm-Ho	5.3	3.6	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	1.35	1.03	1.39	1.05	0.96	0.87	1.10	1.16	1.35	1.53	1.27	1.10
ThO_2	-	9.7	-	3.85	11.0	6.8	3.1	10.5	10.3	-	7.4	4.6
U_3O_8	-	-	-	-	-	-	-	-	-	-	-	-

Table 3. Monazite-(Ce) from placers—Continued.

	116	117	118	119	120	121	122	123	124	125	126	127
La	25.8	23.7	19.8	20.0	25.2	21.5	23.7	21.3	19.6	21.2	23.1	27.1
Ce	45.1	47.1	52.4	50.7	46.6	49.2	47.7	51.8	52.9	49.7	49.4	45.6
Pr	5.6	5.2	4.4	6.0	4.9	6.0	5.4	3.7	4.4	6.2	4.8	4.7
Nd	19.3	19.6	20.5	18.9	19.1	19.3	18.0	19.6	20.2	17.8	18.2	17.8
Sm	3.5	3.1	2.3	2.4	3.0	3.3	3.5	2.0	2.4	4.0	2.5	3.8
Eu	-	-	-	0.2	-	-	-	0.1	-	-	0.2	-
Gd	-	1.3	-	1.0	1.2	-	-	1.2	-	-	1.4	-
Tb	-	-	-	-	-	-	-	-	-	-	0.1	-
Dy	-	-	0.6	0.6	-	0.7	-	0.3	0.5	1.1	0.3	1.0
Ho	0.7	-	-	-	-	-	1.7	-	-	-	-	-
Er	-	-	-	0.2	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(2.9)	(2.3)	(1.6)	(3.0)	(4.8)	(3.8)	(12.2)	-	(2.2)	(9.8)	(2.2)	(4.4)
Method	OS	OS	EP	-	OS	EP	OS	XF	EP	EP	XF	OS
Σ=La+Ce+Pr	76.5	76.0	76.6	76.7	76.7	76.7	76.8	76.8	76.9	77.1	77.3	77.4
La-Nd	95.8	95.6	97.1	95.6	95.8	96.0	94.8	96.4	97.1	94.9	95.5	95.2
Sm-Ho	4.2	4.4	2.9	4.2	4.2	4.0	5.2	3.6	2.9	5.1	4.5	4.8
Er-Lu	-	-	-	0.2	-	-	-	-	-	-	-	-
RE_2O_3	-	-	-	51.31	-	-	-	62.37	-	-	58.8	-
La/Nd	1.34	1.21	0.97	1.07	1.32	1.11	1.32	1.09	0.97	1.19	1.27	1.52
ThO_2	7.35	11.0	7.5	2.85	7.2	4.2	6.2	6.06	5.6	12.1	6.4	5.20
U_3O_8	-	-	-	-	-	-	-	-	-	-	-	-

	128	129	130	131	132	133	134	135	136	137	138	139
La	25.0	20.4	24.4	27.5	24.7	22.7	23.7	26.5	26.9	24.1	19.2	24.7
Ce	47.9	53.3	49.2	45.9	49.5	52.1	50.6	47.4	49.4	50.6	56.0	50.9
Pr	5.2	4.4	4.7	5.0	4.3	3.9	4.5	4.9	4.4	4.3	4.3	4.2
Nd	17.6	18.8	17.3	17.4	19.5	18.1	17.3	18.0	16.6	16.6	18.1	15.9
Sm	2.5	2.4	2.3	4.2	1.8	2.4	2.3	2.5	2.4	2.5	1.8	2.2
Eu	-	-	0.3	-	-	-	-	-	-	0.3	-	0.3
Gd	1.4	-	1.3	-	-	-	1.1	0.7	0.3	1.1	-	1.3
Tb	-	-	0.1	-	-	-	0.1	-	-	0.1	-	0.1
Dy	0.1	0.7	0.3	-	0.2	0.8	0.3	-	-	0.3	0.6	0.3
Ho	-	-	-	-	-	-	-	-	-	-	-	-
Er	0.2	-	0.1	-	-	-	0.1	-	-	0.1	-	0.1
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	0.1	-	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(3.5)	(3.3)	(2.5)	-	(2.1)	(3.0)	(1.5)	(2.6)	(2.2)	(2.2)	(0.7)	(2.2)
Method	-	EP	XF	OS	EP	EP	XF	OS	XF	XF	EP	XF
Σ=La+Ce+Pr	78.1	78.1	78.3	78.4	78.5	78.7	78.8	78.8	80.7	79.0	79.5	79.8
La-Nd	95.7	96.9	95.6	95.8	98.0	96.8	96.1	96.8	97.3	95.6	97.6	95.7
Sm-Ho	4.0	3.1	4.3	4.2	2.0	3.2	3.8	3.2	2.7	4.3	2.4	4.2
Er-Lu	0.3	-	0.1	-	-	-	0.1	-	-	0.1	-	0.1
RE_2O_3	-	-	63.42	-	-	-	58.64	-	-	58.77	-	58.22
La/Nd	1.42	1.09	1.41	1.58	1.27	1.25	1.37	1.47	1.62	1.45	1.06	1.55
ThO_2	-	6.8	7.0	-	9.2	4.7	6.5	12.2	-	6.6	3.6	7.3
U_3O_8	-	-	-	6.1	-	-	-	-	-	-	-	-

Table 3. Monazite-(Ce) from placers—Continued.

	140	141	142	143	144	145	146	147	148	149	150	151
La	22.9	25.6	24.5	18.5	25.9	27.2	20.1	22.2	20.1	26.4	24.4	30.1
Ce	52.5	50.2	51.1	55.3	50.0	49.7	53.9	51.3	56.9	51.7	56.0	52.4
Pr	4.5	4.3	4.5	6.5	4.7	3.8	6.8	7.4	4.4	4.2	5.3	3.9
Nd	16.3	15.6	16.1	15.8	16.7	12.4	12.2	16.0	15.8	14.6	13.7	12.1
Sm	3.3	2.3	2.1	3.6	1.6	1.2	5.1	2.5	2.5	1.8	0.6	0.9
Eu	-	0.2	0.1	-	-	0.1	-	-	-	-	-	0.1
Gd	-	1.3	0.9	-	1.0	5.5	-	-	-	0.8	-	0.3
Tb	-	0.1	0.1	-	-	-	-	-	-	0.1	-	0.1
Dy	0.5	0.3	0.5	0.3	-	0.1	1.9	0.6	0.3	0.3	-	-
Ho	-	-	-	-	-	-	-	-	-	-	-	-
Er	-	0.1	0.1	-	0.1	-	-	-	-	0.1	-	0.1
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(4.7)	(2.5)	(1.5)	(4.6)	(0.9)	(0.9)	(5.2)	(3.2)	(0.8)	(1.7)	-	(0.5)
Method	EP	XF	XF	EP	OS	XF	EP	EP	EP	XF	EP	XF
Σ=La+Ce+Pr	79.9	80.1	80.1	80.3	80.6	80.7	80.8	80.9	81.4	82.3	85.7	86.4
La-Nd	96.2	95.7	96.2	96.1	97.3	93.1	93.0	96.9	97.2	96.9	99.4	98.5
Sm-Ho	3.8	4.2	3.7	3.9	2.6	6.9	7.0	3.1	2.8	3.0	0.6	1.4
Er-Lu	-	0.1	0.1	-	0.1	-	-	-	-	0.1	-	0.1
RE_2O_3	-	58.03	58.60	-	-	62.51	-	-	-	58.24	68.90	61.86
La/Nd	1.40	1.64	1.52	1.17	1.55	2.19	1.65	1.39	1.27	1.81	1.78	2.49
ThO_2	11.4	7.9	8.4	3.3	8.1	7.5	11.7	6.3	5.75	8.1	1.28	6.6
U_3O_8	-	-	-	-	0.3	-	-	-	-	-	-	-

[1]Tb+Y calculated as Y.

Table 4. Dark monazite-(Ce).
[Atomic percent except RE_2O_3, ThO_2, and U_3O_8, which are in weight percent]

	1	2	3	4	5	6	7	8	9	10	11	12
La	10.5	11.4	18.5	14.0	15.3	16.4	15.7	19.6	15.8	17.8	18.2	17.9
Ce	40.2	41.4	33.3	42.9	44.0	43.8	44.4	42.3	44.4	44.2	44.5	44.0
Pr	6.4	6.8	9.1	6.1	6.1	5.5	6.0	4.2	6.0	5.7	5.2	7.4
Nd	32..0	28.5	25.5	28.4	25.5	23.6	24.9	25.6	25.1	25.9	25.7	24.5
Sm	7.6	6.5	5.4	6.0	5.2	5.0	5.3	5.1	5.1	4.5	3.7	3.1
Eu	0.9	1.2	1.7	0.7	0.9	0.8	0.9	1.0	0.9	0.6	0.6	0.6
Gd	2.4	3.8	6.1	1.9	3.0	4.9	2.8	1.5	2.7	1.3	2.1	1.9
Tb	-	-	-	-	-	-	-	0.2	-	-	-	-
Dy	-	0.4	0.4	-	-	-	-	0.3	-	-	-	0.3
Ho	-	-	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	0.2	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	0.3
Yb	-	-	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(1.3)	(1.4)	-	(1.3)	(2.5)	(1.0)	(2.5)	(0.6)	(2.6)	(1.2)	(1.2)	(1.6)
Method	OS	XF	OS	OS	XF	XF	XF	XF	XF	OS	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	67.9	69.3
La-Nd	89.1	88.1	86.4	91.4	90.9	89.3	91.0	91.7	91.3	93.6	93.6	93.8
Sm-Ho	10.9	11.9	13.6	8.6	9.1	10.7	9.0	8.1	8.7	6.4	6.4	5.9
Er-Lu	-	-	-	-	-	-	-	0.2	-	-	-	0.3
RE_2O_3	70.70	67.45	55.70	72.72	-	-	-	66.32	-	67.55	61.4	52.75
La/Nd	0.33	0.40	0.73	0.49	0.60	0.69	0.63	0.77	0.63	0.69	0.71	0.73
ThO_2	0.75	0.32	0.001	0.35	-	-	-	0.54	-	1.0	0.53	0.66
U_3O_8	-	-	-	-	-	-	-	-	-	-	-	-

	13	14	15	16	17	18	19	20	21	22	23	24
La	19.8	21.3	17.9	20.3	21.2	23.3	19.9	19.5	19.6	20.5	23.0	20.3
Ce	44.9	44.1	47.9	44.7	44.8	43.0	46.7	46.5	46.6	46.2	43.5	46.2
Pr	5.7	5.2	5.0	5.9	5.3	5.1	4.8	5.6	5.4	5.0	5.4	5.5
Nd	24.7	24.3	23.9	23.9	23.2	22.6	22.8	23.5	23.5	23.4	22.2	22.1
Sm	2.8	3.1	3.1	3.4	3.6	3.4	2.9	3.2	3.1	3.0	3.3	3.4
Eu	0.5	0.4	0.3	0.5	0.5	0.6	0.4	0.5	0.4	0.4	0.5	0.6
Gd	1.6	1.6	1.5	1.3	1.4	2.0	1.5	1.2	1.4	1.5	2.1	1.9
Tb	-	-	-	-	-	-	-	-	-	-	-	-
Dy	-	-	0.4	-	-	-	-	-	-	-	-	-
Ho	-	-	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	-	-	-	-	-	-	-	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(1.1)	(1.4)	(4.6)	(1.2)	(1.2)	(1.5)	(1.4)	(0.8)	(0.8)	(1.35)	(3.5)	(1.4)
Method	OS	OS	XF	OS	OS	OS	OS	OS	OS	OS	OS	OS
Σ=La+Ce+Pr	70.4	70.6	70.8	70.9	71.3	71.4	71.4	71.6	71.6	71.7	71.9	72.0
La-Nd	95.1	94.9	94.7	94.8	94.5	94.0	94.2	95.1	95.1	95.1	94.1	94.1
Sm-Ho	4.9	5.1	5.3	5.2	5.5	6.0	4.8	4.9	4.9	4.9	5.9	5.9
Er-Lu	-	-	-	-	-	-	-	-	-	-	-	-
RE_2O_3	71.8	55.08	56.4	69.95	71.96	60.99	55.56	65.02	64.90	54.57	49.8	60.07
La/Nd	0.80	0.88	0.75	0.85	0.91	1.03	0.87	0.83	0.83	0.88	1.04	0.92
ThO_2	0.70	0.59	-	0.65	0.68	3.2	0.58	0.60	1.02	0.59	0.57	0.5
U_3O_8	-	-	-	-	-	-	-		-	-	-	-

Table 4. Dark monazite-(Ce)—Continued.

	25	26	27	28	29	30	31	32	33	34	35	36
La	19.7	19.8	17.6	24.7	22.0	21.4	21.6	22.0	21.7	21.9	17.2	22.0
Ce	47.1	47.5	48.9	42.4	45.5	46.1	46.4	46.2	46.9	48.8	51.4	47.5
Pr	5.6	5.5	6.4	5.8	5.5	5.5	5.3	5.2	5.5	3.4	5.7	4.9
Nd	20.3	21.6	21.1	19.9	22.1	22.5	21.8	21.8	20.5	20.6	18.6	21.3
Sm	3.5	3.2	2.9	4.7	2.7	2.7	3.2	2.9	3.4	2.7	4.2	2.6
Eu	0.6	0.6	0.5	0.1	0.4	0.4	0.4	0.5	0.5	0.8	0.3	0.4
Gd	2.0	1.8	2.2	2.4	1.8	1.4	1.3	1.4	1.5	1.1	2.1	1.3
Tb	0.2	-	-	-	-	-	-	-	-	0.2	0.1	-
Dy	0.7	-	0.4	-	-	-	-	-	-	0.3	0.4	-
Ho	0.1	-	-	-	-	-	-	-	-	-	-	-
Er	0.2	-	-	-	-	-	-	-	-	0.2	-	-
Tm	-	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(1.7)	(1.2)	(1.4)	(5.6)	(1.0)	(1.3)	(1.1)	(1.1)	(1.2)	(0.8)	(1.7)	(1.3)
Method	-	OS	-	OS	OS	OS	OS	OS	OS	XF	-	OS
Σ=La+Ce+Pr	72.4	72.8	72.9	72.9	73.0	73.0	73.3	73.4	74.1	74.1	74.3	74.4
La-Nd	92.7	94.4	94.0	92.8	95.1	95.5	95.1	95.2	94.6	94.7	92.9	95.7
Sm-Ho	7.1	5.6	6.0	7.2	4.9	4.5	4.9	4.8	5.4	5.1	7.1	4.3
Er-Lu	0.2	-	-	-	-	-	-	-	-	0.2	-	-
RE_2O_3	-	61.47	46.36	65.21	70.69	56.85	58.70	63.21	62.26	66.82	-	50.82
La/Nd	0.97	0.92	0.83	1.24	1.00	0.95	0.99	1.01	1.06	1.06	0.92	1.03
ThO_2	-	0.5	0.06	9.6	0.70	0.82	0.70	0.83	0.70	0.53	-	0.58
U_3O_8	-	-	-	-	-		-	-	-	-	-	-

	37	38	39	40	41	42	43	44	45	46	47
La	17.3	23.6	23.9	21.1	24.3	22.1	25.3	29.1	31.7	26.3	21.3
Ce	51.6	46.1	47.5	49.2	47.7	52.4	50.2	48.1	48.3	57.9	63.5
Pr	5.7	5.4	4.9	6.3	5.0	4.1	4.5	4.8	2.9	2.6	7.0
Nd	18.8	19.3	19.9	18.6	20.1	17.7	16.3	17.0	13.8	2.8	-
Sm	4.2	3.1	2.2	2.0	2.3	1.4	2.2	0.8	1.6	3.8	5.2
Eu	0.3	0.5	0.4	0.5	0.6	0.7	0.4	0.2	0.3	0.3	0.4
Gd	2.1	1.5	1.2	2.0	-	1.3	1.1	-	0.9	4.6	2.6
Tb	-	0.2	-	-	-	0.1	-	-	0.1	0.1	-
Dy	-	0.3	-	0.2	-	-	-	-	0.3	1.5	-
Ho	-	-	-	-	-	-	-	-	-	-	-
Er	-	-	-	0.1	-	0.2	-	-	0.1	0.1	-
Tm	-	-	-	-	-	-	-	-	-	-	-
Yb	-	-	-	-	-	-	-	-	-	-	-
Lu	-	-	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(1.6)	(1.7)	(1.2)	(0.5)	(1.3)	(0.7)	(0.8)	-	(1.9)	(1.7)	(2.0)
Method	OS	CH	-	XF	OS	XF	OS	-	XF	-	-
Σ=La+Ce+Pr	74.6	75.1	76.3	76.6	77.0	78.6	80.0	82.0	82.9	86.8	91.8
La-Nd	93.4	94.4	96.2	95.2	97.1	96.3	96.3	99.0	96.7	89.6	91.8
Sm-Ho	6.6	5.6	3.8	4.7	2.9	3.5	3.7	1.0	3.2	10.3	8.2
Er-Lu	-	-	-	0.1	-	0.2	-	-	0.1	0.1	-
RE_2O_3	44.74	-	56.85	68.45	59.32	62.46	60.04	69.88	66.09	-	-
La/Nd	0.92	1.22	1.20	1.13	1.21	1.25	1.55	1.71	2.30	9.39	-
ThO_2	1.3	-	0.78	0.66	0.78	1.40	-	-	0.36	0.06	1.3
U_3O_8	-	-	-		-	-	-	-	-	-	-

Table 5. Monazite-(La), monazite-(Nd), and gasparite-(Ce).
[Atomic percent except RE_2O_3, ThO_2, and U_3O_8, which are in weight percent. Entries 1–3 are monazite-(La), entries 4–8 are monazite-(Nd), and entry 9 is gasparite-(Ce)]

	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	-	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(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	-	-	-	0.12	-	-	-	-	1.95
U_3O_8	-	-	-	-	-	-	-	-	-

Table 6. Cheralite.
[Atomic percent except RE_2O_3, ThO_2, and U_3O_8, which are in weight percent]

	1	2	3	4
La	19.5	18.3	20.3	20.7
Ce	45.1	48.1	48.2	50.7
Pr	4.4	5.9	5.9	5.6
Nd	21.5	22.9	19.9	17.7
Sm	6.3	4.8	4.1	3.8
Eu	0.9	-	-	-
Gd	1.5	-	1.3	1.2
Tb	0.2	-	0.1	0.1
Dy	0.2	-	0.2	0.2
Ho	-	-	-	-
Er	-	-	-	-
Tm	0.4	-	-	-
Yb	-	-	-	-
Lu	-	-	-	-
100Y/(Y+Ln)	(0.4)	-	(0.6)	(0.7)
Method	EP	XF	ICP	ICP
Σ=La+Ce+Pr	69.0	72.3	74.4	77.0
La-Nd	90.5	95.2	94.3	94.7
Sm-Ho	9.1	4.8	5.7	5.3
Er-Lu	0.4	-	-	-
RE_2O_3	27.25	-	38.2	31.9
La/Nd	0.91	0.80	1.02	1.17
ThO_2	31.64	-	27.5	25.7
U_3O_8	4.33	-	2.05	6.24

Table 7. Huttonite.
[Atomic percent except RE_2O_3, ThO_2 , and U_3O_8, SiO_2, and P_2O_5, which are in weight 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	-	-	-	-	-	-
100Y/(Y+Ln)	(40.2)	-	-	-	-	-	-
Method	OS	EP	EP	XF	EP	EP	EP
Σ=La+Ce+Pr	0	70.3	71.1	72.9	79.5	80.4	91.0
La-Nd	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	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	17.2	13.5	10.4	10.05	11.1	12.8	8.1
P_2O_5	0.7	7.1	8.9	10.00	10.5	7.4	11.2

Table 8. Average compositions of monazite-(Ce).

[Atomic percent except RE_2O_3, ThO_2, and U_3O_8, which are in weight percent. Entries A–E are from table 2: A, average of 117 analyses for granitic pegmatite; B, average of 187 analyses for granite, granodiorite, and quartz monzonite; C, average of 44 analyses for gneiss; D, average of 13 analyses for alkalic rocks and alkalic pegmatite; E, average of 25 analyses for carbonatite. Entry F is average of 47 analyses for dark monazites (table 5). Entry G is average of 151 analyses for placers (table 4). Note : The averages for rare-earth element compositions do not include data from analyses in which La, Ce, Pr, or Nd was not determined; however, determinations of 100Y/(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 entry A, the average of 1.18 percent becomes 0.40 percent if the highest determination (15.64 percent) is omitted; the average for entry G of 1.16 percent becomes 0.33 percent if the two highest determinations (5.43, 6.1 percent) are omitted]

	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	15.2	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)
Number of determinations	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	-
Number of determinations	17	79	20	-	-	38	-
ThO_2	9.0	6.3	6.0	-	2.1	0.9	7.9
Number of determinations	80	71	3	-	8	37	130
U_3O_8	1.18	0.62	-	-	-	-	1.16
Number of determinations	20	18	-	-	-	-	13

Table 9. Previously published average compositions of monazite.

[Atomic percent. Entry 1 (Fleischer and Altschuler, 1969), 104 granitic pegmatites. Entries 2–5 (Lyakhovich and Balanova, 1971): entry 2, 5 granitic pegmatites; entry 3, 19 granites of palingenic intrusions; entry 4, 14 metasomatic granites; entry 5, 22 gneisses and migmatites. Entries 6–7 (Fleischer and Altschuler, 1969): entry 6, 123 granites, granodiorites, and quartz monzonites; entry 7, 23 alkalic rocks and carbonatites. Entry 8 (Mineev, 1963), average for all monazites]

	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	0.40	0.1
Tm	-	-	0.3	-	-	-	-	
Yb	0.1	0.8	-	-	-	-	0.2	0.1
Lu	-	-	-	-	-	-	-	-
100Y/(Y+Ln)	(4.9)	-	-	-	-	(3.6)	(0.7)	-
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
La/Nd	1.03	1.07	1.15	1.17	1.16	1.31	2.79	1.27

Table 10. Sources of data for monazites given in tables 2–7.

Sample no.	Reference (author and date)		Locality	Source
			TABLE 2	
1	Shukolyukov and others	1979	Alakurtti, northern Karelia, U.S.S.R.	
2	Shukolyukov and others	1979	Northern Karelia, U.S.S.R.	
3	Shukolyukov and others	1979	Chkalov, northern Karelia, U.S.S.R.	
4	Zhirov and others	1961	Alakurtti, northern Karelia, U.S.S.R.	Granite pegmatite.
5	Shukolyukov and others	1979	Chkalov, northern Karelia, U.S.S.R.	
6	Heinrich and others	1960	Brown Derby mine, Gunnison County, Colorado	Granite pegmatite.
7	Mittelfehldt and Miller	1983	Sweetwater pluton, California	Pegmatite.
8	Andersen	1986	Fen district, Norway	Carbonatite.
9	Kalita	1961	Kapraovo, Karelia, U.S.S.R.	Granite pegmatite.
10	Heinrich and others	1960	Brown Derby mine, Gunnison County, Colorado	Granite pegmatite
11	Rapp and Watson	1986	Raade, Norway	Pegmatite.
12	Heinrich and others	1960	Brown Derby mine, Gunnison County, Colorado	Pegmatite.
13	Shukolyukov and others	1979	Chernaya Salma, Karelia, U.S.S.R.	
14	Murata and others	1957	Jamestown, Colorado	Aplite-pegmatite zone.
15	Zhang and Tao	1986	Bayan Obo, China	Aegirine-type ore.
16	Ivantishin and others	1964	Ukrainian shield	Granite.
17	McCarty	1935	New Mexico.	
18	Kalita	1961	Kaita, Karelia, U.S.S.R.	Granite pegmatite.
19	Vainshtein and others	1956b	Karelia, U.S.S.R.	Granite pegmatite.
20	Kornetova and Kazakova	1982	Siberia, U.S.S.R.	Pegmatite.
21	Kalita	1961	Alakurtti, Karelia, U.S.S.R.	Granite pegmatite.
22	Kalita	1969	Northwestern Karelia, U.S.S.R.	Granite pegmatite.
23	Ivantishin and others	1964	Ukrainian shield	Granite gneiss.
24	Semenov and Khomyakov	1981	Northern Karelia, U.S.S.R.	
25	Kalita	1969	Eastern Baltic shield	Granite pegmatite.
26	Quoted by Vlasov	1964	Chernaya Salma, Karelia, U.S.S.R.	Granite pegmatite.
27	Sahama and Vahatalo	1941	Luikohlahti, Karelia, U.S.S.R.	Granite pegmatite.

Table 10. Sources of data for monazites given in tables 2–7—Continued.

Sample no.	Reference (author and date)		Locality	Source
			TABLE 2—Continued	
28	Kornetova and Osolodkina	1966	Siberia, U.S.S.R.	Granite pegmatite.
29	Leonova and Nikitin	1962	Karelia, U.S.S.R.	Granite pegmatite.
30	Vainshtein and others	1956b	Chernaya Salma, Karelia, U.S.S.R.	Pegmatite.
31	Hugo	1970	Styr Kraal, South Africa.	Granite pegmatite.
32	Shukolyukov and others	1979	Temryuk, Karelia, U.S.S.R.	
33	Kalita	1961	Neblogera, Karelia, U.S.S.R.	Granite pegmatite.
34	Zhirov and others	1961	Northern Karelia, U.S.S.R.	Granite pegmatite.
35	Zayats and Kuts	1964	Dniepr region, Ukraine	Biotite gneiss.
36	Murata and others	1957	Grans, Sao Paulo, Brazil	Granite pegmatite; inner part of crystal 37.
37	Murata and others	1957	Grans, Sao Paulo, Brazil	Granite pegmatite; outer part of crystal 36.
38	Ivantishin and others	1964	Ukraine	Granite pegmatite.
39	Kalita	1961	Nuoleinnieme, Karelia, U.S.S.R.	Granite pegmatite.
40	Sahama and Vahatalo	1939	Impilahti, Karelia, U.S.S.R.	
41	Shukolyukov and others	1979	Given, Karelia, U.S.S.R.	
42	Vainshtein and others	1955	Karelia, U.S.S.R.	Pegmatite.
43	Murata and others	1953	Crabtree Creek, North Carolina.	Pegmatite.
44	Lee and Bastron	1967	Mt. Wheeler area, Nevada	Granodiorite-quartz monzonite.
45	Vainshtein and others	1956b	Mozambique	Pegmatite.
46	Ivantishin and others	1964	Ukrainian shield	Granite pegmatite.
47	Ivantishin and others	1964	Kirovgrad-Zhitomir	Granite.
48	Zayats and Kuts	1964	Gnilopyat River basin, Ukraine	Archean garnet-biotite gneiss.
49	Semenov	1963	Southern Asia	Spodumene pegmatite.
50	Khomyakov	1964	Western Tannu-Ola, U.S.S.R.	Calcite vein.
51	McCarty	1935	Not known.	
52	McCarty	1935	Cleveland County, North Carolina.	
53	Shukolyukov and others	1979	Glukhovets, U.S.S.R.	
54	Hugo	1970	Debares, South Africa.	Granite pegmatite.
55	Lee and Bastron	1967	Mt. Wheeler area, Nevada	Granodiorite-quartz monzonite.
56	Lee and Bastron	1967	Mt. Wheeler area, Nevada	Granodiorite-quartz monzonite.
57	Orsa and others	1967	Ukraine	Garnet-muscovite pegmatite.
58	Heinrich and others	1960	Petaca, New Mexico	Granite pegmatite.
59	Zayats and Kuts	1964	Ukraine	Archean biotite gneiss.
60	McCarty	1935	McDowell County, North Carolina.	
61	Vainshtein and others	1955	Brazil.	
62	Lee and Bastron	1967	Mt. Wheeler area, Nevada	Granodiorite-quartz monzonite.
63	Ivantishin and others	1964	Ukraine	Pegmatitic granite.
64	Ivantishin and others	1964	Ukraine	Gneiss.
65	Shukolyukov and others	1979	Not known.	
66	Quoted by Vlasov	1964	Mongolia	Alkali hydrothermalite
67	Mannucci and others	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 and others	1956b	Hittero, Norway.	
71	Zhirov and others	1961	Impilahti, Karelia, U.S.S.R.	Granite pegmatite.
72	Zhang and Tao	1986	Bayan Obo, China	Main ore.
73	Zayats and Kuts	1964	Gnilopat River basin, Ukraine	Archean biotite gneiss.
74	Fujii	1961	Fukushima Prefecture, Japan.	
75	Zhirov and others	1961	Kupchinit, Karelia	Granite pegmatite.
76	Zhirov and others	1961	Popernaloke, Karelia	Granite pegmatite.
77	Zhang and Tao	1986	Bayan Obo, China	East ore, dolomite.
78	Zhirov and others	1961	Tedino, Karelia, U.S.S.R.	Granite pegmatite.
79	Murata and others	1953	Petaca, New Mexico	Granite pegmatite.
80	Shmakin and Shiryayeva	1970	Gutero, Biryasin area, Siberia, U.S.S.R.	Pegmatite.
81	Vainshtein and others	1956b	Kurumkan, eastern Siberia, U.S.S.R.	Cordierite gneiss.
82	Ivantishin and others	1964	Ukraine	Gneiss.
83	Vainshtein and others	1956b	Pysstinoc, Siberia, U.S.S.R.	Quartzite.

Table 10. Sources of data for monazites given in tables 2–7—Continued.

Sample no.	Reference (author and date)		Locality	Source
			TABLE 2—Continued	
84	Heinrich and others	1960	Chaffee County, Colorado	Granite pegmatite.
85	Murata and others	1958	Gramma, Sao Paulo, Brazil	Granite pegmatite.
86	Sahama and Vahatalo	1941	Turku, Finland	Granit.e
87	Lee and Bastron	1967	Mt. Wheeler area, Nevada	Granodiorite-quartz monzonite.
88	Heinrich and others	1960	Petaca, New Mexico	Granite pegmatite.
89	Pluhar	1979	Takua Pa, southern Thailand	Granite pegmatite.
90	Lee and Bastron	1967	Mt. Wheeler area, Nevada	Granodiorite-quartz monzonite.
91	Vainshtein and others	1956b	Zhezholev, Ukraine.	
92	McCarty	1935	Arendel, Norway.	
93	Shukolyukov and others	1979	Eki Varaki, northern Karelia, U.S.S.R.	
94	Ivantishin and others	1964	Chudnov-Berdichevskii, Ukraine	Granite.
95	Murata and others	1958	Pemba, Minas Gerais, Brazil	Granite pegmatite.
96	Lee and Bastron	1967	Mt. Wheeler area, Nevada	Granodiorite-quartz monzonite.
97	Konetova	1963	Siberia, U.S.S.R.	Granite pegmatite.
98	Ivantishin and others	1964	Ukraine	Gneiss.
99	Amli	1975	Troland, Norway	Granite pegmatite.
100	Vainshtein and others	1956b	Arendal, Norway	Pegmatite.
101	Murata and others	1953	Amelia, Virginia	Granite pegmatite.
102	Heinrich and others	1960	Pecos, New Mexico	Granite pegmatite.
103	Zayats and Kuts	1964	Gnilopyat River basin, Ukraine	Garnet-biotite gneiss.
104	Murata and others	1958	Ferros, Minas Gerais, Brazil	Granite pegmatite.
105	Ivantishin and others	1964	Kirovgrad-Zhitomir, Ukraine	Granite.
106	Shukolyukov and others	1979	Nova Pavlova, Karelia, U.S.S.R.	
107	Vainshtein and others	1956b	Gnilopyat River, Ukraine	Pegmatite.
108	Lyakhovich	1962	Eastern Sayan	Granite.
109	Leonova and Nikitin	1962	Chkalov, Karelia	Granite pegmatite.
110	Vainshtein and others	1956b	Zhalzhosk, Ukraine	Gneissic granite.
111	Heinrich and others	1960	Chaffee County, Colorado	Granite pegmatite.
112	Bernstein	1982	North Carolina	Quartz vein in slate.
113	Quoted by Vlasov	1964	European S.S.R.	Alkali granite.
114	Ivantishin and others	1964	Kirovgrad-Zhitomir, Ukraine	Granite.
115	Murata and others	1958	Minas Gerais, Brazil	Granite pegmatite.
116	Leonova and Nikitin	1962	Chkalov, Karelia, U.S.S.R	Granite pegmatite.
117	Shmakin and Shiryayeva	1970	Moma, Siberia, U.S.S.R.	Pegmatit.e
118	Kalita	1969	Eastern Baltic shield, U.S.S.R.	Granite pegmatite.
119	Heinrich and others	1960	Petaca, New Mexico	Granite pegmatite.
120	Kostin and Volzhenkova	1965	Not stated	Quartz-oligoclase vein in gabbro.
121	Murata and others	1953	Portland, Connecticut	Granite pegmatite.
122	Zhirov and others	1961	Tedina, Karelia, U.S.S.R.	Granite pegmatite.
123	Heinrich and others	1960	Park County, Colorado	Granite pegmatite.
124	Marchenko	1967	Southeast Ukraine	Biotite gneiss.
125	Heinrich and others	1960	Park County, Colorado	Granite pegmatite.
126	Wylie	1950	Normanville district, Australia	Pegmatite.
127	Lyakhovich	1962	Talitsk massif, Gornyi Altai	Biotite granite.
128	Vainshtein and others	1956b	Arendal, Norway.	
129	Lyakhovich and Barinskii	1961	Kurokhol massif, western Tuva	Granite.
130	Fishman and others	1968	Sol'ner massif, Polar Urals	Granite.
131	Lee and Bastron	1967	Mt. Wheeler area, Nevada	Granodiorite-quartz monzonite.
132	Heinrich and others	1960	Petaca, New Mexico	Granite pegmatite.
133	Heinrich and others	1960	Petaca, New Mexico	Granite pegmatite.
134	Zhang and Tao	1986	East ore, Bayan Obo, China.	
135	Vainshtein and others	1956b	Tedino, Karelia, U.S.S.R.	
136	Pavlenko and others	1959	Uzuntaig massif, eastern Tuva	Granosyenite.
137	Fishman and others	1968	Source of the Bolshaya Pobk River, U.S.S.R.	
138	Hugo	1970	Kroma Puts, South Africa	Pegmatitic granodiorite.
139	Kucha	1980	Bogatyne area, Lower Silesia, Poland.	
140	Murata and others	1958	Sao Bento, Rio Grande do Norte, Brazil	Granite pegmatite.

Table 10. Sources of data for monazites given in tables 2–7—Continued.

Sample no.	Reference (author and date)		Locality	Source
			TABLE 2—Continued	
141	Lee and Bastron	1967	Mt. Wheeler area, Nevada	Granodiorite-quartz monzonite.
142	Komov and others	1974	Polar Urals	Hydrothermal quartz vein.
143	Murata and others	1953	Hollis, North Carolina	Quartz monzonite pegmatite.
144	Komov and others	1974	Pamirs, Siberia, U.S.S.R.	Albitized quartzite.
145	Vainshtein and others	1956b	Kiev district, Ukraine	Kaolinized granite.
146	Bukanov and Shvetsova	1966	Near-Polar Urals	Quartz vein.
147	Vainshtein and others	1956a	Borshchevoch Ridge, Transbaikal	(average of 10).
148	Zayats and Kuts	1964	Pobozhe, 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	Southeast Ukraine	Biotite-garnet gneiss.
153	Shukolyukov and others	1979	Not given.	
154	Komov and others	1974	Polar Urals	Quartz vein (same as 146?).
155	Graeser and Schwander	1987	Italy	Pegmatite vein in gneiss.
156	Povilaitis and Varshal	1969	Kuu massif, Kazakstan	Metasomatic feldspar rock.
157	Ivantishin and others	1964	Ukraine	Gneiss.
158	Haapala and others	1969	Puumala, Finland	Biotite vein in Precambrian granite.
159	Zhirov and others	1961	Chkalov, Karelia, U.S.S.R.	Granite pegmatite.
160	Bukanov and Shvetsova	1966	Near-Polar Urals	Quartz vein.
161	Choong	1971	Malaysia	(average of 5).
162	Ivantishin and others	1964	Ukraine	Kirovgrad-Zhitomir granite.
163	Ivantishin and others	1964	Ukraine	Gneiss.
164	Pavlenko and others	1959	Ilektag massif, eastern Tuva	Biotite granite.
165	Shmakin and Shiryayeva	1970	Gutaro-Biryagin area, Siberia, U.S.S.R.	Pegmatite.
166	Znamenskii and others	1967	Myakulski River, eastern Sayan	Two-mica granite.
167	Lee and Bastron	1967	Mt. Wheeler area, Nevada	Granodiorite-quartz monzonite.
168	Mineev	1963	Tarbagatay, Kazakhstan	Exocontact metasomatite.
169	Mineev	1963	Tarbagatay, Kazakhstan	Exocontact metasomatite.
170	Murata and others	1958	Uba, Minas Gerais, Brazil	Granite pegmatite.
171	Bearth	1934	Perdatech, Switzerland	Alpine cleft.
172	Bel'kov	1979	Kola Peninsula, U.S.S.R.	Leucocratic granite.
173	Lee and Bastron	1967	Mt. Wheeler area, Nevada	Granodiorite-quartz monzonite.
174	Lee and Bastron	1967	Mt. Wheeler area, Nevada	Granodiorite-quartz monzonite.
175	Vainshtein and others	1956b	Azov region, U.S.S.R.	Pegmatite.
176	Ivantishin and others	1964	Chudnov-Berdichevskii, 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-monzonite.
181	Kovalenko and others	1971	Buge-Gaziyan, Mongolia	Microclinite.
182	Vainshtein and others	1956b	Temryuk, Azov region, U.S.S.R.	
183	Mannucci and others	1986	Val Vigezzo, Italy	Pegmatite.
184	Leonova and Nikitin	1962	Perti Vokera, Karelia, U.S.S.R.	Granite pegmatite.
185	Kapustin	1986	Novopoltov 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 monzonite.
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 monzonite.
192	Kirillov and Ryzhova	1968	Karelia, U.S.S.R.	Sulfatian carbonatite.
193	Murata and others	1958	Nazarene, Minas Gerais, Brazil	Granite pegmatite.
194	L'vov and Zhangurov	1968	Borisovskii massif, Urals	Pegmatite.
195	Vainshtein and others	1956b	Hittero, Norway	Pegmatite.
196	Znamenskii and others	1967	Tickhaya River, eastern Sayan	Biotite granite.

Table 10. Sources of data for monazites given in tables 2–7—Continued.

Sample no.	Reference (author and date)		Locality	Source
			TABLE 2—Continued	
197	Ivantishin and others	1964	Ukraine	Gneiss.
198	Kuts	1966	Azov region, U.S.S.R.	Xenolith in granite.
199	Marchenko	1967	Southeast Ukraine	Garnet-biotite pegmatite.
200	Vainshtein and others	1956b	Yuzhakova, Ukraine	Granite.
201	Vainshtein and others	1956b	Torgevitsy, Ukraine	Granite
202	Lyakhovich	1962	East Sayan	Granite
203	Pavlenko and others	1959	Milzei massif, eastern Tuva	Alaskite.
204	Kuts	1966	Belmichaya, Azov region, U.S.S.R.	
205	White and Nelen	1987	Foote mine, North Carolina	Pegmatite.
206	Mittelfehldt and Miller	1983	Sweetwater Washington pluton, California	Granite.
207a	Murata and others	1958	Juiz de Fera, Minas Gerais, Brazil	Granite pegmatite, outer part of crystal.
207b	Murata and others	1958	Juiz de Fera, Minas Gerais, Brazil	Inner part of crystal.
208	Bel'kov	1979	Kola Peninsula, U.S.S.R.	Metasomatic granite.
209	Znamenskii and others	1967	Eastern Sayan	Biotite granite.
210	Znamenskii and others	1967	Eastern Sayan	Biotite granite.
211	Vainshtein and others	1956b	Kalchik River, Ukraine	Pegmatite.
212	Murata and others	1958	Juiz de Fera, Minas Gerais, Brazil	Granite pegmatite.
213	Vainshtein and others	1956b	Temryuk, Azov region, U.S.S.R.	Pegmatite.
214	Zayats and Kuts	1964	Pobozhe, Ukraine	Archean biotite gneiss.
215	Vainshtein and others	1955	Torgevitsy, Ukraine	Granite.
216a, b	Murata and others	1957	Shelby district, North Carolina	Quartz monzonite (same species collected separately).
217	Mannucci and others	1986	Alps, Italy	Pegmatite.
218	Ivantishin and others	1964	Ukraine	Proterozoic gneiss
219	Vainshtein and others	1955	Zhelzhoskii, Ukraine	Gneissic granite (same as 215?).
220	Znamenskii and others	1967	Tiskhaya River, eastern 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-Cho, 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	Eastern Sayan	Biotite granite.
227	Yalovenko and Yur'yeva	1967	Lazovatka, Ukraine	Granite.
228	Vainshtein and others	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	Sluch River basin, Ukraine	Garnet-biotite gneiss
234	Murata and others	1957	Yucca Valley, California	Granite pegmatite.
235	Vainshtein and others	1955	Torgevitsy, Ukraine	Pegmatite.
236	Lyakhovich	1962	Korovischin massif, Gornyi Altai	Granite.
237	L'vov	1965	Varlamoff massif, Urals	Granite.
238	Lyakovich	1968	Urals	Quartz vein
239	Jefferies	1985	Carnmenellis pluton, Cornwall, England	Biotite granite
240	Wylie	1950	Cooglegong, W. Australia	Pegmatite.
241	Vainshtein and others	1956b	Temryuk, Azov region, U.S.S.R.	
242	Vainshtein and others	1956b	Blyunov mine, Urals	Pegmatite.
243	Zhang and Tao	1986	Bayan Obo, China	Main magnetic ore.
244	Vainshtein and others	1956b	Kiev district, U.S.S.R.	Granite.
245	Bel'kov	1979	Kola Peninsula, U.S.S.R.	Metasomatic granite.
246	Yurk and others; quoted by Lazarenko and others	1980	Ukraine	Aplitic granite.
247	Lyakhovich	1962	Ukraine	Biotite granite.
248	Yalovenko nd Yur'yeva	1967	Rovno, Ukraine	Pegmatite granite.
249	Shmakin and Shiryayeva	1970	Gutero-Biryasin area, Siberia, U.S.S.R.	
250	Ivantishin and others	1964	Ukraine	Gneiss.

Table 10. Sources of data for monazites given in tables 2–7—Continued.

Sample no.	Reference (author and date)		Locality	Source
			TABLE 2—Continued	
251	Lyakhovich	1962	Talitsk massif, Gornyi Altai	Biotite granite.
252	Vainshtein and others	1956b	Fukushima, Japan.	
253	Kuts	1966	Temryuk, Azov region, U.S.S.R.	Pegmatite.
254	Andersen	1986	Fen district, Norway	Carbonatite
255	Murata and others	1958	Juiz de Fera, Minas Gerais, Brazil	Granite pegmatite.
256	Charoy	1986	Cornwall, England	Granite.
257	Povilaitis and Varshal	1969	Kuu massif, Kazakhstan	Quartz-scheelite vein in serpentinite.
258	Pluhar	1979	Phukat, southern Thailand	Granite pegmatite.
259	Mannucci and others	1986	Alps, Italy	Pegmatite.
260	Vainshtein and others	1956b	Temryuk, Azov region, U.S.S.R.	
261	Vainshtein and others	1955	Ostropol, Ukraine	Granite.
262	Vainshtein and others	1956b	Urals	Granite.
263	Marchenko	1967	Southeast Ukraine	Aplitic biotite granite.
264	Lyakhovich	1968	Kazakhstan	Biotite granite.
265	Vainshtein and others	1955	Urals	Two-mica granite.
266	Vainshtein and others	1955	Krivoi Rog, Ukraine.	
267	Vainshtein and others	1956b	Krutocheg, Urals	Granite.
268	Murata and others	1958	Juiz de Fera, Minas Gerais, Brazil	Granite pegmatite.
269	Kornetova	1963	Siberia, U.S.S.R.	Granite pegmatite.
270	Vainshtein and others	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 and others	1980	Berda, Ukraine	Aplitic granite.
276	Murata and others	1957	Shelby district, North Carolina	Sillimanite schist.
277	Ivantishin and others	1964	Ukraine	Gneiss.
278	Lyakhovich	1962	Eastern Sayan	Granite.
279	Povilaitis and Varshal	1969	Kuu massif, Kazakhstan	Quartz-wolframite vein in greisen.
280	Murata and others	1958	Juiz de Fera, Minas Gerais, Brazil	Granite pegmatite.
281	Komov and others	1974	Polar Urals	Quartz vein.
282	Aleksiev and Tsvetkova	1962	Rila Mountains, 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 and others	1956b	Kirovgrad, Ukraine	Granite.
286	Khamrabaev and Azimov	1964	Aktau massif, western Uzbekistan	Granite pegmatite.
287	Zhirov and others	1961	Kheto-Lambina, Karelia, U.S.S.R.	Granite pegmatite.
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	Eastern Sayan	Biotite granite.
292	L'vov and Zhangurov	1968	Dzebyk region, eastern Urals	
293	Vainshtein and others	1956a	Borshchevoch Ridge, Transbaikal	Gneissic granite (average of 6).
294	Murata and others	1958	Ferros, Minas Gerais, Brazil	Granite pegmatite.
295	Lyakhovich	1962	Kochkar massif, Urals	Pegmatite.
296	Vainshtein and others	1955	Badeiba, Transvaal	Pegmatite.
297	Vainshtein and others	1956b	Temryak, Azov region, U.S.S.R.	Pegmatite.
298	Lyakhovich and Kasaeva	1968	Kabaridi-Balkarsk, U.S.S.R.	Precambrian granite.
299	Vainshtein and others	1955	Korea	Pegmatite.
300	Murata and others	1953	Shelby district, North Carolina	Quartz monzonite pegmatite.
301	Pavlenko and others	1966	Milzei massif, eastern Tuva	Biotite granite.
302	Lyakhovich and Barinskii	1961	Edygai massif, western Tuva	Quartz vein.
303	Vainshtein and others	1956b	Temryuk, Azov region, U.S.S.R.	Pegmatite.
304	Mannucci and others	1986	Alps, Italy	Fissure.
305	Mannucci and others	1986	Alps, Italy	Pegmatite.

Table 10. Sources of data for monazites given in tables 2–7—Continued.

Sample no.	Reference (author and date)		Locality	Source
			TABLE 2—Continued	
306	Gavrilova and Turanskaya	1958	Kirovgrad, Ukraine	Granite.
307	Orsa and others	1967	Middle Dniepr region, Ukraine	Pegmatitic granite.
308	Lazarenko and others	1980	Ukraine.	
309a, b, c	Ploshko and Knyazeva	1965	Urushten complex, Caucasus	Three analyses of one sample.
310	L'vov	1965	Demerinskii massif, Urals	Granite gneiss.
311	Murata and others	1957	Chesterfield, Virginia	Granite.
312, 313	Vainshtein and others	1956b	Gorevka, Ukraine.	
314	Aleksiev and Tsvetkova	1962	Rila Mountains, Bulgaria	Granite.
315	Zayats and Kuts	1964	Gnilopyat River basin, Ukraine	Archean biotite gneiss.
316	Nedashovskii and others	1969	Far Eastern U.S.S.R.	Alkali granite.
317, 318	Vainshtein and others	1956b	Gorovka, Ukraine	Granite.
319	Lyakhovich	1962	Murzinsk massif, Urals	Granite.
320	Vainshtein and others	1955	Ostrope, Austria	Pegmatite.
321	Wylie	1950	Olary, South Australia	Gold mine.
322	Ivantishin and others	1964	Chudnov-Berdesinskii, Ukraine	Granite.
323	Aleksiev and Tsvetkova	1962	Rila Mountains, Bulgaria	Biotite granite.
324	Vainshtein and others	1956b	Suberov, Ukraine.	
325	Kuts	1966	Anatolisk, Azov region, U.S.S.R.	Granite.
326	Vainshtein and others	1956b	Kurumkan, eastern Siberia, U.S.S.R.	
327	Zhang and Tao	1986	Bayan Obo, China.	East ore
328	Aleksiev and Tsvetkova	1962	Rila Mountains, Bulgaria	Biotite granite.
329	Semenov	1963	Transbaikal	Granite.
330	Povilaitis and Varshal	1969	Kuu massif, Kazakhstan	Quartz vein.
331	Mannucci and others	1986	Alps, Italy	Pegmatite.
332	Aleksiev and Tsvetkova	1962	Rila Mountains, Bulgaria	Biotite granite.
333	Aleksiev and Tsvetkova	1962	Rila Mountains, Bulgaria	Biotite granite.
334	Bel'kov	1979	Kola Peninsula, U.S.S.R.	Alkali granite.
335	Vainshtein and others	1956b	Zasentriskoi, eastern Siberia, U.S.S.R.	
336	Belolipetskii and Elina	1967	Not given	Alkali granite.
337	Pinkney and Wood, quoted by Semenov	1963	Van Reinsdorf, South Africa	Hydrothermal granite.
338	Bermanec and others	1988	Yugoslavia	Hydrothermal vein in syenite.
339	Murata and others	1957	Shelby district, North Carolina	Biotite schist.
340	L' vov	1965	Samarskii massif, Urals	Granite.
341	Batieva	1976	Kola Peninsula, U.S.S.R.	Alkali granite.
342	Vainshtein and others	1956b	Pastinnec, eastern Siberia, U.S.S.R.	
343	Khomyakov	1964	Tannu-Ola	Quartz syenite.
344	Murata and others	1958	San Rafael, Rio Grande do Norte, Brazil	Granite.
345	Aleksiev and Tsvetkova	1962	Rila Mountains, Bulgaria	Biotite granite.
346	Bel'kov	1979	Polar Urals	Alkali granite.
347	Kapustin	1966	Nama Vara, Karelia, U.S.S.R.	
348	Komov and others	1974	Polar Urals	Quartz vein.
349	Aleksiev and Tsvetkova	1962	Rila Mountains, 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 and others	1974	Polar Urals	Quartz vein.
354	Lyakhovich	1968	Gornyi Altai	Pegmatite.
355	Aleksiev and Tsvetkova	1962	Rila Mountains, Bulgaria	Biotite granite.
356	Bel'kov	1979	Kola Peninsula	Alkali granite.
357	Vainshtein and others	1956b	Temryuk, Azov region, U.S.S.R.	Pegmatite.
358	Zayats and Kuts	1964	Sluch River basin, Ukraine	Biotite gneiss.
359	Ivantishin and others	1964	Ukraine	Lower Proterozoic gneiss (same as 358?).
360	Vainshtein and others	1956a	Borshchevoch ridge, Transbaikal	Granite.
361	Aleksiev and Tsvetkova	1962	Rila Mountains, Bulgaria	Biotite granite.
362	Bel'kov	1979	Kola Peninsula, U.S.S.R.	Metasomatic granite.

Table 10. Sources of data for monazites given in tables 2–7—Continued.

Sample no.	Reference (author and date)		Locality	Source
			TABLE 2—Continued	
363	Ivantishin and others	1964	Ukraine	Gneiss.
364	Borovskii and Gerasimovskii	1945	Urusika River, Siberia, U.S.S.R.	Granite pegmatite.
365	Bel'kov	1979	Kola Peninsula, U.S.S.R.	Alkali granite.
366	Orsa and others	1967	Middle Dniepr region, Ukraine	Pegmatitic granite.
367	Murata and others	1958	Mar de Espinha, Minas Gerais, Brazil	Granite pegmatite.
368	Aleksiev and Tsvetkova	1962	Rila Mountains, 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, eastern Urals	Granite.
374	Aleksiev and Tsvetkova	1962	Rila Mountains, Bulgaria	Biotite granite.
375	Vainshtein and others	1956b	Zasentiske, eastern Siberia, U.S.S.R.	
376	Van Wambeke	1977	Karonge deposit, Burundi Republic.	
377	Murata and others	1958	Mar de Espinha, Minas Gerais, Brazil	Granite pegmatite.
378, 379	Aleksiev and Tsvetkova	1962	Rila Mountains, Bulgaria	Biotite granite.
380	Bel'kov	1979	Kola Peninsula, U.S.S.R.	Metasomatic granite.
381	Aleksiev and Tsvetkova	1962	Rila Mountains, Bulgaria	Biotite granite.
382	L'vov	1965	Varlamoffski massif, Urals	Granite.
383	Aleksiev and Tsvetkova	1962	Rila Mountains, Bulgaria	Biotite granite.
384	Lyakhovich	1962	Ukraine	Biotite granite.
385	Povilaitis and Varshal	1969	Kuu massif, Kazakhstan	Metasomatic albite-quartz replacement of granite.
386	Mannucci and others	1986	Rauris, Italy	Fissure.
387, 388	Aleksiev and Tsvetkova	1962	Rila Mountains, Bulgaria	Biotite granite.
389	Zhirov and others	1961	Eki Varaka, northern Karelia, U.S.S.R.	Granite pegmatite.
390	Kupriyanova and others	1964	European S.S.R.	Quartz-fluorite-molybdenite vein.
391, 392	Aleksiev and Tsvetkova	1962	Rila Mountains, Bulgaria	Biotite granite.
393	Orsa and others	1967	Zaporozh'ye, Ukraine	Plagiomigmatite
394–396	Aleksiev and Tsvetkova	1962	Rila Mountains, Bulgaria	Biotite granite.
397	Shiryayeva	1971	Mamsk region, Siberia, U.S.S.R.	Muscovite pegmatite.
398	Kuts	1966	Ingulets region, Ukraine	Gneiss.
399	Murata and others	1958	Consicao de Meto, Ventre, Minas Gerais, Brazil	Granite pegmatite.
400	McKie	1962	Kangankunde, Malawi	Carbonatite.
401	Aleksiev and Tsvetkova	1962	Rila Mountains, Bulgaria	Biotite granite.
402	Lyakovich	1968	Kazakhstan	Biotite granite.
403	Jefferies	1985	Cornwall, England	Biotite granite.
404, 405	Aleksiev and Tsvetkova	1962	Rila Mountains, Bulgaria	Biotite granite.
406	Ivantishin and others	1964	Ukraine	Gneiss.
407	Jefferies	1985	Cornwall, England	Biotite granite.
408	Murata and others	1958	Mar de Espinha, Minas Gerais, Brazil	Granite pegmatite.
409	Pluhar	1979	Takua Pa, southern Thailand	Granite pegmatite.
410–412	Jefferies	1985	Cornwall, England	Biotite granite.
413	Semenov and Barinskii	1958	Tennet, Yakutia	Alkaline pegmatite.
414	Murata and others	1958	Mar de Espinha, Minas Gerais, Brazil	Granite pegmatite.
415	Vainshtein and others	1955	Aldan	Pegmatite.
416	Murata and others	1958	Juiz de Fera, Minas Gerais, Brazil	Schist wallrock of pegmatite.
417	L'vov	1965	Varlamoff massif, Urals	Granite.
418	L'vov and Zhangurov	1968	Dzhabyk region, eastern Urals	Granite.
419	Bel'kov	1979	Kola Peninsula	Metasomatic granite.
420	Jefferies	1985	Cornwall, England	Biotite granite.
421	Orsa and others	1967	Middle Dniepr region, Ukraine	Granite.
422	Jefferies	1985	Cornwall, England	Biotite granite.
423	Kukharenko and others	1961,	Namo Vara, Karelia	Carbonatite
424	Povilaitis and Varshal	1969	Kuu massif, Kazakhstan.	
425	Ivantishin and others	1964	Ukraine	Gneiss.
426	Aleksiev and Tsvetkova	1962	Rila Mountains, Bulgaria	Biotite granite.
427–428	Jefferies	1985	Cornwall, England	Biotite granite.
429	Vainshtein and others	1956b	Il'men Mountains, Urals	Pegmatite.

Table 10. Sources of data for monazites given in tables 2–7—Continued.

Sample no.	Reference (author and date)		Locality	Source
			TABLE 2—Continued	
430	Shlyukova	1986	Khibina massif, Kola Peninsula, U.S.S.R.	Pegmatite.
431	Murata and others	1958	Mar de Espinha, Minas Gerais, Brazil	Granite pegmatite.
432	Lyakhovich	1968	Kazakhstan	Granite.
433	Vainshtein and others	1956a	Borshchevoch ridge, Transbaikal	Granite (average of 8).
434	Vainshtein and others	1956b	Il'men Mountains, Urals	Pegmatite.
435	Andersen	1986	Fen district, Norway	Carbonatite.
436	Proshchenko	1967	Eastern Siberia, U.S.S.R.	Albitite.
437	Murata and others	1958	Mar de Espinha, Minas Gerais, Brazil	Granite pegmatite.
438	Borovskii and Gerasimovskii	1945	Elizavetinsk, Urals	Granite pegmatite.
439	Kovalenko and others	1971	Ink-Khairken, Mongolia	Microclinite.
440	Aleksiev and Tsvetkova	1962	Rila Mountains, Bulgaria	Biotite granite.
441	Semenov and Khomyakov	1981	India	Weakly magnetic concentrate.
442–444	Shlyukova	1986	Khibina massif, Kola Peninsula, U.S.S.R.	
445	Murata and others	1958	Mar de Espinha, Minas Gerais, Brazil	Schist wallrock of granite pegmatite.
446	Komov and others	1974	Pamirs, Siberia, U.S.S.R.	Quartz-carbonate vein.
447	Jefferies	1985	Cornwall, England	Biotite granite.
448	Papunen and Lindsjo	1972	Korsnas, Finland	Skarn, lead deposit.
449	Murata and others	1957	Hollis, North Carolina	Quartz monzonite dike.
450	Jefferies	1985	Cornwall, England	Biotite granite.
451	Andersen	1986	Fen district, Norway	Carbonatite.
452	Murata and others	1958	Mar de Espinha, Minas Gerais, Brazil	Granite pegmatite.
453	L'vov and Zhangurov	1968	Dzhabyk region, eastern Urals	Granite
454	Murata and others	1958	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.
457	Yalovenko and Yur'eva	1967	Roches, Ukraine	Granite.
458	Zhang and Tao	1986	Bayan Obo, China	Main ore.
459	Murata and others	1958	Juiz de Feros, Minas Gerais, Brazil	Granite pegmatite.
460	Murata and others	1958	Mar de Espinha, Minas Gerais, Brazil	Granite pegmatite.
461	Zayats and Kuts	1964	Ukraine	Archean biotite gneiss.
462	Ivantishin and others	1964	Ukraine	Gneiss (same as 461?).
463	L'vov and Zhangurov	1968	Dzhabyk region, eastern Urals	Granite.
464	Jefferies	1985	Cornwall, England	Biotite granite.
465	Orsa and others	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 and others	1974	Polar Urals	Quartz vein.
471	Komov and others	1974	Pamirs, Siberia, U.S.S.R.	Dolomitized quartzite.
472, 473	Jefferies	1985	Cornwall, England	Biotite granite.
474	Vladykin and others	1982	Mongolia	Arfvedsonite granite.
475	Lyakhovich	1967	Azov region, U.S.S.R.	
476	Jefferies	1985	Cornwall, England	Biotite granite.
477	Kretser 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, eastern Urals	Granite.
481	Jefferies	1985	Cornwall, England	Biotite granite.
482	Vainshtein and others	1955	Central Asia	Quartz vein.
483	Zayats and Kuts	1964	Pobuzhe, Ukraine	Garnet-biotite gneiss.
484	Vainshtein and others	1956b	Pyat Palsen, Aldan	Graphite granite.
485	Murata and others	1958	Shelby district, North Carolina	Biotite gneiss.
486	Borovskii and Gerasimovskii	1945	Andermanskii, Uriskiken River, Siberia, U.S.S.R.	Granite.
487	Orsa and others	1967	Middle Dniepr region, Ukraine	Plagiomigmatite.
488	Povilaitis and Varshal	1959	Kuu massif, Kazakhstan	Vein granite.

Table 10. Sources of data for monazites given in tables 2–7—Continued.

Sample no.	Reference (author and date)		Locality	Source
			TABLE 2—Continued	
489	Mineev and others	1962	Vishnevye Mountains, Urals	Alteration product of chevkinite, fenite.
490	Es'kova and Ganzeev	1964	Urals	Fenitized granite pegmatite.
491	Povilaitis and Varshal	1959	Kuu massif, Kazakhstan	Quartz-wolframite vein in gneiss.
492	Murata and others	1958	San Rafael, Rio Grande do Norte, Brazil	Pegmatite.
493	Vainshtein and others	1961	Eastern Sayan	Carbonatite.
494	Murata and others	1957	Mt. Pass, California	Carbonatite.
495	Povilaitis and Varshal	1959	Kuu massif, Kazakhstan	Vein granite.
496	Murata and others	1958	Sabinopolis, Brazil	Granite pegmatite.
497	Vinogradov and Elina	1968	Northwestern Kola Peninsula, U.S.S.R.	Granite.
498	Zhang and Tao	1986	East ore, Bayan Obo, China	Aegirine-rich ore.
499	Kuznetsova and others	1980	Northern Siberia, U.S.S.R.	Dolomite-ankerite carbonatite.
500	Murata and others	1958	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 and others	1958	Sabinopolis, Brazil	Granite pegmatite.
505	Vainshtein and others	1955	Urals	Pegmatite.
506	Serdyuchenko and others	1967	Byelorussia	Precambrian biotite gneiss.
507	Chistyakova and Kazakova	1968	Kazakhstan	Granite pegmatite.
508	L'vov and Zhangurov	1968	Chelyabin district, eastern Urals	Granite.
509	Zhang and Tao	1986	Bayan Obo, China.	
510	Ivantishin and others	1964	Ukraine	Gneiss.
511	Zhang and Tao	1986	Bayan Obo, China.	
512	Vainshtein and others	1961	Eastern Sayan	Carbonatite.
513	Kalenor and others	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	Eastern Sayan	Carbonatite.
516	Mineev	1968	Northwestern Tarbagatau, Kazakhstan	Pegmatite.
517	Mineev	1968	Northwestern Tarbagatau, Kazakhstan	Biotite apogranite.
518	Chistov	1965	Eastern Siberia, U.S.S.R.	Carbonatite.
519	Murata and others	1953	Mt. Pass, California	Carbonatite.
520	Vetoshkina and others	1980	Ploska Mountain, Kola Peninsula, U.S.S.R.	Amazonite pegmatite.
521	Semenov and others	1967	Tarbagatau, Kazakhstan	Quartz-fluorite pegmatite.
522	Povilaitis and Varshal	1959	Kuu massif, Kazakhstan	Granite.
523	Zuev and Kosterin	1961	Central Asia	Hydrothermal (average of 4).
524	Lyakhovich	1968	Kazakhstan	Biotite granite.
525	Povilaitis and Varshal	1959	Kuu massif, Kazakhstan	Granite.
526	Mineev	1968	Northwestern Tarbagatau, Kazakhstan	Biotite apogranite.
527	Quoted by Vlasov	1964	Mongolia	Alkali hydrothermalite.
528	Michael	1988	Bishop Tuff, California	Inclusion in pyroxene.
529	Zhang and Tao	1986	Bayan Obo, China	Aegirine-rich ore.
530	Semenov and others	1978	Tamil Nadu, India	Carbonatite.
531	Komov and others	1974	Pamirs	Quartzite.
532	Zhang and Tao	1986	Bayan Obo, China	Aegirine-rich ore (same as 529?).
533	Jobbins and others	1977	Sri Lanka	Gem.
534	Murata and others	1957	Magnet Cove, Arkansas	Aplite-pyrite dike in carbonatite.
535	Bloomfield and Garson	1965	Kangankunde Hill, Malawi	Carbonatite.
536	Semenov	1963	Kazakhstan	Greisen.
537	Plaksenko and others	1982	Shiryaeva, pluton, U.S.S.R.	Gabbro-dolerite.
538	Povilaitis and Varshal	1969	Kuu massif, Kazakhstan	Granite.
539	Kuznetsova and others	1980	Northern Siberia, U.S.S.R.	Dolomite-ankerite carbonatite.
540	Borovskii and Gerasimovskii	1945	Kounrad deposit, Balkhesh, U.S.S.R.	Granite.
541	Marchenko	1967	Southeastern Ukraine	Hydrothermal gneissic xenolith in syenite.
542	Zhang and Tao	1986	Bayan Obo, China	Late-stage vein.

Table 10. Sources of data for monazites given in tables 2–7—Continued.

Sample no.	Reference (author and date)		Locality	Source
			TABLE 2—Continued	
543	Pavlenko and others	1959	Dugdin massif, eastern Tuva	Pegmatite schlieren in granosyenite.
544	Komov and others	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 and others	1955	Kazakhstan	Hydrothermally altered pegmatite.
548	Rose and others	1958	Magnet Cove, Arkansas	Carbonatite.
549	Lyakhovich	1962	Eldzhurtin massif, northern Caucasus.	
550	Quoted by Vlasov	1964	Kounrad, Kazakhstan.	
551	Pluhar	1979	Phuket, southern Thailand	Granite pegmatite.
552	Vainshtein and others	1955	Vishnevye Mountains, Urals	Carbonate vein.
553	Vainshtein and others	1955	Central Kazakstan.	Quartz vein.
554	Zhang and Tao	1986	Bayan Obo, China	
555	Es'kova and Ganzeev	1964	Vishnevye Mountains, Urals	Dolomite vein in ultramafic rock.
556	Vainshtein and others	1955	Kazakhstan	Hydrothermally altered pegmatite.
557	Zhang and Tao	1986	Bayan Obo, China	Dolomite type, main ore.
558	Pluhar	1979	Phuket, southern Thailand	Granite pegmatite.
559	Es'kova and Ganzeev	1964	Vishnevye Mountains, Urals	Alkalic muscovite-corundum pegmatite.
560	Es'kova and Ganzeev	1964	Vishnevye Mountains, Urals	Albitite in miaskite.
561	Heinrich and Levinson	1961	Ravalli County, Montana	Carbonatite.
562	Zhabin and Svyazhin	1962	Vishnevye Mountains, Urals	Albitite.
563	Somina and Bulakh	1966	Eastern Sayan	Carbonatite.
564	Es'kova and Ganzeev	1964	Vishnevye Mountains, Urals	Alkali pegmatite.
565	Gramaccioli and Segelstad	1978	Piani, Italy	Pegmatite.
			TABLE 3	
1	Pluhar	1979	Ranang Province, southern Thailand.	
2	Flinter and others	1963	Johore State, Malaysia	Alluvial.
3	Pluhar	1979	Phang Nge Province, southern Thailand.	
4	Nekrasov	1972	Kular region, Far Eastern U.S.S.R.	SiO_2 12.04 percent; P_2O_5 24.08 percent.
5	McCarty	1935	China	
6	Pluhar	1979	Phuket Province, southern Thailand.	
7	Li and Grebennikova	1962	Siberia, U.S.S.R.	
8	Flinter and others	1963	Parak, Malaysia	Alluvial.
9	McCarty	1935	India.	
10	Nekrasov	1972	Kular region, Far Eastern U.S.S.R.	SiO_2 12.04 percent; P_2O_5 24.08 percent.
11a–f	Richartz	1961	Brazil	Black sand (separated into magnetic fractions; listed in order of increasing magnetism.
12	Pluhar	1979	Ranang Province, southern Thailand.	
13	McCarty	1935	India.	
14–16	Pluhar	1979	Ranang Province, southern Thailand.	
17	McCarty	1935	Idaho.	
18	McCarty	1935	Florida.	
19	Flinter and others	1963	Kadah State, Malaysia	Alluvial.
20–22	Pluhar	1979	Ranang Province, southern Thailand.	
23	Hedrick	1988	Florida.	
24	Zemel	1936	Aldan, U.S.S.R.	Gold placer.
25	Pluhar	1979	Ranang Province, southern Thailand.	
26	Pluhar	1979	Phang Nge Province, southern Thailand.	
27, 28	Pluhar	1979	Ranang Province, southern Thailand.	
29	Pluhar	1979	Phang Nge Province, southern Thailand.	
30–33	Pluhar	1979	Ranang Province, southern Thailand.	
34	Flinter and others	1963	Silian, Malaysia	Alluvial.
35	Flinter and others	1963	Trong Parak, Malaysia	Alluvial.
36–38	Pluhar	1979	Ranang Province, southern Thailand.	

Table 10. Sources of data for monazites given in tables 2–7—Continued.

Sample no.	Reference (author and date)		Locality	Source
			TABLE 3—Continued	
39	Lozinski	1969	Baltic Sea coast	Black sand.
40–43	Pluhar	1979	Ranang Province, southern Thailand.	
44	Pluhar	1979	Phang Nge Province.	
45–50	Pluhar	1979	Ranang Province, southern Thailand.	
51	Flinter and others	1963	Kanper Perak, Malaysia	Alluvial.
52	Pluhar	1979	Ranang Province, southern Thailand.	
53, 54	Pluhar	1979	Phang Nge Province, southern Thailand.	
55	Hedrick	1988	Eastern Australia.	
56, 57	Pluhar	1979	Ranang Province, southern Thailand.	
58	Flinter and others	1963	Serenban, Malaysia.	Alluvial.
59	Kosterin and others	1962	Maritime Province, Far Eastern, U.S.S.R.	
60	Pluhar	1979	Phuket Province, southern Thailand.	
61–64	Pluhar	1979	Ranang Province, southern Thailand.	
65	Trace	1960	Hardin County, Illinois	Cherty residuum overlying limestone.
66	Pluhar	1979	Ranang Province, southern Thailand.	
67	Flinter and others	1963	Semeling, Kedah State, Malaysia	Alluvial.
68	Flinter and others	1963	Batu Gugel, Perak State, Malaysia	Alluvial.
69–71	Pluhar	1979	Ranang Province, southern Thailand.	
72	Flinter and others	1963	Pertang, Perak State, Malaysia	Alluvial.
73	Flinter and others	1963	Bider, Perak State, Malaysia	Alluvial.
74	Flinter and others	1963	Petaling, Salanger State, Malaysia	Alluvial.
75	Pluhar	1979	Ranang Province, southern Thailand.	
76	Pluhar	1979	Ranang Province, southern Thailand.	
77	Pluhar	1979	Phang Nge Province, southern Thailand.	
78	Pluhar	1979	Ranang Province, southern Thailand.	
79	Pluhar	1979	Phang Nge Province, southern Thailand.	
80, 81	Pluhar	1979	Ranang Province, southern Thailand.	
82	Pluhar	1979	Phang Nge Province, southern Thailand.	
83	Pluhar	1979	Ranang Province, southern Thailand.	
84	Pluhar	1979	Phang Nge Province, southern Thailand.	
85	Pluhar	1979	Ranang Province, southern Thailand.	
86–88	Pluhar	1979	Ranang Province, southern Thailand.	
89	Flinter and others	1963	Selangor State, Malaysia	Alluvial.
90, 91	Pluhar	1979	Ranang Province, southern Thailand.	
92	Soong	1978	Taiwan	Beach sand.
93	Pluhar	1979	Phukat Province, southern Thailand.	
94	Pluhar	1979	Ranang Province, southern Thailand.	
95	Pluhar	1979	Phang Nge Province, southern Thailand.	
96	Pluhar	1979	Phang Nge Province, southern Thailand.	
97	Pluhar	1979	Ranung Province, southern Thailand.	
98	Hedrick	1988	India.	
99	Flinter and others	1963	Sunghai, Perak State, Malaysia	Alluvial.
100	Pluhar	1979	Ranung Province, southern Thailand.	
101	Flinter and others	1963	Pulau Besur, Malacca State, Malaysia	Alluvial.
102	Murata and others	1953	Travancore, India.	
103	Pluhar	1979	Ranung Province, southern Thailand.	
104	Hwang and others	1981	Australia.	
105	Pluhar	1979	Ranung Province, southern Thailand.	
106	Semenov and Turanskaya, quoted by Vlasov (v. 2, p. 283)	1964	Korea.	
107	Chen and others	1973	Taiwan	Beach sand.
108–110	Pluhar	1979	Ranang Province, southern Thailand.	
111	Pluhar	1979	Phang Nge Province, southern Thailand.	
112	Wylie	1950	Scottsdale district, Tasmania.	
113	Hedrick	1988	China.	
114	Rosenblum	1974	Liberia	Beach sand.

Table 10. Sources of data for monazites given in tables 2–7—Continued.

Sample no.	Reference (author and date)		Locality	Source
			TABLE 3—Continued	
115	Pluhar	1979	Phuket Province, southern Thailand.	
116	Wylie	1950	Byron Bay, New South Wales, Australia.	
117	Murata and others	1957	Byron Bay, New South Wales,	Split of sample 116
118	Pluhar	1979	Ranang Province, southern Thailand.	
119	Chen and others	1973	Taiwan	Beach sand.
120	Murata and others	1953	Pacific Grove, California.	
121	Pluhar	1979	Ranang Province, southern Thailand.	
122	Wylie	1950	Stannum, New South Wales, Australia	Alluvial.
123	Smirnov	1969	Riphaen sediments, Middle Dniester area, Ukraine.	
124	Pluhar	1979	Ranang Province, southern Thailand.	
125	Pluhar	1979	Phang Nge Province, southern Thailand.	
126	Rosenblum	1974	Liberia	Beach sand.
127	Wylie	1950	Cape Everard, Victoria, Australia	Beach sand.
128	Hedrick	1988	W. Australia.	
129	Pluhar	1979	Ranang Province, southern Thailand.	
130	Rosenblum	1974	Liberia	Beach sand.
131	Wylie	1950	King Island, Australia	Beach sand.
132	Pluhar	1979	Ranang Province, southern Thailand.	
133	Pluhar	1979	Phuket Province, southern Thailand.	
134	Rosenblum	1974	Liberia	Beach sand.
135	Murata and others	1953	Pacific Grove, California.	
136	Heinrich and others	1960	Pacific Grove, California	Split of sample 135.
137	Rosenblum	1974	Liberia	Beach sand.
138	Pluhar	1979	Phuket Province, southern Thailand.	
139	Rosenblum	1974	Liberia	Beach sand.
140	Pluhar	1979	Ranang Province, southern Thailand.	
141, 142	Rosenblum	1974	Liberia	Beach sand.
143	Pluhar	1979	Phong Nge Province, southern Thailand.	
144	Hammond	1946	Travancore, India	Beach sand.
145	Rosenblum	1974	Liberia	Beach sand.
146	Pluhar	1979	Phang Nge Province, southern Thailand.	
147	Pluhar	1979	Phuket Province, southern Thailand.	
148	Pluhar	1979	Ranang Province, southern Thailand.	
149	Rosenblum	1974	Liberia	Beach sand.
150	Styles and Young	1983	Afu Hills, Nigeria.	
151	Rosenblum	1974	Liberia	Beach sand.
			TABLE 4	
1	Rosenblum and Mosier	1983	Kivu, Zaire	Alluvial.
2	Nekrasova and Nekrasov	1983	Indigirka River, northeastern Yakutia	Alluvial.
3	Kosterin and others	1962	Maritime Province, eastern Siberia, U.S.S.R.	Cassiterite placer.
4	Rosenblum and Mosier	1983	Kivu, Zaire	Alluvial.
5–7	Donnot and others	1973	Brittany, France	Paleozoic gray schist.
8	Nekrasova and Nekrasov	1983	Indigirka River, northeastern Yakutia.	
9	Donnot and others	1973	Brittany, France	Paleozoic gray schist.
10	Rosenblum and Mosier	1983	Kivu, Zaire	Alluvial.
11	Rosenblum and Mosier	1983	France	Alluvial.
12	Chen, Li, and Wu	1973	Taiwan	Beach sand.
13	Rosenblum and Moser	1983	Livengood, Alaska	Alluvial.
14	Rosenblum and Moser	1983	Taiwan	Beach sand.
15	Serdyuchenko and Kochetkov	1974	Timan, U.S.S.R.	Riphaen shale.
16, 17	Rosenblum and Mosier	1983	Kivu, Zaire	Alluvial.
18	Rosenblum and Mosier	1983	Ruby, Alaska	Alluvial.
19	Rosenblum and Mosier	1983	Southwestern Taiwan	Beach sand.
20	Rosenblum and Mosier	1983	Eagle, Alaska	Alluvial.
21	Rosenblum and Mosier	1983	Teller, Alaska	Alluvial.
22	Rosenblum and Mosier	1983	Southwestern Taiwan	Beach sand.

Table 10. Sources of data for monazites given in tables 2–7—Continued.

Sample no.	Reference (author and date)		Locality	Source
			TABLE 4—Continued	
23	Rosenblum and Mosier	1983	Montana	Alluvial.
24	Rosenblum and Mosier	1983	Rio San Juan, Peru	Alluvial.
25	Soong	1978	Taiwan	Beach sand.
26	Rosenblum and Mosier	1983	Rio Morro, Peru	Alluvial.
27	Chen, Li, and Wu	1973	Taiwan	Beach sand.
28, 29	Rosenblum and Mosier	1983	Taiwan	Beach sand.
30	Rosenblum and Mosier	1983	Tanana, Alaska	Alluvial.
31	Rosenblum and Mosier	1983	Livengood, Alaska	Alluvial.
32	Rosenblum and Mosier	1983	Talkeetna, Alaska	Alluvial.
33	Rosenblum and Mosier	1983	Livengood, Alaska	Alluvial.
34	Nekrasova and Nekrasov	1983	Obrivisty River, northeastern Yakutia	Alluvial.
35	Soong	1978	Taiwan	Beach sand.
36	Rosenblum and Mosier	1983	Taiwan	Beach sand.
37	Soong, quoted by Rosenblum and Mosier	1983	Southwestern Taiwan	Beach sand (same as sample 35?).
38	Hwang and others	1981	Taiwan	Beach sand.
39	Rosenblum and Mosier	1983	Tanana, Alaska	Alluvial.
40	Nekrasova and Nekrasov	1983	Sclar River, northeastern Yakutia	Alluvial.
41	Rosenblum and Mosier	1983	Tanana, Alaska	Alluvial.
42	Nekrasova and Nekrasov	1983	Dzhatuk River, northeastern Yakutia	Alluvial.
43	Rosenblum and Mosier	1983	Ophir, Alaska	Alluvial.
44	Soong	1978	Taiwan	Beach sand.
45	Nekrasova and Nekrasov	1983	Vera River, northeastern Yakutia	Alluvial.
46	Vaquero	1979	Spain	Alluvial.
47	Soong	1978	Taiwan	Beach sand.
			TABLE 5	
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, U.S.S.R.	Dark monazite.
5	Proshchenko, quoted by Vlasov, v. 1, p. 243	1964	Northern Yakutia	Alkali granite pegmatite.
6	Graeser and Schwander	1987	Italy	Pegmatite vein in gneiss.
7	Shukolyukov and others	1979	Alakurtti, northern 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 6	
1	Bowles and others	1980	Kuttakhuzhi, Travancore, India	Kaolinized pegmatite.
2	Pavlenko and others	1959	Bayankul massif, eastern Tuva	Amazonite pegmatite.
3, 4	Foord and others	1993	Kuttakuzhi,Trivandrum, Kerala State, India	Pegmatite dike.
			TABLE 7	
1	Kosterin and Zuev	1962	Not given	Veinlet in granophyre.
2, 3	Kucha	1980	Bogatyn area, Lower Silesia, Poland	Huttonite-monazite.
4	Pavlenko and others	1966	Southeastern Siberia, U.S.S.R.	"Cerphosphorhuttonite," 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 11. Locality index.

Country	Table	Sample number
		Africa
Burundi Republic	2	376
Liberia	3	114, 126, 130, 134, 137, 139, 141, 142, 145, 149, 151
Malawi	2	400, 535
Mozambique	2	45
Nigeria	3	150
South Africa	2	31, 54, 138, 296, 337
Zaire	4	1, 4, 10, 16, 17
		Asia
"South Asia"	2	49
China	2	15, 72, 77, 134, 149, 243, 327, 458, 478, 498, 503, 509, 511, 514, 529, 532, 542, 545, 546, 554, 557
	3	5, 113
India	2	190, 441, 530
	3	9, 13, 98, 102, 144
Japan	2	74, 223, 252
Korea	2	299
	3	106
Malaysia	2	161
	3	2, 8, 19, 34, 35, 51, 58, 67, 68, 72–74, 89, 99, 101
Mongolia	2	66, 181, 439, 474, 527
Sri Lanka	2	533
Taiwan	3	92, 107, 119
	4	12, 14, 19, 22, 25, 27–29, 35–38, 44, 47
Thailand	2	89, 258, 409, 551, 558
	3	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	2	20, 28, 80, 83, 97, 117, 165, 249, 269, 364, 397, 486
	3	7
Central Asia	2	482, 523
East Siberia, Far Eastern U.S.S.R., Maritime Province	2	81, 316, 326, 335, 342, 375, 436, 513, 518
	3	4, 10, 59
	4	3
Northern Siberia	2	499, 539
Aldan	2	415, 484
	3	24
Balkhash	2	540
Gornyi Altai	2	127, 236, 251, 271, 354
Kabaridi-Balkarsk, A.S.S.R.	2	298
Kazakhstan	2	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	2	144, 446, 471, 531
Polar Urals	2	130, 142, 146, 154, 160, 232, 281, 346, 348, 350, 353, 470, 471, 544
Sayan	2	108, 166, 196, 202, 209, 210, 220, 226, 278, 291, 493, 512, 515, 563
Tannu-Ola	2	50, 343
Timan	4	15
Transbaikal	2	147, 293, 329, 351, 360, 433
Tuva	2	129, 136, 164, 203, 301, 302, 543
Urals	2	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	2	286
Yakutia	2	413
	4	2, 8, 34, 40, 42, 45

Table 11. Locality index—Continued.

Country	Table	Sample number
		Australia
Australia	2	126
	3	131
East Australia	3	55, 104
South Australia	2	321
New South Wales	3	116, 117, 122
Tasmania	3	112
Victoria	3	127
West Australia	2	240
	3	128
		Europe
Austria	2	320
Bulgaria	2	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	2	239, 256, 272, 283, 369, 370, 403, 407, 410–412, 420, 422, 427, 428, 447, 450, 464, 472, 473, 476, 481, 502
Finland	2	86, 158, 448
France	4	5–7, 9, 11
Italy	2	67, 155, 183, 217, 259, 304, 305, 331, 386, 565
Norway	2	8, 11, 70, 92, 99, 100, 128, 195, 231, 254, 435, 451
Poland	2	139
Spain	4	46
Switzerland	2	171
U.S.S.R.	2	53, 113, 137, 185, 390, 469, 537
Azov region	2	150, 175, 182, 198, 204, 213, 221, 222, 241, 253, 260, 289, 297, 303, 325, 357, 475
Baltic region	2	25, 118
	3	39
Armenia	2	479
Byelorussia	2	506
Caucasus	2	229, 309a, b, c, 456, 549
Karelia and Kola Peninsula	2	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, 419, 423, 430, 442–444, 467, 497, 501, 520
Ukraine	2	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, 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, 457, 461, 462, 465, 483, 487, 510, 541
	3	123
Yugoslavia	2	338
		North America
United States		
Alaska	4	13, 18, 20, 21, 30–33, 39, 41, 43
Arkansas	2	534, 548
California	2	7, 206, 234, 494, 519, 528
	3	120, 135, 136
Colorado	2	6, 10, 12, 14, 84, 111, 123, 125
Connecticut	2	121
Florida	3	18, 23
Idaho	3	17
Illinois	2	179
	3	65
Montana	2	561
	4	23
Nevada	2	44, 55, 56, 62, 87, 90, 96, 131, 141, 167, 173, 174, 180, 188, 191
New Mexico	2	17, 58, 79, 88, 102, 119, 132, 133
North Carolina	2	43, 52, 60, 68, 69, 112, 143, 205, 216a, b, 276, 300, 339, 449, 485
Virginia	2	101, 311

Table 11. Locality index—Continued.

Country	Table	Sample number
		South America
Brazil	2	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
	3	11a–f
Peru	4	24, 26
		No locality given
	2	51, 65, 120, 153, 336, 477

REFERENCES CITED

Aleksiev, Elena, and Tsvetkova, V., 1962, Mineralogical and chemical study of monazites from granites of the Rila Mountains: Bulgarska Akademiia na Naukite, Sofia, Geologicheski Institut, Trudove Vurkhu Geologiiata na Bulgariia, Seriia Geokhimiia i Polezni Izkopaemi, v. 3, p. 5–24. [In Bulgarian with German and Russian summaries.]

Amli, Reidar, 1975, Mineralogy and rare-earth geochemistry of apatites and xenotime from the Gloseheria granite pegmatite, southern Norway: American Mineralogist, v. 60, p. 607–620.

Andersen, Tom, 1986, Compositional variation of some rare-earth minerals from the Fen complex (Telemark, S.E. Norway)—Implications for the mobility of rare earths in a carbonatite system: Mineralogical Magazine, v. 50, p. 503–509.

Balashov, Yu.A., and Pozharitskaya, L.K., 1968, Factors regulating the behavior of rare earth elements in the carbonatite process: Geokhimiia 1968, p. 285–303. [In Russian; translation in Geochemistry International, v. 5, p. 271–288.]

Batieva, I.D., 1976, Petrology of alkalic granitoids of the Kola Peninsula: Nauka, p. 1–224. [In Russian.]

Bayliss, Peter, and Levinson, A.A., 1988, A system of nomenclature for rare-earth mineral species—Revision and extension: American Mineralogist, v. 73, p. 422–423.

Bearth, P., 1934, X-ray spectroscopic analysis of a turnerite from the Tavetsch: Schweizerische Mineralogische Petrographische Mitteilungen, v. 14, p. 442–446. [In German.]

Bel'kov, I.V., 1979, Accessory minerals of the granitoids of the Kola Peninsula: Nauka, p. 1–185. [In Russian.]

Belolipetskii, A.P., and Elina, N.A., 1967, Composition of rare earths in accessory minerals in veins of alkaline granites: Materialy po Mineralogii Kol'skogo Poluostrova Leningrad, v. 5, p. 124–128. [In Russian.]

Bermanec, V., Tibljas, D., Gessner, M., and Kniewald, G., 1988, Monazite in hydrothermal veins from Alinci, Yugoslavia: Contributions to Mineralogy and Petrology, v. 38, p. 139–150.

Bernstein, L.R., 1982, Monazite from North Carolina, having the alexandrite effect: American Mineralogist, v. 67, p. 356–359.

Bloomfield, K., and Garson, M.S., 1965, The geology of the Kirk Range–Lusungwe Valley area: Malawi Geological Survey Department Bulletin 17, p. 1–234.

Borovskii, I.B., and Gerasimovskii, V.I., 1945, Rare earths in minerals: Academie Sciences U.S.S.R., Comptes Rendus, v. 49, 353–356.

Bowie, S.H.U., and Horne, J.E.T., 1953, Cheralite, a new mineral of the monazite group: Mineralogical Magazine, v. 30, p. 93–99.

Bowles, J.F.W., Jobbins, E.A., and Young, S.R., 1980, A re-examination of cheralite: Mineralogical Magazine, v. 43, p. 885–888.

Bukanov, V.V., and Shvetsova, I.V., 1966, Typomorphic features of accessory monazite from a vein of Alpine type of the Near-Polar Urals: Mineralogicheskii Sbornik (L'vov University), v. 20, p. 595–599. [In Russian.]

Charoy, B., 1986, The genesis of the Cornubian batholith (southwest England)—The example of the Carnmenellis pluton: Journal of Petrology, v. 27, p. 571–604.

Chen, M.C., Li, K.T., and Wu, K.C., 1973, A study of black monazite in Taiwan heavy sand: Mining and Metallurgy (Taiwan), v. 17, no. 3, p. 61–72. [In Chinese.]

Chistov, L.B., 1965, Features of the rare-earth mineralization of ore of the crust of weathering of carbonatite deposits of eastern Siberia: Geologiia Rudnykh Mestorozhdenii, v. 7, no. 3, p. 75–81. [In Russian.]

Chistyakova, M.B., and Kazakova, M.E., 1968, Rare-earth minerals from crystal-bearing cavities in granitic pegmatites, Kazakhstan: Akademiia Nauk S.S.S.R. Mineralogicheskii Muzei Trudy, Moscow, v. 18, p. 245–249. [In Russian.]

Choong, M.Y., 1971, The analysis of rare earths in monazite by x-ray spectrometry: Malaysia Geological Survey, Annual Report for 1969, p. 113–115.

Clark, A.M., 1984, Mineralogy of the rare-earth elements, *in* Henderson, P., ed., Developments in geochemistry, 2—Rare-earth element geochemistry: Elsevier, Amsterdam, p. 33–61.

Donnot, M., Guigues, J., Lulzac, Y., Magnien, A., Parfenoff, A., and Picot, P., 1973, A new type of europium deposit—Gray monazite with europium in nodules in the Paleozoic schists of Brittany: Mineralium Deposita, v. 8, p. 7–18. [In French.]

Dubrovskii, M.I., 1968, Accessory minerals of rocks of the Yuroaivsk granitic complex: Materialy po Mineralogii Kol'skogo Poluostrova Leningrad, v. 6, p. 111–112. [In Russian.]

El-Hinnawi, E.E., 1964, Mineralogical and geochemical studies in Egyptian (U.A.R.) black sands: Beitrage Mineralogie und Petrographie, v. 9, p. 519–532.

Es'kova, E.M., and Ganzeev, A.A., 1964, Rare-earth elements in accessory minerals of Vishnevye Mountains: Geokhimiia 1964, p. 1267–1279. [In Russian; translation in Geochemistry International 1964, p. 1152–1163.]

Evensen, N.M., Hamilton, P.J., and O'Nions, R.K., 1978, Rare-earth abundances in chondritic meteorites: Geochimica et Cosmochimica Acata, v. 42, p. 1199–1212.

Fishman, M.V., Yushkin, N.F., Goldin, B.A., and Kalinin, E.F., 1968, Mineralogy, typomorphism, and genesis of accessory minerals of igneous rocks of the northern Urals and Timan: Nauka, Leningrad, p. 1–251. [In Russian.]

Fleischer, Michael, 1978, Relation of the relative concentration of lanthanides in titanite to type of host rocks: American Mineralogist, v. 63, p. 869–875.

Fleischer, Michael, and Altschuler, Z.S., 1969, Relationship of the rare-earth composition of minerals to geological environment: Geochimica et Cosmochimica Acta, v. 33, p. 725–732.

———1986, The lanthanides and yttrium in minerals of the apatite group—An analysis of the available data: Neues Jahrbuch Mineralogie, Monatshefte 1986, p. 467–480.

Flinter, B.H., Butler, J.R., and Harral, G.M., 1963, A study of alluvial monazite from Malaysia: American Mineralogist, v. 48, p. 1210–1226.

Foord, E.E., Fitzpatrick, J.J., Crock, J.G., and Lichte, F.E., 1993, A further re-examination of cheralite, (LREE,Ca,Th,U)(P,Si)O_4, from the type locality: Trends in Mineralogy, Research Trends, Trivandrum, India, p. 103–105.

Fujii, Isao, 1961, Distribution of rare-earth elements in rare-earth minerals from Japan, Korea, and northeastern China: Journal of the Mineralogical Society of Japan, v. 5, p. 167–180. [In Japanese; abstract in Mineralogical Abstracts, v. 16, p. 50 (1963).]

Gavrilova, L.K., and Turanskaya, R.V., 1958, Distribution of rare earths in rock-forming and accessory minerals of certain granites: Geokhimiia 1958, p. 124–129. [In Russian; translation in Geochemistry 1958, p. 163–170.]

Graeser, Stefan, and Schwander, Hans, 1987, Gasparite-(Ce) and monazite-(Nd)—Two new minerals of the monazite group from the Alps: Schweizerische Mineralogische und Petrographische Mitteilungen, v. 67, p. 103–117.

Gramaccioli, C.M., and Segelstad, T.V., 1978, A uranium- and thorium-rich monazite from a South-Alpine pegmatite at Fiona, Italy: American Mineralogist, v. 63, p. 757–761.

Haapala, Ilmeri, Ervamaa, Pentti, Lofgren, Arvo, and Ojanpera, Pentti, 1969, An occurrence of monazite in Puumala, eastern Finland: Bulletin of the Geological Society of Finland, v. 41, p. 117–124.

Hammond, R.F., 1946, Technology and uses of monazite sand: American Institute of Mining and Metallurgical Engineers, Mining Technology, v. 10, Technical Publication 2037, p. 1–5.

Hedrick, J.B., 1988, Availability of rare earths: Ceramic Bulletin, v. 67, p. 858–861.

Heinrich, E.W., Borup, R.A., and Levinson, A.A., 1960, Relationships between geology and compositions of some pegmatitic monazites: Geochimica et Cosmochimica Acta, v. 19, p. 222–231.

Heinrich, E.W., and Levinson, A.A., 1961, Carbonatitic niobium-rare-earth deposits, Ravalli County, Montana: American Mineralogist, v. 46, p. 1424–1447.

Heinrich, E.W., and Wells, R.G., 1980, The diversity of rare-earth mineral deposits and their geological domains, *in* McCarthy, G.J., and Rhyne, J.J., eds., The rare earths in modern science and technology: New York-London, Plenum Press, p. 511–516.

Holt, D.M., 1965, The Kangankunde Hill rare-earth prospect, Malawi: Malawi Geological Survey Bulletin 20, p. 1–130. [Abstract in Mineralogical Abstracts, v. 17, p. 369 (1965).]

Hugo, P.J., 1970, The pegmatites of the Kenhardt and Gordonia districts, Cape Province: South Africa Department of Mines, Geological Survey Memoir 58, p. 1–94.

Hwang, Jon-Mau, Shih, Jeng-Shang, Yeh, Yu-Chai, and Wu, Shaw-Chii, 1981, Determination of rare-earths in monazite sand and rare-earth impurities in high-purity rare earth oxides, by high-performance liquid chromatography: Analyst (London), v. 106, p. 869–873.

Ivantishin, M.N., Kul'skaya, C.A., Gornyi, G.Ya., and Eliseeva, G.D., 1964, Geochemistry and analytical chemistry of the cerium sub-group in rare-earth elements; Part 1, Accessory rare-earth minerals and elements of the Ukrainian crystalline shield: Akademiia Nauk Ukrainian S.S.R., Seriia Petrografiia, Mineralogiia, Geokhimiia, no. 21, p. 1–168. [In Russian.]

Jefferies, N.L., 1985, The distribution of the rare-earth elements within The Carnmenellis pluton, Cornwall: Mineralogical Magazine, v. 49, p. 495–504.

Jobbins, E.A., Tresham, A.E., and Young, B.R., 1977, Gem monazite from Sri Lanka: Journal of Gemology, v. 15, p. 295–297.

Kalenov, A.D., Anikeev, V.I., and Sokova, E.P., 1963, A case of complex replacement of loparite: Akademiia Nauk S.S.S.R. Doklady, v. 152, p. 183–186. [In Russian.]

Kalita, A.P., 1961, Rare-earth pegmatites of Alakutti and the Ladoga region: Akademiia Nauk S.S.S.R., Institut Mineralogiia, Geokhimii, Kristallokhimii Redkikh Elementov, p. 1–118. [In Russian.]

———1969, Features of the distribution of lanthanides and yttrium in rare-earth granitic pegmatites of the eastern part of the Baltic Shield, *in* Features of the distribution of rare earths in pegmatites: Nauka, Moscow, p. 79–100. [In Russian.]

Kapustin, Yu.L., 1966, Geochemistry of rare-earth elements in carbonatites: Geokhimiia 1966, p. 1311–1321. [In Russian; translation in Geochemistry International, v. 3, no. 6, p. 1054–1064.]

———1986, Rare-metal mineralization in late carbonatites of the Novopoltov massif: Novye Dannye Mineralogiia, v. 33, p. 43–52. [In Russian.]

Khamrabaev, I.Kh., and Azimov, P.T., 1964, Rare-earth and niobotantalate accessory minerals in granites and pegmatites of the Aktau massif, western Uzbekistan: Akademiia Nauk Uzbekskoi S.S.R., Tashkent, Institut Geologiia i Geofiziki, Voprosy Mineralogiiai Geokhimii, p. 172–183. [In Russian.]

Khomyakov, A.P., 1964, Distribution of rare-earth elements in carbonate-hematite veins of western Tannu-Ola: Geokhimiia 1964, p. 85–88. [In Russian; translation in Geochemistry International 1964, p. 50–53.]

Kirillov, A.S., and Ryzhova, R.I., 1968, Geochemistry of rare-earth elements in carbonatites of the Karelian-Kola Province: Leningrad University, Mineralogiiai, Geokhimiya, v. 3, p. 87–97. [In Russian.]

Komov, I.L., Mel'nikova, E.M., and Kokarev, G.N., 1974, Some typomorphic features of accessory monazite from hydrothermal quartz veins and altered rocks of Pamir and the Urals: Akademiia Nauk S.S.S.R. Mineralogicheskii Muzei Trudy, Moscow, v. 23, p. 87–93. [In Russian.]

Kornetova, V.A., 1963, Association of ilmenorutile and monazite in Siberian pegmatites: Akademiia Nauk S.S.S.R. Mineralogiia Muzei Trudy, Moscow v. 14, p. 96–107. [In Russian.]

Kornetova, V.A., and Kazakova, M.E., 1982, Monazite and its association in some pegmatites of Siberia: Novye Dannye Mineralogiia, v. 30, p. 191–194. [In Russian.]

Kornetova, V.A., and Osolodkina, G.A., 1966, Aquamarine from crystal-bearing pegmatite and monazite deposited in cavities of its leaching: Akademiia Nauk S.S.S.R. Mineralogiia Muzei Trudy, Moscow v. 17, p. 216–220. [In Russian.]

Kosterin, A.V., Alekhine, K.N., and Kizyura, V.E., 1962, Monazite of unusual genesis: Akademiia Nauk S.S.S.R., Dalnevostochniyi Filial, Vladivostok, Soobshcheniia, no. 15, p. 23–26. [In Russian.]

Kosterin, A.V., and Zuev, V.N., 1962, Hydrothermal huttonite: Vsesoiuznoe Mineralogicheskoe Obshchestvo Zapiski, v. 91, p. 99–102. [In Russian.]

Kostin, N.E., and Volzhenkova, A.Ya., 1965, The effect of country rock on the composition of rare-earth mineralization: Geologiia Rudnykh Mestorozhdenii, v. 7, no. 1, p. 95–98. [In Russian.]

Kovalenko, V.I., and others, 1971, Rare-metal granitic rocks of Mongolia: Nauka, Moscow, p. 1–230. [In Russian.]

Kucha, Henryk, 1980, Continuity in the monazite-huttonite series: Mineralogical Magazine, v. 43, p. 1031–1034.

Kukharenko, A.A., Bulakh, A.G., and Baklanova, K.A., 1961, Sulfate-monazite from carbonatites of the Kola Peninsula: Vsesoiuznoe Mineralogicheskoe Obshchestvo Zapiski, v. 90, p. 373–381. [In Russian.]

Kupriyanova, I.I., Volkova, M.I., and Goroshchenko, Z.I., 1964, Rare-earth minerals of a molybdenum deposit in the European part of the U.S.S.R.: Akademiia Nauk S.S.S.R. Mineralogicheskii Muzei Trudy, Moscow, v. 15, p. 123–133. [In Russian.]

Kuts, V.P., 1966, Features of the distribution, morphology, and composition of accessory monazites from crystalline rocks of the Azov region, Mineralogicheskii Sbornik (L'vov University), v. 20, p. 279–284. [In Russian.]

Kuznetsova, I.N., Rozinova, E.L., and Mishchenko, K.S., 1980, Accessory rare-earth mineralization in dolomite-ankerite carbonatites and their weathering crusts in the northern Siberian platform, *in* Alkalic magmatism and apatite-bearing of northern Siberia: Nauchno-issledovatel'skii Institut Geologiia Arktikii, Leningrad, p. 101–111. [In Russian.]

Lazarenko, E.K., and others, 1980 [1981], Mineralogy of the Azov region, Kiev: Nauk Dumka, p. 1–430. [In Russian.]

Lee, D.E., and Bastron, Harry, 1967, Fractionation of rare-earth elements in allanite and monazite as related to geology of the Mt. Wheeler mine area, Nevada: Geochimica et Cosmochimica Acta, v. 31, p. 339–356.

Leonova, V.A., and Nikitin, Yu.V., 1962, Mineralogy of monazites of pegmatitic vein of Chupa: Vsesoiuznoe Mineralogischeskoe Obshchestvo Zapiski, v. 91, p. 136–145. [In Russian.]

Levinson, A.A., 1966, A system of nomenclature for rare-earth minerals: American Mineralogist, v. 51, p. 152–158.

Li, A.F., and Grebennikova, C.T., 1962, Low-thorium monazite: Vsesoiuznoe Mineralogicheskoe Obshchestvo, Vostochno-Sibirskoe Otdelenie Zapiski, Irkutsk, no. 4, p. 155–161. [In Russian.]

Lozinski, Jan, 1969, The chemical composition of monazites from beach sands of the Baltic Sea: Polska Akademiia Nauk, Kom. Nauk Mineralogiia, Prace Mineralogiia, no. 16, p. 43–49. [In Polish with English summary.]

L'vov, B.K., 1965, Petrology, mineralogy, and geochemistry of granitic rocks of the Kochkarsk region, Urals: Leningradskii Gosudarstvennyi Universitet, p. 1–164. [In Russian.]

L'vov, B.K., and Zhangurov, A.A., 1968, Accessory monazite from granites and metamorphic rocks of the eastern Ural anticlinorium, *in* Accessory minerals of igneous rocks: Nauka, Moscow, p. 196–204. [In Russian.]

Lyakhovich, V.V., 1962, Rare-earth elements in accessory minerals of granitic rocks: Geokhimiia 1962, p. 37–52. [In Russian; translation in Geochemistry 1962, p. 39–55.]

———1967, Features of the distribution of the rare-earth elements between accessory minerals of granites: Geokhimiia 1967, p. 828-833. [In Russian; translation in Geochemistry International 1967, p. 691–695.]

———1968, Accessory minerals, their genesis, composition, classification, and indicator characteristics: Nauka, Moscow, p. 1–276. [In Russian.]

Lyakhovich, V.V., and Balanova, T.T., 1971, Averge contents and composition of rare-earth elements in accessory minerals of granitic rocks: Geokhimiia, v. 2, p. 131–143. [In Russian.]

Lyakhovich, V.V., and Barinskii, R.L., 1961, Features of the composition of rare earths in accessory minerals of granitic rocks: Geokhimiia 1961, p. 467–479. [In Russian; translation in Geochemistry 1961, p. 495–509.]

Lyakhovich, V.V., and Kasaeva, T.A., 1968, Accessory minerals and correlation of intrusive rocks: Mineralogiicheskii Sbornik (L'vov University), v. 22, p. 132–138. [In Russian.]

Maksimovich, Zoran, and Panto, Gyorgy, 1980, Bastnaesite-(La) and monazite-(Nd)—A new variety of monazite from the Marmara bauxite deposit, Greece: Srpska Akademija Nauka i Umetnosti, Belgrade, Odeljenje Prirodno-Matematickih Nauka, Bulletin, v. 72, no. 20, p. 35–42. [Abstract in American Mineralogist, v. 68, p. 849 (1983).]

———1983, Mineralogy of yttrium and lanthanide elements in karstic bauxite: Travaux Comite Internationale Etude Bauxites, Alumine, et Aluminum, v. 13, p. 191–200. [In English.]

Mannucci, Gregorio, Dielle, Valeria, Gramaccioli, C.M., and Pilati, Tullio, 1986, A comparative study of some pegmatitic and fissure monazite from the Alps: Canadian Mineralogist, v. 24, p. 469–474.

Marchenko, E.Ya., 1967, Certain characteristics of accessory monazite from Precambrian crystalline rocks in southeastern Ukrainian S.S.R.: Akademiia Nauk S.S.S.R., Doklady, v. 176, p. 153–155. [In Russian; translation in Doklady Academy Science, U.S.S.R., Earth Science Series, v. 176, p. 142–145.]

Marchenko, E.Ya., and Goncharova, E.I., 1964, Role of halides in the formation and subsequent alteration of pneumatolytic-hydrothermal monazite: Akademiia Nauk S.S.S.R., Doklady, v. 155, p. 349–352. [In Russian.]

McCarty, C.N., 1935, The quantitative estimation of some of the rare-earth ores by means of their arc spectra: Urbana, University of Illinois, Ph.D. thesis, p. 1–8.

McKie, Duncan, 1962, Goyazite and florencite from two African carbonatites: Mineralogical Magazine, v. 33, p. 281–287.

Meliksetyan, B.M., 1963, The geochemistry of yttrium and the rare earths in granitic rocks of the Megri pluton: Akademiia Nauk Armianskoi S.S.R., Yerevan, Geologicheskie i Geograficheskie Nauki, Izvestiia, v. 16, no. 3, p. 45–49. [In Russian.]

Michael, P.J., 1988, Partition coefficients for rare-earth elements in mafic minerals of high silica rhyolites—The importance of accessory mineral inclusions: Geochimica et Cosmochimica Acta, v. 52, p. 275–282.

Mineev, D.A., 1963, Geochemical differentiation of the rare-earth elements: Geokhimiia 1963, p. 1082–1100. [In Russian; translation in Geochemistry 1963, p. 1129–1149.]

———1968, Geochemistry of apogranites and rare-earth metasomatites of northwestern Tarbagatau, eastern Kazakhstan: Institut Mineralogiia, Geokhimii, Kristallokhimii, Redkikh Elementov, Nauka, Moscow, p. 1–183. [In Russian.]

Mineev, D.A., Makarochkin, B.A., and Zhabin, A.G., 1962, Study of the behavior of lanthanides in the process of alteration of rare-earth minerals: Geokhimiia 1962, no. 6, p. 590–597. [In Russian.]

Mittelfehldt, D.W., and Miller, C.F., 1983, Geochemistry of the Sweetwater Wash pluton, California—Implications for "anomalous" trace element behavior during differentiation of felsic magma: Geochimica et Cosmochimica Acta, v. 47, p. 109–124.

Mohr, D.A., 1984, Zoned porphyroblasts of metamorphic monazite in the Anakeeste Formation, Great Smoky Mountains, North Carolina: American Mineralogist, v. 69, p. 292–300.

Murata, K.J., Dutra, C.V., Teiseira da Costa, M., and Branco, J.J.R., 1958, Composition of monazites from pegmatites in eastern

Minas Gerais, Brazil: Geochimica et Cosmochimica Acta, v. 16, p. 1–14.

Murata, K.J., Rose, H.J., Jr., and Carron, M.K., 1953, Systematic variation of rare earths in monazite: Geochimica et Cosmochimica Acta, v. 4, p. 292–300.

Murata, K.J., Rose, H.J., Jr., Carron, M.K., and Glass, J.J., 1957, Systematic variation of rare earths in cerium-earth minerals: Geochimica et Cosmochimica Acta, v. 11, p. 141–151.

Nedashkovskii, P.G., Lagovskaya, E.A., and Demchenko, V.S., 1969, Principles of a change in the composition of rare earth elements in accessory minerals of alkaline granites and related alkaline metasomatites: Akademiia Nauk S.S.R., Dal'nevostockniyi Filial, Vladivostok, Dal'nevostochnyi Geologicheskii Institut, Geokhimicheskie Tsikly Dal'nego Vostoka, p. 29–36. [In Russian; abstract in Chemical Abstracts, v. 73, no. 24, 122523 (1970).]

Nekrasov, I.Ya., 1972, New data on a mineral of the monazite-cheralite-huttonite group: Akademiia Nauk S.S.S.R. Doklady, v. 204, p. 941–943. [In Russian.]

Nekrasova, R.A., and Nekrasov, I.Ya., 1983, Kularite as an authigenic variety of monazite: Akademiia Nauk S.S.S.R. Doklady, v. 268, p. 688–693. [In Russian.]

Orsa, V.I., Eliseeva, G.D., and Kazantseva, A.I., 1967, Rare-earth assemblages in the accessory minerals of the ancient crystalline rocks of the Middle Dneipr region: Geokhimiia 1967, p. 243–247. [In Russian; translation in Geochemistry International, v. 4, no. 1, p. 170–173 (1967).]

Papunen, Heikki, and Lindsjo, O., 1972, Apatite, monazite, and allanite—Three rare-earth minerals from Koranas, Finland: Bulletin of the Geological Society of Finland, v. 44, p. 123–129.

Pavlenko, A.S., Orlova, L.P., and Akhmanova, N.V., 1966, Cerphosphorhuttonite—A mineral of the monazite group: Akademiia Nauk S.S.S.R. Mineralogicheskii Muzei Trudy, Moscow, v. 16, p. 166–174. [In Russian.]

Pavlenko, A.S., Vainshtein, E.E., and Turanskaya, N.V., 1959, Certain regularities in the behavior of rare earths and yttrium in magmatic and post-magmatic processes: Geokhimiia 1959, p. 291–309. [In Russian; translation in Geochemistry 1959, p. 357–380.]

Plaksenko, A.N., Frolov, S.M., and Polezhaeva, L.I., 1982, The genesis of monazite from basic rocks: Akademiia Nauk S.S.S.R. Doklady, v. 264, p. 693–697. [In Russian.]

Ploshko, V.V., 1961, Pneumatolytic-hydrothermal monazite of Malaya Laba River, northern Caucasus: Akademiia Nauk S.S.S.R. Izvestiia, Seriia Geologicheskaia, Moscow, 1961, no. 1, p. 86–93. [In Russian.]

Ploshko, V.V., and Knyazeva, D.N., 1965, Rare earths, yttrium, and thorium in post-magmatic processes of acidic intrusions of the Urushten complex, northern Caucasus, *in* Accessory elements as criteria of the comagmatic metallogenic specialization of magmatic complexes: Nauka, Moscow, p. 146–152. [In Russian.]

Pluhar, Emanuel, 1979, Geochemistry of monazites from Thailand and its application to prospecting for tin ores: Berliner Geowissenschaftlichen Abhandlungen, ser. A, no. 12, p. 1–53. [In German.]

Povilaitis, M.M., and Varshal, G.M., 1959, Some typomorphic features of accessory monazite from intrusive and post-magmatic formations of the Kuu Granitic massif, central Kazakstan, *in* Typomorphic minerals: Nauka, Moscow, p. 195–209. [In Russian.]

Proshchenko, E.G., 1967, Rare-earth minerals from albitites of Eastern Siberia, *in* Mineralogy of hydrothermalites of alkalic massifs: Nauka, Moscow, p. 103–136. [In Russian.]

Rapp, R.P., and Watson, E.B., 1986, Monazite solubility and dissolution kinetics—Implications for the thorium and light rare earth chemistry of felsic magmas: Contributions to Mineralogy and Petrology, v. 94, p. 304–316.

Richartz, W., 1961, Crystal chemical study and magnetic treatment of monazite: Fortschritt Mineralogie, v. 39, p. 53–59. [In German.]

Rose, H.J., Jr., Blade, L.V., and Ross, Malcolm, 1958, Earthy monazite from Magnet Cove, Arkansas: American Mineralogist, v. 43, p. 995–997.

Rosenblum, Sam, 1974, Analyses and economic potential of monazite in Liberia: U.S. Geological Survey Journal of Research, v. 2, no. 6, p. 689–692.

Rosenblum, Sam, and Mosier, E.L., 1983, Mineralogy and occurrence of europium-rich dark monazite: U.S. Geological Survey Professional Paper 1181, p. 1–67.

Sahama, T.G., and Vahatalo, Veikko, 1939, The rare-earth content of wiikite: Finland Geologinen Tutkimuslaitos Bulletin, no. 125, p. 97–109.

———1941, X-ray spectroscopic study of rare earths in some Finnish eruptive rocks and minerals: Bulletin Commission Geol. Finlande 126, p. 50–83.

Semenov, E.I., 1963, Mineralogy of the rare earths: Akademiia Nauk S.S.S.R., Moscow, p. 1–412. [In Russian.]

———1969, Mineralogy of the alkalic massif of Ilimaussaq, Greenland: Institut Mineralogiia, Geokhimii, Kristallokhimii Redkikh Elementov, Nauka, Moscow, p. 1–165. [In Russian.]

Semenov, E.I., and Barinskii, R.L., 1958, Characteristics of the composition of rare earths in minerals: Geokhimiia 1958, p. 314–333. [In Russian; translation in Geochemistry 1958, p. 398–419.]

Semenov, E.I., and Khomyakov, A.F., 1981, Magnetic susceptibility of rare-earth minerals: Diagnostika i Diagnosticheskie Svoistva Mineralov, p. 88–93. [In Russian; abstract in Chemical Abstracts, 1982, v. 97, no. 6, p. 41642.]

Semenov, E.I., Kostyunina, L.P., and Kulakov, M.P., 1967, Rare-earth accessory mineralizations in quartz-fluorite pegmatites of Kazakhstan, *in* Mineralogy of pegmatites and hydrothermalites of alkalic massifs: Nauka, Moscow, p. 137–149. [In Russian.]

Semenov, E.I., Upendran, R., and Subramanian, V., 1978, Rare-earth minerals of carbonatites of Tamil Nadu, India: Journal of the Geological Society of India, v. 19, p. 550–557.

Serdyuchenko, D.P., and Kochetkov, C.S., 1974, Metasedimentary monazite in the Riphaean shales of Timan: Akademiia Nauk S.S.S.R. Doklady, v. 218, p. 1175–1177. [In Russian.]

Serdyuchenko, D.P., Pap, A.N., Borkovskaya, V.N., and Bykova, A.N., 1967, A thorium-free monazite from Precambrian gneisses of Byelorussia and its genesis: Akademiia Nauk S.S.S.R. Doklady, v. 175, p. 917–919. [In Russian.]

Shiryayeva, V.A., 1971, Distribution factors of rare-earth elements in accessory minerals of muscovite pegmatite, *in* Geochemistry of Siberian pegmatites: Nauka, Moscow, p. 102–111. [In Russian.].

Shlyukova, Z.V., 1986, Mineralogy of contact formations of the Khibina massif, Kola Peninsula: Nauka, Moscow, p. 1–96. [In Russian.]

Shmakin, B.M., and Shiryayeva, V.A., 1970, The composition of rare-earth minerals in muscovite pegmatites of eastern Siberia: Geokhimiia 1970, p. 163–168. [In Russian.]

Shukolyukov, Yu.A., Kapusta, Ya.S., Verkhovskii, A.B., Matukov, D.I., and Timokhina, L.A., 1979, Xenon from spontaneous and neutron-induced fission of uranium in monazite: Geokhimiia 1979, p. 672–685 . [In Russian.]

Smirnov, G.I., 1969, Accessory monazite from Riphaean sediments of the Middle Pre-Dniester area: Mineralogicheskii Sbornik (L'vov University), v. 23, p. 85–91. [In Russian.]

Somina, M.Ya., and Bulakh, A.G., 1966, Florencite from carbonatites of eastern Sayan and some problems of the chemical constitution of the Crandallite group: Vsesoiuznoe Mineralogicheskoe Obshchestvo Zapiski, v. 95, p. 537–550. [In Russian.]

Soong, Kuo-Liang, 1978, The genesis of the black monazite from Taiwan: Acta Oceanographica Taiwanica, no. 8, p. 43–62.

Styles, M.T., and Young, E.R., 1983, Fluocerite and its alteration products from the Afa Hills, Nigeria: Mineralogical Magazine, v. 47, p. 41–46.

Trace, R.D., 1960, Significance of unusual mineral occurrence at Hicks Dome, Hardin County, Illinois: U.S. Geological Survey Professional Paper 400–B, p. 63–64.

Vainshtein, E.E., Pozharitskaya, L.K., and Turanskaya, N.V., 1961, The behavior of rare earths in the process of formation of carbonatites: Geokhimiia 1961, p. 1031–1034. [In Russian; translation in Geochemistry 1961, p. 1151–1154.]

Vainshtein, E.E., Tugarinov, A.I., and Turanskaya, N.V., 1955, The distribution of rare earths in monazites: Akademiia Nauk S.S.S.R. Doklady, v. 104, p. 268–271. [In Russian.]

———1956a, Distribution of rare earths in granitic monazites: Akademiia Nauk S.S.S.R. Doklady, v. 106, p. 691–692. [In Russian.]

———1956b, Regularities in the distribution of rare earths in certain minerals: Geokhimiia 1956, p. 35–56. [In Russian; translation in Geochemistry 1956, p. 159–178.]

Van Wambeke, L., 1977, The Karonge rare-earth deposits, Republic of Burundi—New mineralogical geochemical data, and origin of the mineralization: Mineralium Deposita, v. 12, p. 373–380.

Vaquero, Nazabal, C., 1979, Discovery, for the first time in Spain, of an abnormal facies monazite containing europium: Boletín Geológico Minero, v. 90, p. 374–379. [In Spanish.]

Vetoshkina, A.M., Gordienko, V.V., Elina, N.A., and Polezhaeva, L.I., 1980, Yttrofluorite and accompanying rare-earth minerals of amazonite pegmatites of Ploskaya Mountain, Kola Peninsula: Mineralogicheskii Zhurnal, Kiev, v. 2, no. 4, p. 51–58. [In Russian.]

Vinogradov, A.N., and Elina, N.A., 1968, Distribution of rare earths in granitic rocks of the northwestern part of the Kola Peninsula: Materialy po Mineralogiia Kol'skogo Poluostrova, Leningrad, v. 6, p. 80–92. [In Russian.]

Vladykin, N.V., Smirnova, E.V., and Kovalenko, V.I., 1982, Rare-earth elements in minerals of Mongolia, *in* Geochemistry of rare elements in endogenic processes: Nauka, Sibirskoe Otedelenie, Novosibirsk, p. 178–205. [In Russian.]

Vlasov, K.A., ed., 1964, Geochemistry and mineralogy of rare elements and genetic types of their deposits [2 volumes]: English translation by Israel Program for Scientific Translations, Jerusalem, v. 1, 688 p., v. 2, 945 p.

Wang, Kianjue, 1078, A new mineral—Liangaitukuang [brabantite]: Kexue Tonbao, v. 23, p. 743–745. [In Chinese.]

Wells, R.G., 1977, Light lanthanoid partitioning in rocks and minerals containing rare earths, *in* McCarthy, G.J., and Rhyne, J.J., eds, The rare earths in modern science and technology: New York and London, Plenum Press, p. 253–258.

White, J.S., and Nelen, J.E., 1987, Monazite and calcioancylite from the Foote Mine, North Carolina: Mineralogical Record, v. 16, p. 203–220.

Wylie, A.M., 1950, Composition of some Australian monazites: Australian Journal of Applied Science, v. 1, p. 164–171.

Yalovenko, I.P., and Yur'yeva, A.L., 1967, Accessory monazites in rocks of the Novo-Ukraine massif: Mineralogicheskii Sbornik (L'vov University), v. 21, p. 299–304. [In Russian.]

Zayats, A.P., and Kuts, V.F., 1964, Rare-earth elements in accessory minerals of gneisses of the Ukrainian crystalline shield: Geokhimiia 1964, p. 1209–1211. [In Russian.]

Zemel', V.K., 1936, Analyses of monazite from the gold placers of Aldan and southern Yenisei: Zhurnal Prikladnoi Khimii, v. 9, p. 1969–1971. [In Russian.]

Zhabin, A.G., and Svyazhin, N.V., 1962, Concentrically zoned aggregates of rare-earth earth minerals from the alkalic complex of Vishnevye Mountain: Institut Mineralogiia, Geokhimii, i Kristallokhimii Redkikh Elementov Trudy, Moscow, v. 9, p. 55–56. [In Russian.]

Zhang, Pei-Shan, and Tao, Kejie, 1986, Bayan-Obo mineralogy: Beijing, Ko Hsueh International Publishing, p. 1–208. [In Chinese with English summary.]

Zhirov, K.K., Bandurkin, G.A., and Lavrent'ev, Yu.G., 1961, Geochemistry of rare-earth elements in pegmatites of northern Karelia: Geokhimiia 1961, p. 991–1004. [In Russian; translation in Geochemistry 1961, p. 1107–1118.]

Znamenskii, E.S., Rekholainen, G.I., Popolitov, E.I., and Flerova, K.V., 1967, Geochemistry of rare earths in Proterozoic granitic rocks of Eastern Sayan: Geologiia i Geofizika, Novosibirsk, 1967, no. 2, p. 137–140. [In Russian.]

Zuev, V.N., and Kosterin, A.V., 1961, Xenotime from a hydrothermal mineralization in central Asia: Akademiia Nauk S.S.S.R. Mineralogicheskii Muzei Trudy, Moscow, v. 12, p. 208–211. [In Russian.]

Published in the Central Region, Denver, Colorado
Manuscript approved for publication June 13, 1995
Edited by Judith Stoeser
Graphics by Dennis L. Welp
Photocomposition by Joan Nadeau
Table composition by Judith Stoeser

☆ U.S. GOVERNMENT PRINTING OFFICE: 1995 - 673-046 / 20003 REGION NO. 8

SELECTED SERIES OF U.S. GEOLOGICAL SURVEY PUBLICATIONS

Periodicals

Earthquakes & Volcanoes (issued bimonthly).

Preliminary Determination of Epicenters (issued monthly).

Technical Books and Reports

Professional Papers are mainly comprehensive scientific reports of wide and lasting interest and importance to professional scientists and engineers. Included are reports on the results of resource studies and of topographic, hydrologic, and geologic investigations. They also include collections of related papers addressing different aspects of a single scientific topic.

Bulletins contain significant data and interpretations that are of lasting scientific interest but are generally more limited in scope or geographic coverage than Professional Papers. They include the results of resource studies and of geologic and topographic investigations; as well as collections of short papers related to a specific topic.

Water-Supply Papers are comprehensive reports that present significant interpretive results of hydrologic investigations of wide interest to professional geologists, hydrologists, and engineers. The series covers investigations in all phases of hydrology, including hydrology, availability of water, quality of water, and use of water.

Circulars present administrative information or important scientific information of wide popular interest in a format designed for distribution at no cost to the public. Information is usually of short-term interest.

Water-Resources Investigations Reports are papers of an interpretive nature made available to the public outside the formal USGS publications series. Copies are reproduced on request unlike formal USGS publications, and they are also available for public inspection at depositories indicated in USGS catalogs.

Open-File Reports include unpublished manuscript reports, maps, and other material that are made available for public consultation at depositories. They are a nonpermanent form of publication that may be cited in other publications as sources of information.

Maps

Geologic Quadrangle Maps are multicolor geologic maps on topographic bases in 7 1/2- or 15-minute quadrangle formats (scales mainly 1:24,000 or 1:62,500) showing bedrock, surficial, or engineering geology. Maps generally include brief texts; some maps include structure and columnar sections only.

Geophysical Investigations Maps are on topographic or planimetric bases at various scales, they show results of surveys using geophysical techniques, such as gravity, magnetic, seismic, or radioactivity, which reflect subsurface structures that are of economic or geologic significance. Many maps include correlations with the geology.

Miscellaneous Investigations Series Maps are on planimetric or topographic bases of regular and irregular areas at various scales; they present a wide variety of format and subject matter. The series also includes 7 1/2-minute quadrangle photogeologic maps on planimetric bases which show geology as interpreted from aerial photographs. The series also includes maps of Mars and the Moon.

Coal Investigations Maps are geologic maps on topographic or planimetric bases at various scales showing bedrock or surficial geology, stratigraphy, and structural relations in certain coal-resource areas.

Oil and Gas Investigations Charts show stratigraphic information for certain oil and gas fields and other areas having petroleum potential.

Miscellaneous Field Studies Maps are multicolor or black-and-white maps on topographic or planimetric bases on quadrangle or irregular areas at various scales. Pre-1971 maps show bedrock geology in relation to specific mining or mineral-deposit problems; post-1971 maps are primarily black-and-white maps on various subjects such as environmental studies or wilderness mineral investigations.

Hydrologic Investigations Atlases are multicolored or black-and-white maps on topographic or planimetric bases presenting a wide range of geohydrologic data of both regular and irregular areas; the principal scale is 1:24,000, and regional studies are at 1:250,000 scale or smaller.

Catalogs

Permanent catalogs, as well as some others, giving comprehensive listings of U.S. Geological Survey publications are available under the conditions indicated below from USGS Map Distribution, Box 25286, Building 810, Denver Federal Center, Denver, CO 80225. (See latest Price and Availability List.)

"Publications of the Geological Survey, 1879-1961" may be purchased by mail and over the counter in paperback book form and as a set microfiche.

"Publications of the Geological Survey, 1962-1970" may be purchased by mail and over the counter in paperback book form and as a set of microfiche.

"Publications of the U.S. Geological Survey, 1971-1981" may be purchased by mail and over the counter in paperback book form (two volumes, publications listing and index) and as a set of microfiche.

Supplements for 1982, 1983, 1984, 1985, 1986, and for subsequent years since the last permanent catalog may be purchased by mail and over the counter in paperback book form.

State catalogs, "List of U.S. Geological Survey Geologic and Water-Supply Reports and Maps For (State)," may be purchased by mail and over the counter in paperback booklet form only.

"Price and Availability List of U.S. Geological Survey Publications," issued annually, is available free of charge in paperback booklet form only.

Selected copies of a monthly catalog "New Publications of the U.S. Geological Survey" is available free of charge by mail or may be obtained over the counter in paperback booklet form only. Those wishing a free subscription to the monthly catalog "New Publications of the U.S. Geological Survey" should write to the U.S. Geological Survey, 582 National Center, Reston, VA 22092.

Note.–Prices of Government publications listed in older catalogs, announcements, and publications may be incorrect. Therefore, the prices charged may differ from the prices in catalogs, announcements, and publications.