

GY343 Petrology Problem: REE Fractionation

Problem Description

Below are REE analyses taken from an Island Arc complex of igneous rocks. Also included is the average REE chondritic abundances, and the values for MORB:

REE	Chondrite	MORB	Arc Tholeiite	Peridotite	Alkali basalt
La	0.330	3.20	49.50	0.76	5.02
Ce	0.880	11.70	105.60	6.76	14.17
Pr	0.112	1.33	12.32	0.75	1.62
Nd	0.600	7.90	60.00	5.16	12.12
Sm	0.181	2.44	12.67	1.90	3.42
Eu	0.069	0.91	0.14	0.95	1.01
Gd	0.249	3.34	4.48	3.28	3.76
Tb	0.047	0.58	0.47	0.59	0.79
Ho	0.070	0.93	0.49	0.95	1.03
Er	0.200	2.70	1.20	2.78	2.82
Tm	0.030	0.42	0.09	0.44	0.40
Yb	0.200	2.50	0.40	2.61	3.10
Lu	0.034	0.44	0.03	0.46	0.50

All values above are in ppm. Field relations exposed in the Arc complex suggest that the peridotite may be the restite material produced from fractional crystallization of the subducted ocean lithosphere. Additionally, the Arc Tholeiite or Alkali Basalt or both may be derived from the residual melt produced by fractional crystallization. Assume that the MORB represents the original slab REE abundance.

Products

For this problem, produce or answer the following:

(1) Produce the standard REE histogram (“spidergram”) using a spreadsheet program. Plot all of the above compositions on the graph. Print a hard copy of the graph to turn in. The Y-axis should be scaled in log units from 1 to 1000. Label the plot with a title and axes labels. Turn on the legend feature of the spreadsheet graph module. Use different marker symbols for each sample.

(2) Using the above abundances and your plot from (1), interpret the data in terms of whether or not the Arc Tholeiite or Alkali basalt could be related to the peridotite via fractional crystallization of a MORB magma. Use the following relationship to test your hypothesis:

$$(ppm_source) = (ppm_melt)(x) + (ppm_restite)(1 - x)$$

Where x is the proportion of melt. The value of x should be consistent throughout the REE if the

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assumption that the melt, restite, and source are related by fractionation is correct. A more algebraically useful form of the above equation is below:

$$(x) = \frac{(ppm_source) - (ppm_resite)}{(ppm_melt) - (ppm_restite)}$$

I encourage you to calculate within the spreadsheet itself rather than by hand. You will be provided with a spreadsheet template file to begin this problem on designated workstations. Please make your own directory, and copy the template to that directory.

(3) Print the spreadsheet “numbers” with your numerical check included. Include a paragraph explaining why or why not the basalts are related to the peridotite.