The Geochemistry and Petrology of Ptarmigan Lake, Colorado

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The Ptarmigan Lake pluton is located in the central Sawatch Mountain Range, Colorado. It is has been previously documented as part of the larger Kroenke Granodiorite pluton, which is Boulder Creek in age; that is, approximately 1.7 b.y. old (Barker, Arth, Peterman, and Friedman, 1976).

Geomorphologically, the Ptarmigan Lake region is a large cirque, approximately a mile in diameter. Interlayered amphibolites and felsites form the south wall as well as the southern end of the east and west walls of the cirque. These interlayers are probably the result of bimodal volcanism, but because of metamorphism, all primary structures have been obliterated. The layers are generally weakly to moderately foliated and often lineated as well.

The boundary between the pluton and the country rock is partly conformable which brings up the question of anatexis. Could the Ptarmigan Lake pluton have formed by melting of the felsic interlayers? The process of anatexis refers to any process that produces a melt of some proportion less than the whole (Best, 1982). The presence of amphibolite xenoliths as well as the pluton's conformable boundary with the wall rocks suggests there is ample reason to hypothesize that anatexis may have occurred. After sampling the wall rocks (especially the felsite layers) as well as the pluton, data was gathered from thin section petrography and whole rock chemistry, including both major and selected trace element information.

Petrographically, the felsic layers contain in order of decreasing abundance, plagioclase, quartz, microcline, biotite, zircon, muscovite, hornblende, and sphene. The mafic layers contain plagioclase, albite, quartz, hornblende, zircon, biotite, apatite, and sphene. The Ptarmigan Lake pluton contains plagioclase, quartz, microcline, biotite, apatite, sphene, hornblende, and magnetite.

Chemically, the three types compare as follows: (data in weight percent)

TABLE 1.

	METAMORPHIC LAYERS		PTARMIGAN LAKE PLUTON
	MAFIC	FELSIC	PLUTON
SiO_2	47 - 50 %	62 - 77 %	72 - 75 %
Al_2O_3	14 - 17 %	13 - 19 %	13 - 15 %
FeO*	9 - 13%	1 - 6 %	2 - 3 %
MgO	4.5 - 8.3 %	0 - 2 %	.14 - .4%
CaO	9 - 11%	.2 - 5 %	.8 - 2%
Na_2O	2 - 3.6 %	2.6 - 4.7 %	3.6 - 5.4%
K_2O	.7 - 1.7 %	1.5 - 5 %	2.5 - 5 %
# of samples	5	14	6

On the whole, the metamorphic sequence contains approximately the same amount of Al_2O_3 and FeO*, and the K/Rb and Rb/Sr ratios are quite similar. However, the mafic layers contain less SiO_2, Na_2O, and K_2O, and considerably more CaO, MgO,, and FeO* compared to the felsic layers. (See figure 1)

REE analyses reveal that the felsites have a Eu anomaly whereas the Ptarmigan pluton does not, and that the concentration of REE in the pluton are significantly lower than those of the felsite layers. (See figure 2)

As a result of the disparity between the REE results, it is clear that the Ptarmigan pluton is not remobilized felsite. Anatexis has not occurred.

A second question to be considered: Is the Ptarmigan pluton really part of the larger Kroenke Lake granodiorite?

A comparison of major element oxides between the Kroenke Lake granodiorite and the Ptarmigan Lake pluton is as follows:

TABLE 2.

	Ptarmigan Lake	Kroenke Lake	TRONDHJEMITES*
SiO_2	72 - 75 %	69.2 - 71.6 %	>ca.68%,usually<75%
Al_2O_3	13 - 15 %	15.7 - 17.7 %	>15% @ 70% SiO_2, <14% @ 75% SiO_2
FeO*+MgO	2.14 - 3.4 %	2.5 - 4.9%	< 3.4%
CaO	.8 - 2 %	2.2 - 4.1 %	1.5 - 3.0 % (higher in calcic trondhjemites)
Na_2O	3.6 - 5.4 %	4.3 - 5.7 %	4.0 - 5.5%
K_2O	2.5 - 5 %	1.4 - 3.1 %	< ca. 2.5%, and typically <2 %
# of samples	6	6	*from Barker, 1979

In hand sample Ptarmigan plutonics appear very similiar to that of Kroenke Lake. Kroenke Lake granodiorite rocks are white to buff in color, fine to medium grained, and are often foliated (Barker and Brock, 1965). Ptarmigan Lake plutonics are white to gray in color, fine to medium grained, with plagioclase, quartz, biotite, and magnetite as dominant minerals. The pluton is also weakly to moderately foliated as well as lineated. Furthermore, it contains many amphibolite "wisps" that could represent partially assimilated amphibolite.

The Ptarmigan Lake pluton varies from the Kroenke Lake granodiorite in subtle, but definite ways. It contains more SiO_2 and K_2O, but less Al_2O_3, MgO, and CaO.

The distinctions could arise in several ways. The two plutons may have originated at different geologic times. Even if they were co-magmatic, the two plutons could have followed different crystallization histories perhaps involving differing amounts of fractionation and assimilation.

The Ptarmigan Lake pluton "looks" like Kroenke Lake and has in fact been defined as Kroenke Lake granodiorite (Brock and Barker, 1972). Chemically it fits the description of Trondhjemite as revised by Barker(1979) with only one exception. Clearly, the K_2O content is too high.

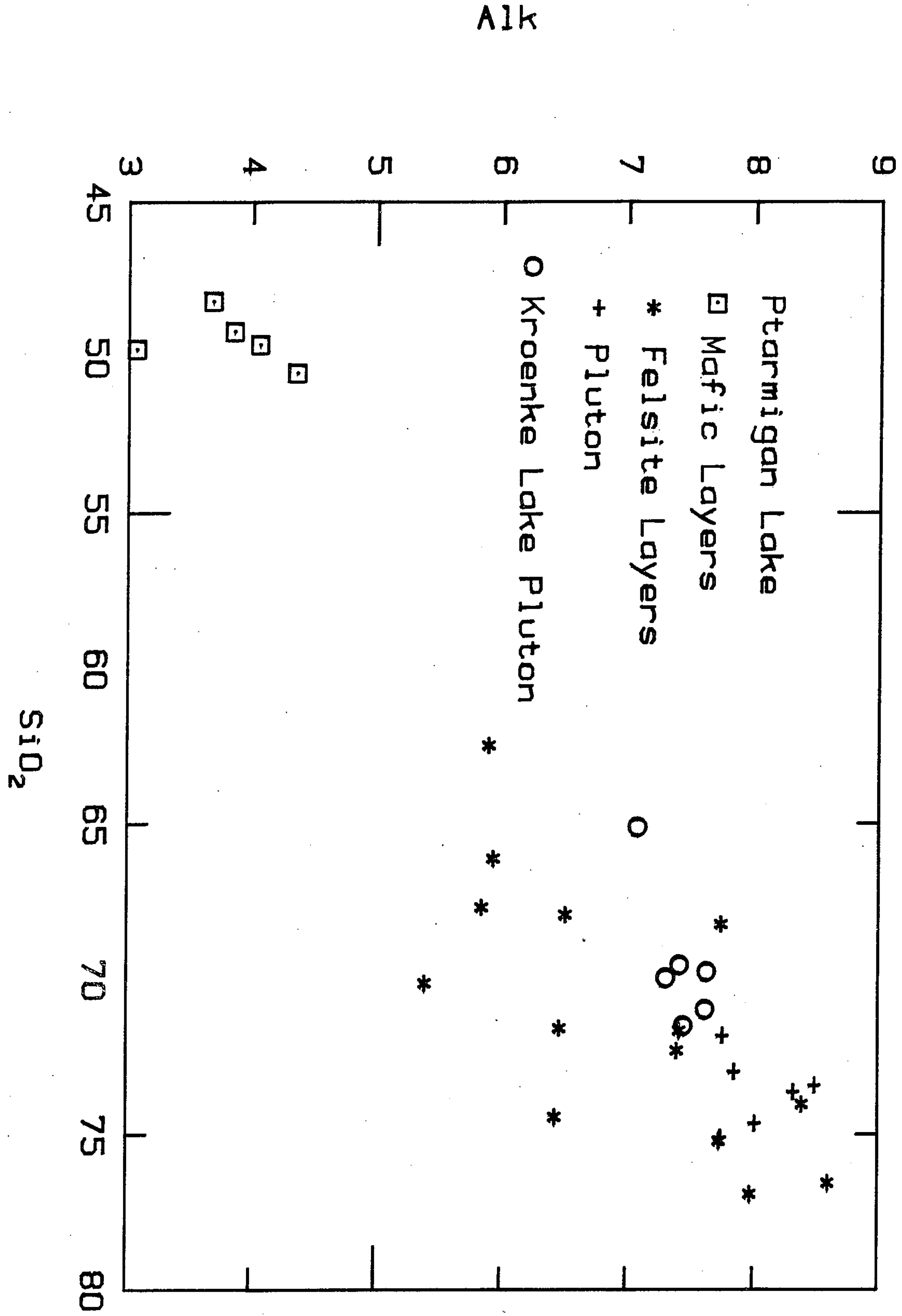
Alk
SiO2
Ptarmigan Lake
Mafic Layers
Felsite Layers
Pluton
Kroenke Lake Pluton
3
4
5
6
7
8
9
45
50
55
60
65
70
75
80

Figure 1.

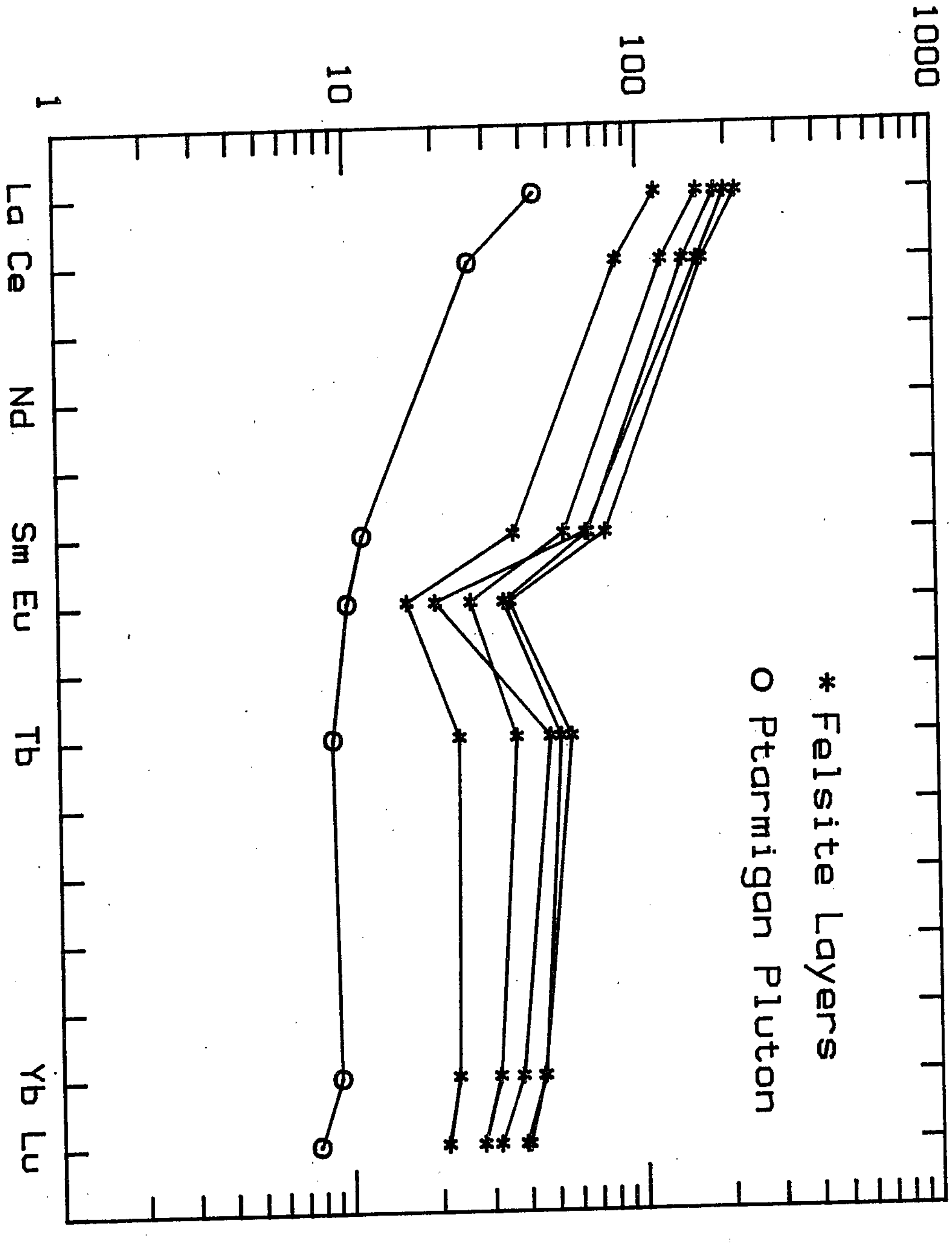
* Felsite Layers
O Ptarmigan Pluton
1000
100
10
1
La
Ce
Nd
Sm
Eu
Tb
Yb
Lu

Figure 2.