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The age and composition of the Beaver volcanic field, northern Alaska[1]

By

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Data and Discussion

A recent $^{39}Ar/^{40}Ar$ date on the Beaver volcanic field shows that it is the northernmost exposure of Late Cretaceous and early Tertiary volcanic rocks in Alaska. The field straddles the Arctic Circle in the Beaver quadrangle, which is located between 66 to 67 degrees north latitude and 147 to 150 degrees west longitude (Figure 1). The field marks the north easternmost part of a vast magmatic province that extends from the Alaska Range to the Arctic Circle and Bristol Bay, extending out onto the Bering Sea shelf as far west as St. Matthew and St. Lawrence Islands (Moll-Stalcup, 1994).

The Beaver volcanic field was first mapped by Brosgé and Reiser between 1960 and 1972. They show a small field (approximately 100 km^2) of Tertiary or Cretaceous rhyolite (Unit TKr) on their map of the Beaver Quadrangle (Brosgé and others, 1973). Paleozoic quartz mica schists of the Ruby terrane crop out near the volcanic field and presumably underlie it. Samples collected for K/Ar dating in 1973 were not dated at that time and were stored in a warehouse until we retrieved them in 1988 while working on a regional compilation of magmatism in Alaska (Moll-Stalcup and others, 1994). In 1991 biotite was separated from one sample of rhyolite welded tuff and was dated at 60.1±1.8 Ma (Table 1). Prior to this age determination, we assumed that the field was about 40 Ma, similar to other rhyolite fields in western Alaska such as the field at Indian Mountain (39.9-41.6 Ma; Miller and Lanphere, 1981) or the rhyolite field at Dulbi River (43.2 Ma; Patton and Moll-Stalcup, unpublished data, 1990). The new age clearly places the field in the Late Cretaceous to early Tertiary magmatic province (75-56 Ma). The closest volcanic rocks of this age are in the Kanuti volcanics, approximately 75 km to the west-southwest. A number of Late Cretaceous and early Tertiary plutons occur about 130 km to the south and southeast on the other side of the Yukon River and Tintina-Kaltag fault system.

Thin sections of samples collected prior to 1973 suggest that most of the field is rhyolite welded tuff. Rhyolites vary from very fresh glass with minor perlitic cracks to samples modified by secondary devitrification. Rocks typically have 3% phenocrysts of quartz, sanidine, plagioclase, and biotite in a groundmass of densely welded glass shards. Some samples contain densely welded black glassy fiamme. Rocks often contain volcanic rock fragments. Altered tuff samples have calcite replacing feldspar phenocrysts in a groundmass of partially devitrified glass. A highly altered porphyritic rhyolite intrudes the field and may be part of the crystalline core of a large exogenous or intrusive dome. Samples of the porphyritic intrusive rock have phenocrysts of altered plagioclase, sanidine, and quartz in a holocrystalline groundmass of quartz, plagioclase, K-feldspar, mica, and zircon.

One chemical analysis on the dated sample from the Beaver volcanic field is a typical high-K calc-alkalic rhyolite (Table 2). Like all rhyolites from the Late Cretaceous and early Tertiary province the Beaver rhyolite has a strong Nb and Ta anomaly (Figure 2), similar to arc magmas. The rhyolite is compositionally more similar to rhyolite from the Nowitna volcanic field, over 350 m to the southwest than to rhyolites from the Kanuti volcanic field (Figure 2). The Nowitna and Kanuti volcanic fields were previously studied by Moll-Stalcup and Arth (1989). The Nowitna volcanic field overlies the Paleozoic or Precambrian schists of the Ruby and Nixon Fork terranes, whereas the Kanuti volcanic field overlies oceanic rocks of the Koyukuk terrane. The similar chemical compositions of the Beaver and Nowitna rhyolites may be fortuitous or may reflect their similar tectonic environment, mechanism of evolution, and basement contamination.

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Table 1. $^{40}Ar/^{39}Ar$ age on rhyolite sample from the Beaver volcanic field.
The Beaver volcanic field has a $^{40}Ar/^{39}Ar$ age of:

Field No.	Material	$^{40}Ar/^{39}Ar$	$^{37}Ar/^{39}Ar$*	$^{36}Ar/^{39}Ar$	$^{36}Ar_{Ca}$ (%)	$^{40}Ar_R$	J	Calculated age (Ma)
73ABe335b	Biotite	3.435	0.06744	0.000828	219	92.8	0.01064	60.1±1.8

*Corrected for ^{37}Ar decay, half-life=35.1 days.
Subscripts indicate calcium-derived (Ca) and radiogenic (R) argon.
Analysts: J.Y. Saburomaru and J.C. Von Essen

Age measurements were made using the $^{40}Ar/^{39}Ar$ technique of K-Ar dating. The age of the sample is calculated using the formula: $t_u=1/\lambda$ $\log_e(1+F \times J)$ where the decay constant of ^{40}K is 5.543×10^{-10} and $F=(^{40}Ar_R/^{39}Ar_K)$, which is the ratio of radiogenic ^{40}Ar to potassium-derived ^{39}Ar in the sample. J is a function of the integrated fast-neutron flux in the reactor and is determined by a monitor mineral of known age.

Table 2. Major and trace-element abundances for the Beaver volcanic field

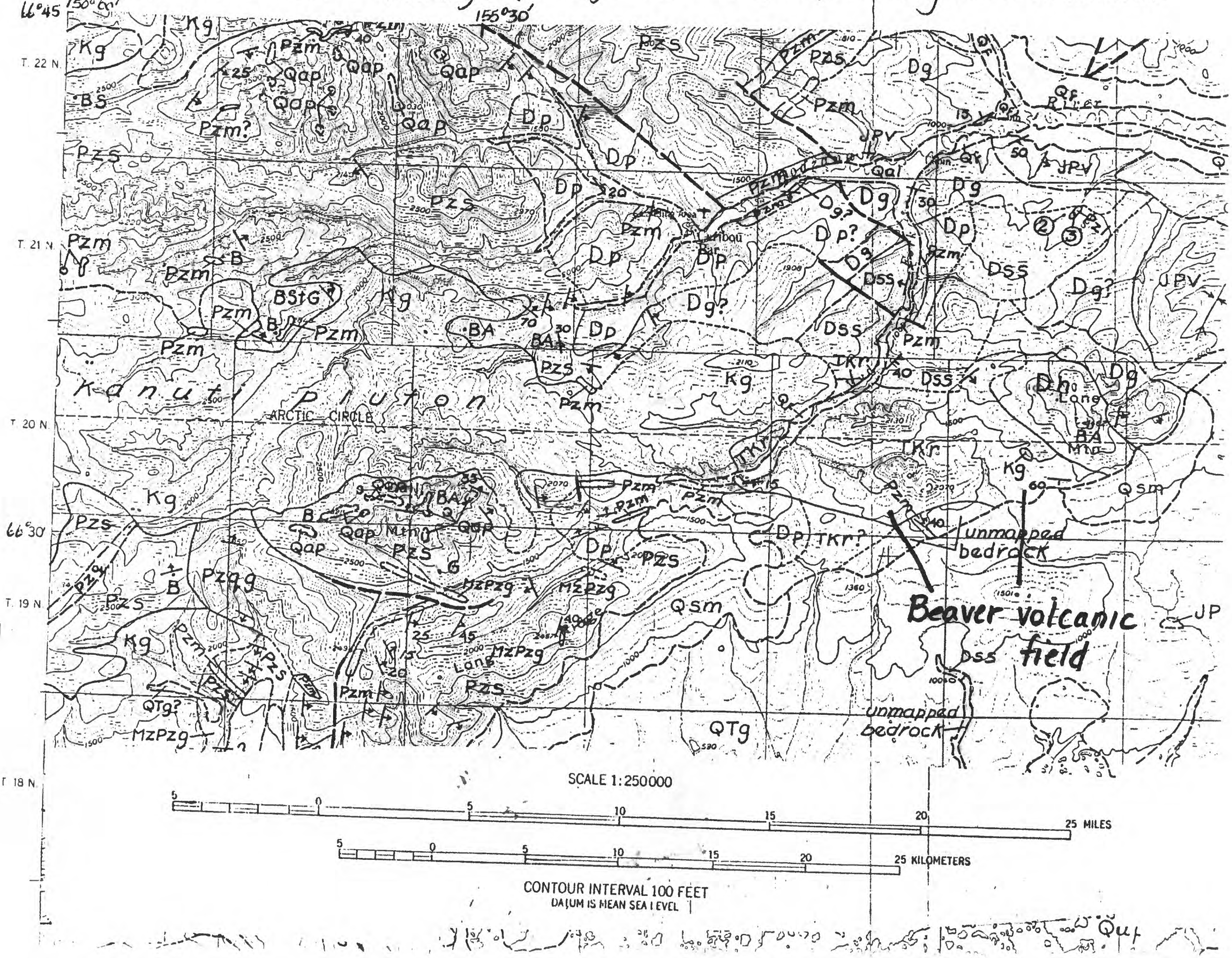
[All major oxides, except FeO, CO_2, H_2O^+, and H_2O^- by X-ray fluorescence following the methods of Taggart and others (1990). FeO by titration following the method of Papp and others (1990). CO_2, and H_2O by the methods of Norton and Papp (1990). USGS analysts T. Fries, S.T. Pribble, Menlo Park, Calif. and J.E. Taggert, and D.F. Siems, Lakewood, Colo.]. Trace elements by instrumental neutron activation analysis (INAA) unless otherwise noted in the first column by the acronyms XRF for energy-dispersive X-ray fluorescence. Methods described in USGS Bulletin 1770 (Baedecker, 1987). USGS analysts: J. Kent and Bi-Shia W. King, Menlo Park, Calif.; R. J. Knight, Lakewood, Colo.]

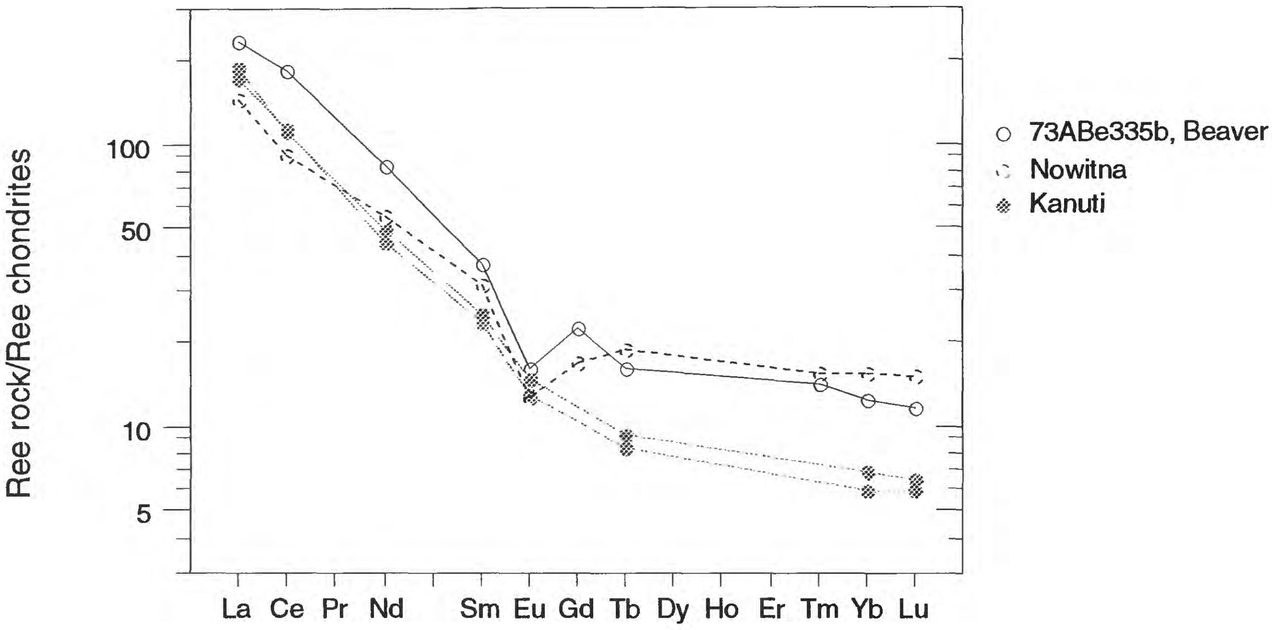
sample	73ABe335b
Major elements in weight percent	
SiO_2	71.30
Al_2O_3	14.20
FeO	0.34
Fe_2O_3	1.15
MgO	0.29
CaO	0.80
Na_2O	3.46
K_2O	5.22
TiO_2	0.34
P_2O_5	0.10
MnO	<0.02
H_2O+	0.87
H_2O-	0.85
CO_2	0.38
Total	99.30

Trace elements in parts per million

Rb (XRF)	176	La	76.1
Rb	161	Ce	159
Cs	5.28	Nd	52.5
Sr (XRF)	138	Sm	7.65
Sr	112	Eu	1.22
Ba	1020	Gd	6.12
Y (XRF)	32	Tb	0.767
Nb (XRF)	30	Tm	0.438
Co	0.651	Yb	2.72
Ni	<2.0	Lu	0.395
Cr	4.27	W	4.28
Hf	7.77	As	7.71
Sb	0.395	Zr	309
Ta	1.63	Sc	4.67
Th	29.5		
U	5.22		
Zn	37		

Figure 1. Area of Beaver Quadrangle (Brosgé and others, 1973) showing the volcanic field.





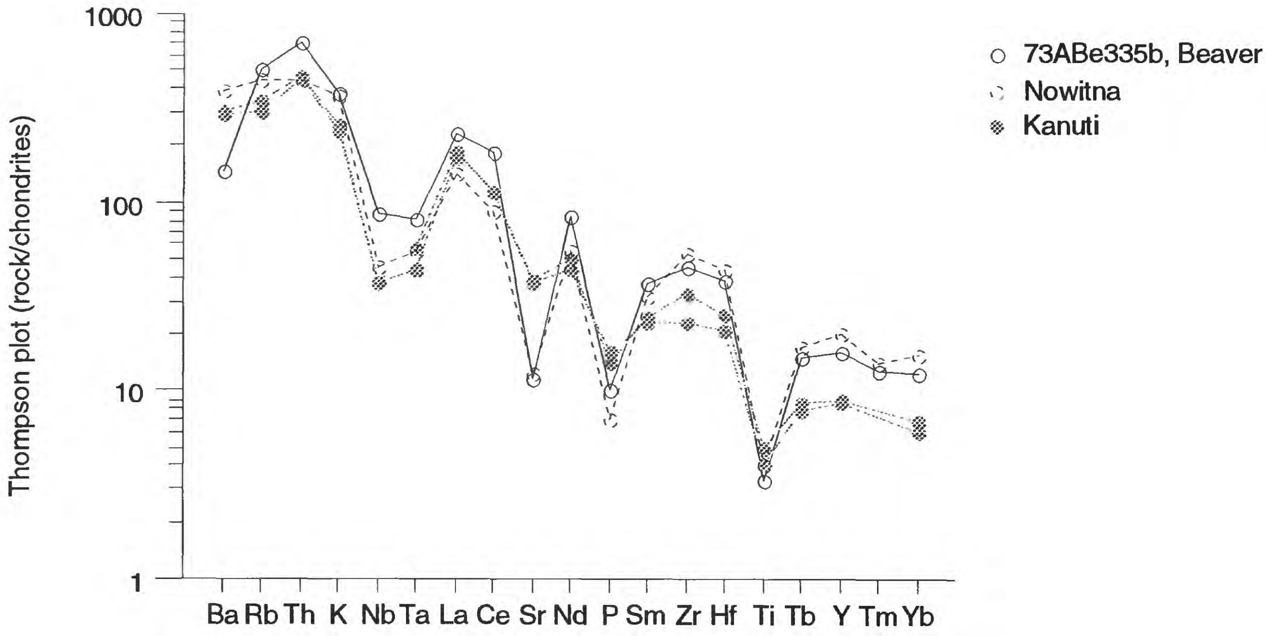


Figure 2. REE and spidergrams (Thompson, 1981) for rhyolites from the Beaver volcanic field, the Kanuti volcanic field, and the Nowitna volcanic field. The Beaver rhyolite is most like rhyolite from the Nowitna volcanic field. Data normalized to the values given in Thompson and others (1984) and plotted using the program of Wheately and Rock (1988).