Uranium- Thorium- Lead isotopic ages of Monazite from the Snake Creek-Williams Canyon intrusion of the southern Snake Range, Nevada

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URANIUM-THORIUM-LEAD ISOTOPIC AGES OF MONAZITE FROM THE SNAKE CREEK-WILLIAMS CANYON INTRUSION OF THE SOUTHERN SNAKE RANGE, NEVADA

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ABSTRACT

The Snake Creek-Williams Canyon intrusion of the southern Snake Range, Nevada, exhibits a strong compositional zonation. Ten samples from this pluton, with SiO_2 contents ranging from 63.7 to 76.2%, determined a Rb-Sr isochron age of 155 ± 4 m.y. and a corresponding initial $^{87}Sr/^{86}Sr$ of 0.70714 ± 0.00006. Three additional samples of the intrusion plotted above this ten-point isochron. These three samples are mineralogically similar to each other but distinct from other parts of the Snake Creek-Williams Canyon intrusion. This mineralogical difference probably results from assimilation of argillite by the invading melt. Uranium-thorium-lead isotopic ages given by accessory monazite from one of these three samples are concordant and are in excellent agreement with the Rb-Sr isochron age of 155 ± 4 m.y. The uranium-thorium-lead ages prove that the three samples are an integral part of the Snake Creek-Williams Canyon intrusion and that any subsequent thermal or tectonic event has not adversely affected the uranium-thorium-lead systematics of the accessory monazite. We therefore conclude that these three samples did not plot on the 155 m.y. isochron because assimilation of the Osceola Argillite variably changed and significantly increased the initial $^{87}Sr/^{86}Sr$ ratio in a restricted part of the invading melt.

INTRODUCTION

The much-studied Snake Creek-Williams Canyon intrusion of the southern Snake Range, Nevada (fig. 1), exhibits a strong compositional zonation which has developed primarily as a result of *in situ* fractional crystallization (Lee and Christiansen, 1983). Ten samples of this zoned pluton, with SiO_2 contents ranging from 63.7 to 76.2%, fit a Rb-Sr isochron with an indicated age of 155 ± 4 m.y. and an initial $^{87}Sr/^{86}Sr$ of 0.70714 ± 0.00006 (Lee and others, in press). However, three other samples of this intrusion plot above the ten-point isochron (fig. 2). Each of these three samples contains accessory monazite, and the purpose of this paper is to discuss the uranium-thorium-lead isotopic ages of monazite recovered from one of these samples.

The gradual and systematic change of accessory mineral types precipitated during crystallization is one of the most striking features of the Snake Creek-Williams Canyon intrusion (Lee and Van Loenen, 1971). The most mafic (eastern) parts of the mass (63% SiO_2) contain 2% epidote, 1% sphene, 0.5% magnetite, and well-developed allanite, apatite, and zircon. As SiO_2 increases, the amounts and types of accessory minerals change gradually, until the most felsic (western) parts of the intrusion (76% SiO_2) contain only ilmenite, garnet, monazite, and

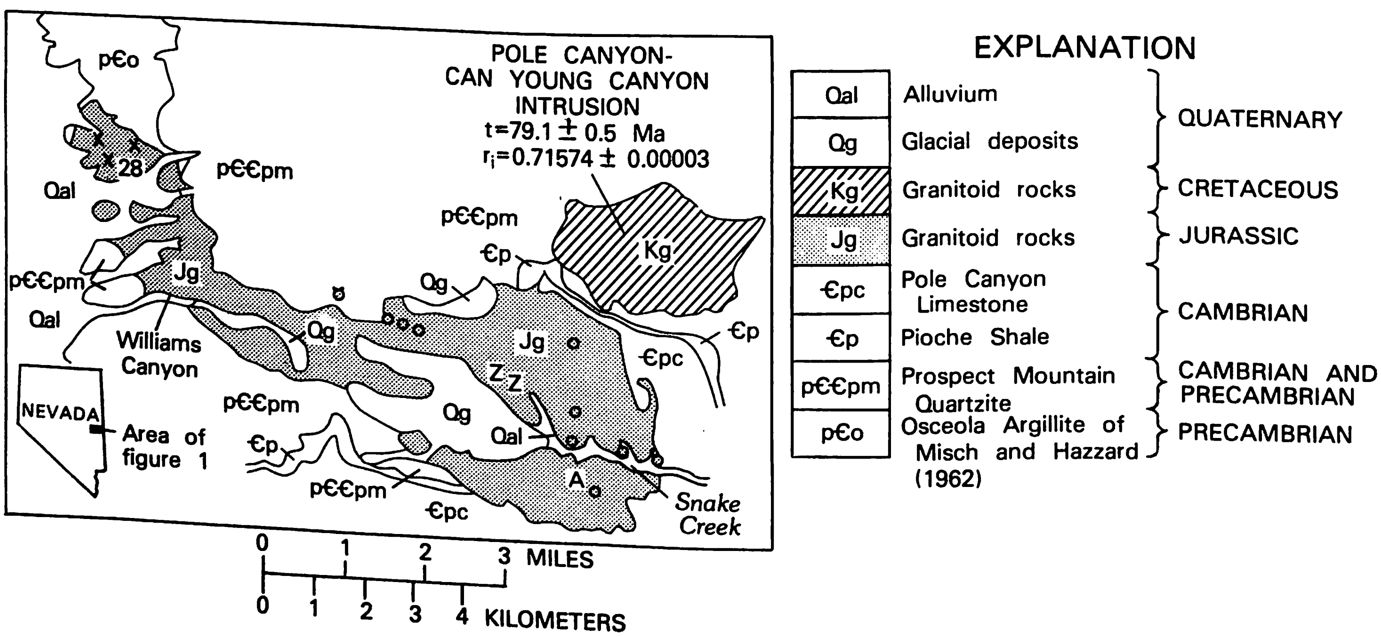

FIGURE 1. Simplified geologic map showing the Snake Creek-Williams Canyon and the Pole Canyon-Can Young Canyon intrusions. Map modified from Lee and Van Loenen (1971, pl. 1). Open circles show locations of samples used for ten-point isochron. Samples indicated by crosses plot above the ten-point isochron (fig. 2). Monazite described in this paper recovered from sample number 28. Sample sites for uranium-thorium-lead isotopic ages of zircons (Z's) and potassium-argon age of amphibole (A) are indicated.

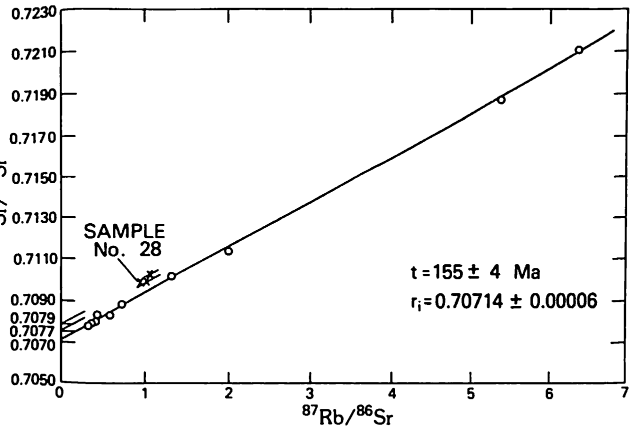

FIGURE 2. Strontium evolution diagram for the Snake Creek-Williams Canyon pluton (open circles). Samples 27, 28, and 59 (X's) were collected from the extreme northwestern part of the pluton (fig. 1), where the intrusive body is in contact with the Osceola Argillite, and were not used in calculating the isochron. t, time in millions of years; r_i, initial $^{87}Sr/^{86}Sr$. Data from Lee and others (in press).

trace amounts of apatite and zircon. The entire suite of accessory minerals comprises only about 0.1 weight % of the most felsic parts of the intrusion.

An additional feature of some of the more felsic parts of the Snake Creek-Williams Canyon intrusion is of special relevance to this study. In the western part of the igneous outcrop area, where the pluton is in contact with Osceola Argillite, some of the zircon in the rock is present as acicular inclusions in apatite. In the Pole Canyon-Can Young Canyon 2-mica granite (fig. 1), the same feature is so well developed that nearly all the zircon occurs as acicular inclusions in apatite (Lee and Van Loenen, 1971, p. 5, 38, 39). Moreover there is ample evidence that the Pole Canyon-Can Young Canyon intrusion formed through anatexis of the Osceola Argillite and spatially related sediments (Lee and others, 1981). In other words, where these intrusions have been affected by assimilation or anatexis of Osceola Argillite, zircon tends to be present as acicular inclusions in apatite. And, finally, the three samples of the Snake Creek-Williams Canyon pluton that plot above the ten-point isochron are displaced toward the "field" of samples from the 2-mica granite of the Pole Canyon-Can Young Canyon area (Lee and others, in press). Apparently the assimilation of the argillite has affected the rubidium-strontium systematics of the two intrusions in a similar manner and has resulted in the peculiar apatite-zircon relationship described.

ANALYTICAL RESULTS

Uranium-thorium-lead data for the monazite recovered from sample 28 (fig. 1) are listed in table 1. All four ages based on these data are in excellent agreement with the 155 ± 4 m.y. age indicated by the ten-point isochron.

Other radiometric age data obtained for the Snake Creek-Williams Canyon intrusion also are in agreement with the 155 ± 4 m.y. rubidium-strontium age. Lee and others (1968, 1981) present uranium-thorium-lead isotopic ages for zircons recovered from the more mafic (SiO_2 = 65.8 and 71.8%) parts of the pluton, and Lee and others (1970) list a 156 ± 5 m.y. K-Ar age for hornblende recovered from a xenolith in the most mafic part of the intrusion.

However, biotites and muscovites recovered from throughout the intrusion gave spuriously young K-Ar ages. These young K-Ar ages were interpreted to result from loss of argon due to thermal stresses related to Tertiary activity along the overlying Snake Range decollement (Lee and others, 1970). Stable isotope work on the dated muscovites and biotites support this interpretation of the spuriously young ages (Lee and others, 1984).

SUMMARY AND CONCLUSIONS

The strongly zoned Snake Creek-Williams Canyon intrusion crystallized 155 ± 4 m.y. ago, as indicated by a ten-point rubidium-strontium isochron based on samples representing the entire range of compositional types exposed. This 155 ± 4 m.y. age has been confirmed by uranium-thorium-lead study of zircons from the more mafic parts of the intrusion, and by a 156.5 ± 5 m.y. K-Ar age for hornblende recovered from a xenolith in the most mafic part.

However, rubidium-strontium data for three samples from the more felsic parts of the intrusion are anomalous in that they plot above the ten-point isochron. All three of these samples contain accessory monazite. Concordant uranium-thorium-lead ages were determined for monazite recovered from one of these three samples. All four ages are in excellent agreement with the 155 ± 4 m.y. rubidium-strontium age. This is especially noteworthy in view of the uncertainties that may attend uranium-thorium-lead dating of monazite.

The three samples that plot above the ten-point isochron are mineralogically distinct from other parts of the Snake Creek-Williams Canyon pluton in that the zircon tends to occur as acicular inclusions in apatite. Based on the evidence discussed here, this mineralogical peculiarity is attributed to the influence of argillite on this part of the

TABLE 1. Uranium-thorium-lead data for monazite from sample 28, lat. 38°58'24"N, long. 114°21'24"W, Snake Creek-Williams Canyon area, southern Snake Range, Nevada

[Based on measured ratios of the coexisting feldspar; the isotopic composition of the initial lead is taken as $^{204}Pb:^{206}Pb:^{207}Pb:^{208}Pb$ = 1:19.23:15.71:39.18. Sample weight: 1.159 mg. Analyst: Loretta Kwak]

Concentration (ppm)			Isotopic composition of lead (atom %)				Atomic ratios			
U	Th	Pb	^{204}Pb	^{206}Pb	^{207}Pb	^{208}Pb	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	$^{208}Pb/^{232}Th$
893.9	46,733	394.1	0.1927	8.494	3.26	88.05	0.02436	0.16534	0.04923	0.00758
							Age (m.y.			
							155.1	155.4	158.5	152.7

Snake Creek-Williams Canyon intrusion. Figure 2 shows the plot of the three samples above the 155-m.y. isochron. The uranium-thorium-lead results listed here also establish an age of 155 ± 4 m.y. Therefore parallel 155 m.y. isochrons can be drawn through the three points that lie above the ten-point isochron. These reference isochrons (fig. 2) show that the initial $^{87}Sr/^{86}Sr$ ratios for these three samples range from 0.7077 to 0.7079. Thus assimilation of the argillite has served to increase the ^{87}Sr content of the invading melt in a capricious fashion.

If another intrusion is found to contain acicular zircon in apatite and to have isotopic Rb-Sr ratios that scatter on a $^{87}Sr/^{86}Sr$ versus $^{87}Rb/^{86}Sr$ diagram, one should consider the possibility that assimilation of pelitic sediments might have been part of the emplacement and crystallization history of that pluton. One such example is the 2-mica granite of the Kern Mountains, which is exposed about 80 km to the north of the Snake Creek-Williams Canyon intrusion (Lee and others, 1981).

Taken together, the mineralogical and Rb-Sr isotopic factors discussed here may help us to direct future research in our efforts to understand igneous processes.

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