Age of the Lake City Caldera and related Sunshine Peak Tuff, Western San Juan Mountains, Colorado

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AGE OF THE LAKE CITY CALDERA AND RELATED SUNSHINE PEAK TUFF, WESTERN SAN JUAN MOUNTAINS, COLORADO*

Harald H. Mehnert
Peter W. Lipman
and
Thomas A. Steven
U. S. Geological Survey
Denver, CO 80225

Potassium-argon dating has demonstrated that the Tertiary volcanic history of the San Juan Mountains has been relatively simple (Lipman and others, 1970). Volcanic activity began about 35 m.y. ago with the eruption of intermediate-composition lavas and breccias from scattered central volcanoes. From about 30 to 26 m.y. ago this type of activity was accompanied by voluminous ash-flow eruptions of quartz latite and low-silica rhyolite with associated caldera collapses. After about 25 m.y. ago, volcanism shifted from intermediate composition lavas and associated differentiates to a strikingly different bimodal association of basalt and high-silica alkali rhyolite.

One of the remaining problems concerned the age and petrogenetic associations of the Lake City caldera located in the northwestern part of the volcanic field (fig. 1). This caldera formed during eruption of the Sunshine Peak Tuff (Luedke and Burbank, 1968), which as originally mapped, is shown confined to the interior of the caldera, where it is a kilometer or more thick. Larsen and Cross (1956) considered the Sunshine Peak Tuff to be one of the older volcanic units but we (Lipman and others, 1970, p. 2344) have previously hypothesized that instead it might be the youngest major ash-flow sheet, and Lake City the youngest caldera in the San Juan volcanic field. This interpretation was based on the petrologic similarity of intracaldera Sunshine Peak Tuff to the rhyolitic welded tuff at Jarosa Mesa, previously dated at 22.0-22.9 m.y. (Steven and others, 1967), that occurs as erosional remnants around the high rim south and east of the Lake City caldera. Both the intracaldera Sunshine Peak Tuff and the tuff at Jarosa Mesa are unique among ash-flow tuffs of the San Juan field in that they contain 76 percent or more SiO_2, have abundant quartz phenocrysts and very sodic alkali feldspar phenocrysts, and lack plagioclase phenocrysts.

This tentative petrologic correlation is strongly supported by our additional radiometric determinations. We have dated biotite and sodic sanidine both from intracaldera Sunshine Peak Tuff and from an immediately overlying silicic intracaldera lava flow. The two mineral pairs are highly accordant, and the difference between the mean age of the Sunshine Peak Tuff—22.5 m.y.—and that of the overlying lava flow—22.8 m.y.—is within analytical uncertainty. These ages are in excellent agreement with the feldspar ages previously obtained from the welded rhyolite tuff at Jarosa Mesa—22.0 and 22.9 m.y. We therefore interpret the tuff at Jarosa Mesa to be the outflow sheet of Sunshine Peak Tuff. Recent mapping in the Lake City area by Lipman, Steven, and David Johnston, demonstrates that the previous ideas about the older age of the Sunshine Peak resulted from miscorrelations.

The Lake City caldera is thus the youngest ash-flow related caldera in the San Juan field, and with the Sunshine Peak Tuff, is part of the Miocene-Pliocene bimodal basalt-rhyolite volcanic association, whereas all of the other ash-flow sheets are Oligocene in age and belong to the older intermediate-composition volcanic association. These contrasting petrologic associations have fundamental significance, both in the San Juan field and, more widely, in Cenozoic volcanic rocks of the Western United States (Christiansen and Lipman, 1972).

The estimated analytical uncertainties of the K-Ar ages are at one standard deviation. Constants are: $\lambda_e = 0.584 \times 10^{-10} yr^{-1}$, $\lambda_\beta = 4.72 \times 10^{-10} yr^{-1}$, $K^{40}/K_{total} = 1.22 \times 10^{-4}$ gm/gm.

SAMPLE DESCRIPTIONS

1. USGS(D)-Ds445 — K-Ar — (sanidine) 22.4±0.6 m.y. (biotite) 22.7±0.6 m.y.

Intracaldera Sunshine Peak Tuff. Partly welded rhyolitic tuff, a few m below top of unit (107°22′25″W, 37°56′30″N; at saddle along jeep road just N of 12,195′ point, Hinsdale Co., CO), containing about 25%

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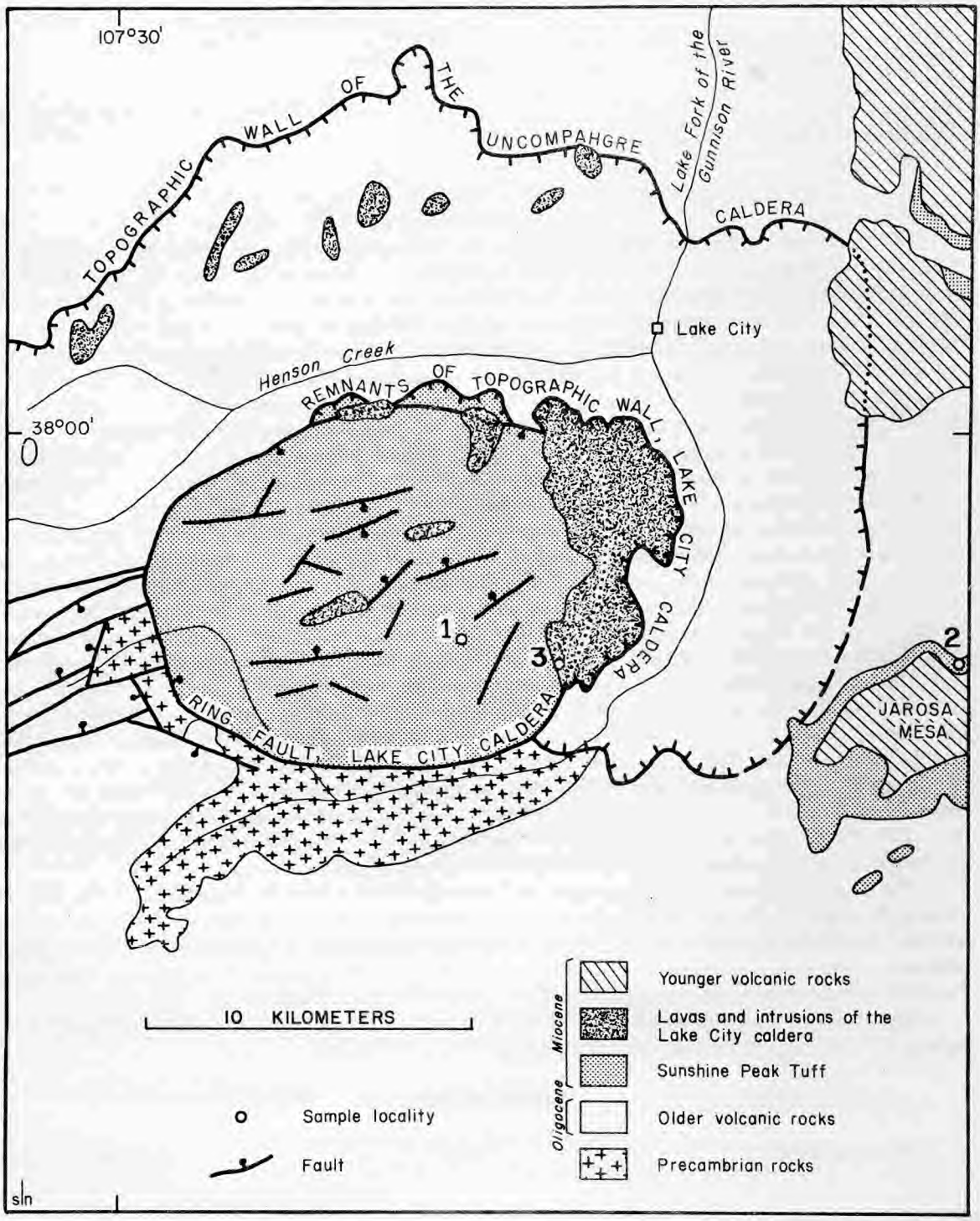

Figure 1. Generalized geologic map of Lake City caldera area, Colorado, showing location of dated rock samples (numbers are keyed to sample descriptions).

phenocrysts of sanidine, quartz, and minor biotite. Analytical data: (sanidine) K_2O = 8.29%, $^{*}Ar^{40}$ = 2.77 x 10^{-10} mole/gm; $^{*}Ar^{40}/\Sigma Ar^{40}$ = 87%. (Biotite) K_2O = 8.62%, $^{*}Ar^{40}$ = 2.90 x 10^{-10} mole/gm; $^{*}Ar^{40}/\Sigma Ar^{40}$ = 82%. Collected by: P. W. Lipman and T. A. Steven, U. S. Geological Survey; dated by: H. H. Mehnert, U. S. Geological Survey.

2. Steven and others (1967) — K-Ar — (sanidine) 22.9±0.6 m.y.
USGS(D)-S342B — (sanidine) 22.0±0.6 m.y.

Outflow Sunshine Peak Tuff (from eastern part of Jarosa Mesa, 2 km W of Spring Creek Pass, Hinsdale Co., CO); formerly called rhyolite of Hinsdale Formation. Collected by: T. A. Steven, U. S. Geological Survey; dated by: H. H. Mehnert and J. D. Obradovich, U. S. Geological Survey.

3. USGS(D)-Ds442 — K-Ar — (sanidine) 22.7±0.6 m.y.
(biotite) 22.9±0.6 m.y.

Quartz latite flow of Grassy Mountain. Black basal vitrophyre (107°21′10″W, 37°56′15″N, E fork of Williams Creek, Hinsdale Co., CO), containing about 20% phenocrysts of sanidine, plagioclase, and biotite. Analytical data: (sanidine) K_2O = 8.80%, $^{*}Ar^{40}$ = 2.97 x 10^{-10} mole/gm; $^{*}Ar^{40}/\Sigma Ar^{40}$ = 83%. (Biotite) K_2O = 8.36%, $^{*}Ar^{40}$ = 2.84 x 10^{-10} mole/gm; $^{*}Ar^{40}/\Sigma Ar^{40}$ = 66%. Collected by: H. R. Covington and T. A. Steven, U. S. Geological Survey; dated by: H. H. Mehnert, U. S. Geological Survey.

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