K/AR AGES OF SILICIC VOLCANISM IN THE TWIN PEAKS/COVE CREEK DOME AREA, SOUTHWESTERN UTAH

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Located approximately twenty kilometers north of the Roosevelt Hot Springs Known Geothermal Resource Area is the Twin Peaks/Cove Creek Domes silicic volcanic center. Here approximately four cubic kilometers of rhyolite domes, obsidian flows and volcanoclastic deposits are exposed. The area lies in the southern portion of the Black Rock Desert graben, near the eastern margin of the Basin and Range province in west-central Utah (Fig. 1).

The silicic volcanic rocks in the Twin Peaks area were described by Haugh (1979), who proposed that the distribution of volcanics was related to ring dike fissures associated with a trap door Glencoe-type caldera collapse. Carrier (1979) undertook a gravity and heat flow study of the area and concluded that little or no subsidence had actually occurred. Present day heat flow values are near typical background for the Basin and Range (96 mW/m^2). Locally associated basalts have been studied by Condie and Barsky (1972), Best and Brimhall (1974), Hoover (1974) and Clark (1977). Local lacustrine limestones were described by Zimmerman (1961) and Clark (1977).

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Constants Used:

$\lambda\beta = 4.962 \times 10^{-10}\ yr^{-1}$
$\lambda\epsilon = 0.581 \times 10^{-10}\ yr^{-1}$
$\lambda = 5.543 \times 10^{-10}\ yr^{-1}$
$^{40}K/K_{tot} = 1.167 \times 10^{-4}$ atom/atom

DISCUSSION

Volcanic activity in the Twin Peaks area produced a series of flows, domes and volcanoclastic deposits in an arcuate pattern as shown in Figure 1. No voluminous ash-flow deposits are presently exposed in the Twin Peaks field. However, small volumes of welded and non-welded ash deposits occur in the western part of the region (Haugh, 1979), and within and to the south of the area volcanic ash has been found interbedded in fluvial and lacustrine deposits which are contemporaneous with the rhyolitic volcanism. The restricted occurrence of these sedimentary sequences raise the intriguing question as to whether they are related to a cauldron lake. At present, this question remains unanswered. The occurrence of a hundred meter section composed predominantly of limestone within the area suggests an appreciable amount of subsidence with respect to the water level during its deposition. Drill hole logs (Carrier, 1979) confirm the presence of a greater than 100 meter sequence of lacustrine sediment elsewhere in the immediate area. The possibility of cauldron subsidence is indicated by the existence of a buried tuff chemically related to the Twin Peaks rhyolite system which was encountered in a drill hole ten kilometers south of any exposed silicic volcanic in the Twin Peaks area. The tuff has a minimum thickness of 80 m. A substantially larger eruptive volume than has been previously recognized (Carrier, 1979; Haugh, 1979) is probable based on this finding, and suggests that there may have been a greater degree of subsidence of the roof block than indicated by geophysical studies.

Clark (1977) considered the basalts in the area to be younger than the rhyolites. Basalt on the southwest slope of South Twin Peak is included as fragments within the rhyolite, indicating that basaltic activity commenced prior to the emplacement of South Twin Peak, the youngest rhyolite in the area. Basalts lie below, within and above the tuffaceous lacustrine sequence, indicating that basalts were erupted before, during, and after the silicic activity.

A north-south trending anticlinal arch which postdates the silicic volcanism, extends for over 10 km through the Twin Peaks area, uplifting and tilting basalts and limestones, most prominently just to the southeast of South Twin Peak. The sedimentary sequence is well exposed in the core of this anticline where it is capped by younger basalts.

Lipman and others (1977) presents two dates on silicic units from the Twin Peaks area. They date South Twin Peak at 2.33 ± 0.12 m.y. and obsidian from Cudahy Mine at 2.38 ± 0.15 m.y. Luedke and Smith (1978) report the previous dates plus two additional ones: 2.22 m.y. on material from northern Coyote Hills and 2.35 m.y. on South Twin Peak. The dates quoted by Luedke and Smith appear to have been calculated using old constants and they have apparently reversed sample locations for North and South Twin Peaks as the date reported in Lipman and others (1977) was for South Twin Peak, not North Twin Peak.

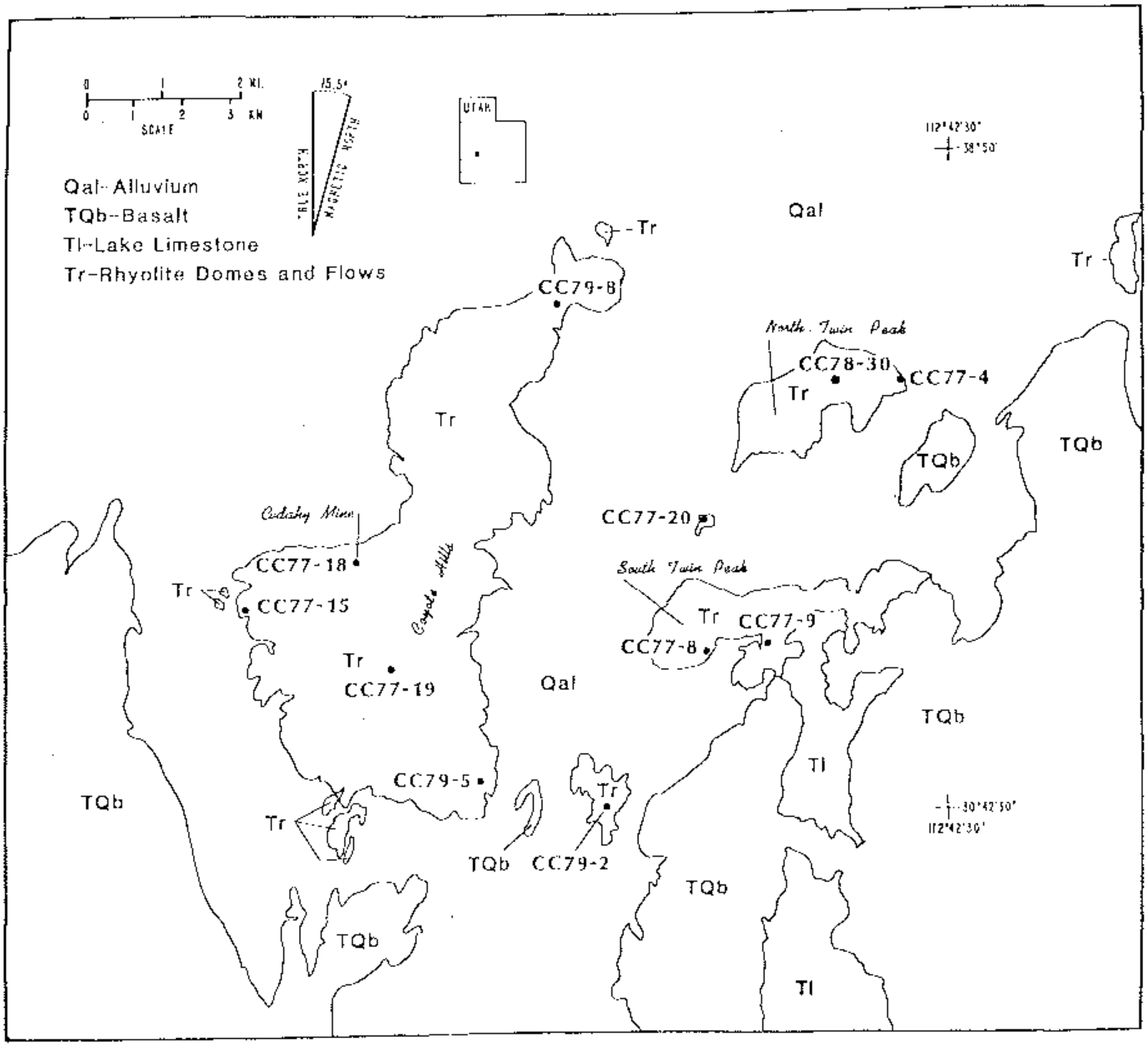

FIGURE 1. Generalized geologic map and sample locations for silicic volcanics of the Cove Creek Domes/Twin Peaks area, southwestern Utah.

Only three dates have been obtained on basalts in the area: 2.0 m.y. at Black Point (Clark, 1977), and 0.97 and 0.92 m.y. for the Black Rock flow (Condie and Barsky, 1972). The Black Point flow is at the extreme northeast of Fig. 1, the Black Rock flow occurs along the western margin of Fig. 1.

Additional dating of samples from the Cove Creek/Twin Peaks area was undertaken to provide temporal constraints on the petrological model that has been developed for the silicic rocks. The oldest dates are for rhyolite in the Coyote Hills, 2.74 m.y. and 2.67 m.y. An intermediate set of ages on obsidians from Coyote Hills and just east of South Twin Peak range from 2.63 m.y. to 2.43 m.y. The youngest ages reported here are for North and South Peaks rhyolite; 2.43 m.y. to 2.35 m.y.

Chemical modeling of the evolution of magma in the area (Crecraft and others, 1979), coupled with the dating reported here indicates that two chemically distinct eruptive sequences are present. Each sequence is characterized by progression from less silicic to more silicic rocks.

In the first sequence, represented by units in the Coyote Hills, eruption of the least silicic unit (the event dated by samples CC77-15 and CC79-2) occurred 2.7 m.y. ago. This unit is overlain by a more silicic unit (represented by samples CC77-9, 18, 19 and CC79-8) and was erupted 2.4 to 2.6 m.y. ago. The chemistry of this sequence indicates that the variation of major and trace element abundances cannot be attributed to any simple crystal fractionation model but probably are the result of liquid state differentiation similar to the model presented by Hildreth (1979). The time interval indicated (200,000 yrs) suggests the magma which was tapped first to produce the older units and then again to produce the younger units, was sustained in a liquid state for a considerable time. In order for this to occur, resupply of heat (perhaps by basaltic magma rising from the mantle) would be essential to prevent the magma from solidifying.

A second sequence of rocks is present in the North and South Twin Peaks area. Samples CC77-4, CC77-8, CC77-20 and CC78-30 have been used to date this sequence. Rocks first erupted 2.5 m.y. ago are less silicic than later erupted material dated at 2.4 to 2.3 m.y. The most silicic, and probably youngest unit, is the dome at South Twin Peak. This second sequence shows evidence for both liquid state differentiation as well as crystal settling. A detailed report on the petrology and chemistry of these units is now under preparation and will contain the detailed evidence for the evolutionary model sketched above.

SAMPLE DESCRIPTIONS

1. *CC77-4* K/Ar

Rhyolite of North Twin Peak (38°47′22″N, 112° 42′39″W; UT). Contains phenocrysts of quartz, plagioclase and sanidine. Biotite is the only mafic phase. Groundmass comprises about seventy percent of this unit and is composed of quartz, feldspar and accessory oxides, apatite, sphene and zircon. *Analytical data:* K = 7.56%, radiogenic $^{40}Ar = 3.175 \times 10^{-11}$ m/gm, atmospheric $^{40}Ar = 24\%$.

(sanidine) 2.35 ± 0.08 m.y.

2. *CC77-8* K/Ar

Rhyolite of South Twin Peak (38°43′47″N, 112°45′ 55″W; UT). Phenocryst content of this rhyolite varies from 3 to 20%. Quartz, plagioclase, sanidine and biotite comprise the phenocryst content. The groundmass is composed of fine grained quartz, sanidine, plagioclase, oxides, and zircon. *Analytical data*: K = 9.38%, radiogenic $^{40}Ar = 3.830 \times 10^{-11}$ m/gm, atmospheric $^{40}Ar = 24\%$.

(sanidine) 2.35 ± 0.08 m.y.

3. *CC77-9* K/Ar

Obsidian (just E of South Twin Peak; 38°43′51″W, 112°45′03″W; UT). Sample consists of apache tears sampled from a partially devitrified obsidian flow; contains rare sanidine, plagioclase and oxides. Total crystal content is less than one percent. *Analytical data*: K = 4.36%, radiogenic $^{40}Ar = 1.986 \times 10^{-11}$ m/gm, atmospheric $^{40}Ar = 46\%$.

(whole rock) 2.63 ± 0.10 m.y.

4. *CC77-15* K/Ar

Rhyolite of Coyote Hills (38°44′22″N, 112°52′05″W; UT). Plagioclase is the dominant phenocryst with smaller phenocrysts of sanidine, augite and hypersthene. Groundmass comprises 84% of the rock and consists mainly of plagioclase with quartz, sanidine, oxides, and zircon. *Analytical data*: K = 4.91%, radiogenic $^{40}Ar = 2.335 \times 10^{-11}$ m/gm, atmospheric $^{40}Ar = 38\%$.

(sanidine) 2.74 ± 0.10 m.y.

5. *CC77-18* K/Ar

Obsidian from Coyote Hills (38°45′24″N, 112°51′ 03″W; UT). This glass is essentially devoid of any minerals with extremely rare biotite, sanidine, and plagioclase crystallites. *Analytical data*: K = 3.99%, radiogenic $^{40}Ar = 1.758 \times 10^{-11}$ m/gm, atmospheric $^{40}Ar = 42\%$.

(whole rock) 2.54 ± 0.09 m.y.

6. *CC77-19* K/Ar

Obsidian from Coyote Hills (38°43′17″N, 112°50′ 30″W; UT). Rock is similar to CC77-18. *Analytical data*: K = 4.11%, radiogenic $^{40}Ar = 1.733 \times 10^{-11}$ m/gm, atmospheric $^{40}Ar = 60\%$.

(whole rock) 2.43 ± 0.12 m.y.

7. *CC77-20* K/Ar

Rhyolite (from an outcrop midway between North and South Twin Peaks (38°45′47″N, 112°45′58″W; UT). Petrographically unit is similar to North Twin Peak.

Analytical data: K = 8.52%, radiogenic $^{40}Ar = 3.720 \times 10^{-11}$ m/gm, atmospheric ^{40}Ar = 21%.

(sanidine) 2.51 ± 0.08 m.y.

8. *CC78-30* K/Ar

Rhyolite (North Twin Peak; 38°47′22″N, 112°44′03″W; UT). Sample is similar to CC77-4. *Analytical data*: K = 8.27%, radiogenic $^{40}Ar = 3.491 \times 10^{-11}$ m/gm, atmospheric ^{40}Ar = 22%.

(sanidine) 2.43 ± 0.08 m.y.

9. *CC79-2* K/Ar

Rhyolite of Coyote Hills (38°42′04″N, 112°47′23″W; UT). Sample is similar to CC77-15, both chemically and petrographically. *Analytical data*: K = 1.54%, radiogenic $^{40}Ar = 0.715 \times 10^{-11}$ m/gm, atmospheric ^{40}Ar = 54%.

(plagioclase) 2.67 ± 0.10 m.y.

10. *CC79-8* K/Ar

Obsidian (northern Coyote Hills; 38°48′13″N, 112°48′06″W; UT). Sample is similar to CC77-9. *Analytical data*: K = 4.60%, radiogenic $^{40}Ar = 2.096 \times 10^{-11}$ m/gm, atmospheric ^{40}Ar = 23%.

(whole rock) 2.63 ± 0.09 m.y.

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