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

STANLEY H. EVANS, JR.
HARRISON R. CRECRAFT
WILLIAM P. NASH

Department of Geology and Geophysics, University of Utah, Salt Lake City, UT 84112

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).

The work reported here was funded by the Division of Geothermal Energy, U.S. Department of Energy, contract No. DE-AC07-80ID12079, to Earth Sciences Division, University of Utah Research Institute with subcontract to the Department of Geology and Geophysics, University of Utah. The authors would also like to thank Dr. F. H. Brown, M. B. Sienkewicz, M. Jennison, N. Lundeen and B. Griffey for their assistance in running the Potassium/Argon Laboratory.

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.

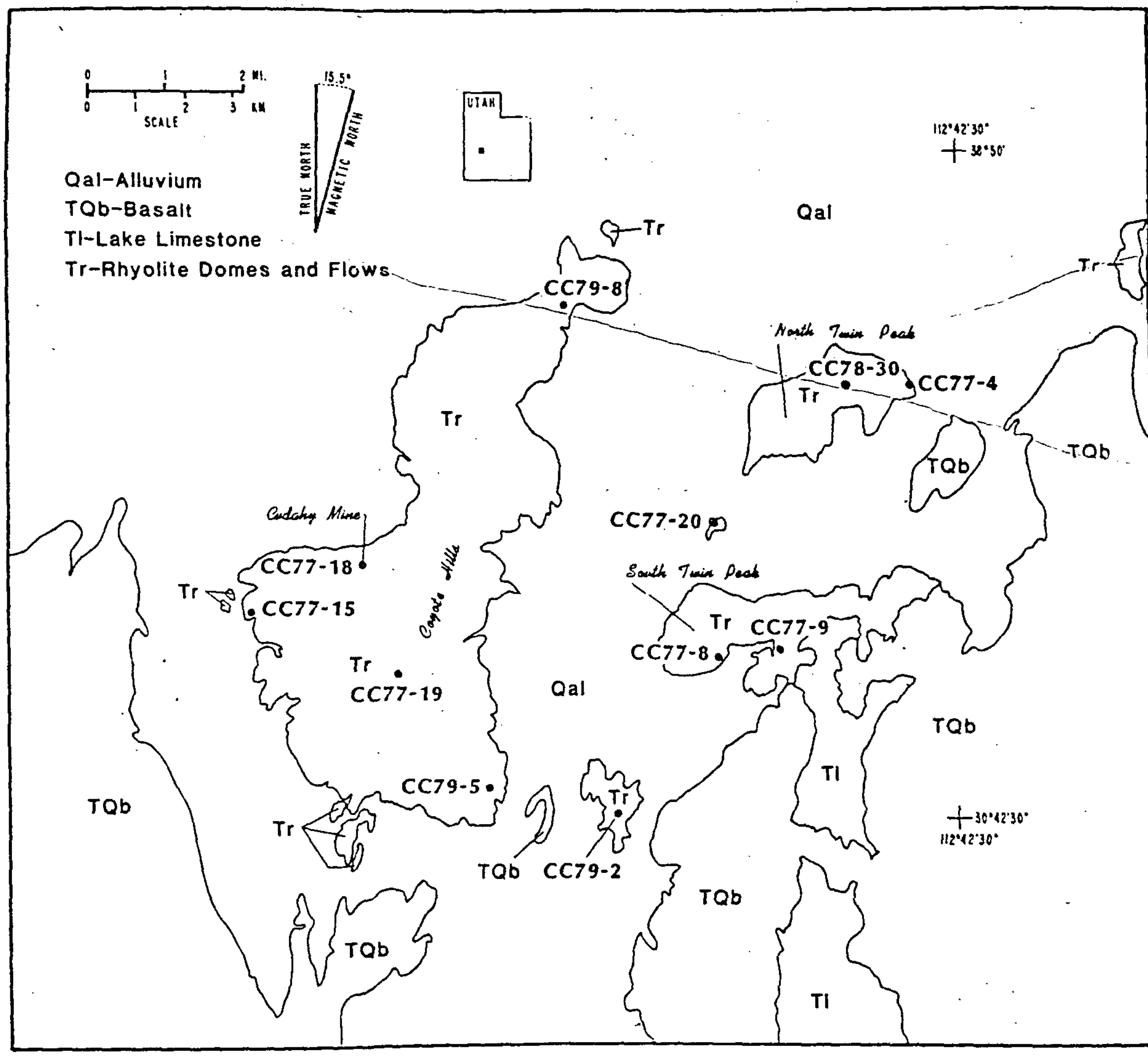


FIGURE 1. Generalized geologic map and sample locations for silicic volcanics of the Cove Creek Domes/Twin Peaks area, southwestern Utah.

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 dat*[a: 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/A[r]

Rhyolite of South Twin Peak (38°43′47″N, 112°4[?]′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″N, 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°[?]′03″W; UT). This glass is essentially devoid of any minerals with extremely rare biotite, sanidine, and plagioclase crystallites. *Analytical data*: K = 3.9[?]%, 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°[?]′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 P[eak]

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.**

REFERENCES

Best, M. G., and Brimhall, W. H. (1974) Late Cenozoic alkalic basaltic magmas in the western Colorado Plateau and the Basin and Range transition zone, U.S.A., and their bearing on mantle dynamics: Geol. Soc. Amer. Bull., v. 85, p. 1677–1690.

Carrier, D. L. (1979) Gravity and heat flow studies at Twin Peaks—an area of Late Tertiary silicic volcanism in Millard County, Utah: M.S. thesis, Univ. Utah.

Clark, E. E. (1977) Late Cenozoic volcanic and tectonic activity along the eastern margin of the Great Basin in the proximity of Cove Fort, Utah: Brigham Young Univ. Geol. Studies, v. 24, pt. 1, p. 87–114.

Condie, K., and Barsky, C. K. (1972) Origin of Quaternary basalts from the Black Rock Desert region, Utah: Geol. Soc. Amer. Bull., v. 83, p. 333–352.

Crecraft, H. R., Nash, W. P., and Evans, S. H. (1979) Chemical evolution and development of compositional gradients in a silicic magma: G. S. A. Ann. Meeting Abs., v. 11, no. 7, p. 406.

Haugh, G. R. (1978) Late Cenozoic, cauldron-related silicic volcanism in the Twin Peaks area, Millard County, Utah: Brigham Young Univ. Geol. Studies, v. 25, pt. 3, p. 67–82.

Hildreth, W. (1979) The Bishop Tuff—evidence for the origin of compositional zonation in silicic magma chambers: Geol. Soc. Amer. Spec. Paper 180, p. 47–75.

Hoover, J. D. (1974) Periodic Quaternary volcanism in the Black Rock Desert, Utah: Brigham Young Univ. Geol. Studies, v. 21, pt. 1, p. 3–72.

Lipman, P. W., Rowley, P. D., Mehnert, H. H., Evans, S. H., Jr., Nash, W. P., and Brown, F. H. (1978) Pleistocene rhyolite of the Mineral Mountains, Utah Geothermal and archeological signifiance: U. S. Geol. Survey Journal of Research, v. 6, no. 1, p. 133–147.

Luedke, R. G., and R. L. Smith (1978) Map showing distribution composition and age of Late Cenozoic volcanic centers in Colorado, Utah, and southwestern Wyoming: U.S. Geol. Survey Map I-1091-B.

Zimmerman, J. T. (1961) Geology of the Cove Creek area, Millard County and Beaver County, Utah: M.S. thesis, Univ., of Utah.

NEW MEXICO TECH PRINT PLANT
Camera-ready copy provided by the Nevada Bureau of Mines and Geology
Presswork: Text and cover printed on Davidson 600
Paper: Body on 60-lb white offset; cover on 65-lb Russett
Ink: Van Son rubber base plus all-purpose black

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

STANLEY H. EVANS, JR.
HARRISON R. CRECRAFT
WILLIAM P. NASH

Department of Geology and Geophysics, University of Utah, Salt Lake City, UT 84112

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).

The work reported here was funded by the Division of Geothermal Energy, U.S. Department of Energy, contract No. DE-AC07-80ID12079, to Earth Sciences Division, University of Utah Research Institute with subcontract to the Department of Geology and Geophysics, University of Utah. The authors would also like to thank Dr. F. H. Brown, M. B. Sienkewicz, M. Jennison, N. Lundeen and B. Griffey for their assistance in running the Potassium/Argon Laboratory.

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.

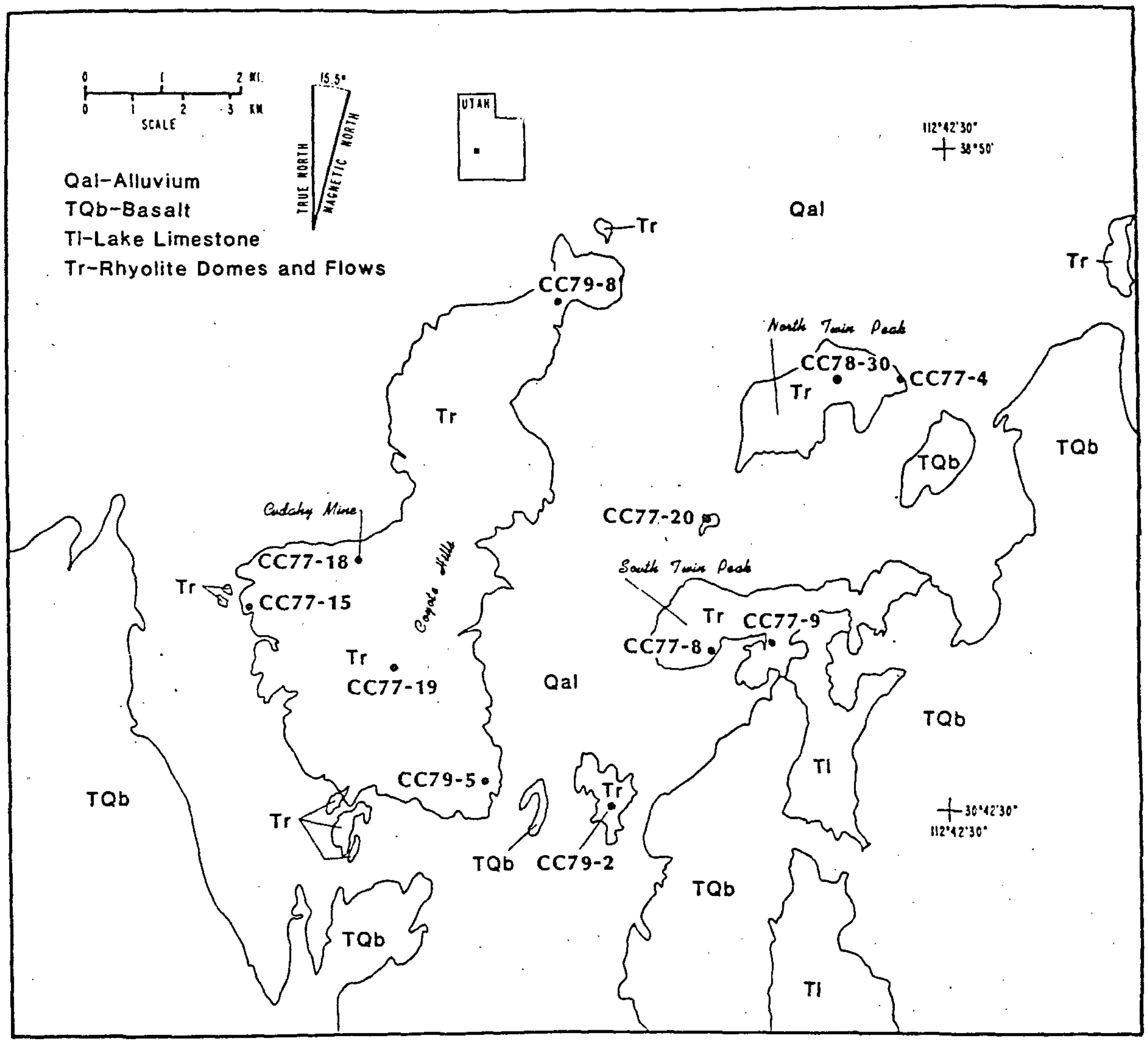


FIGURE 1. Generalized geologic map and sample locations for silicic volcanics of the Cove Creek Domes/Twin Peaks area, southwestern Utah.

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 x 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 x 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 x 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 x 10^{-11} m/gm, atmospheric ^{40}Ar = 23%.

(whole rock) 2.63 ± 0.09 m.y.

REFERENCES

Best, M. G., and Brimhall, W. H. (1974) Late Cenozoic alkalic basaltic magmas in the western Colorado Plateau and the Basin and Range transition zone, U.S.A., and their bearing on mantle dynamics: Geol. Soc. Amer. Bull., v. 85, p. 1677–1690.

Carrier, D. L. (1979) Gravity and heat flow studies at Twin Peaks—an area of Late Tertiary silicic volcanism in Millard County, Utah: M.S. thesis, Univ. Utah.

Clark, E. E. (1977) Late Cenozoic volcanic and tectonic activity along the eastern margin of the Great Basin in the proximity of Cove Fort, Utah: Brigham Young Univ. Geol. Studies, v. 24, pt. 1, p. 87–114.

Condie, K., and Barsky, C. K. (1972) Origin of Quaternary basalts from the Black Rock Desert region, Utah: Geol. Soc. Amer. Bull., v. 83, p. 333–352.

Crecraft, H. R., Nash, W. P., and Evans, S. H. (1979) Chemical evolution and development of compositional gradients in a silicic magma: G. S. A. Ann. Meeting Abs., v. 11, no. 7, p. 406.

Haugh, G. R. (1978) Late Cenozoic, cauldron-related silicic volcanism in the Twin Peaks area, Millard County, Utah: Brigham Young Univ. Geol. Studies, v. 25, pt. 3, p. 67–82.

Hildreth, W. (1979) The Bishop Tuff—evidence for the origin of compositional zonation in silicic magma chambers: Geol. Soc. Amer. Spec. Paper 180, p. 47–75.

Hoover, J. D. (1974) Periodic Quaternary volcanism in the Black Rock Desert, Utah: Brigham Young Univ. Geol. Studies, v. 21, pt. 1, p. 3–72.

Lipman, P. W., Rowley, P. D., Mehnert, H. H., Evans, S. H., Jr., Nash, W. P., and Brown, F. H. (1978) Pleistocene rhyolite of the Mineral Mountains, Utah Geothermal and archeological signifiance: U. S. Geol. Survey Journal of Research, v. 6, no. 1, p. 133–147.

Luedke, R. G., and R. L. Smith (1978) Map showing distribution composition and age of Late Cenozoic volcanic centers in Colorado, Utah, and southwestern Wyoming: U.S. Geol. Survey Map I-1091-B.

Zimmerman, J. T. (1961) Geology of the Cove Creek area, Millard County and Beaver County, Utah: M.S. thesis, Univ., of Utah.

NEW MEXICO TECH PRINT PLANT
Camera-ready copy provided by the Nevada Bureau of Mines and Geology
Presswork: Text and cover printed on Davidson 600
Paper: Body on 60-lb white offset; cover on 65-lb Russett
Ink: Van Son rubber base plus all-purpose black

AREA
UT
Beaver

TO Utah Geology

A PRELIMINARY GEOLOGIC MAP OF THE WILDCAT CREEK AREA, EASTERN BEAVER COUNTY, UTAH

by

Galen Haugh

Brigham Young University

A PRELIMINARY GEOLOGIC MAP OF THE WILDCAT CREEK AREA, EASTERN BEAVER COUNTY, UTAH

Although the area around Wildcat Creek in eastern Beaver County is shown on the state Geologic Map to be comprised of Tertiary Sevier River Formation, field investigation has revealed a variety of rock types, mostly igneous. In view of the geothermal potential in the nearby Cove Fort-Sulfurdale area to the northeast, a geologic map correcting this discrepancy would be of vital interest to companies developing the geothermal potential of the area. A preliminary geologic map of the Wildcat Creek area was made in August, 1976, using aerial photos at a scale of 1:36,500. The area lies between the Mineral Mountains and Interstate 15 and encompasses about 300 km^2 (115 $miles^2$). The area is dominated by a series of north-south trending ridges and washes, influenced by Basin and Range block faulting, and by a line of silicic lava domes. The following rock types are found:

Granite

Granitic rocks crop out extensively in the southern part of the area and extend northward along Maple Flats. The outcrops form rounded boulders; grus is widespread and in areas of thick soil development the presence of granitic bedrock can be inferred by the granular consistency of the soil and occasional round granitic cobbles. Composition ranges from monzonite to quartz monzonite. Although rock textures are generally equigranular and fine to medium grained, local phenocrysts of feldspar up to 1 cm long are common. Alteration is moderate; the feldspar crystals are milky pink and white, the quartz phenocrysts appear slightly milky, and biotite, the predominant mafic mineral, has been partially oxidized.

Diorite:

North of and adjacent to the area of granitic rocks is an area underlain by pyroxene diorite. The homogeneity and small size of this body indicate it could be a single intrusion. This body has undergone moderate alteration; the feldspar crystals are milky white and the pyroxenes are chloritized.

Rhyolite:

Silicic extrusive rocks, predominately rhyolite, crop out in the northern part of the area. The presence of a number of silicic domes, for example Gillies Hill and Woodtick Hill, indicate several individual eruptive centers. The rhyolite domes are outlined by a hachure pattern on the geologic map. Of particular interest is the association with the rhyolite of secondary quartz in joints and fractures and siliceous sinter, found along Interstate 15 at Mud Spring. The rhyolite on Gillies Hill contains numerous partially resorbed basaltic xenoliths.

Dacite and Andesite:

Intermediate extrusive rocks predominate in the center of the area. Rock types include andesite and dacite. Alteration is locally extreme.

Indeed, large areas of aphyric felsitic rocks with quartz veins and stringers occur in the area of andesite and dacite. These areas of alteration have highly variable and gradational contacts and hence were not mapped. However, it is of interest to note that the occurrences of felsitic rocks in the andesites and dacites are adjacent to the rhyolite domes, perhaps indicating an association with the rhyolite eruptions.

Tuffs:

Tuffaceous rocks are localized on Gillies Hill, apparently a volcanic center and the highest point in the area. The tuffs are foliated, poorly indurate, and light tan in color.

Vitrophyre:

Two areas of vitrophyre lie east of Gillies Hill. The areas are confined to separate hills in contact with rhyolite domes--apparently separate bodies associated with the rhyolite eruptions. The vitrophyre is rhyolitic with phenocrysts of quartz and sanidine.

Basalt:

Basaltic rocks occur on the north and west sides of the map. Morphologically the basalts are low lying, lobate flows. Separate flows can be distinguished on the aerial photos as coming from several vents now covered by cinder cones, for example Crater Knoll.

Marble:

In the middle of the map are three small bodies of marble, lying stratigraphically above the surrounding dacite and andesite. The origin of these bodies is unknown at this time.

Quaternary alluvium:

Alluvium, which skirts the area on practically all sides, can easily be separated into older and younger. Older alluvium includes such areas as The Hogback, with flat erosional surfaces distinctly above the present drainage system. Younger alluvium occurs in areas of the present drainage system, predominately Cunningham Wash and the Wildcat Creek drainage. It appears that the two distinctly separate bodies of alluvium reflect rejuvenation due to uplift of the area.

Age of the Rocks

Although definite ages of the rock types in the area have not been determined, approximate time relations can be assigned based upon structural and stratigraphic relations and by comparing these rocks with similar, chronologically determined units in adjacent areas.

It is probable that the granite in the Wildcat Creek area and those in the Mineral Mountains are roughly of the same age, if not the same body. Granitic rocks in the Mineral Mountains, cropping out a mere two kilometers to the west, have been assigned several ages. Armstrong (1970) determined a K-Ar age of 9.2 ± 0.3 m.y., using biotite. Park (1968) used biotite and muscovite associated with beryllium mineralization contemporaneous with but slightly later than the crystallization of the pluton to calculate a K-Ar age of 15.5 ± 1.5 m.y. Stern (in Wheelan, 1970) used zircon to obtain a lead-alpha age of 10 ± 10 m.y. The high uncertainty is explained by low lead content of the sample, near the limit of detection. Ages derived by the K-Ar method are much more precise than those derived by other methods, and are preferred.

However, since Ar concentrations record the last thermal event above 300° C, and because waters of 300° C have been located by geothermal development at Roosevelt Hot Springs just west of the Mineral Mountains, the K-Ar ages cited above must be considered as minimal dates on the pluton.

Silicic alteration of the andesite and dacite in contact with the granite indicates intrusion of the grainitic body into andesitic country rock. This relationship, which suggests the andesite and dacite are older than the granitic material, is corroborated by ages of other intermediate extrusive rocks in the general area, which range between 17 and 34 m.y. (Stewart and Carlson, 1976).

More recent silicic volcanism has also produced alteration of the dacite and andesite. Rhyolites 25 kilometers to the north have been dated at 0.4 to 2.2 m.y. (Lipman et al, 1977). The rhyolite domes in the Wildcat creek area likely fall within this age range.

Structural relations indicate the basaltic flows and cones are the youngest of the indurated rock units. Within the area the oldest basaltic flows are no more than one million years (Clark, 1977). Ages of morphologicall similar basalt flows in the Black Rock Desert, 50 kilometers to the north, have all been found to be less than 1 million years old (Hoover, 1974).

Acknowledgements

Appreciation is given to M.G. Best, L.F. Hintze, and G.R. Nielsen for help in manuscript preparation and reviewing and to Phillips Petroleum Company for financial assistance in support of this project.

Bibliography

Armstrong, R.L., 1970, Geochronology of Tertiary igneous rocks, eastern Basin and Range Province, western Utah, eastern Nevada, and vicinity: Geochim. Cosmochim. Acta, v. 34, p. 203-232.

Clark, E., 1977, Late Cenozoic volcanic and tectonic activity along the eastern margin of the Great Basin in the proximity of Cove Fort, Utah: M.S. thesis, Brigham Young University, Provo, Utah.

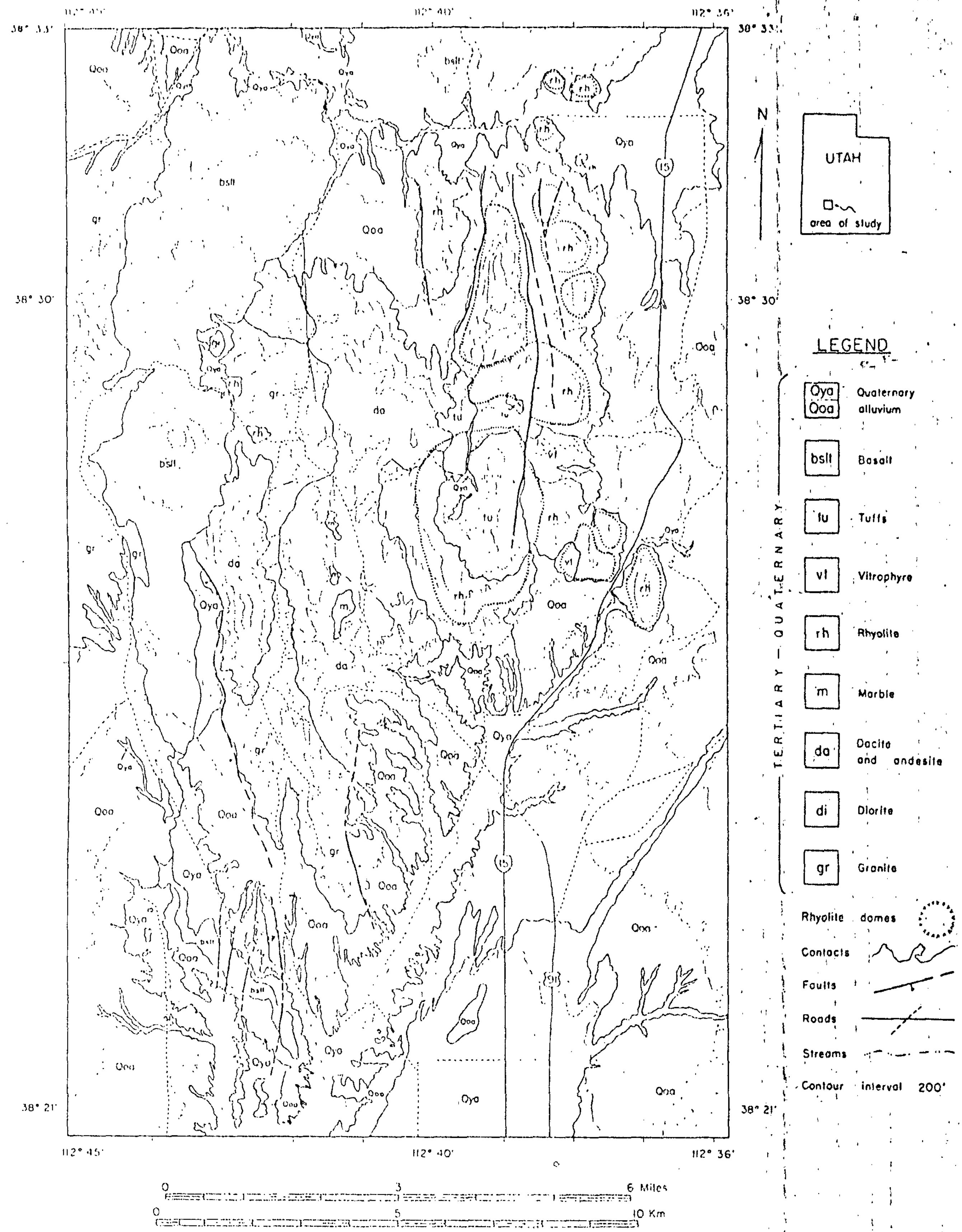
Hoover, J.D., 1974, Periodic Quaternary volcanism in the Black Rock Desert, Utah: BYU Geology Studies, v. 21, part 1, p. 3-72.

Lipman, P.W., Rowley, P.D., Mehnert, H.H., Evans, S.H., Nash, P.W., and Brown, F.H., 1977, Pleistocene rhyolite of the Mineral Mountains, Utah: geothermal and archaeological significance: in press.

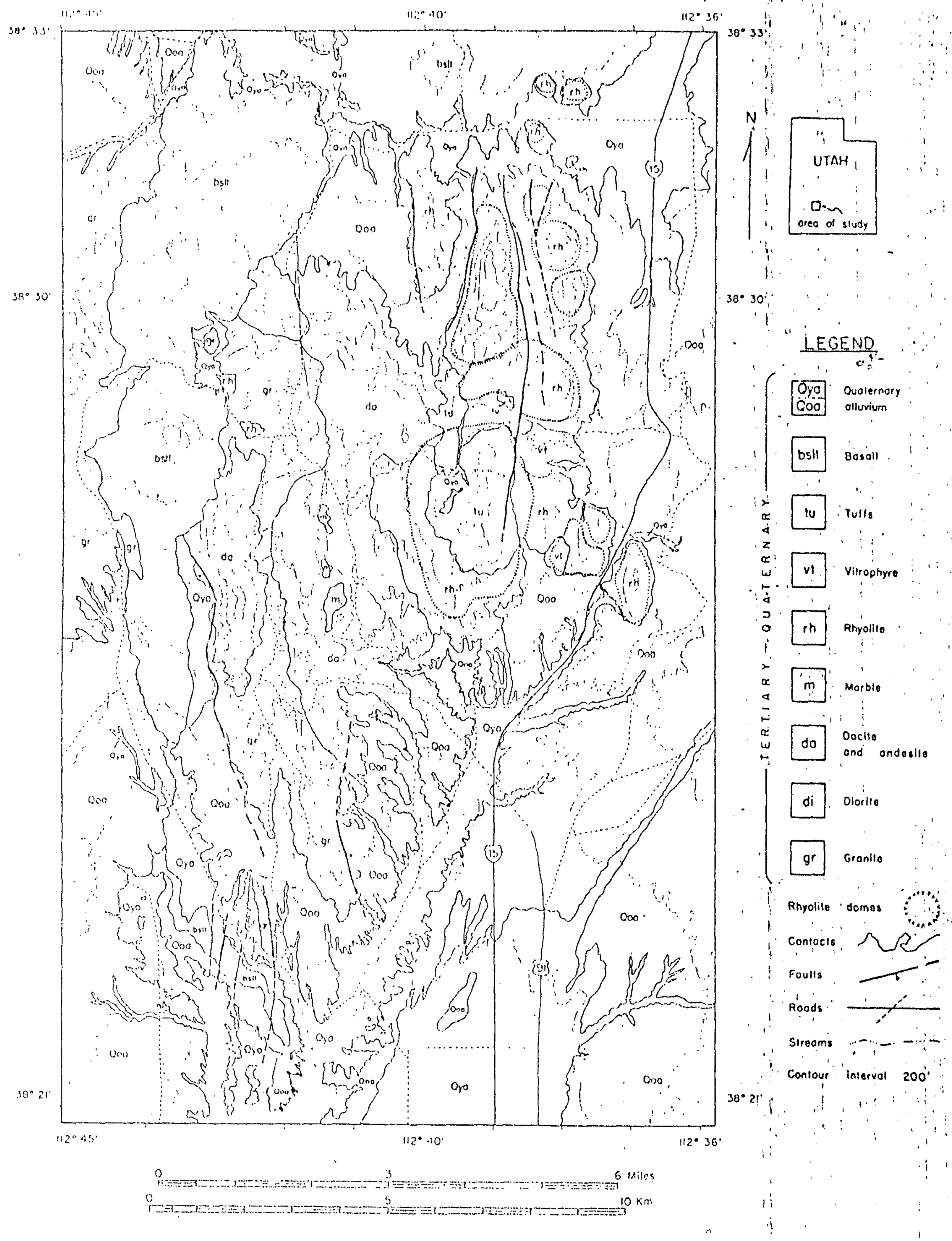
Park, G.M., 1968, Geochronology of beryllium deposits, Utah: M.S. thesis, University of Utah, Salt Lake City, Utah.

Stewart, J.H., and Carlson, J.E., 1976, Cenozoic rocks of Nevada: Nevada Bureau of Mines and Geology, Map 52, University of Nevada, Reno, Nevada.

Wheelan, J.A., 1970, Radioactive and isotopic age determinations of Utah rocks: Utah Geol. Mineralog. Survey Bull., No. 81, p. 25.



38° 33'
38° 30'
38° 21'
112° 45'
112° 40'
112° 36'
N
UTAH
area of study
LEGEND
Qya Qoa Quaternary alluvium
bslt Basalt
tu Tuffs
vt Vitrophyre
rh Rhyolite
m Marble
da Dacite and andesite
di Diorite
gr Granite
TERTIARY — QUATERNARY
Rhyolite domes
Contacts
Faults
Roads
Streams
Contour interval 200'
0 3 6 Miles
0 5 10 Km



112° 45'
112° 40'
112° 36'
38° 33'
38° 30'
38° 21'
N
UTAH
area of study
LEGEND
TERTIARY — QUATERNARY
Qya
Qoa
Quaternary alluvium
bslt
Basalt
tu
Tuffs
vt
Vitrophyre
rh
Rhyolite
m
Marble
da
Dacite and andesite
di
Diorite
gr
Granite
Rhyolite domes
Contacts
Faults
Roads
Streams
Contour interval 200'
0
3
6 Miles
0
5
10 Km