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K-Ar AGES OF VOLCANIC ROCKS FROM THE MAGIC RESERVOIR ERUPTIVE CENTER, SNAKE RIVER PLAIN, IDAHO

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Bimodal basalt-rhyolite volcanism is characteristic throughout the development of the Snake River Plain (SRP)—Yellowstone province (Armstrong and others, 1975; Leeman, 1982a). In this paper, we present results of a detailed geochronologic study along the north-central margin of the SRP in the eastern Mt. Bennett Hills-Picabo Hills area (Magic Reservoir area). Late Cenozoic eruptive products in this area include early ash-flow tuffs, later rhyolite lavas, domes, and tuffs, hybrid (mixed) lavas, and late olivine basalt flows. The relative distribution of these units has been determined in the Magic Reservoir area through reconnaissance (Malde and others, 1963) and detailed mapping (Schmidt, 1961; Smith, 1966; Struhsacker and others, 1982). A compilation of these maps and an overview of stratigraphic relations was given by Leeman (1982b).

Here we present 10 new K-Ar age determinations and discuss their geological significance. Our results and previous dates obtained by Armstrong and others (1975, 1980) and Struhsacker and others (1982) now provide a reasonably complete absolute chronology for eruptive history of this area. General geographic locations and sampling localities are shown in figures 1 and 2 respectively. The following discussion of stratigraphic relations is keyed to a generalized geologic map (fig. 2) and a stratigraphic column (fig. 3).

Post-Challis volcanic rocks in the area can be clearly divided into older (ca. 9–10 m.a.) Idavada Volcanics and younger (< 6 m.a.) volcanic rocks of the Magic Reservoir area (Magic Reservoir Volcanics). The sources of ash-flow tuffs of the Idavada Volcanics appear to be distal because several individual cooling units actually thicken southward. The Idavada Volcanics exposed in the eastern Mt. Bennett Hills and in the Timmerman-Picabo Hills are chemically distinct from the younger Magic Reservoir Volcanics, but are similar to the rhyolitic lavas of the Bruneau-Jarbidge eruptive center (Bonnichsen, 1982). One unit of Banbury Basalt flows (McHan Basalt of Smith, 1966) is intercalated with the Idavada ash-flow tuffs. A sample of this basalt (L80-62) yielded a K-Ar age slightly older than that for the overlying ash flow cooling unit (L80-78). The source(s) of these basalts is unknown but is probably local.

Post-Idavada volcanism in the Magic Reservoir area began with eruption of extensive porphyritic lavas of quartz latite bulk composition. However, glasses in fresh samples are actually rhyolitic in composition, so it is the high crystal content that is responsible for the more mafic bulk composition. We have retained the name Rhyolite of Magic Reservoir (Tmr) for this multiple flow unit following Malde and others (1963). This unit has been dated at 5.8 m.a. by Struhsacker and others (1982), but a younger age (4.2 m.a.) is reported here for a sample (L80-38) from the southern margin of the area. The latter flow also has distinct chemistry compared to all other analyzed samples from this unit. Extensive ferrolatitic hybrid lavas (the Square Mtn. Ferrolatite, Tsf) were erupted next; these flows locally overlie Rhyolite of Magic Reservoir in the north and central parts of the study area. The absolute age of this unit has not been determined, but it is bracketed (about 5.6 and 5.8 m.a.) by dated stratigraphic units. Minor rhyolitic ash-flow and air-fall deposits (herein called the Young Tuff, Tyt) were erupted from vents in the vicinity of Magic Hot Springs and were deposited over a restricted region in the vicinity of Magic Reservoir. The Young Tuff is equivalent to the ash-flow tuffs and related domes (rhyolitic ash-flow tuffs and domes of Magic Reservoir) mapped by Struhsacker and others (1982) who reported K-Ar ages of about 4.8 and 5.6 m.a. for this multiflow unit. We obtained an age of 13.0 m.a. for one sample (L80-57A) of Young Tuff, but this age is clearly too old because the tuff contains xenoliths of units having younger ages (Rhyolite of Magic Reservoir and Square Mtn. Ferrolatite). The old age obtained for our sample of Young Tuff could be due to inclusion of xenocrysts of Mesozoic or older basement rocks which also occur as xenoliths in the tuff. This interpretation is supported by an elevated $^{87}Sr/^{86}Sr$ ratio (0.72039, as measured on whole-rock) which suggests contamination by old crustal rocks.

Porphyritic rhyolite dome lavas (here designated as Young Domes, Tyd) were extruded around the eruptive center between 3 m.a. and 4 m.a. These highly evolved high-silica rhyolites appear to represent the waning stages of silicic volcanism in the area. Subsequent volcanism (Pleistocene-Recent) was predominantly basaltic. Detailed mineral chemistry and petrochemistry will be published elsewhere for each of the eruptive units that have been dated. Some representative major element analyses are given in table 1.

In summary, volcanism in the Magic Reservoir area postdates the early (and more voluminous) Idavada eruptive activity by a significant time interval (at least 3 m.y.). The younger rhyolites (Magic Reservoir Volcanics) do not fit early observations (Armstrong, et al., 1975) of a relatively systematic age progression for silicic magmatism in the Snake River Plain—Yellowstone province, although the early Idavada tuffs are consistent with this interpretation. Thus, anomalously young silicic magmatism is clearly documented in the Magic Reservoir area (as in a few other areas of the SRP, Armstrong, et al., 1975; Leeman, 1982c). In all cases so far studied (Leeman, 1982c; unpublished data), such anomalous rhyolites, particularly dome lavas, are chemically evolved relative to early ash-flow tuffs. Although it could be argued that the later rhyolites represent more differentiated magmas derived from continuously evolving magma chambers related to the early rhyolites, the large time intervals between the two rhyolite eruptive phases render this an unlikely possibility. Preliminary Sr and Nd isotopic data also emphasize significant differences between compositions of the early and late rhyolites from the Magic Reservoir area (Leeman and others, 1985; unpublished data), hence they likely do not originate from an evolving, closed system magma reservoir. Detailed petrogenetic studies of this bimodal basalt-rhyolite suite indicate that the young rhyolites more likely represent a separate episode of crustal anatexis in re-

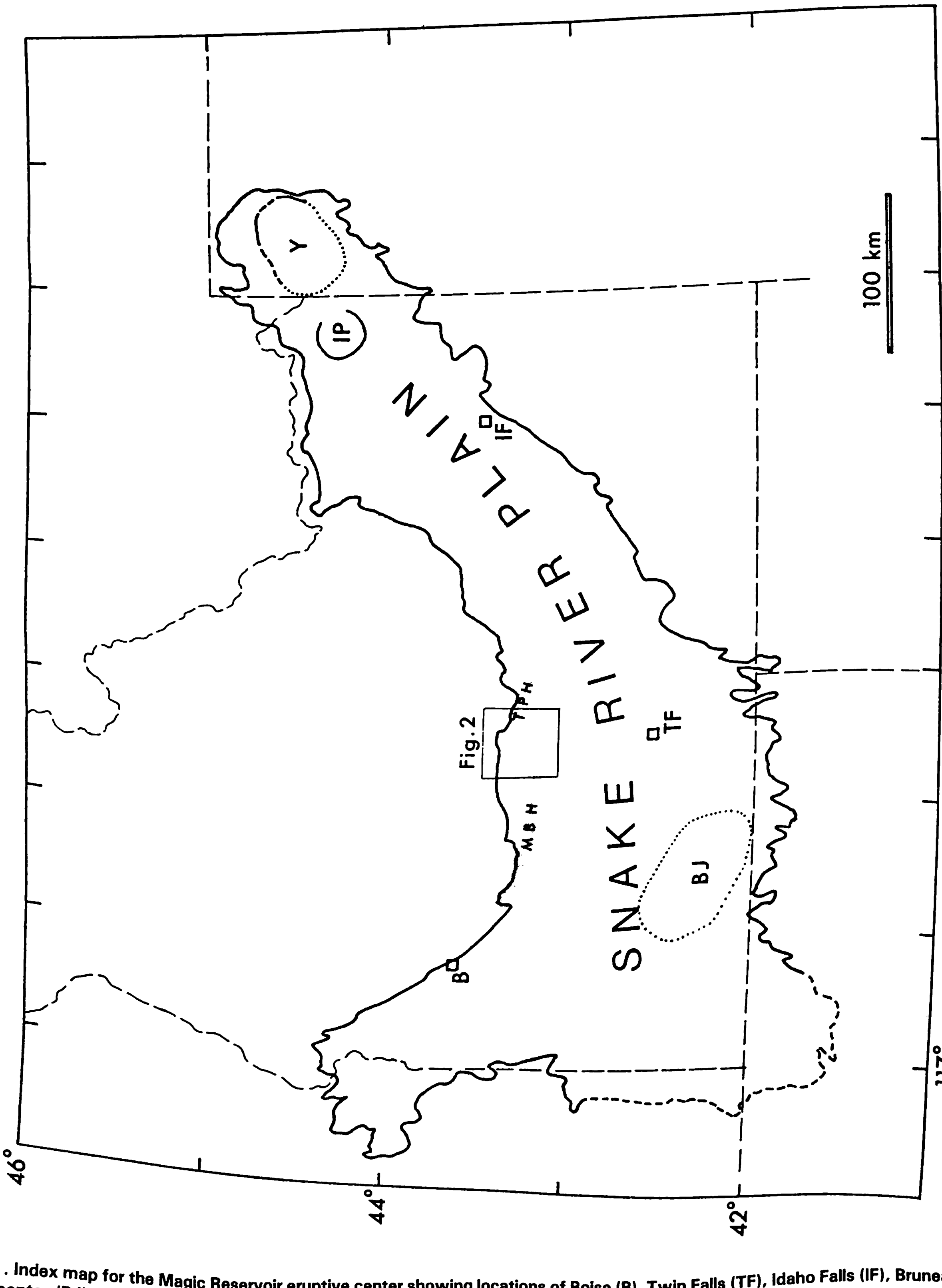

FIGURE 1. Index map for the Magic Reservoir eruptive center showing locations of Boise (B), Twin Falls (TF), Idaho Falls (IF), Bruneau-Jarbidge eruptive center (BJ), Mount Bennett Hills (MBH), Timmerman-Picabo Hills (TPH), Island Park caldera (IP), and Yellowstone caldera (Y). The large square at the north-central margin of the SRP corresponds to the geologic map of the study area (fig. 2).

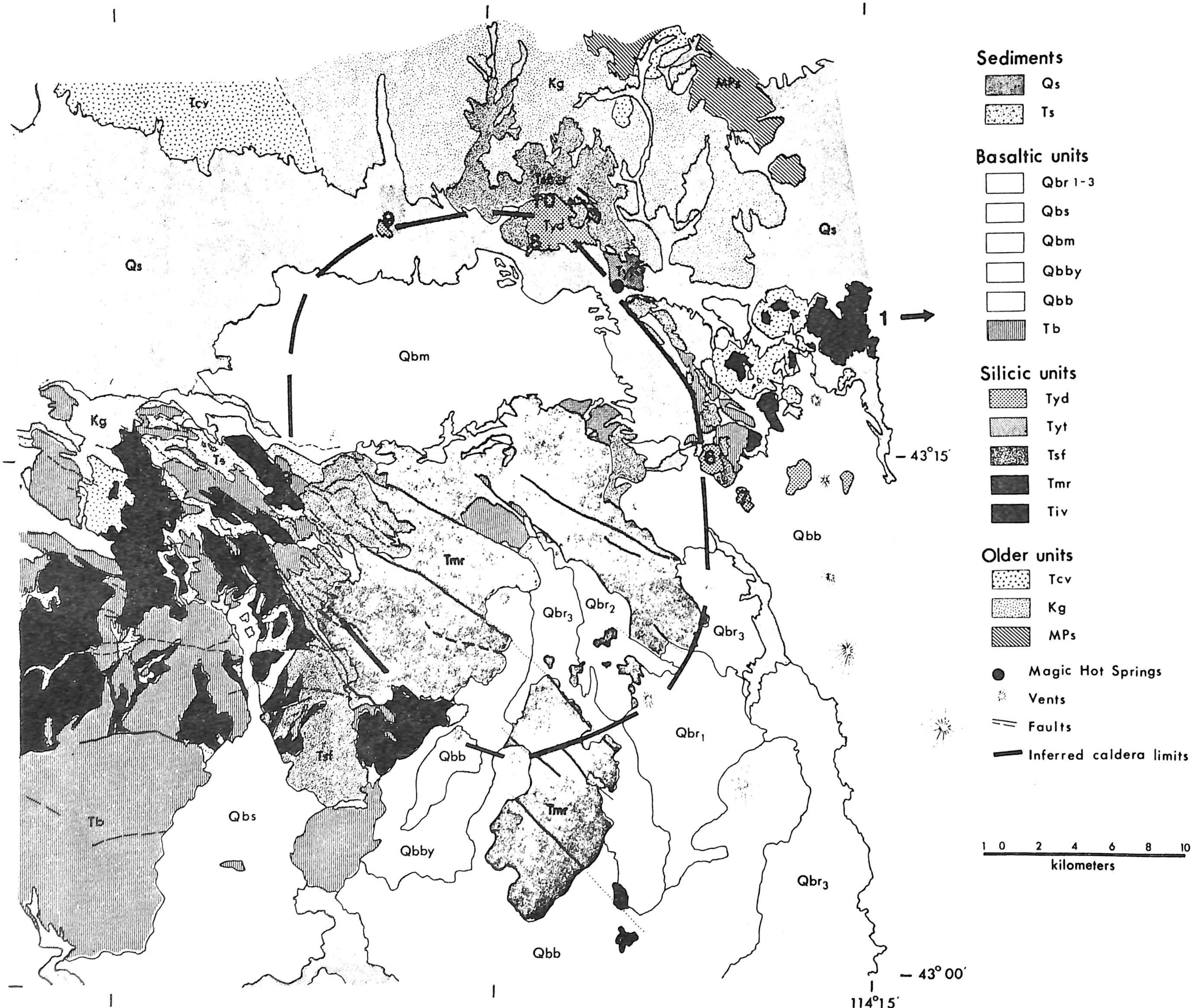

FIGURE 2. Geologic map of the Magic Reservoir eruptive center. See text for the abbreviations and summary of age determinations. The numbers in circles show sampling localities of the dated samples (modified after Leeman, 1982b).

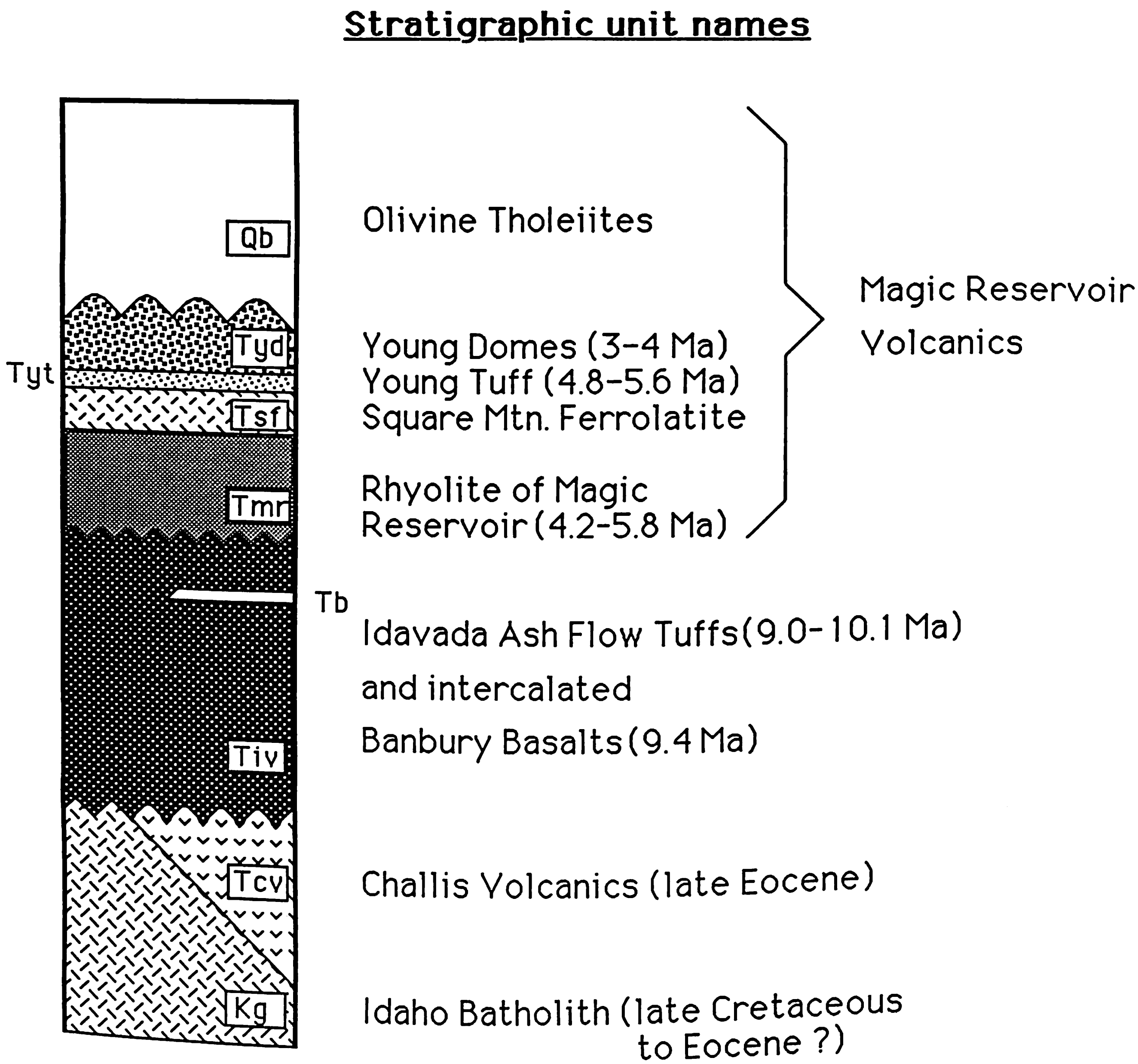

FIGURE 3. Generalized stratigraphic column for the Magic Reservoir eruptive center.

TABLE 1. Major element compositions.

Number / Sample Name	1 L80-30	2 L80-78	3 L80-62	4 L80-38	5 L80-57A	6 L80-34A	8 L80-59
SiO_2	70.0	68.4	49.9	67.4	74.5	75.1	75.2
TiO_2	0.57	0.77	1.79	0.84	0.26	0.08	0.15
Al_2O_3	12.61	13.12	16.20	13.65	12.62	12.79	12.51
Fe_2O_3	3.98	4.54	13.65	6.09	2.24	1.66	2.28
MnO	0.05	0.07	0.19	0.10	0.04	0.04	0.03
MgO	0.42	0.76	5.16	0.57	0.17	0.01	0.03
CaO	1.65	2.29	7.69	2.30	0.78	0.45	0.37
Na_2O	2.64	2.96	3.78	3.64	3.27	4.11	3.31
K_2O	5.31	4.68	1.60	4.57	5.43	4.77	5.20
P_2O_5	0.10	0.17	0.43	0.23	0.02	0.02	0.03
LOI	1.90	1.88	—	—	—	—	—
TOTAL	99.27	99.60	100.39	99.42	99.31	99.02	99.12

sponse to injection of mafic magmas at crustal levels (Honjo and Leeman, 1985; unpublished data).

All except one sample (L80-62) were dated using feldspar separates. After samples were sieved to 60–100 mesh and thoroughly cleaned, feldspars were separated using magnetic separation and heavy liquid techniques. Small (< 5 mm) whole-rock chips were used to date sample L80-62. K concentrations were determined by atomic absorption spectrophotometry at the Oregon State University. Ar isotope analyses using ^{38}Ar isotope dilution method were performed at O.S.U. with an AEI-MS10 mass spectrometer equipped with two in-line high vacuum extraction systems. The following constants were used: $K^{40}/\Sigma K = 1.167 \times 10^{-4}$ atom/atom, $K\lambda_\beta = 4.962 \times 10^{-10}$/yr, $K\lambda_\epsilon = 0.581 \times 10^{-10}$/yr.

SAMPLE DESCRIPTIONS

All samples were collected by W. P. Leeman except for MMR-1 which was collected by D. J. Matty. Mineral separations were performed by N. Honjo, and the samples were dated by K. R. McElwee.

1. *L80-30* K-Ar
Idavada Volcanics (43°16'25",114°00'21"W; Blaine Co., ID) plagioclase bearing welded tuff; Picabo-B unit of Schmidt (1961); SiO_2 = 70.0%. *Analytical data:* K = 0.972%; $^*Ar^{40} = 0.3323 \times 10^{-6}$ cc/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 54.9%.
(plagioclase) 8.98 ± 0.12 m.y.

2. *L80-78* K-Ar
Idavada Volcanics (43°7'15"N,114°35'23"W; Lincoln Co., ID) plagioclase bearing vitric welded tuff; City of Rocks Tuff of Smith (1966); SiO_2 = 68.4%. *Analytical data:* K = 1.06%; $^*Ar^{40} = 0.3690 \times 10^{-6}$ cc/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 56.6%.
(plagioclase) 9.15 ± 0.13 m.y.

3. *L80-62* K-Ar
Banbury Basalt (43°15'00"N,114°41'33"W; Camas Co., ID) olivine tholeiite; McHan Basalt of Smith (1966); SiO_2 = 49.9%. *Analytical data:* K = 1.31%; $^*Ar^{40} = 0.4711 \times 10^{-6}$ cc/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 85.1%.
(whole rock) 9.44 ± 0.11 m.y.

4. *L80-38* K-Ar
Rhyolite of Magic Reservoir (43°00'52"N, 114°23'46"; Lincoln Co., ID) ferroaugite and pigeonite bearing quartz latite; SiO_2 = 67.4%. *Analytical data:* K = 2.66%; $^*Ar^{40} = 0.4194 \times 10^{-6}$ cc/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 69.7%.
(anorthoclase + andesite) 4.15 ± 0.05 m.y.

5. *L80-57A* K-Ar
Young Tuff (43°20'15"N,114°24'2"W; Blaine Co., ID) rhyolitic ferrohypersthene-bearing vitric tuff; SiO_2 = 74.5%. *Analytical data:* K = 7.31%; $^*Ar^{40} = 3.632 \times 10^{-6}$ cc/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 75.5%.
(sanidine) 13.03 ± 0.15 m.y.

6. *L80-34A* K-Ar
Young Dome rhyolite (43°15'19"N,114°21'18"W; Rattlesnake Butte; Blaine Co., ID) hornblende and biotite bearing; SiO_2 = 75.1%. *Analytical data:* K = 8.58%; $^*Ar^{40} = 0.9519 \times 10^{-6}$ cc/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 74.5%.
(sanidine) 2.92 ± 0.04 m.y.

7. *L80-37* K-Ar
Young Dome rhyolite (43°14'13"N,114°19'57"W; Blaine Co., ID) ferroaugite and fayalitic olivine bearing. *Analytical data:* K = 7.25%; $^*Ar^{40} = 0.9086 \times 10^{-6}$ cc/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 46.3%.
(sanidine) 3.29 ± 0.05 m.y.

8. *L80-59* K-Ar
Young Dome rhyolite (43°21'29"N,114°28'24"W; SW foot Moonstone Mtn.; Blaine Co., ID) hornblende and biotite bearing; SiO_2 = 75.2%. *Analytical data:* K = 7.13%; $^*Ar^{40} = 0.8171 \times 10^{-6}$ cc/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 85.1%.
(sanidine) 3.02 ± 0.04 m.y.

9. *L81-16* K-Ar
Young Dome rhyolite (43°22'21"N,114°34'33"W; Camas Co., ID) hornblende, biotite, and allanite bearing. *Analytical data:* K = 7.95%; $^*Ar^{40} = 1.177 \times 10^{-6}$ cc/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 54.7%.
(sanidine) 3.89 ± 0.04 m.y.

10. *MMR-1* K-Ar
Young Dome rhyolite (43°22'18"N,114°28'00"W; N foot of Moonstone Mtn.; Blaine Co., ID) ferroaugite, pigeonite, hornblende, biotite, and allanite bearing. *Analytical data:* K = 7.72%; $^*Ar^{40} = 1.137 \times 10^{-6}$ cc/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 40.0%.
(sanidine) 3.88 ± 0.06 m.y.

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