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## TERTIARY VOLCANICS ALONG THE EASTERN FLANK OF THE PIONEER MOUNTAINS, SOUTHWESTERN MONTANA

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Tertiary volcanics on the eastern slopes of the East Pioneer Mountains are calc-alkalic, typically continental volcanic rocks. The bulk of the volcanic rocks are middle Eocene (50–46 m.y.). One outcrop of glassy volcanic rocks appears to be Oligocene.

The volcanic rocks of Eocene age occur as thin flows (a few meters to a few tens of meters thick) of no great individual lateral extent. These flows were subaerial and have abundant columnar joints; much of each unit shows oxidation and autobrecciation. Sampling of these units for radiometric dating is necessarily confined to the more massive flows having less oxidized or altered strata. As a result, the ages are biased toward the massive units, but there appears to be little evidence to suspect a great age difference between the various units.

A vitrophyre with perlitic texture has been correlated with the Lowland Creek Volcanics, west of Butte, Montana; this vitrophyre probably was part of a volcanic neck. Biotite phenocrysts from the vitrophyre gave a K-Ar age of 50.4 m.y. (sample 5) in agreement with the age of the Lowland Creek Volcanics (Smedes and Thomas, 1965). An ash bed intercalated with flows along the eastern slopes of the Pioneer Mountains contains much siliceous pumice and crystals of biotite which are petrographically identical to the perlite and biotite in the dated vitrophyre and is interpreted as an airfall equivalent. The penecontemporaneity of the flows and airfall ash is evident.

These volcanic rocks are additional evidence of the widespread volcanic activity that occurred during the Eocene in northwestern United States (Marvin and others, 1980; Armstrong, 1974; Smedes and Prostka, 1972; and Pearson and Obradovich, 1977).

The Oligocene volcanics may be integral parts of regional volcanic activities that produced scattered occurrences of volcanic rocks of similar age in southwestern Montana (Marvin and others, 1974; Chadwick, 1978).

The eleven K-Ar ages reported in this article were determined by the USGS geochronology laboratories in Denver, Colorado. They were obtained using techniques described by Dalrymple and Lanphere (1969) and calculated using the following decay constants and isotopic abundance:  $\lambda_{\beta} = 4.962 \times 10^{-10}/\text{yr}$ ,  $\lambda_{\epsilon} = 0.581 \times 10^{-10}/\text{yr}$ , and  $^{40}\text{K}/\text{K} = 0.01167$  atomic percent (Steiger and Jager, 1977).

Ten of the reported ages were obtained from whole-rock material which in several cases contained glass or suspected glass. The calculated K-Ar ages are considered minimum ages under these circumstances; the actual time of crystallization may be slightly older than the listed age. Several of these ages have been previously mentioned by Zen and others (1979).

The rock names are based on whole-rock chemical analyses and are named according to Rittmann's nomenclature (1952).

### SAMPLE DESCRIPTIONS

#### *Oligocene volcanics*

1. *USGS(D)-612-1* K-Ar  
Rhyodacite (45°37'24"N, 112°49'18"W; SW¼ S27,T2S,R10W; Vipond Park 15' quad., Beaverhead Co., MT). *Analytical data:* K<sub>2</sub>O = 1.77, 1.76%; \*<sup>40</sup>Ar = 0.6994 × 10<sup>-10</sup> mol/gm, \*<sup>40</sup>Ar/Σ<sup>40</sup>Ar = 62%. *Comments:* Rhyodacite is characterized by a pilotaxitic texture; labradorite, augite, hypersthene, olivine (rare), opaques, and glass (25%) are present. This specimen came from an isolated outcrop of rhyodacite.  
(whole rock) 27.3 ± 1.0 m.y.

#### *Eocene volcanics*

2. *USGS(D)-115-2* K-Ar  
Dacite-rhyodacite (45°41'26"N, 112°48'13"W; SW¼ S2,T2S,R10W; Vipond Park 15' quad., Beaverhead Co., MT). *Analytical data:* K<sub>2</sub>O = 3.10, 3.08%; \*<sup>40</sup>Ar = 2.133 × 10<sup>-10</sup> mol/gm, \*<sup>40</sup>Ar/Σ<sup>40</sup>Ar = 96%. *Comments:* This specimen is characterized by a trachytic texture; plagioclase, augite, hypersthene, opaque minerals, and possibly some glass are present. This specimen came from a flow unit stratigraphically higher than the flow unit represented by sample No. 3.  
(whole rock) 47.3 ± 1.6 m.y.
3. *USGS(D)-114-1* K-Ar  
Melarhyodacite (45°41'10"N, 112°48'13"W; SW¼ S2,T2S,R10W; Vipond Park 15' quad., Beaverhead Co., MT). *Analytical data:* K<sub>2</sub>O = 2.53, 2.53%; \*<sup>40</sup>Ar = 1.734 × 10<sup>-10</sup> mol/gm, \*<sup>40</sup>Ar/Σ<sup>40</sup>Ar = 88%. *Comments:* This volcanic unit is characterized by a pilotaxitic texture; plagioclase, olivine, augite (rare), and opaque minerals are present. This specimen came from a flow unit stratigraphically lower than the flow unit represented by sample No. 2.  
(whole rock) 47.0 ± 1.6 m.y.
4. *USGS(D)-395-1* K-Ar  
Rhyolite (45°39'35"N, 112°46'35"W; SE¼ S13,T2S,R10W; Vipond Park 15' quad., Beaverhead Co., MT). *Analytical data:* K<sub>2</sub>O = 8.47, 8.46%; \*<sup>40</sup>Ar = 6.231 × 10<sup>-10</sup> mol/gm, \*<sup>40</sup>Ar/ΣAr = 83%. *Comments:* The vitrophyric rhyolite contains crystals of plagioclase, microcline, biotite, partly resorbed quartz, and microlites. It is correlated with the Lowland Creek Volcanics (Smedes and Thomas, 1965). This specimen probably is from a volcanic rock.  
(biotite) 50.4 ± 1.7 m.y.

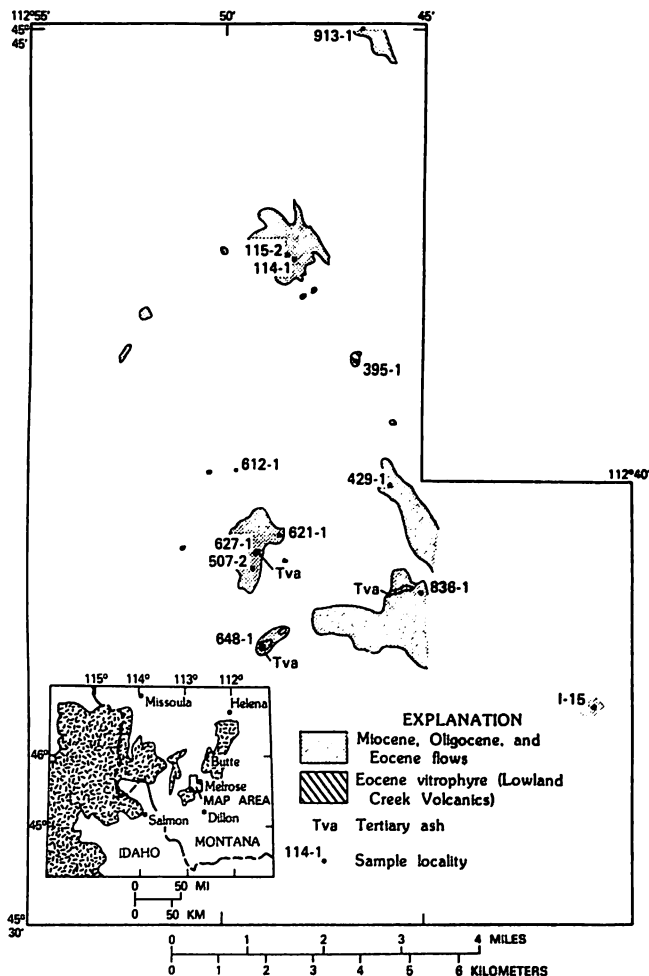


FIGURE 1. Map of eastern two thirds of the Vipond Park 15-minute quadrangle and western two thirds of the Earls Gulch 7.5-minute quadrangle, showing areas of Tertiary volcanic rocks and sample localities. Inset shows location of detailed map in southwestern Montana, the major Cretaceous batholiths, and major communities.

5. *USGS(D)-507-2* K-Ar  
Trachyandesite (45°36'05''N, 112°49'17''W; SE½ S3,T3S,R10W; large rock ledge on steep slope, Vipond Park 15' quad., Beaverhead Co., MT). *Analytical data:* K<sub>2</sub>O = 2.73, 2.67%; \*<sup>40</sup>Ar = 1.886 x 10<sup>-10</sup> mol/gm, \*<sup>40</sup>Ar/Σ<sup>40</sup>Ar = 94%. *Comments:* This specimen is composed of plagioclase, augite, hypersthene, opaque minerals, biotite (rare), microlites, and possibly some glass. It is coeval with the other dated andesite specimens, No. 6 and No. 7.

(whole rock) 47.9 ± 1.6 m.y.

6. *USGS(D)-627-1* K-Ar  
Trachyandesite (45°36'20''N, 112°49'00''W; E½ S3,T3S,R10W; Vipond Park 15' quad., Beaverhead Co., MT). *Analytical data:* K<sub>2</sub>O = 1.56, 1.56%; \*<sup>40</sup>Ar = 1.050 x 10<sup>-10</sup> mol/gm, \*<sup>40</sup>Ar/Σ<sup>40</sup>Ar = 87%. *Comments:* Specimen is composed of plagioclase, quenched augite-pigeonite, skeletal olivine, biotite (rare), opaque minerals, and possibly some glass. It is coeval with the other dated andesite specimens, No. 5 and No. 7. This trachyandesite overlies an ash bed.

(whole rock) 46.1 ± 1.6 m.y.

7. *USGS(D)-621-1* K-Ar  
Andesite (45°36'35''N, 112°48'35''W; NW¼ S3,T3S,R10W; Vipond Park 15' quad., Beaverhead Co., MT). *Analytical data:* K<sub>2</sub>O = 1.28, 1.27%; \*<sup>40</sup>Ar = 0.8675 x 10<sup>-10</sup> mol/gm, \*<sup>40</sup>Ar/Σ<sup>40</sup>Ar = 82%. *Comments:* This andesite is characterized by a pilotaxitic texture; plagioclase, augite-pigeonite, olivine, biotite (rare), opaque minerals, and possibly some glass are present. It is coeval with dated specimens No. 5 and No. 6. This andesite overlies an ash bed.

(whole rock) 46.7 ± 1.6 m.y.

8. *USGS(D)-648-1* K-Ar  
Basalt (45°34'43''N, 112°48'59''W; NE¼ S15,T3S,R10W; Vipond Park 15' quad., Beaverhead Co., MT). *Analytical data:* K<sub>2</sub>O = 1.02, 1.02%; \*<sup>40</sup>Ar = 0.7435 x 10<sup>-10</sup> mol/gm, \*<sup>40</sup>Ar/Σ<sup>40</sup>Ar = 85%. *Comments:* This basalt is characterized by crystals of andesine, quenched augite-pigeonite, skeletal olivine, opaque minerals, and possibly some glass, and by a pilotaxitic texture. The basalt overlies an ash bed.

(whole rock) 49.9 ± 1.7 m.y.

9. *USGS(D)-429-1-2* K-Ar  
Basalt (45°37'27''N, 112°45'42''W; NW¼ S31,T2S,R9W; Vipond Park 15' quad., Beaverhead Co., MT). *Analytical data:* K<sub>2</sub>O = 1.32, 1.33%; \*<sup>40</sup>Ar = 0.9627 x 10<sup>-10</sup> mol/gm, \*<sup>40</sup>Ar/Σ<sup>40</sup>Ar = 88%. *Comments:* Basalt is characterized by small quenched crystals of olivine and augite, less than 1% glass, and a pilotaxitic texture.

(whole rock) 49.8 ± 1.9 m.y.

10. *USGS(D)-836-2* K-Ar  
Basalt (45°35'35''N, 112°45'01''W; NW¼ S8,T3S,R9W; just N of Cherry Creek Road, Vipond Park 15' quad., Beaverhead Co., MT). *Analytical data:* K<sub>2</sub>O = 1.05, 1.05%; \*<sup>40</sup>Ar = 0.6976 x 10<sup>-10</sup> mol/gm, \*<sup>40</sup>Ar/Σ<sup>40</sup>Ar = 73%. *Comments:* Basalt is characterized by a hyalopilitic texture and crystals of andesine, olivine, and augite-pigeonite.

(whole rock) 45.6 ± 1.6 m.y.

11. *USGS(D)-I-15* K-Ar  
Melarhyodacite (45°33'43''N, 112°40'50''W; C S23,T3S,R9W; Earls Gulch 7.5' quad., Beaverhead Co., MT). *Analytical data:* K<sub>2</sub>O = 2.67, 2.68%; \*<sup>40</sup>Ar = 1.839 x 10<sup>-10</sup> mol/gm, \*<sup>40</sup>Ar/Σ<sup>40</sup>Ar = 86%. *Comments:* Specimen is characterized by a pilotaxitic texture and crystals of olivine, augite, and hypersthene; some glass may be present.

(whole rock) 47.1 ± 1.6 m.y.

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