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FISSION-TRACK AGES OF PLEISTOCENE VOLCANIC ASH
DEPOSITS IN THE CENTRAL PLAINS, U.S.A.

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Fission-track ages presented here were obtained as part of a Ph.D research program at Louisiana State University at Baton Rouge. This program was largely supported by the Nebraska Geological Survey. The purpose of the program was to reevaluate the framework of the classification of glacial deposits in eastern Nebraska. This required the study of some deposits of till and ash in Iowa, Kansas, and South Dakota.

Numerous deposits of white to very light gray Pleistocene volcanic ash of rhyolitic composition occur throughout the Central Plains. These deposits are lenticular and range from a few inches to 20 or more feet thick. In most cases, the ash lentils comprise a part of a fluvial-lacustrine sequence. The basal portion of the ash lentils contains virtually no admixed sand, silt, or clay. Because of this, samples were collected from the basal portion of the ash. The ash is predominately silt-size and generally contains less than 5% fine-sand-size particles. In all samples, virtually no alteration of the glass shards was visible upon examination with the petrographic microscope.

Fission-track dates were determined on glass shards from eleven volcanic ash deposits considered to be important in dating and reevaluating the classification framework of glacial deposits in eastern Nebraska (see figure 1). Seven of these ash deposits occur in the region covered by Pleistocene continental glaciers and are associated with glacial tills.

In addition to fission-track dating, ash shards from the eleven deposits were analyzed for iron, manganese, and samarium (see figure 2). The selection of these elements for analysis was based on results of studies by Borhardt and others (1972) and Izett and others (1970). Statistical analysis of the fission-track-age data and inspection of the chemical data indicated that five different ashes are represented among the eleven deposits dated.

A new terminology for Pleistocene volcanic ashes in the Central Plains is proposed. As shown below, the terminology requires knowledge of the age as well as of the iron, manganese, and samarium content of the ash.

<u>Ash Name</u>	<u>Age</u>	<u>Chemical Criteria</u>
Pearlette (restricted)	≈0.61 m.y.	≈ 1.1% Fe, 280 ppm Mn, 12 ppm Sm
Hartford	≈0.74 m.y.	≈ 1.1% Fe, 280 ppm Mn, 13 ppm Sm
Bishop	≈0.82 m.y.	≈ 0.6% Fe, 200 ppm Mn, 5 ppm Sm
Coleridge	≈1.21 m.y.	≈ 1.0% Fe, 240 ppm Mn, 11 ppm Sm
Borchers	≈1.97 m.y.	≈ 1.2% Fe, 280 ppm Mn, 14 ppm Sm

During the development of the classification of the Pleistocene sequence of the Central Plains the numerous deposits of volcanic ash were thought to be about the same age—late Kansan—and were collectively termed Pearlette Ash. Within this context, the Pearlette Ash was used as a key bed for regional correlations. The diverse ages of these ash deposits show that some of these correlations are in error and that parts of the classification scheme of Pleistocene deposits in the Central Plains need reworking.

The position of the younger ashes [Pearlette ash (restricted), Hartford ash and Bishop ash] within the classification scheme has not yet been determined with certainty. However, it is probable that these ashes are Kansan in age (following the classification scheme of Reed and Dreeszen, 1965).

The Coleridge ash occurs near the top of Reed and Dreeszen's Nebraskan sequence in eastern Nebraska and the date of 1.21 ± 0.05 m.y. for this ash is probably a good estimate for their Nebraskan-Kansan boundary.

The oldest glacial deposits in the Central Plains have not yet been dated. However, in Meade County, Kansas, the Borchers ash is overlain by a vertebrate fauna considered to be early Pleistocene (Aftonian) in age (Hibbard, 1972). This ash, in turn, overlies several meters of sand and gravel which unconformably rests on the Ogallala Formation (Pliocene). Hibbard (1972) believes the sand and gravel to have been deposited during or after Alpine glaciation but before the Nebraskan glaciation. If Hibbard's interpretations are correct, the dates of 1.97 ± 0.25 m.y. (this study) and 1.9 ± 0.2 m.y. (fission-track on zircon, Naeser and others, 1971) for the Borchers ash may approximate the initiation of continental glaciation in the Central Plains, U.S.A.

The constants used in the age calculations are: $\lambda_F = 6.85 \times 10^{-17} \text{ yr}^{-1}$, $\lambda_D = 1.54 \times 10^{-10} \text{ yr}^{-1}$, $\rho = 580 \times 10^{-24} \text{ cm}^2$, and $U^{235}/U^{238} = 7.25 \times 10^{-3}$. The calculated ages reported for each sample represent the mean and one standard deviation of at least three age determinations. The age reported for each lettered grouping represents the mean and standard error of the sample means in that group. All samples were collected and dated by the author.

SAMPLE DESCRIPTION

The lettered groupings below, along with proposed names, indicate ashes that have insignificant age differences and are chemically similar. Sample numbers correspond to those in figures 1 and 2. The analytical data represents the results of at least three age determinations per sample. All samples were irradiated simultaneously.

A. Pearlette Ash (restricted) — [0.61±0.04 m.y.]

1. Fission-track (glass) 0.64±0.07 m.y.
Volcanic ash (SW¼, Sec. 2, T31S, R28W; Cudahy Ash Mine, Meade Co., KS). This is the reference locality for the Pearlette ash (restricted). This ash was sampled at the type locality of Hibbard's (1944) Cudahy Fauna which immediately underlies the ash. Analytical data: total fossil tracks counted = 329, total induced tracks counted = 1565, $\rho_s = 1034 \pm 27 \text{ tracks/cm}^2$, $\rho_i = 14,761 \pm 990 \text{ tracks/cm}^2$, $\rho = 1.47 \pm 0.11 \times 10^{14} \text{ neutrons/cm}^2$.
2. Fission-track (glass) 0.57±0.02 m.y.
Volcanic ash (SW¼, SE¼, Sec. 26, T4N, R11E; Elk Creek Ash Site, Johnson Co., NB). Analytical data: total fossil tracks counted = 304, total induced tracks counted = 1605, $\rho_s = 956 \pm 24 \text{ tracks/cm}^2$, $\rho_i = 15,138 \pm 1615 \text{ tracks/cm}^2$, $\rho = 1.47 \pm 0.11 \times 10^{14} \text{ neutrons/cm}^2$.
3. Fission-track (glass) 0.59±0.05 m.y.
Volcanic ash (SE¼, Sec. 8, T78N, R33W; unnamed ash site, Guthrie Co., IA). Analytical data: total fossil tracks counted = 357, total induced tracks counted = 1824, $\rho_s = 1123 \pm 10 \text{ tracks/cm}^2$, $\rho_i = 17,203 \pm 1188 \text{ tracks/cm}^2$, $\rho = 1.47 \pm 0.11 \times 10^{14} \text{ neutrons/cm}^2$.
4. Fission-track (glass) 0.64±0.07 m.y.
Volcanic ash (Center Sec. 26, T9N, R2E; Dam 7 or Mammut moodiei Site, Seward Co., NB). Analytical data: total fossil tracks counted = 944, total induced tracks counted = 4180, $\rho_s = 933 \pm 116 \text{ tracks/cm}^2$, $\rho_i = 13,142 \pm 1011 \text{ tracks/cm}^2$, $\rho = 1.47 \pm 0.11 \times 10^{14} \text{ neutrons/cm}^2$.

B. Hartford Ash — [0.74±0.04 m.y.]

5. Fission-track (glass) 0.71±0.04 m.y.
Volcanic ash (NW¼, NE¼, Sec. 5, T81N, R44W; Little Sioux Site or County Line Section, Harrison Co., IA). Analytical data: total fossil tracks counted = 658, total induced tracks counted = 2790, $\rho_s = 1034 \pm 86 \text{ tracks/cm}^2$, $\rho_i = 13,157 \pm 1444 \text{ tracks/cm}^2$, $\rho = 1.47 \pm 0.11 \times 10^{14} \text{ neutrons/cm}^2$.

6. Fission-track (glass) 0.76 ± 0.09 m.y.
 Volcanic ash (SW¼, NE¼, Sec. 11, T102N, R51W; Hartford Site, Minnehaha Co., SD). This is the reference locality for the Hartford ash. Analytical data: total fossil tracks counted = 759, total induced tracks counted = 3034, $\rho_s = 1192 \pm 157$ tracks/cm², $\rho_i = 14,310 \pm 2247$ tracks/cm², $\phi = 1.47 \pm 0.11 \times 10^{14}$ neutrons/cm².
- C. Bishop Ash – [0.82±0.16 m.y.]
7. Fission-track (glass) 0.82 ± 0.16 m.y.
 Volcanic ash (SE¼, Sec. 26, T3N, R8W; unnamed ash site, Nuckolls Co., NB). This ash is unlike the other ashes dated in that it is chalky white and contains numerous brown biotite crystals. Izett and others (1970) correlated this ash with the Bishop Tuff of eastern California on the basis of similar petrographic and chemical characteristics. Analytical data: total fossil tracks counted = 161, total induced tracks counted = 599, $\rho_s = 1179 \pm 246$ tracks/cm², $\rho_i = 12,700 \pm 2260$ tracks/cm², $\phi = 1.47 \pm 0.11 \times 10^{14}$ neutrons/cm².
- D. Coleridge Ash – [1.21±0.05 m.y.]
8. Fission-track (glass) 1.26 ± 0.40 m.y.
 Volcanic ash (SW¼, NE¼, Sec. 11, T2N, R20W; type locality of the Sappa Formation, Harlan Co., NB). Analytical data: total fossil tracks counted = 116, total induced tracks counted = 726, $\rho_s = 2907 \pm 204$ tracks/cm², $\rho_i = 22,235 \pm 5699$ tracks/cm², $\phi = 1.47 \pm 0.11 \times 10^{14}$ neutrons/cm².
9. Fission-track (glass) 1.16 ± 0.20 m.y.
 Volcanic ash (SE corner Sec. 32, T15N, R3E; David City locality, Butler Co., NB). This ash was sampled by coring (Nebraska Geological Survey Test Holes 16-B-48 and 19-B-66). Analytical data: total fossil tracks counted = 421, total induced tracks counted = 1104, $\rho_s = 2978 \pm 215$ tracks/cm², $\rho_i = 23,423 \pm 661$ tracks/cm², $\phi = 1.47 \pm 0.11 \times 10^{14}$ neutrons/cm².
10. Fission-track (glass) 1.22 ± 0.17 m.y.
 Volcanic ash (NW¼, NE¼, NE¼, Sec. 11, T29N, R1E; Coleridge ash site, Cedar Co., NB). This is the reference locality for the Coleridge ash. Analytical data: total fossil tracks counted = 296, total induced tracks counted = 1542, $\rho_s = 2578 \pm 207$ tracks/cm², $\rho_i = 19,349 \pm 2928$ tracks/cm², $\phi = 1.47 \pm 0.11 \times 10^{14}$ neutrons/cm².
- E. Borchers Ash – [1.97±0.25 m.y.]
11. Fission-track (glass) 1.97 ± 0.25 m.y.
 Volcanic ash (NW¼, NE¼, Sec. 21, T33S, R28W; Borchers Ranch ash site, Meade Co., KS). This is the reference locality for the Borchers ash, the type locality of the Meade and Crooked Creek Formations, and also the type locality of Hibbard's (1941) Borchers Fauna which occurs in the silts immediately overlying the ash. Analytical data: total fossil tracks counted = 694, total induced tracks counted = 3215, $\rho_s = 3273 \pm 250$ tracks/cm², $\rho_i = 15,161 \pm 1348$ tracks/cm², $\phi = 1.47 \pm 0.11 \times 10^{14}$ neutrons/cm².

References and figures 1 & 2 follow

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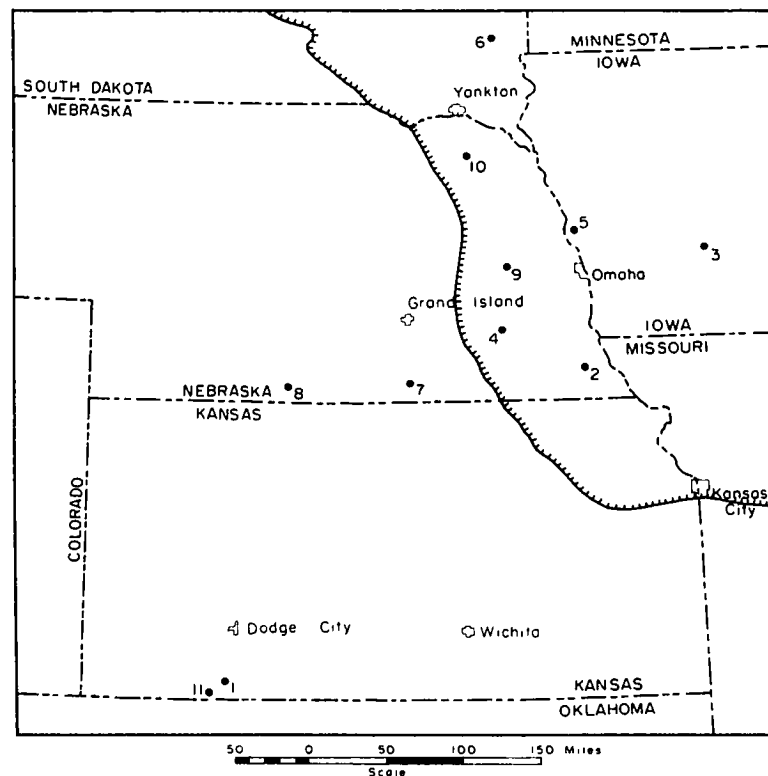


Figure 1 - Generalized location of volcanic ash sample sites. Hatched line approximates maximum extent of continental glaciation (hatchures on glacier side).

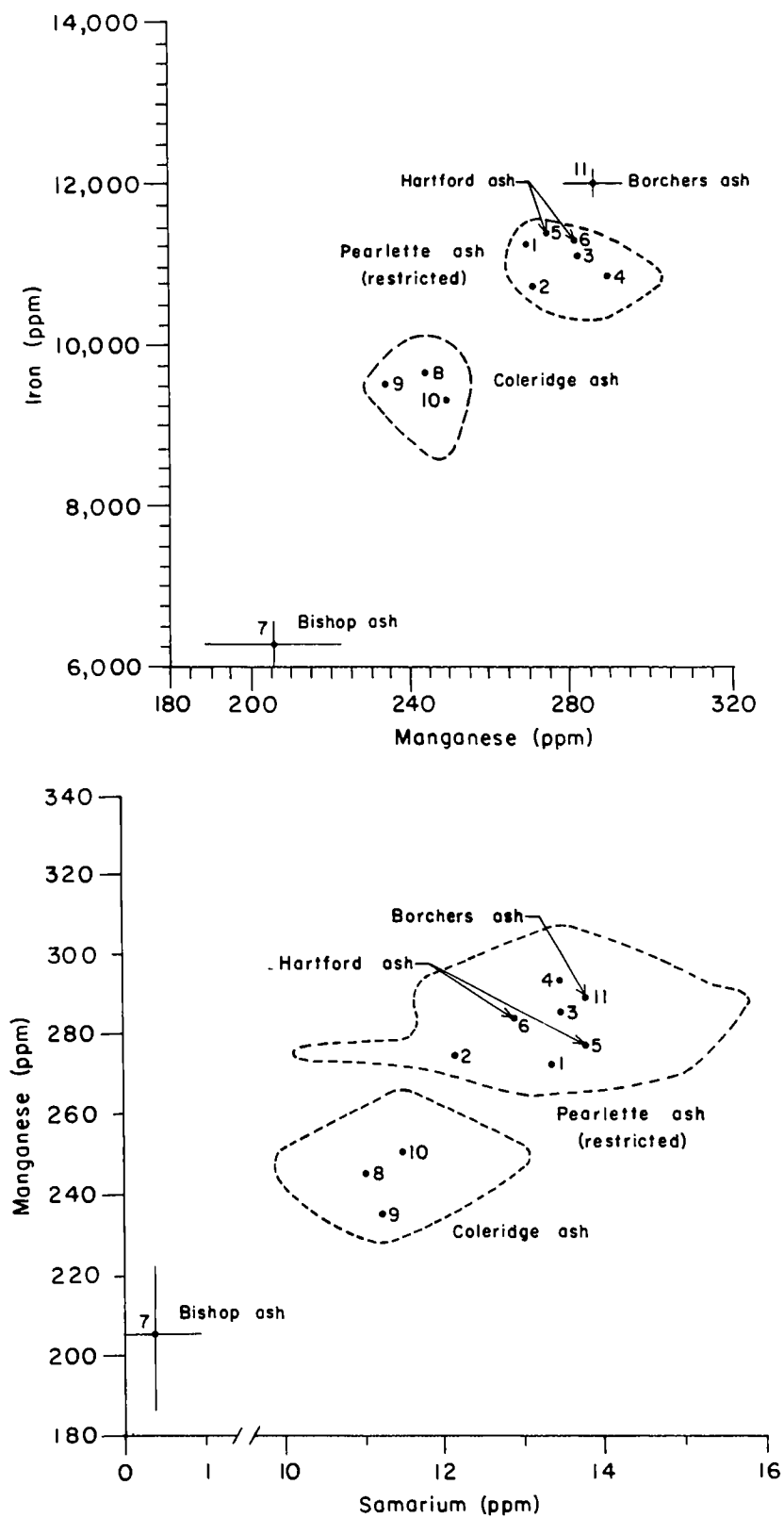


Figure 2 - Relationships of the concentration of selected chemical elements in the ash shards. Numbers correspond to those in figure 1. Dots are mean values with dashed lines showing standard deviations.