THE CANTWELL ASH BED, A HOLOCENE TEPHRA IN THE CENTRAL ALASKA RANGE

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INTRODUCTION

Recent geoarcheological research has led to the recognition, correlation, and dating of a Holocene volcanic ash layer in the central Alaska Range. The importance of tephrochronology in Quaternary studies such as archeology, geomorphology, palynology, and pedology lies primarily as a time-stratigraphic marker horizon through which intersite and intrasite stratigraphic comparisons can be made. This paper briefly describes one unreported tephra from the Cantwell vicinity, including its stratigraphic setting, distribution, chemical and petrographic characteristics, and possible correlation with other known Alaskan ash beds or volcanic vent sources.

STRATIGRAPHIC SETTING

The author observed a volcanic ash layer of apparent Holocene age in six exposures in the upper Nenana River valley in 1976 and 1977 (Bowers, 1978a,b). This tephra was found to extend from the Carlo Creek archeological site southward as far as mile 103.0 on the Denali Highway (figs. 1 and 2). The tephra was not observed farther north than the Carlo Creek locality, nor has it been reported by other workers in the Nenana River valley (Thorson and Hamilton, 1977; Wahrhaftig, 1958). The six localities reported here represent one area of the probably widespread geographic distribution of these pyroclastic deposits.

Tephra samples were collected from four locations: 1) Carlo Creek archeological site, mile 223.5 Parks Highway, 2) roadcut, mile 218.3 Parks Highway (type locality; table 2), 3) roadcut, mile 130.8 Denali Highway, and 4) 'the ash' archeological site, mile 103.0 Denali Highway (figs. 1 and 2). Where observed, the ash ranges in field-moist color from yellowish brown (10YR5/4) to very pale brown (10YR8/4). Ash depth ranges from 5 to 73 cm (table 1, fig. 2). Tephra thickness appears to increase to the east; this is probably a function of local deposition and preservation conditions. On the basis of field observations, these pyroclastic deposits were laid down during a variety of localized episodes of eolian sedimentation.

DESCRIPTION

In an attempt to correlate the tephra deposits in the Cantwell area, four ash samples were examined under a petrographic microscope. Sample pretreatment (removal of simple iron compounds and organic matter) followed previously established procedures (Smith and others, 1968, 1975). On the basis of preliminary comparisons of the refractive index of glass shards, phenocryst suite, and glass-shard morphologies, this tephra set evidently represents one eruptive event of a single volcanic source.

Visual comparison of tephra grains indicates a textural range of about 0.25 to 0.1 mm (fine-sand class). Because of an apparent fining of tephra grains in an eastern direction, a southwestern or western source is suggested (R. Okazaki, pers. comm., 1977).

The refractive index of the samples ranges from 1.500 to 1.504. Phenocrysts include an abundance of plagioclase and hornblende; hypersthene, magnetite, and ilmenite are minor constituents. Trace amounts of augite and detrital fragments of mica schist are present (Okazaki, pers. comm., 1977).

The glass-shard morphologies indicate a dominance of medium vesicular forms, containing thin cell walls (terminology based on Smith and others, 1968). Tubular forms are also present, but are less common (Okazaki, pers. comm., 1977).

One sample of ash from the type locality was submitted for elemental analysis by electron microprobe. The technique used was identical with that reported by Smith and Westgate (1969), as modified by Smith and others (1975, 1977a, 1977b). Data were recorded for Al, Mg, Ca, Fe, and K by using a set-beam ARL-EMX microprobe at the Idaho Bureau of Mines and Geology. Analysis of the Cantwell tephra indicates the following proportions (in percent) of major elements: Al = 7.82, K = 1.85, Ca = 1.78, Fe = 1.48, and Mg = 0.24 (U. Moody, pers. comm.). Percentages of Ca, Fe, and K particularly have proven to be key elements for describing glass components of like tephra (Smith and Westgate, 1969; Smith and others, 1975, 1977a, 1977b).

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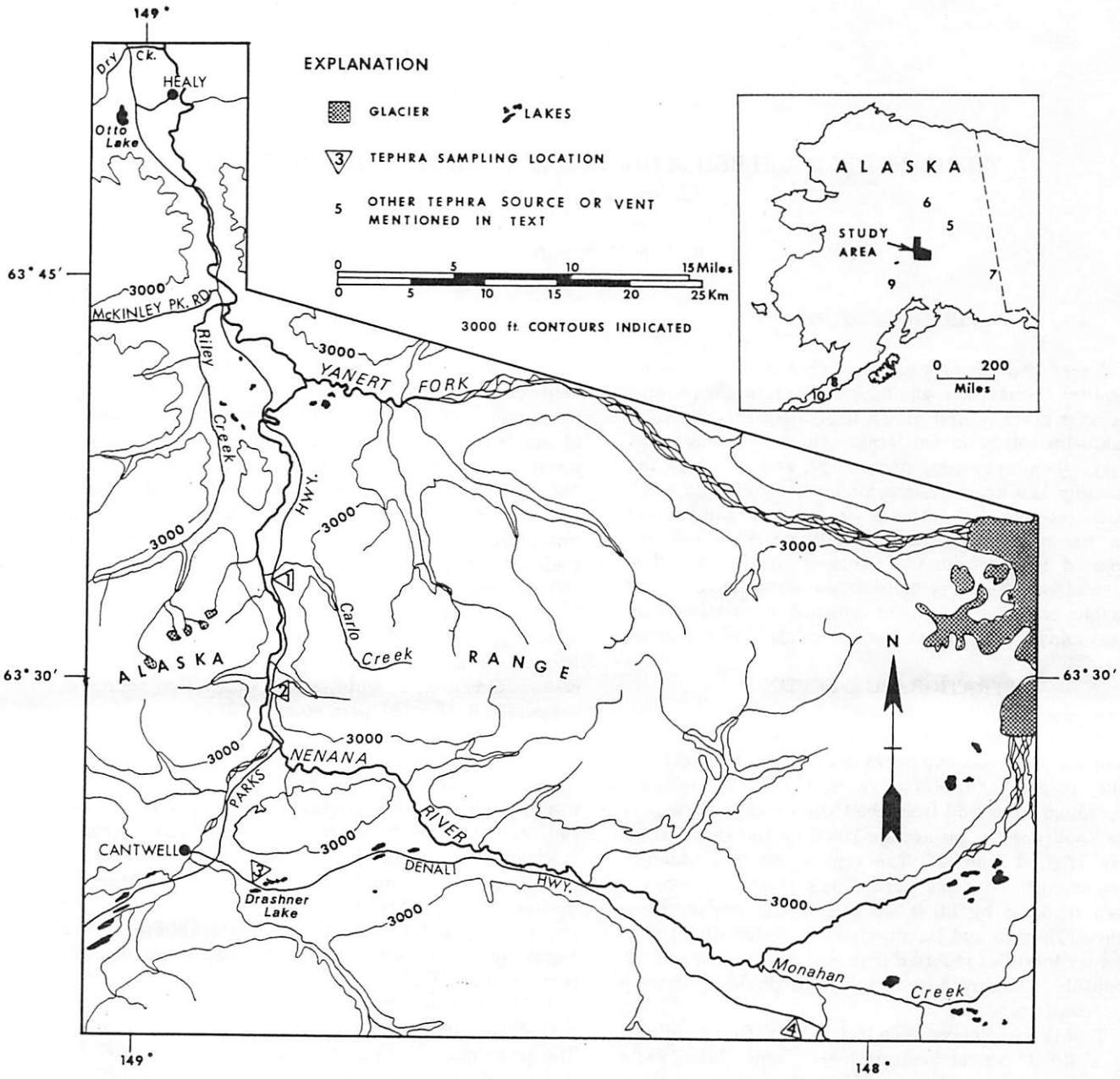

Figure 1. Location map showing tephra sampling localities and possible source vents mentioned in text. 1 - Carlo Creek Site, 2 - Cantwell Ash type locality, 3 - mile 130.8 Denali Highway, 4 - Ash site, mile 103.0 Denali Highway, 5 - Jarvis Creek type locality, 6 - Wilber Creek type locality, 7 - White River Ash source, 8 - Aniakchak caldera, 9 - Hayes volcanic vent, and 10 - Veniaminof Caldera.

AGE

A single radiocarbon date, obtained from sampling locality 2, provides a maximum age limit for this ash horizon of 3,780 ± 80 B.P. (WSU 1747). This date was determined from a 20-gm sample of wood collected from between 0.5 and 1.5 cm below the tephra layer. Within the 2-m-thick loess section at the type locality, the ash is 72 to 73 cm below ground surface and is fairly continuous.

Allowing for the date's standard deviation, maximum estimates of wood growth and an ensuing 0.5 cm of eolian deposition at locality 2, sample WSU 1747 conservatively dates the Cantwell area ashfall to within a 100- to 200-year span between about 3,600 and 3,800 years ago.

blende, hypersthene, and magnetite. The average chemical composition is: SiO_2 = 67.4%, Al_2O_3 = 15.1%, TiO_2 = 0.5%, MgO = 2.0%, FeO = 2.0%, Fe_2O_3 = 2.2%, Na_2O = 4.1%, K_2O = 2.5%, CaO = 4.1%." The northern lobe of the bilobate White River Ash has been fairly precisely dated by more than a dozen radiocarbon dates at 1,890 years B.P. (Lerbekmo and Campbell, 1969, p. 110; Lerbekmo and others, 1975, p. 203; Denton and Karlèn, 1977, p. 72).

Although some similarities are noted in comparisons of refractive indexes and phenocrysts, correlation of the Cantwell and White River tephras can probably be ruled out because of differences in geographical distribution, age, and sorting of the former. The White River Ash has not been reported farther west than the Delta area, located about 175 km northeast of the upper Nenana River sampling localities. Even if a western lobe of pyroclastic ejecta from the White River source did reach as far west as the Nenana River valley, there still exists an apparent temporal difference of about 1,900 years between the two tephra units.

POSSIBLE SOUTHWESTERN ALASKA SOURCES

On the basis of radiocarbon dates, other possible sources for the Cantwell Ash are the Aniakchak and Veniaminof Calderas (loc. 8 and 10, fig. 1), located about 885 and 995 km southwest of Cantwell, respectively, and the Hayes volcanic vent (loc. 9, fig. 1), which is about 45 km northwest of Mt. Spurr and 275 km southwest of Cantwell (T. Miller, pers. comm). Aniakchak apparently underwent a major eruption about 3,500 years ago (Miller and Smith, 1977, p. 174; Miller, pers. comm.) whereas Veniaminof has been tentatively dated at 3,700 years ago (Miller and Smith, 1975, p. 1201). A dated organic layer beneath a tephra horizon near the vent indicates that the Hayes volcanic vent also erupted about 3,700 years B.P. (T. Miller, pers. comm.).

CONCLUSIONS

The Cantwell volcanic ash cannot be unequivocally correlated with the Wilber Creek, Jarvis Creek, or White River Ash Beds. Comparisons of phenocryst morphologies and refractive indexes suggest that Jarvis Creek and Cantwell Ashes are not the same. Correlation with the White River Ash source can probably be discounted because of the differences in apparent age and geographical distribution of the two ash horizons and the apparent decrease in grain size of Cantwell Ash in the direction of the White River source. On the basis of the sparse available data, the Cantwell Ash Bed is most likely the result of an eruption on the Alaska Peninsula or southwestern Alaska Range between about 3,600 and 3,800 years ago.

Table 1. *Summary of stratigraphic data for six Cantwell Ash localities (figs. 1 and 2).*

Locality	Site	Location[1]	Ash depth below surface (cm)	Enclosing sediment	Ash color (moist)	Ash thickness (cm)
1A	Carlo Creek archeological site (HEA 031), mile 223.5, Parks Highway	NW¼ NE¼, sec. 1, T. 16 S. R. 7 W.	19-20	Eolian silt loam	10YR5/4	0.5-1.0
1B	Terrace 6 m below Carlo Creek site		42-43	Eolian silt loam	10YR6/4	0.5-1.0
1C	Roadcut, mile 223.0, Parks Highway		44-45	Eolian silt loam	10YR6/4	1.0
2	Roadcut, mile 218.3, Parks Highway (Type locality)	SW¼ SE¼, sec. 25, T. 16 S. R. 7 W.	72-73	Eolian silt clay	10YR7/4	1.0
3	Roadcut, mile 130.8, Denali Highway	SE¼ SW¼, sec. 2, T. 18 S. R. 7 W.	5-10	Eolian silt	10YR7/4	2.5-5.0
4	Roadcut, 'the ash' archeological site (HEA 100), mile 103.0, Denali Highway	SE¼ NW¼, sec. 3, T. 19 S. R. 3 W.	20-27	Eolian silt	10YR8/4	3.0-7.0

[1]Source: USGS Healy Quadrangle 1:250,000 series.

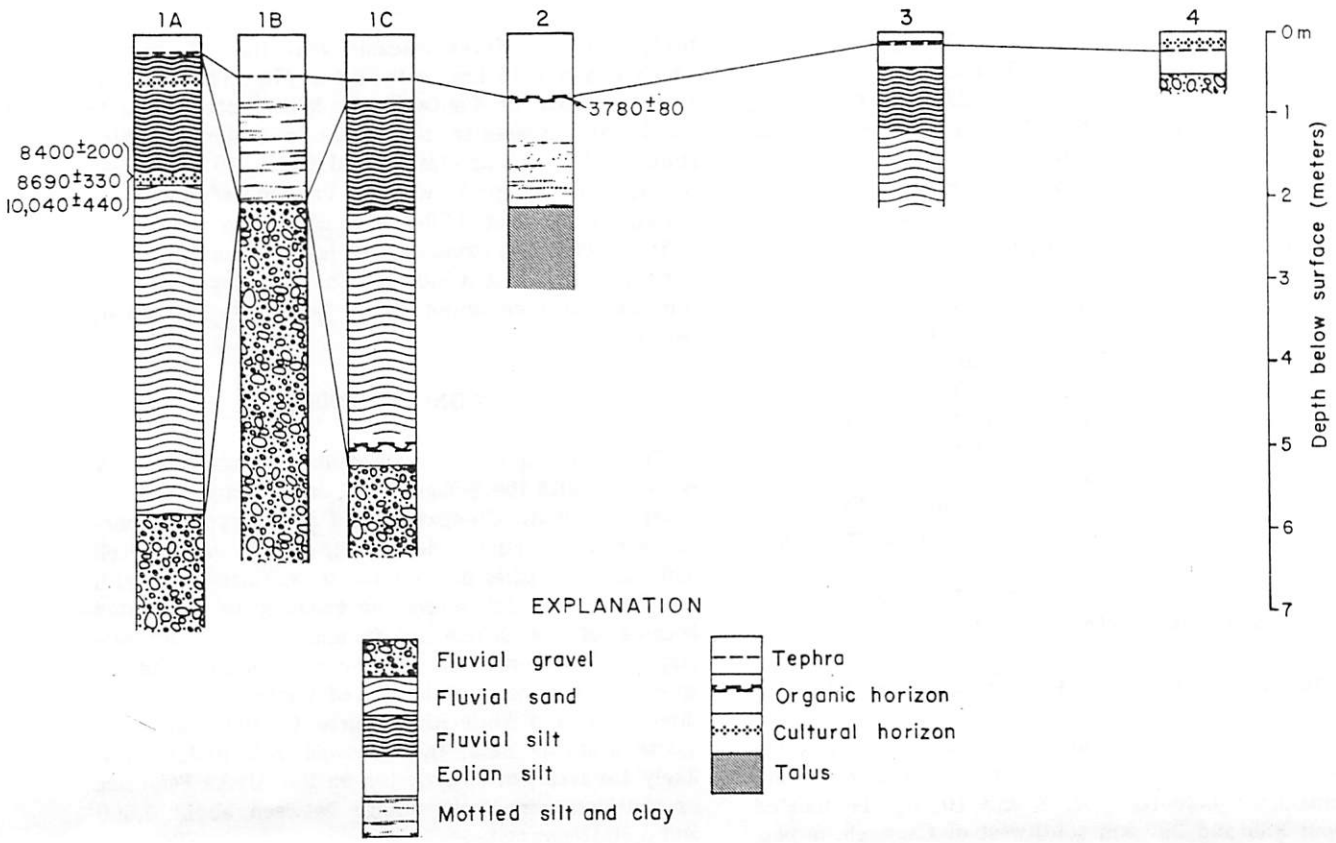

Figure 2. Correlation of six generalized stratigraphic sections, upper Nenana River valley. Refer to locations in fig. 1. Dates indicated in radiocarbon years B.P. Relative elevations above sea level not indicated.

POSSIBLE CORRELATIONS WITH OTHER KNOWN ALASKAN ASH BEDS

Although the samples collected from the Cantwell region appear to represent a single ashfall, it has not been possible to trace this tephra to its source or to definitely correlate it with other recognized ash horizons in interior Alaska.

JARVIS CREEK ASH BED

A temporal similarity is indicated with the Jarvis Creek Ash Bed (Reger and others, 1964; Pèwè, 1975), which has been radiocarbon dated at 3,500 years B.P. (Reger, oral comm.). However, the refractive indexes do not compare favorably. The average refractive index of the Jarvis Creek Ash is 1.515, with a major mode of 1.506 to 1.520 and a minor mode of 1.555 (Reger, oral comm.). In addition to different refractive indexes, a difference was also noted in general shard morphologies and phenocrysts (Okazaki, pers. comm.).

The type locality for the Jarvis Ash Bed (fig. 1, loc. 5) is about 175 km northeast of Cantwell. There it occurs as a 6-mm-thick layer in Engineer Loess near the junction of the Delta and Tanana Rivers (Pèwè, 1975). Pèwè (1975, p. 19) suggests that the Wrangell Mountains may be a possible source for this tephra.

WILBER CREEK ASH BED

The poorly known Wilber Creek Ash Bed, formally named by Pèwè (1975) for the type locality 10 km southwest of Livengood, 240 km north of Cantwell, may also represent a correlative tephra horizon with the volcanic ash from the Nenana River valley. At the type locality (loc. 6, fig. 1) the Wilber Ash is 5 to 25 mm thick (Pèwè, 1975). Pèwè (1975) suggests that the Jarvis Creek and Wilber Creek volcanic ashes may be correlative. However, little is presently known about the Wilber Creek Ash Bed except that it is of Holocene age and may be less than 4,200 years old (Pèwè, 1975, p. 18).

WHITE RIVER ASH BED

A less likely correlation is the well-documented source of the White River Ash. The source of this widespread tephra is located on the Alaska-Yukon border, near Mt. Bona, 435 km southeast of Cantwell (loc. 7, fig. 1). White River Ash has been described (Lerbekmo and Campbell, 1969, p. 109) as a "...rhyodacite composed of glass (n = 1.502), andesine, horn-

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Table 2. *Pedologic description of Cantwell Ash type locality, mile 218.3 Parks Highway*[1]

Soil horizon	Depth (cm)	Description
H+Ap	25-0	Modern organic mat, decomposed vegetation; minor highway disturbance and overburden.
Ah	0-5	Dark-reddish-brown (5YR2.5/2, moist) silt loam; massive; very friable, slightly sticky, slightly plastic; many fine roots; abrupt, wavy boundary.
Bh	5-15	Dark-brown (10YR3/3, moist) silt loam; massive; friable, slightly sticky, slightly plastic; many fine roots; abrupt, wavy boundary.
2Bhir	15-16	Dark-yellowish-brown (10YR3/6, moist) silt loam; massive; friable, slightly sticky, slightly plastic; many fine roots; abrupt, wavy boundary.
2Bir	16-32	Dark-brown (10YR3/3, moist) silt loam; massive; friable, slightly sticky, slightly plastic; few very fine interstitial pores; few small roots; abrupt, wavy boundary.
2Bg	32-72	Weak, red (2.5YR4/2, moist) silt clay; massive; firm, sticky, plastic. Mottles: distinct, medium common, dark-yellowish brown (10YR4/6, moist), and distinct, medium common, weak red (10YR4/2, moist). A few discontinuous organic lenses (wood?) present just above lower contact; abrupt, wavy boundary.
3C	72-73	Very pale-brown (10YR7/4, moist) volcanic ash; structureless; abrupt, wavy boundary (tephra sample PB-76-1).
4Bhb	73-78	Dark-yellowish-brown (10YR3/4, moist) silt loam; massive; slightly sticky, slightly plastic; few roots. Wood fragments and peat(?) are present from 0.5 to 1.5 cm below upper contact (radiocarbon sample: WSU 1747). Clear, distinct boundary.
4Cg	78-138	Dusky-red (2.5YR3/2, moist) clay loam; massive; firm, sticky, very plastic; few roots. Unit contains a number of diffuse buried soil horizons that are very dark brown (10YR2/2, moist). Frequency of angular rock fragments (up to 25 by 25 cm) increases with depth; abrupt, wavy boundary.
4Cgr	138-200+	Dark-reddish-gray (5YR4/2, moist) silty clay; massive; firm, very sticky, very plastic. Strong gleying and mottling. Contains many angular rock fragments.
R	200+	Angular decomposed bedrock and talus.

[1]Convention: 1975 USDA.

REFERENCES CITED

Bowers, P.M., 1978a, Research summary: 1977 investigations of the Carlo Creek Archeological Site, central Alaska: unpub. report submitted to Univ. Alaska Museum, Fairbanks.

_____, 1978b, Geology and archeology of the Carlo Creek site, an early Holocene campsite in the central Alaska Range: Am. Quaternary Assoc., Abs. of 5th Biennial Conference, Edmonton, 1978, p. 188.

Denton, G.H., and Karlèn, W., 1977, Holocene glacial and tree-line variations in the White River valley and Skolai Pass, Alaska and Yukon Territory: Quaternary Research, v. 7, p. 63-111.

Lerbekmo, J.F., and Campbell, F.A., 1969, Distribution, composition, and source of the White River Ash, Yukon Territory: Canadian Jour. Earth Sci., v. 6, p. 109-116.

Lerbekmo, J.F., Westgate, J.A., Smith, D.G.W., and Denton, G.H., 1975, New data on the character and history of the White River volcanic eruption, Alaska: *in* Suggate, R.P., and Cresswell, M.M., ed., Quaternary Studies: Wellington, The Royal Society of New Zealand, p. 203-209.

Miller, T.P., and Smith, R.L., 1975, Ash flows on the Alaska Peninsula (Abs.): A preliminary report on their distribution, composition, and age: Geol. Soc. America Abs. with Programs, v. 7, no. 7, p. 1201.

_____, 1977, Spectacular mobility of ash flows around Aniakchak and Fisher calderas, Alaska: Geology, v. 5, p. 173-176.

Pèwè, T.L., 1975, Quaternary stratigraphic nomenclature in central Alaska: U.S. Geol. Survey Prof. Paper 862, 32 p.

Reger, R.D., Pèwè, T.L., West, F.H., and Skarland, I., 1964, Geology and archeology of the Yardang Flint station, Alaska Univ. Anthro. Papers, v. 12, no. 2, p. 92-100.

Smith, H.W., Okazaki, R., and Aarstad, 1968, Recent volcanic ash in soils of northeastern Washington and northern Idaho: Northwest Sci., v. 42, no. 4, p. 150-159.

Smith, H.W., Okazaki, R., and Knowles, C.R., 1975, Electron microprobe analysis as a test of the correlation of West Blacktail ash with Mount Saint Helens pyroclastic layer T: Northwest Sci., v. 49, 209-215.

_____, 1977a, Electron microprobe data for tephra attributed to Glacier Peak, Washington: Quaternary Research, v. 7, p. 197-206.

_____, 1977b, Electron microprobe analysis of glass shards from tephra assigned to set W, Mount Saint Helens, Washington: Quaternary Research v. 7, p. 207-217.

Smith, D.G.W., and Westgate, J.A., 1969, Electron probe technique for characterizing pyroclastic deposits: Earth and Planetary Sci. Letters, v. 5, p. 313-319.

Thorson, R.M., and Hamilton, T.D., 1977, Geology of the Dry Creek Site: A stratified early man site in interior Alaska: Quaternary Research, v. 7, p. 149-176.

Wahrhaftig, C., 1958, Quaternary geology of the Nenana River valley and adjacent parts of the Alaska Range: U.S. Geol. Survey Prof. Paper 293-A, p. 1-78.