GEOCHEMICAL CHARACTERIZATION AND CORRELATION OF ARTIFACT AND SOURCE OBSIDIAN, NORTH CASCADES NATIONAL PARK, WASHINGTON

by

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Paper presented at the 50th Annual Northwest Anthropological Conference
Central Washington University, Ellensburg, WA

April 18, 1997

1. Introduction

A. Background

1. This paper describes the geochemical trace element analysis and characterization of two distinctive varieties of obsidian that occur in the northern Cascades Range of Washington.

2. At present, there are documented occurrences of obsidian, both of them dark, porphyritic vitrophyres.

3. The outcrops of vitrophyre-like obsidian occur along the ridge crest of a high divide separating the Nooksack, Little Chilliwack, and Chilliwack Rivers, which form part of the southern headwaters of thē lōwer Fraser River, in today's North Cascades National Park (hereafter, "the park").

4. The area of obsidian occurrence is above the forest line, within a subalpine parkland mosaic consisting of tree islands surrounded by heather-huckleberry dominated tundras, and above this, an alpine zone dominated by fellfield and turf communities (Franklin and Dyrness 1988), and bare rock, permanent snow pack, and small glaciers.

5. The highest summits on the ridge include Copper Mountain, a glacial horn at 7,142 ft elevation (2,177 m) and the unnamed summit of Copper Fire Lookout at 6,260 ft (1,908 m) elevation.

B. Research Problem

1. Until the early 1980s, conventional wisdom held that archeological sites in the highest, most interior portions of the Cascade Range of Washington were rare or nonexistent, largely because Native people were thought to have little knowledge of and to have made little use of land above the forest line.

2. Notwithstanding this belief, federal land-managing agencies charged with the responsibility to inventory and evaluate the cultural resources under their care began to document the regular occurrence of archeological sites at high elevations.

3. In North Cascades National Park, reconnaissance surveys on Copper Ridge have resulted in the documentation of 13 prehistoric lithic scatters dominated by flaking debris having visual similarities that match two local but very restricted vitrophyre outcrops.

4. Because some of the sites appear to be workshops where the outcrop vitrophyre was cleaned and reduced, the conclusion seems warranted that all vitrophyre in the Copper Ridge sites is correlated with the local sources. However, this conclusion must be confirmed independently with evidence from geochemical characterization and comparison of artifacts and source samples.

C. Objectives of Study:

1. to chemically characterize the Copper Ridge vitrophyre sources using x-ray fluorescence analytic methods to measure trace element concentrations of samples,

2. to compare the geochemical signature of vitrophyre source samples with the signature of artifacts recovered from two prehistoric archeological sites on the ridge,

3. to confirm or deny a geochemical similarity between the sources and the artifacts,

4. and through dating of the site, to estimate the dates of procurement and use of the vitrophyre.

2. Vitrophyre Sources on Copper Ridge

A. The vitrophyre is within the Hannegan Volcanics, which is mapped as part of the Mt. Baker volcanic rocks and is dated to the Pliocene, 4.4 my in age (Tabor et al. 1995).

B. There are two main outcrop localities:

1. Locality 1

a. Two nearby outcrops are located here. The first consists of a 1 m thick dike of vitrophyre that can be traced for more than 100 m, at the 5,600 ft elevation, along the northeast facing cirque wall of an unnamed summit. The second outcrop is 600 m away along the steep west-facing slope of the ridge crest.

b. The vitrophyre here ranges in appearance from a translucent, black, to transparent green, to an opaque, light gray glass with a pronounced conchoidal fracture; within the glass groundmass are abundant light-colored phenocrysts composed mostly of plagioclase (Staatz et al. 1972:34). The second outcrop is similar in

stratified by two thin volcanic ash beds and in association with imported tabular hearth rocks.

4. Based on a series of radiocarbon dates, the site was utilized between 4,470 and 1,460 radiocarbon years ago.

Beta No.	NOCA Sample No.	Uncorrected Radiocarbon Age
97235	484-SS-4	2300±100 BP
96057	484-SS-3	4350±50 BP
96058	484-SS-5	4470±70 BP
96059	484-SS-6	6040±90 BP
96060	484-SS-7	1460±110 BP
96061	484-SS-8	3400±90 BP

5. Based on the presence of artifacts above a primary tephra identified as Wn from Mt. St. Helens, the site was also occupied after 500 years ago.

6. The only diagnostic artifacts from the site consist of several fragmented, small, stemmed and notched projectile points corresponding to middle- and late-prehistoric period styles.

7. Site 45WH484 is located 2.5 km from the vitrophyre source locality 2 and 4.5 km from source locality 1.

C. 45WH478 is one of several vitrophyre reduction workshops located adjacent to the locality 1 outcrop.

1. The site is small and is known only from its expression on the ground surface.

2. The age and subsurface integrity of the site are unknown.

3. Site 45WH478 is located 6.6 km from source locality 2, but immediately adjacent to source locality 1.

4. Results of X-Ray Fluorescence

A. The analysis of the samples was completed using a Spectrace 5000 energy-dispersive X-ray fluorescence spectrometer. All source samples were analyzed for the trace elements zinc, lead thorium, rubidium, strontium, yttrium, zirconium, niobium, titanium, manganese, barium, and iron.

B. Analysis of vitrophyre source samples

1. A total of 17 samples from the two source localities were analyzed (Hughes 1994 and 1995; Skinner and Davis 1996).

2. The samples from source localities 1 and 2 were separated into two geochemical source groups based on trace element composition, and are termed varieties 1 and 2, respectively (Hughes 1995; Skinner and Davis 1996:4).

3. The average trace element composition of the two groups is shown in the table:

4. Three elements are diagnostic, i.e., they separate the two obsidian sources: Rb, Sr, and Zr.

C. Vitrophyre artifact samples

1. The trace element composition of five artifacts was determined by XRF analysis. The artifacts consisted of one core and four pieces of flaked debitage.

2. Of the four artifacts from 45WH484, two were firmly correlated with nearby source variety 2 and two were provisionally correlated with variety 2 (Skinner and Davis 1996:6) (show binary diagram)

3. The single artifact from 45WH478 was correlated with adjacent source variety 1 (Hughes 1994)

5. Conclusions

1. Based on their trace element composition, two geochemically distinct varieties of obsidian-like vitrophyre from Copper Ridge bedrock sources were identified.

2. In each case, prehistoric artifacts from two sites on this subalpine/alpine ridge geochemically correlate with the closest source to the site, suggesting extremely localized and perhaps, expedient use of the two vitrophyre varieties.

3. A larger number of bedrock samples need to be geochemically characterized in order to more accurately identify the range of trace element variability for the different sources.

4. Based on the occupation chronology developed at 45WH484, the use of source variety 2 has spanned at least the last 4,500 radiocarbon years.

5. Finally, these results describe only the second well-documented and chemically-characterized obsidian source in the State of Washington, and following on McClure's earlier artifact-to-source correlations (1989) further south, demonstrates middle- and late-prehistoric period use of restricted obsidian sources in the most rugged portions of the Cascade Range.

6. References Cited

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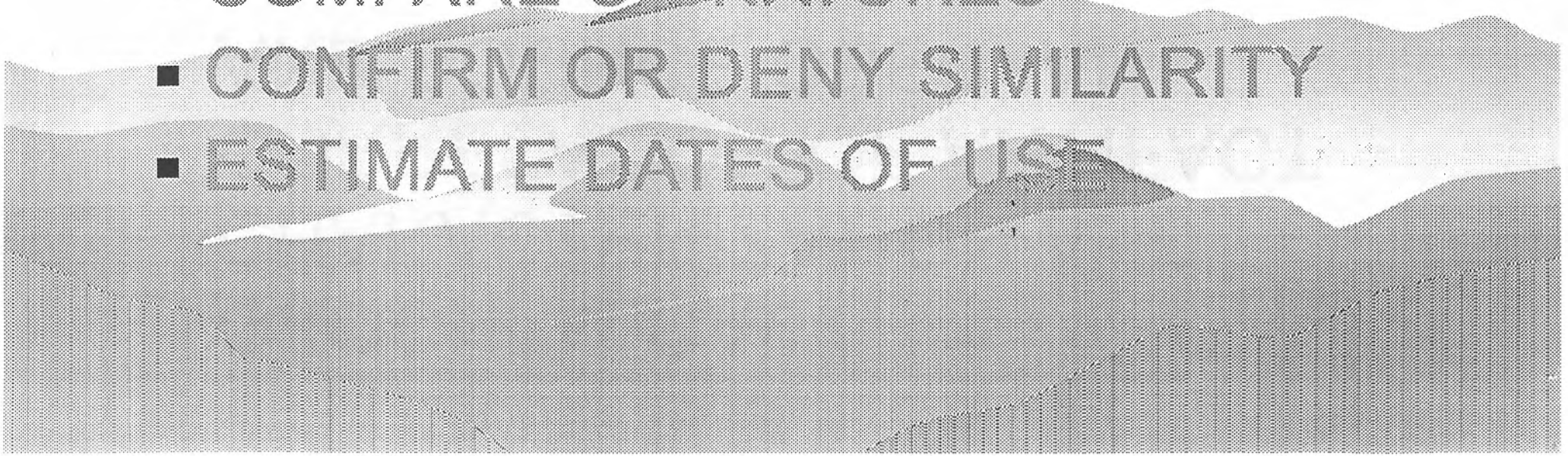
GEOCHEMICAL CHARACTERIZATION AND CORRELATION OF ARTIFACT AND SOURCE OBSIDIAN

NORTH CASCADES NATIONAL PARK, WASHINGTON

Robert R. Mierendorf & Craig E. Skinner

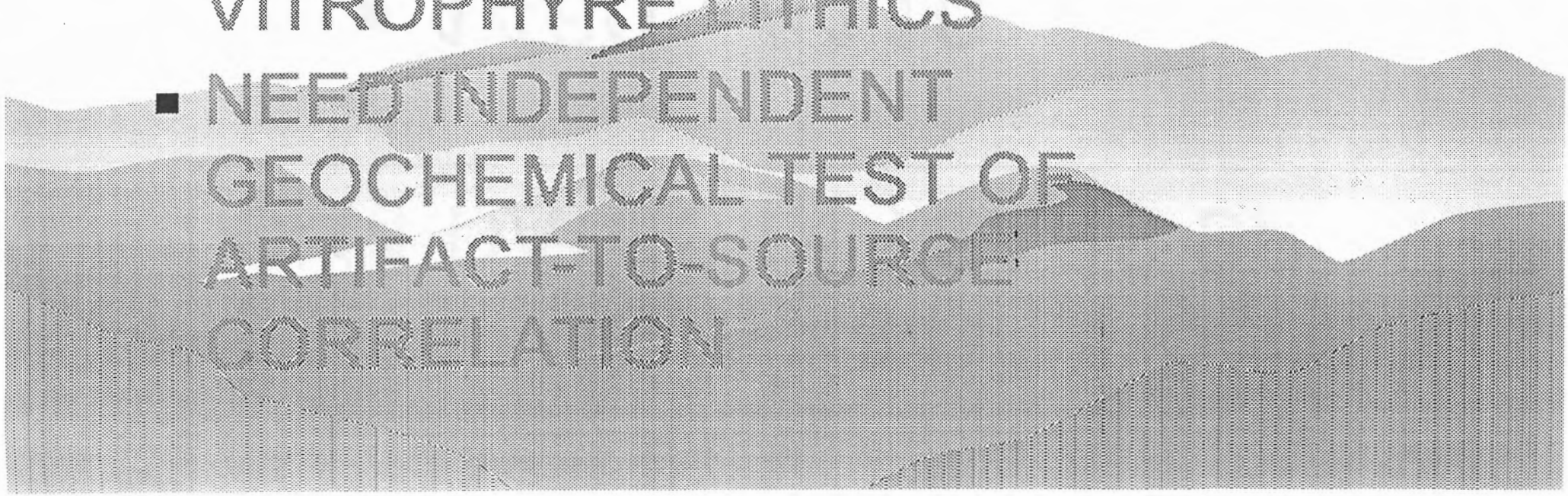
OBJECTIVES

- CHEMICALLY CHARACTERIZE SOURCES
- CHEMICALLY CHARACTERIZE ARTIFACTS
- COMPARE SIGNATURES
- CONFIRM OR DENY SIMILARITY
- ESTIMATE DATES OF USE



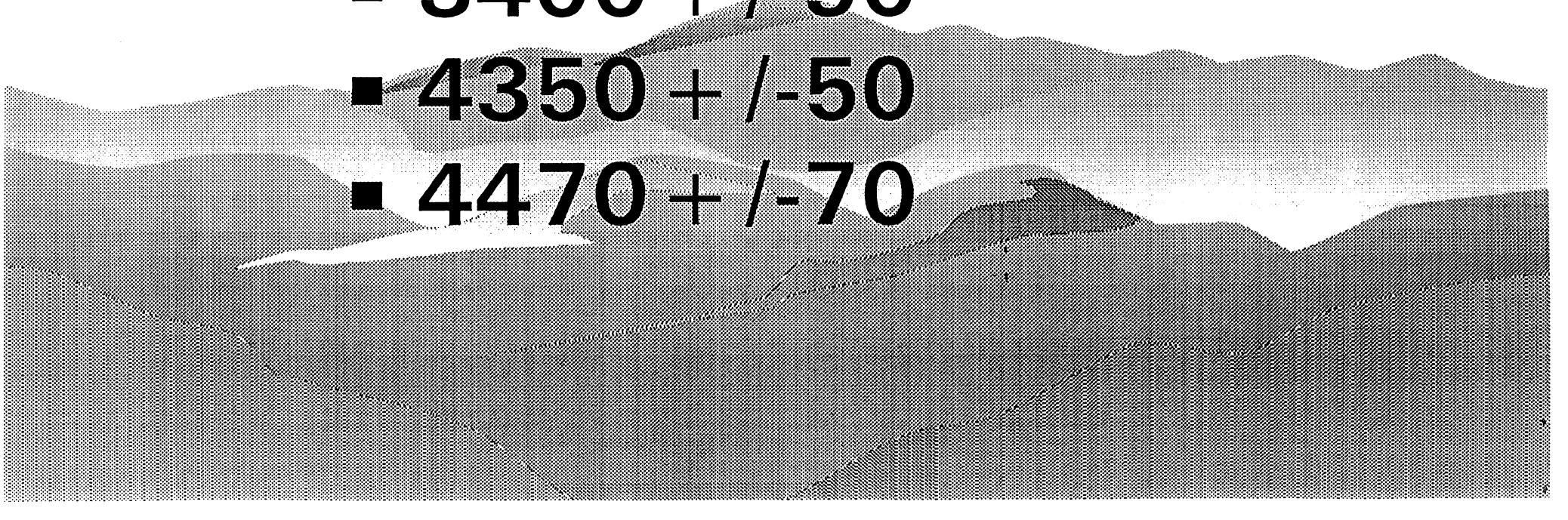
RESEARCH PROBLEM

- VISUAL SIMILARITY BETWEEN LITHIC ARTIFACT & OUTCROP APPEARANCE
- ABUNDANT SITES DOMINATED BY VITROPHYRE LITHICS
- NEED INDEPENDENT GEOCHEMICAL TEST OF ARTIFACT-TO-SOURCE CORRELATION



45WH484
C-14 DATES IN YEARS BP

- 1460 + /-110
- 2300 + /-100
- 3400 + /-90
- 4350 + /-50
- 4470 + /-70

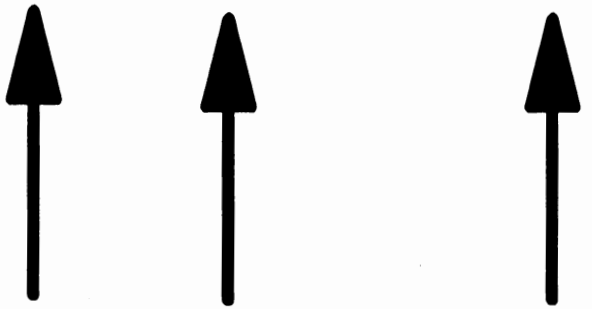


Variety 1: Trace Element Concentrations (ppm)

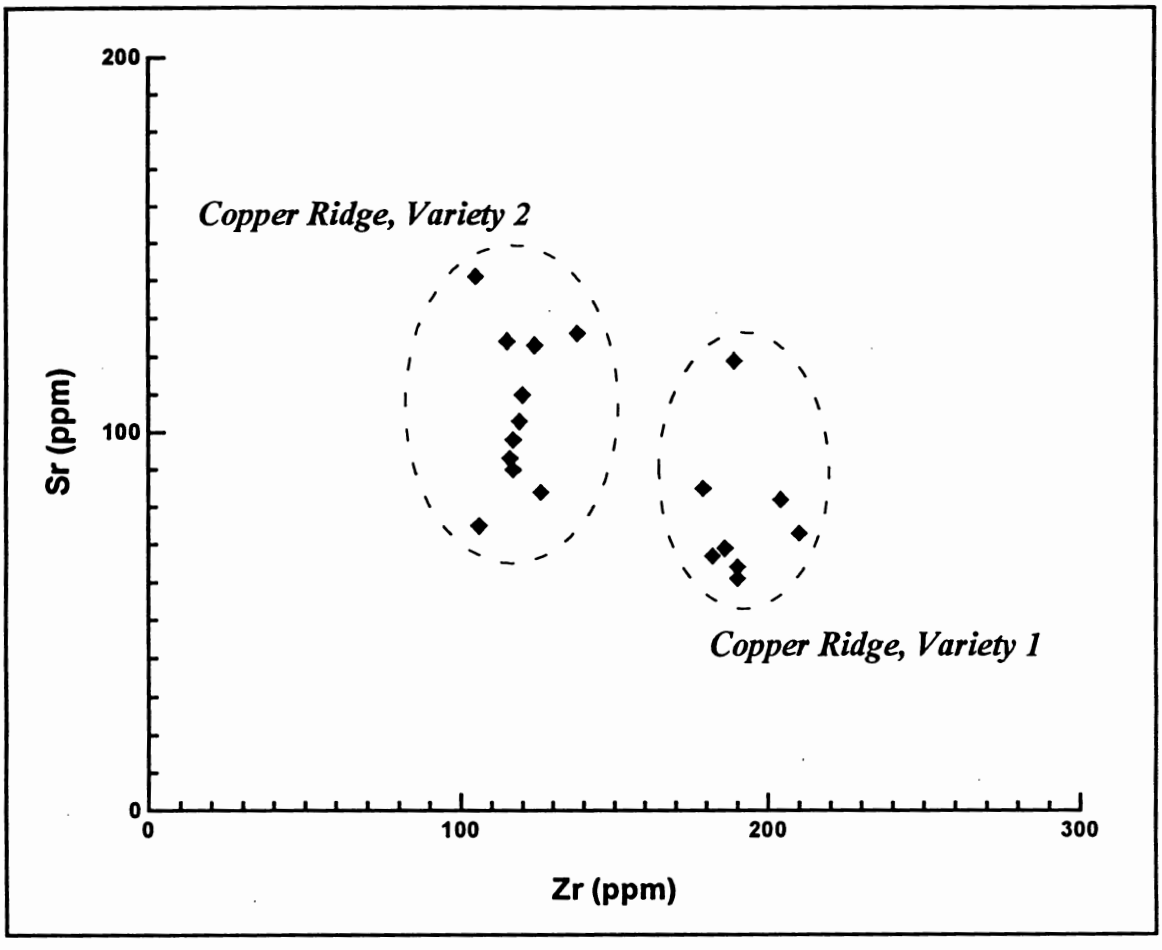
Zn	Pb	Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	Fe2O3
44	16	95	84	25	198	15	789	313	740	0.98

Variety 2:

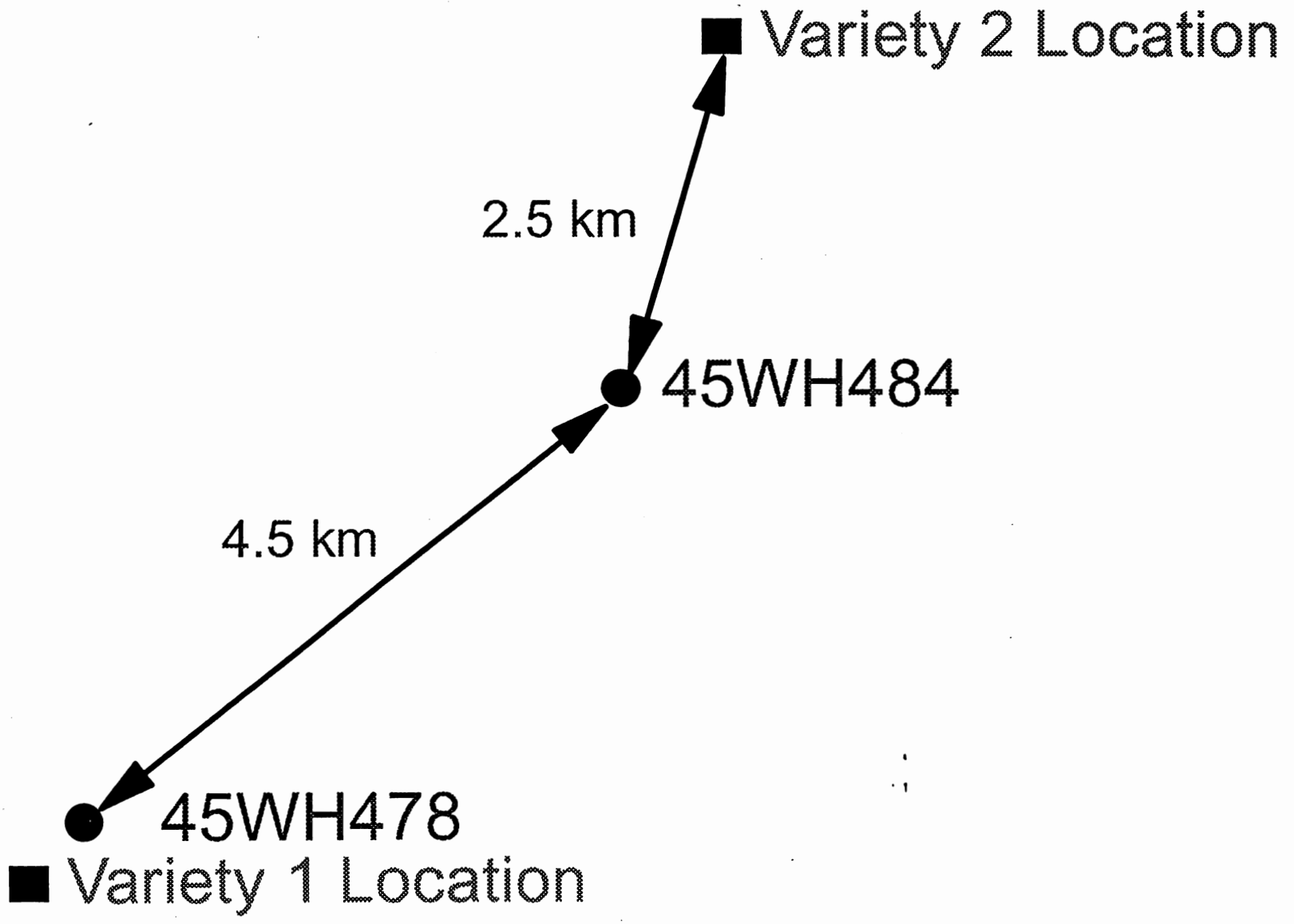
43	20	136	113	19	125	12	745	269	675	0.69



DIAGNOSTIC ELEMENTS


200
100
0
Sr (ppm)
Copper Ridge, Variety 2
Copper Ridge, Variety 1
0
100
200
300
Zr (ppm)

SITE-TO-SOURCE SPATIAL RELATIONSHIPS:



Source Trace Element Concentrations (ppm):

Zn	Pb	Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	Fe2O3
44	16	95	84	25	198	15	789	313	740	0.98
43	20	136	113	19	125	12	745	269	675	0.69

45WH484 Artifact Trace Element Concentrations:

69	20	161	101	17	123	10	615	172	599	0.36
32	22	129	98	16	117	5	689	223	724	0.57
46	19	138	96	16	122	7	665	177	621	0.44
39	23	137	133	14	117	8	584	150	563	0.34

45WH478 Artifact Trace Element Concentrations:

nm	nm	90	73	24	210	13	1294	424	nm	1.42

CONCLUSIONS

- TWO GEOCHEMICALLY DISTINCT OBSIDIAN SOURCES
- ARTIFACTS CORRELATE WITH CLOSEST SOURCE
- NEED LARGER SAMPLE TO CHARACTERIZE SOURCES
- VARIETY 2 UTILIZED AT LEAST 4,500 RADIOCARBON YEARS
- ONLY THE SECOND DOCUMENTED AND [illegible] OBSIDIAN-BASED SOURCE IN NM