RHYOLITE SOURCING IN EASTERN BERINGIA

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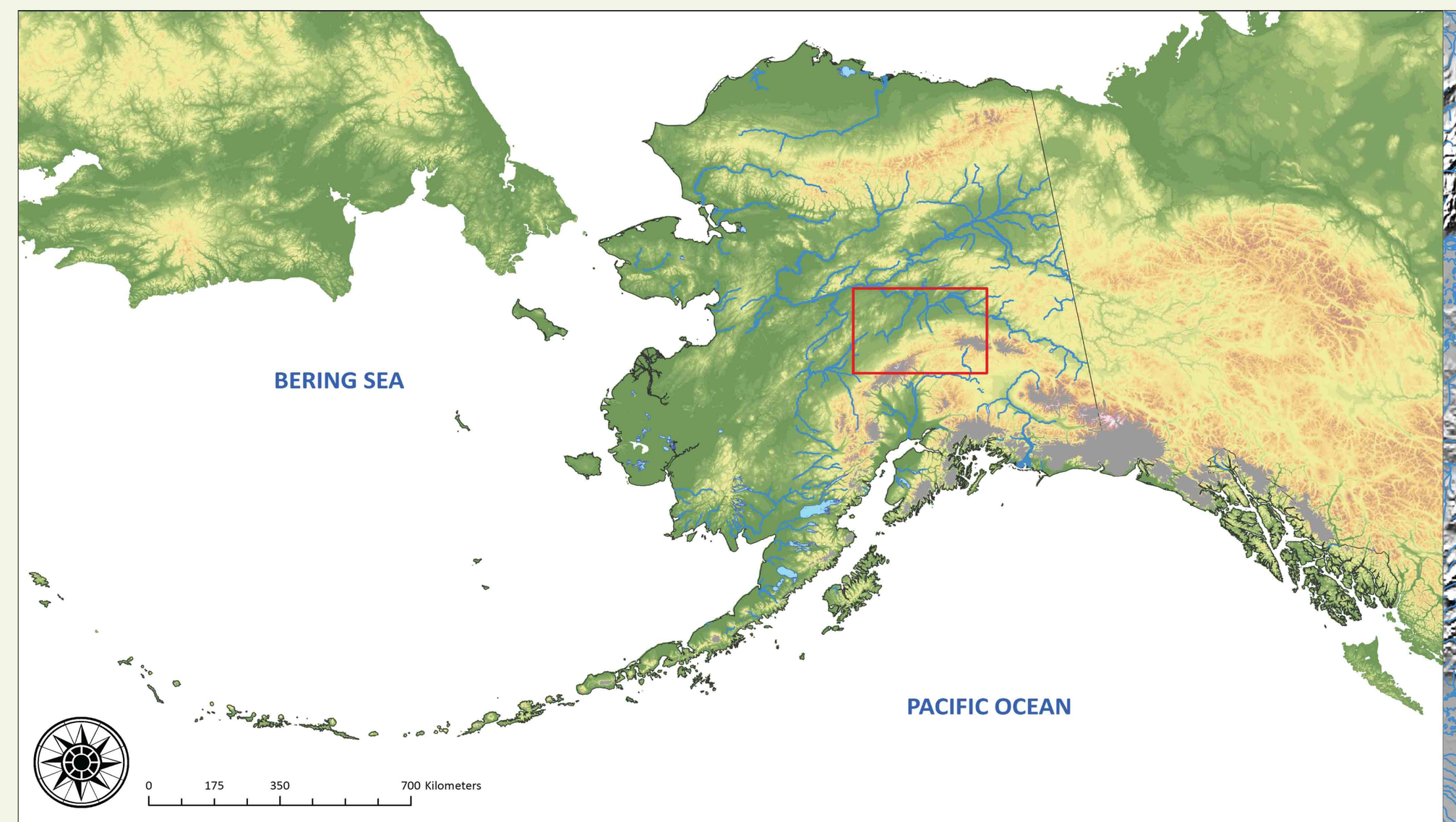
INTRODUCTION

Lithic provenance analyses are an important tool for examining prehistoric behaviors associated with raw material procurement and mobility, and for reconstructing land use strategies. In Eastern Beringia such studies are in their infancy and have largely been confined to obsidian, yet other kinds of fine-grained volcanic rocks are even more common in lithic assemblages of interior Alaska and are also well-suited to geochemical characterization using a variety of techniques. Provenance studies using rocks other than obsidian, however, are limited by a lack of source catalogs and large, datasets of geochemical data against which new analyses can be compared. We present here an initial attempt to describe geochemical variation among rhyolite artifacts from interior Alaska with the intent of identifying and delineating "source" clusters. Portable X-ray Fluorescence (PXRF) technology was used to analyze 679 rhyolite artifacts from 123 sites in interior Alaska (Figure 1), many of which derive from stratified or dated contexts that range from late Pleistocene to the late Prehistoric period (ca. 200 BP). Additionally, a growing body of geological source samples have been assembled in an attempt to link geochemical groups known from archaeological context to the geologic origin of primary and secondary sources of lithic raw materials. Our preliminary results recognize ten distinct geochemical groups that are likely correlated with distinct geological sources. Two of these sources have been pinpointed, one (Group Tek) in the central Alaska Range and the second (Group TLM) in the Talkeetna Mountains. The remaining eight are believed to be located in the central Alaska Range, likely around the Nenana River valley and Talkeetna Mountains.



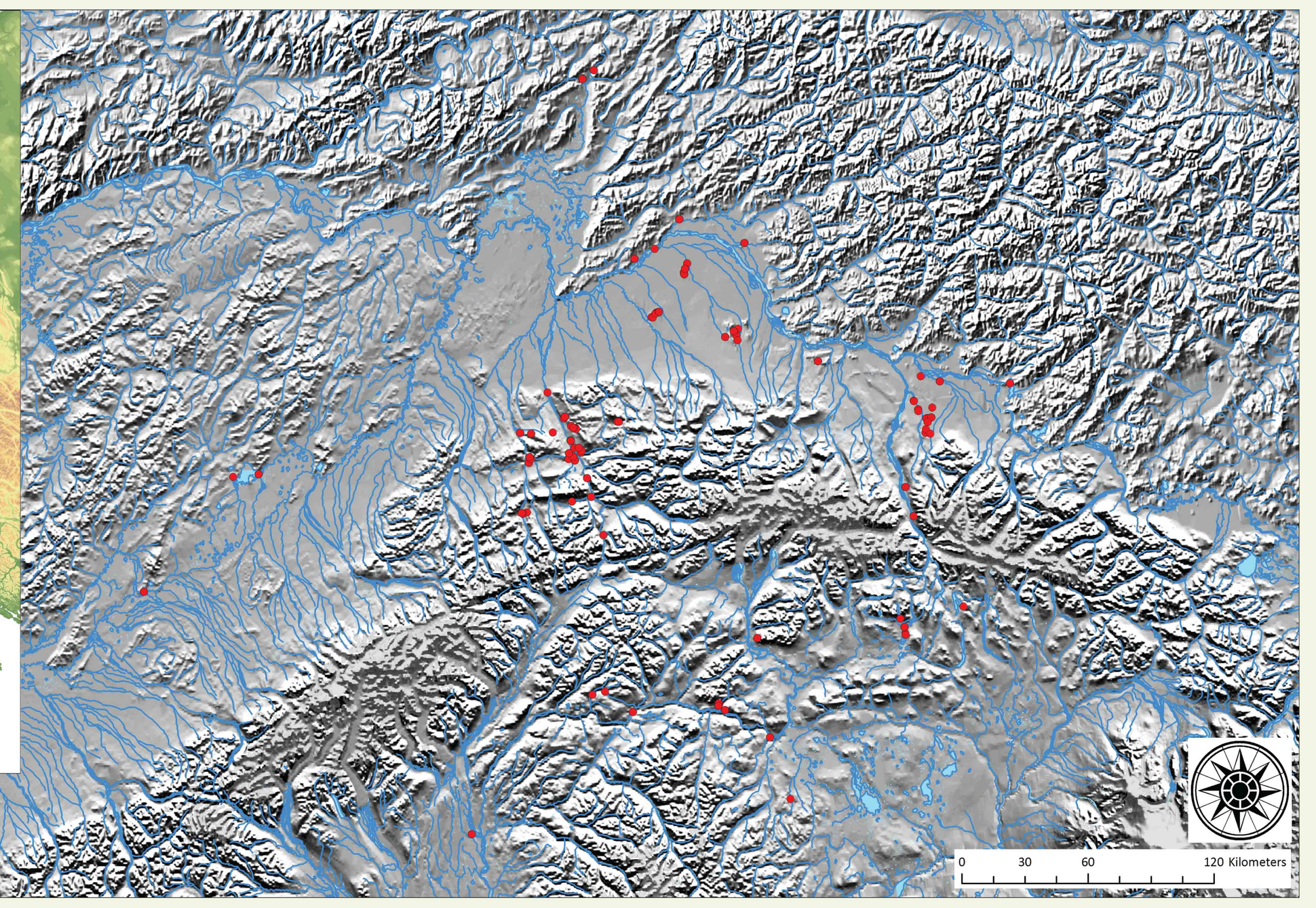


Figure 1. Overview of Beringia and location of sites sampled within this study.

METHODS AND GROUP DELINEATIONS

Non-destructive x-ray fluorescence (XRF) analyses were conducted at the University of Alaska Museum Archaeology Department using a portable Bruker Tracer III-V portable XRF analyzer (Figure 2) equipped with a rhodium tube and a SiPIN detector with a resolution of ca. 170 eV FHWM for 5.9 keV X-rays (at 1000 counts per second) in an area of 7 mm2.

Figure 2. Portable Bruker Tracer III-V

Methods followed those described by Philips and Speakman (2009). Analyses were conducted at 40 keV, 15 µA, using a 0.076-mm copper filter and 0.0305 aluminum filter in the X-ray path for a 200 second live-time count. Ten elements were measured: Potassium (K), Manganese (Mn), Iron (Fe), Gallium (Ga), Thorium (Th), Rubidium (Rb), Strontium (Sr), Yttrium (Y), Zirconium (Zr), and Niobium (Nb). Peak intensities for these elements were calculated as ratios to the Compton peak of rhodium, and converted to elemental concentrations using linear regressions derived from the analysis of well-characterized samples analyzed by NAA and/or XRF and were reported in parts-per-million (ppm). Source assignments are made by comparing the composition of analyzed samples to a catalog of source samples, when possible. Correlations between artifacts and source signatures are generally considered meaningful when key elements fall within two standard deviations of mean source values (Hughes 1998).

A total of 679 artifacts consisting of debitage and formal tools from 123 sites were sampled from collections at the UA Museum of the North from October 2012 to September 2013. The number of rhyolite artifacts per assemblage varied depending on the number of artifacts within each site assemblage. At a minimum thirty artifacts were sampled from each site, more when possible.

Geochemical groups were initially identified by aid of trivariate plots, scatterplots (Figure 3) and histograms of key elements measured by PXRF. Once basic characteristics of these groups were observed principal component analysis was used to test the validity of these groups.

Geochemical groupings were defined on the basis of discriminate and principal component analyses. In performing our statistics we used the following trace elements to delineate clusters (Rb, Sr, Y, Zr, and Nb. Two components yielded Eigenvalues greater than one: Component 1 (Group A) = 2.790; Component 2 (Group B) = 1.138. These two distinct groups are demonstrated in the Principal Component Score Plot (Figure 4).

Table 1 lists the two groups with the average and standard deviation values for the five trace elements measured.

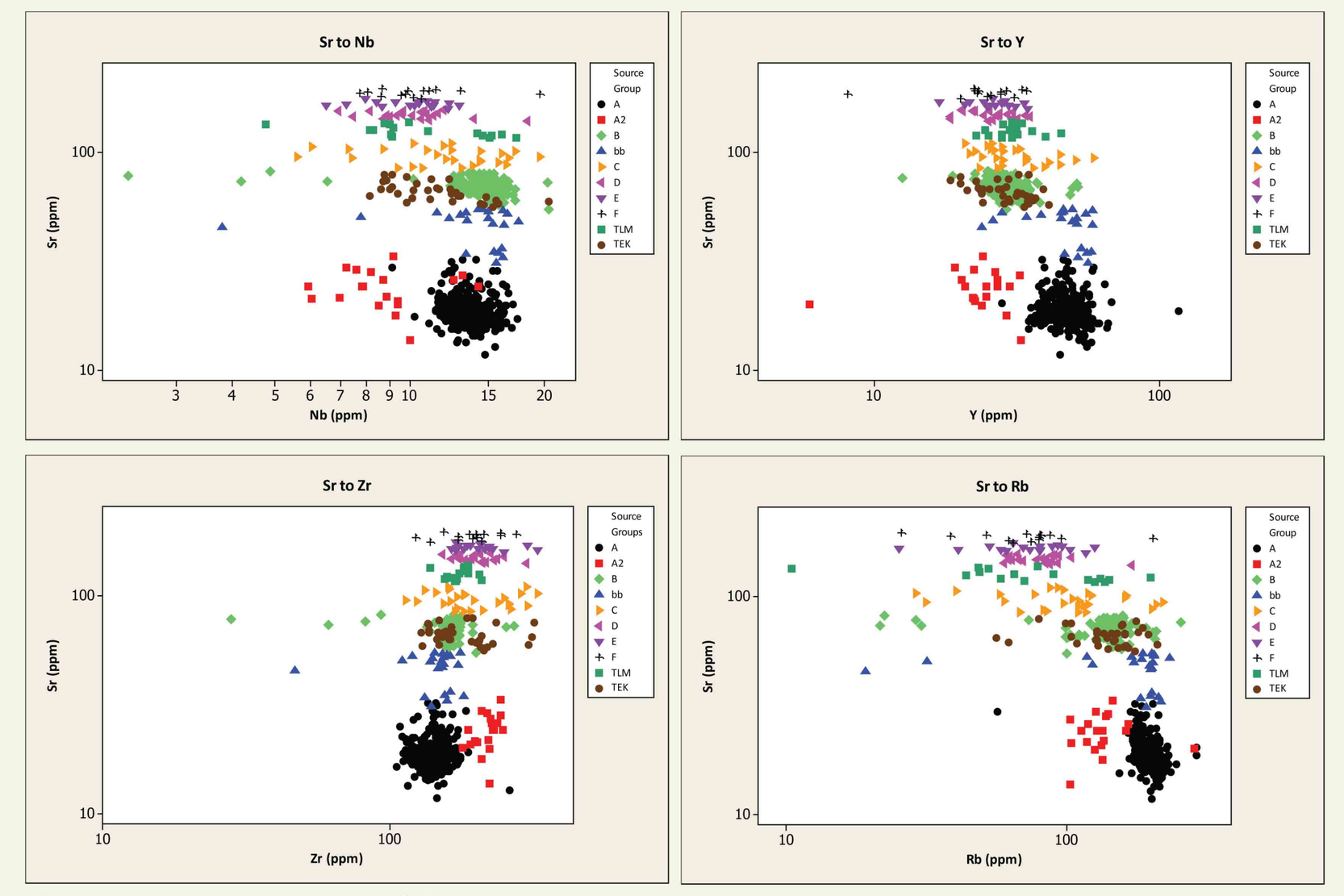


Figure 3. Scatterplots of key trace elements.

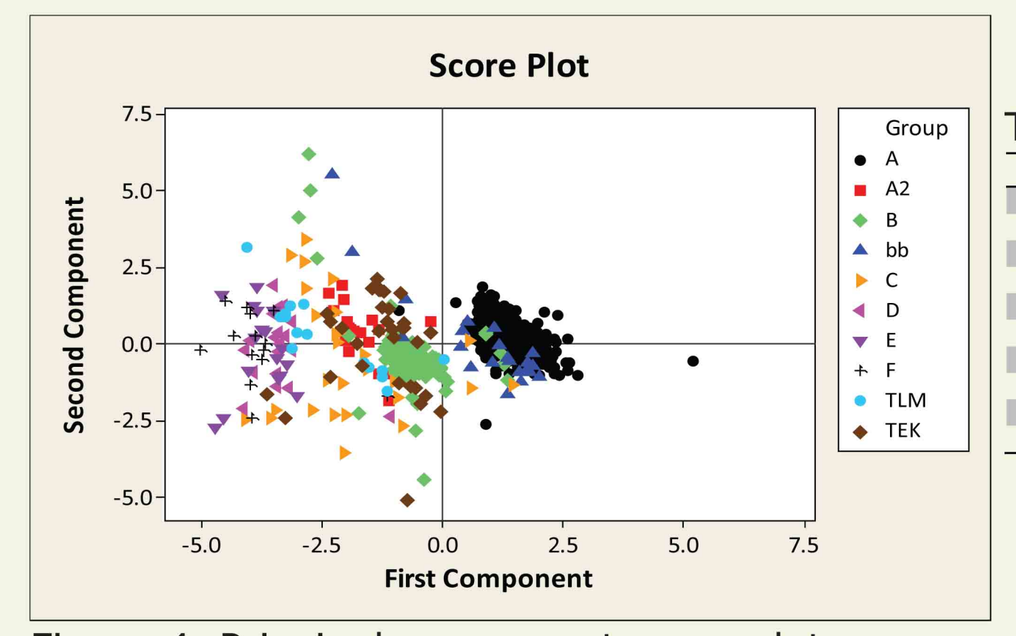


Figure 4. Principal component score plot.

Table 1. Trace element composition

Rb	Sr	Y	Zr	Nb	Source Group
197±16	19±3	48±7	145±16	14±1	A
138±40	24±5	24±6	217±20	9±2	A2
176±55	46±8	47±10	146±28	14±3	bb
140±37	66±6	29±6	183±51	12±3	Teklanika
141±26	70±5	29±6	162±21	15±2	B
107±50	95±8	32±9	201±60	12±4	C
89±49	124±7	31±6	174±18	11±4	Talkeetna
83±25	147±5	26±5	202±34	10±2	D
78±26	165±4	27±4	210±46	10±2	E
79±41	186±6	25±6	194±42	11±3	F

PEOPLE AND RHYOLITE

Geological sources for eight of the ten groups identified in this study remain unknown. Tentative geochemical links between artifacts and geological specimens from the upper Talkeenta and Teklanika Rivers, respectively seem valid. Additional sampling and geochemical analyses from these sources are needed to confirm each source. Despite this limitation interesting results have emerged concerning human procurement and use of rhyolite in prehistory.

The earliest use of these hypothetical sources appears in the archaeological record during the late Pleistocene with continued use through the late Prehistoric period. Although these groups are geochemically distinct there is variability in regards to how people used a given rhyolite source. Table 2 highlights the similarities and differences among each group in regard to the number of early stage decortication flakes, interior flakes, tools, and microblade technology for all samples analyzed.

Group	Cortical Spall	Interior Flake	Unifacial Tool	Bifacial Tool	Microblade Technology	Other	TOTAL
A	22 (7%)	149 (44%)	57 (17%)	52 (15%)	55 (16%)	2 (1%)	337
A2	0 (0%)	12 (63%)	3 (16%)	0 (0%)	4 (21%)	0 (0%)	19
B	20 (12%)	90 (52%)	29 (17%)	20 (12%)	12 (7%)	2 (1%)	173
bb	1 (5%)	10 (45%)	2 (9%)	7 (32%)	1 (5%)	0 (0%)	22
C	0 (0%)	18 (67%)	4 (15%)	4 (15%)	1 (3%)	0 (0%)	27
D	0 (0%)	12 (60%)	4 (20%)	2 (10%)	2 (10%)	0 (0%)	20
E	0 (0%)	10 (59%)	4 (24%)	1 (5%)	2 (12%)	0 (0%)	17
F	1 (7%)	4 (29%)	4 (29%)	3 (21%)	2 (14%)	0 (0%)	14
TAL	1 (6%)	12 (75%)	1 (6%)	0 (0%)	2 (13%)	0 (0%)	16
TEK	3 (9%)	17 (50%)	9 (26%)	5 (15%)	0 (0%)	0 (0%)	34

Table 2. Technological similarities and differences among each rhyolite group.

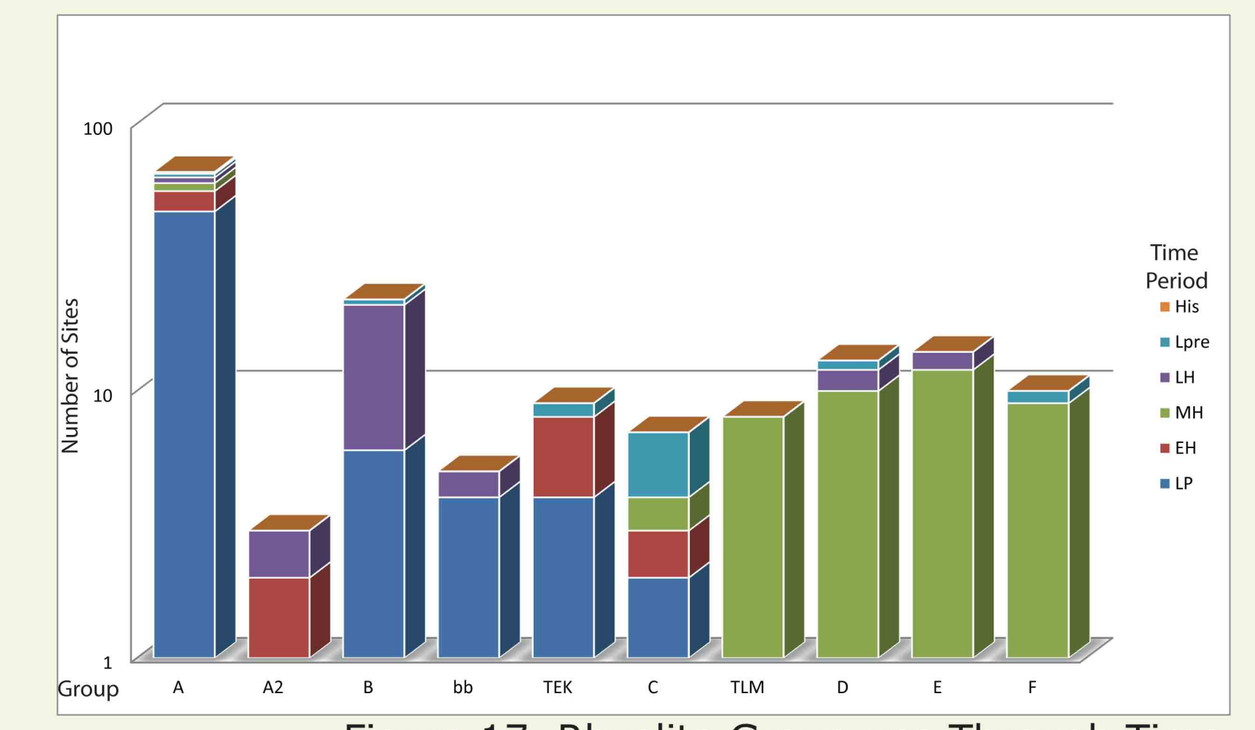


Figure 17. Rhyolite Group-use Through Time

Groups A and B are the most extensively used rhyolite groups in interior Alaska and were exploited from the Late Pleistocene through the Late Prehistoric. These two geologic sources appear to be located in the central Alaska Range, consistent with glacial chronologies that show the central Alaska Range as largely ice-free during the Late Pleistocene/Early Holocene (Dortch 2006). An ice-free Alaska Range would have given people direct access to these raw materials and to a variety of other resources. This hypothesis is supported in the archaeological record, for example, at Teklanika West, where Component 2 contains preserved remains of bison (*Bison* sp.) in association with Group B rhyolite artifacts (Coffman 2011). Other sites in the foothills of the Alaska Range (e.g. Dry Creek (Powers et al. 1983) Owl Ridge (Phippen 1988)) contain preserved faunal materials in association with both A and B rhyolites.

Tentatively supported by our results is the increased use of the uplands during the Middle Holocene (cf. Potter 2008). This is supported by an increased use of Groups D, E, F, and Talkeetna River rhyolites (Figure 17). Our sample size is small but the earliest these rhyolite groups appear prehistorically is in the Middle Holocene predominately in the Upper Susitna River valley and supports the hypothesis that humans were shifting resource exploitation to more upland resources (e.g. caribou and sheep) during this time (Potter 2008). Conversely, the increased use of these groups may be linked to increased warming and melting of glacial ice in the Talkeetna Mountains and in southcentral Alaska. Such ice sheets would have receded significantly, exposing these "new" and untapped raw material resources to people.

SOURCE GROUP A and A2

Figure 5. Sample of Group A and A2 artifacts

Rhyolite assigned to Groups A (n=337) and A2 (n=19) are beige to white in color (Figure 5), with some artifacts exhibiting a slight luster to them. These two distinct rhyolite groups range in age from the Late Pleistocene to Late Prehistoric (last 200 years). Sites containing these two types of rhyolite span much of interior Alaska and cover an area of approximately 92,000 km2 (Figure 6).

Almost half of the rhyolite artifacts analyzed in this study were assigned to Group A. This material is excellent quality for flintknapping and was frequently used in the manufacture of microblades (A: n=51; 15%; A2: n=4; 21%). This may be due to the fine-grained, brittle nature, and lack of flaws (homogeneousness) of the stone, making it ideal to produce microblades. Bifacial material is also represented within Group A rhyolite (n=15; 15%).

The precise geological sources for these two rhyolite groups are currently unknown, but the densest concentration of sites with abundant Group A and A2 rhyolite occur in interior Alaska, suggesting source locations in the central Alaska Range (Figures 7 and 8).

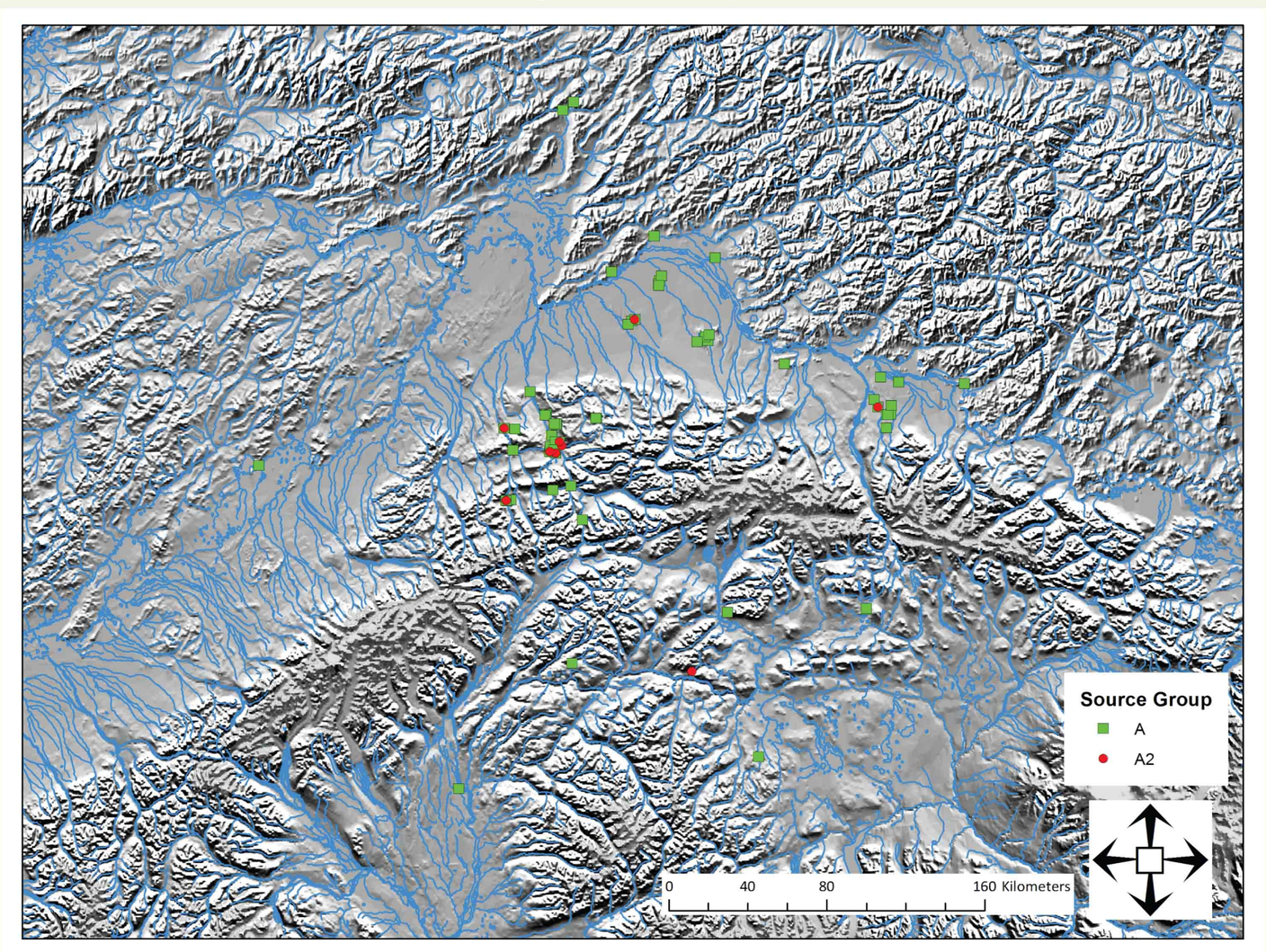


Figure 6. Distribution of Group A and A2 rhyolite.

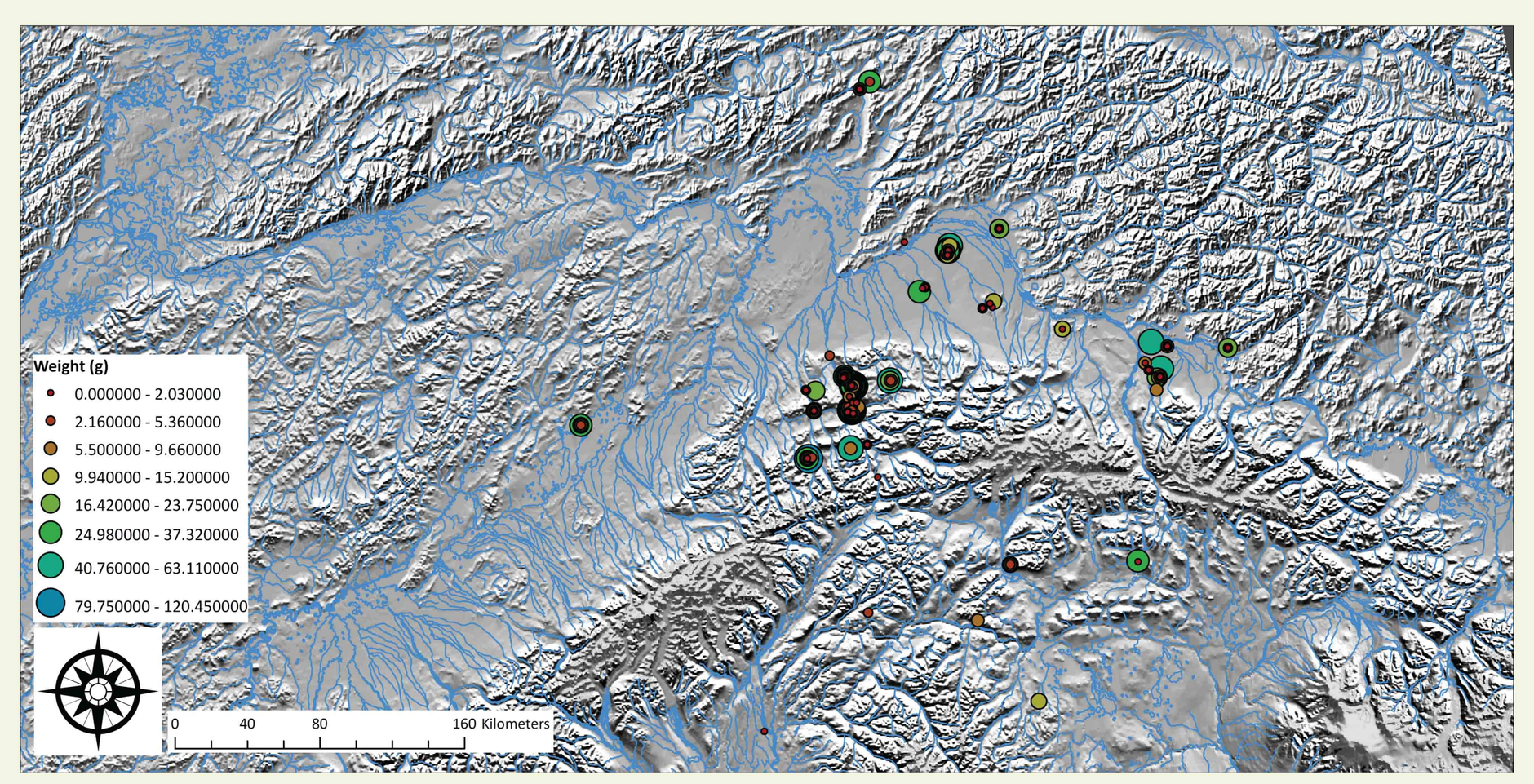


Figure 7. Group A and A2 samples mapped by weight (g).

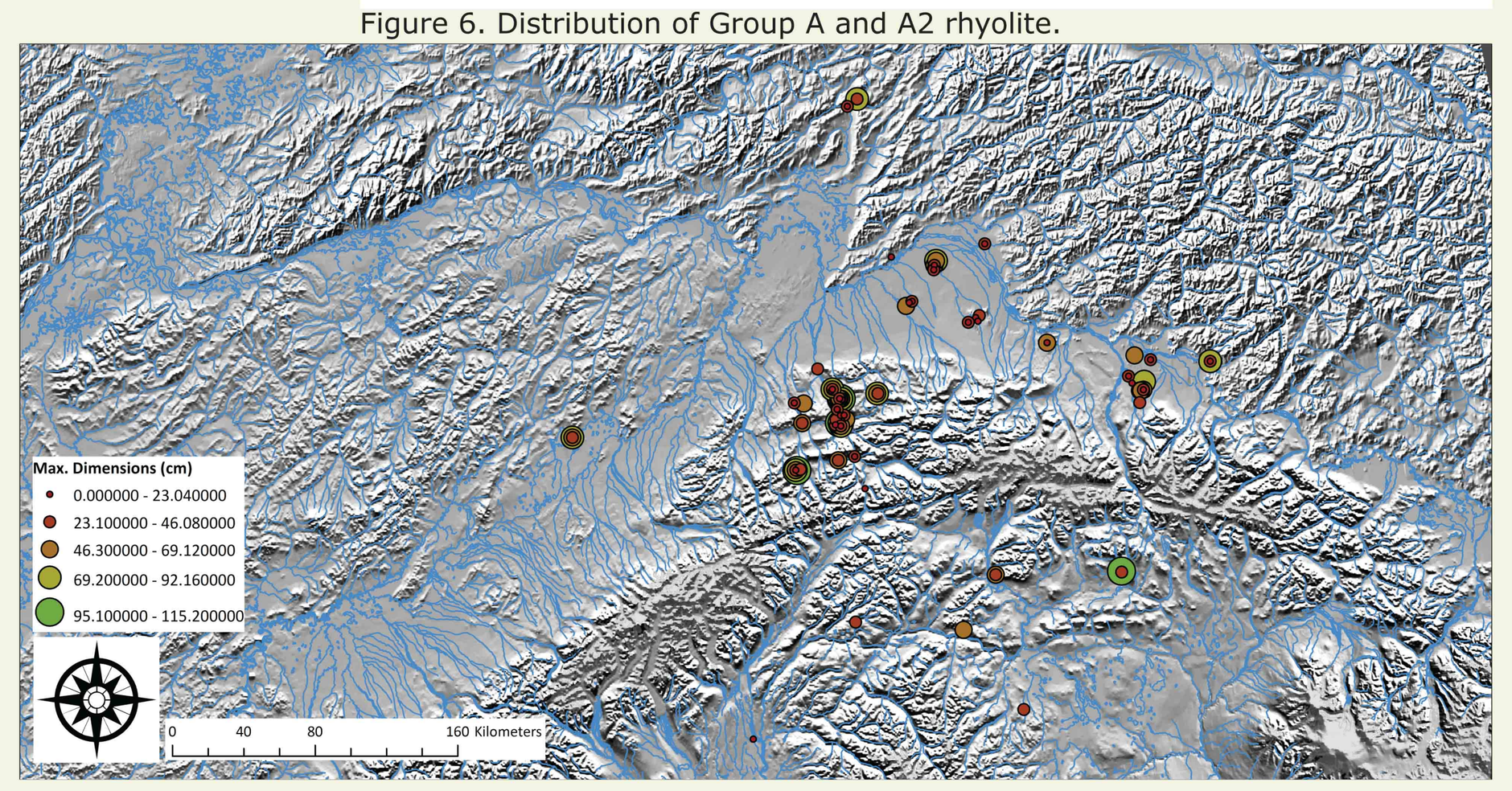


Figure 8. Group A and A2 samples mapped by max. dimension (cm).

SOURCE GROUP B, bb, and Teklanika

Figure 9. Sample of Group B, bb, Tek artifacts

Rhyolite assigned to Groups B (n=173), bb (n=22), and Teklanika (Tek.) (n=34) is predominantly beige to white in color (Figure 9) with some artifacts exhibiting shades of light purple and rose. Similar to Groups A and A2; Groups B, bb, and Tek. were all used from the Late Pleistocene through the Late Prehistoric. These three groups are spatially distributed throughout interior Alaska and in most instances co-occur with Group A and A2 rhyolites (Figure 10).

Group B is the second most common form of rhyolite and represents a quarter of the rhyolite artifacts analyzed and identified geochemically in this study. Unifacial (n=29; 17%) and bifacial (n=20; 12%) tools were the most common tools analyzed. Microblade technology (n=12; 7%) is not as common as with Group A and A2 rhyolite. This may be limited to sample size or due to the material itself, in that it was non-conducive to manufacturing of microblades and microblade technology.

The precise locations of the geological sources for Group B and bb are currently unknown. Based on weight and maximum dimension of artifacts the two sources might be located in the central Alaska Range (Figures 11 and 12). The Teklanika source was identified in 2013 and is located in the upper Teklanika River valley on an un-named tributary of the Teklanika River, near Calico Creek, central Alaska. Additional sampling from this location is needed to fully characterize this source.

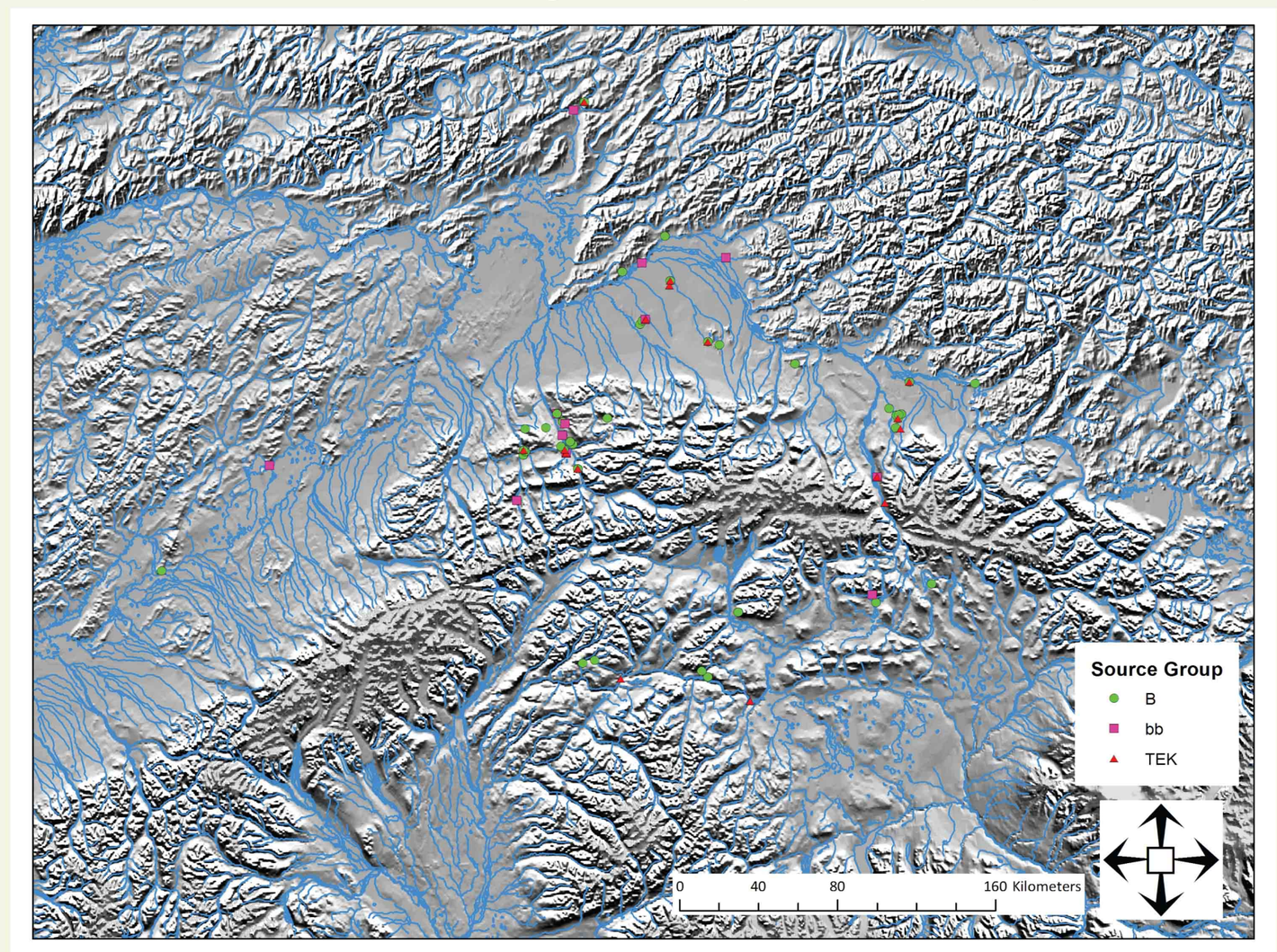


Figure 10. Distribution of Group B, bb, and Tek rhyolite.

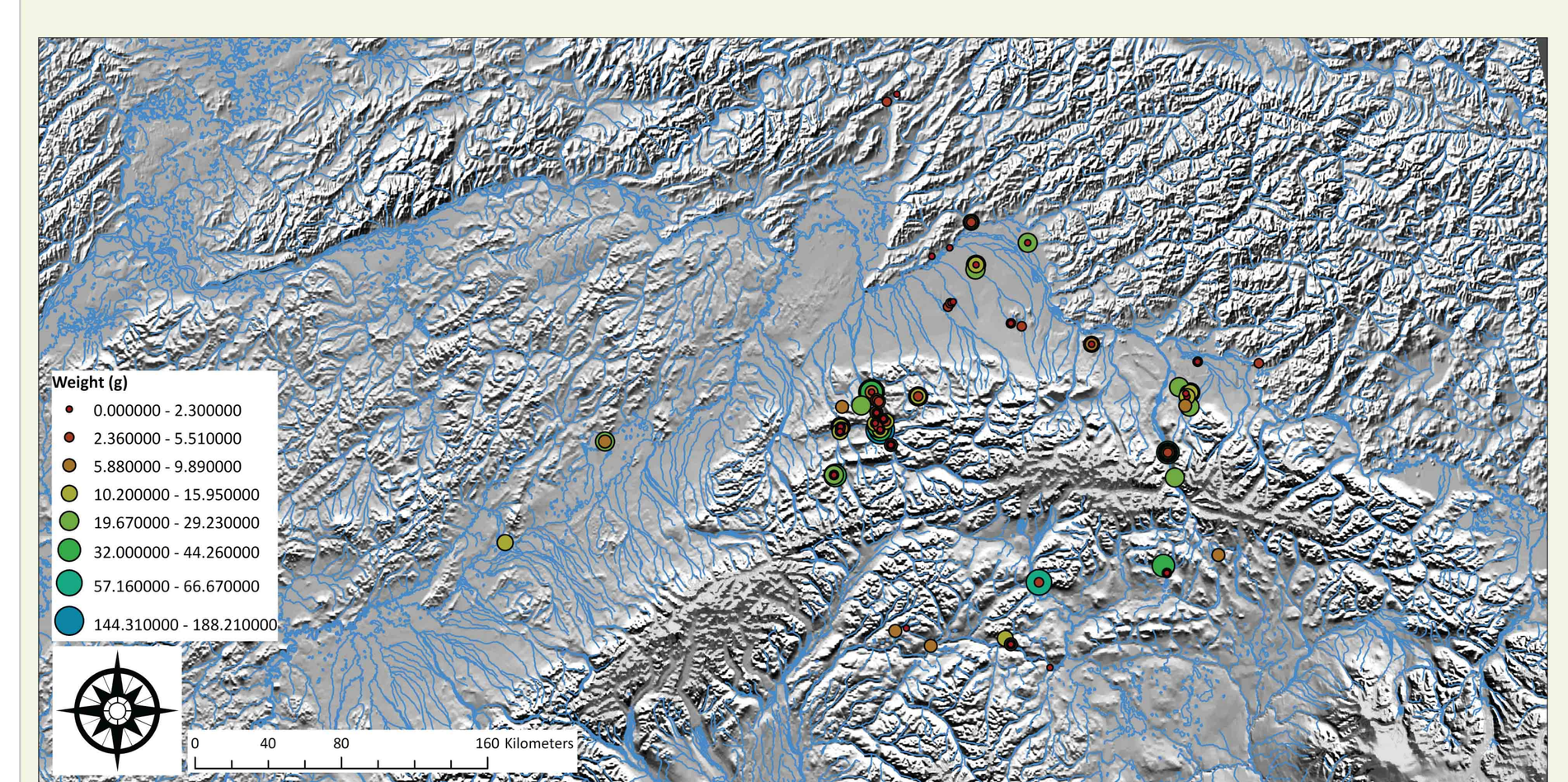


Figure 11. Group B, bb, and Tek. samples mapped by weight (g).

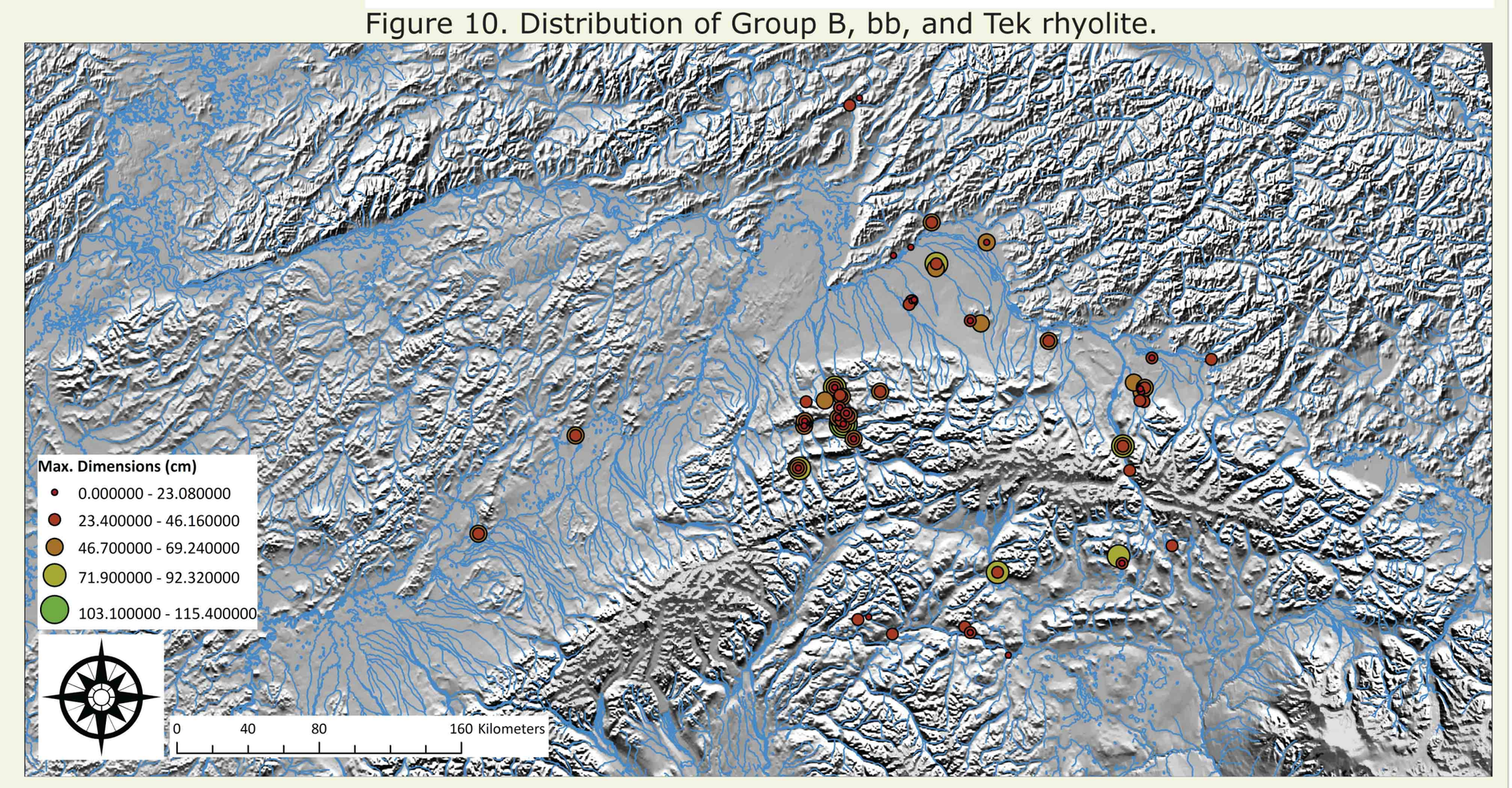


Figure 12. Group B, bb, and Tek. samples mapped by max. dimension (cm).

SOURCE GROUP C, D, E, F, Talkeetna River

Figure 13. Sample of Group C, D, E, F, TLM artifacts

Rhyolite assigned to source groups C (n=27), D (n=20), E (n=17), F (n=14), and Talkeetna Mountain. (n=16) is olive green to light grey in color with some artifacts also being olive green to light brown (Figure 13). With the exception of Group C rhyolite, these groups were not widely used prehistorically until the Middle Holocene. Limited use of Group C rhyolite appears from the Late Pleistocene through Late Prehistoric.

Sample sizes for all of these groups are limited making it difficult to fully gauge the technological organization of these groups. At this time, it can be observed that these group materials fractured in a way that allowed for both the manufacture of bifacial and microblade technology.

Geological sources for Groups C, D, E, and F are currently unknown. Based on weight and maximum dimension of artifacts these sources might be located in either Talkeetna Mountains or in the Alaska Range (Figures 14, 15, and 16). The Talkeetna Mountain source was documented in 2001 J. Schmidt of the USGS. The source is located at the headwaters of the Talkeetna River in the Talkeetna Mountains. Currently, samples from Schmidt and Gamble (2003) match geochemically to artifacts from our study. Additional sampling from this location is needed to characterize this source.

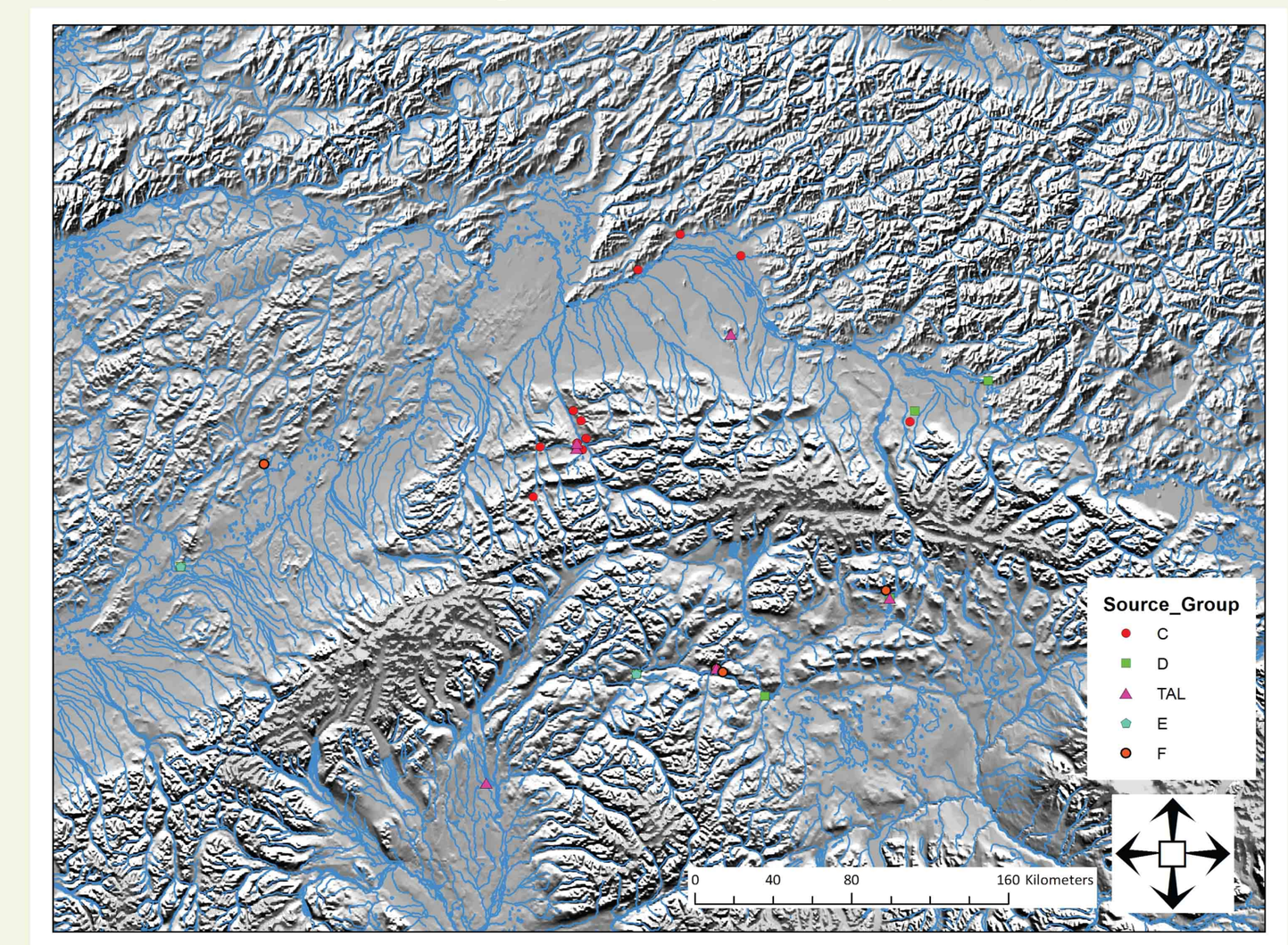


Figure 14. Distribution of Group C, D, E, F, and TLM rhyolite.

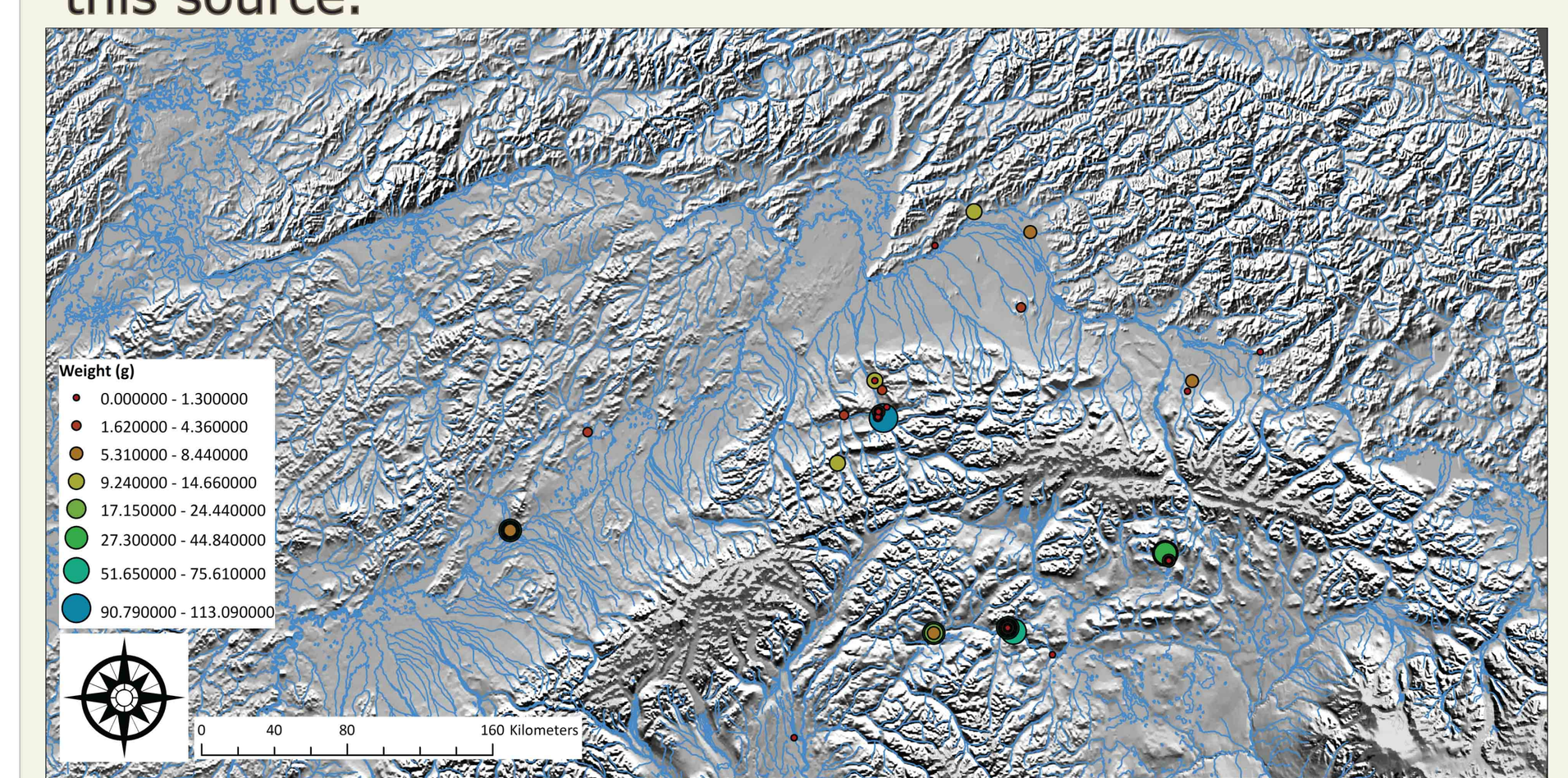


Figure 15. Group C, D, E, F, TLM. samples mapped by weight (g).

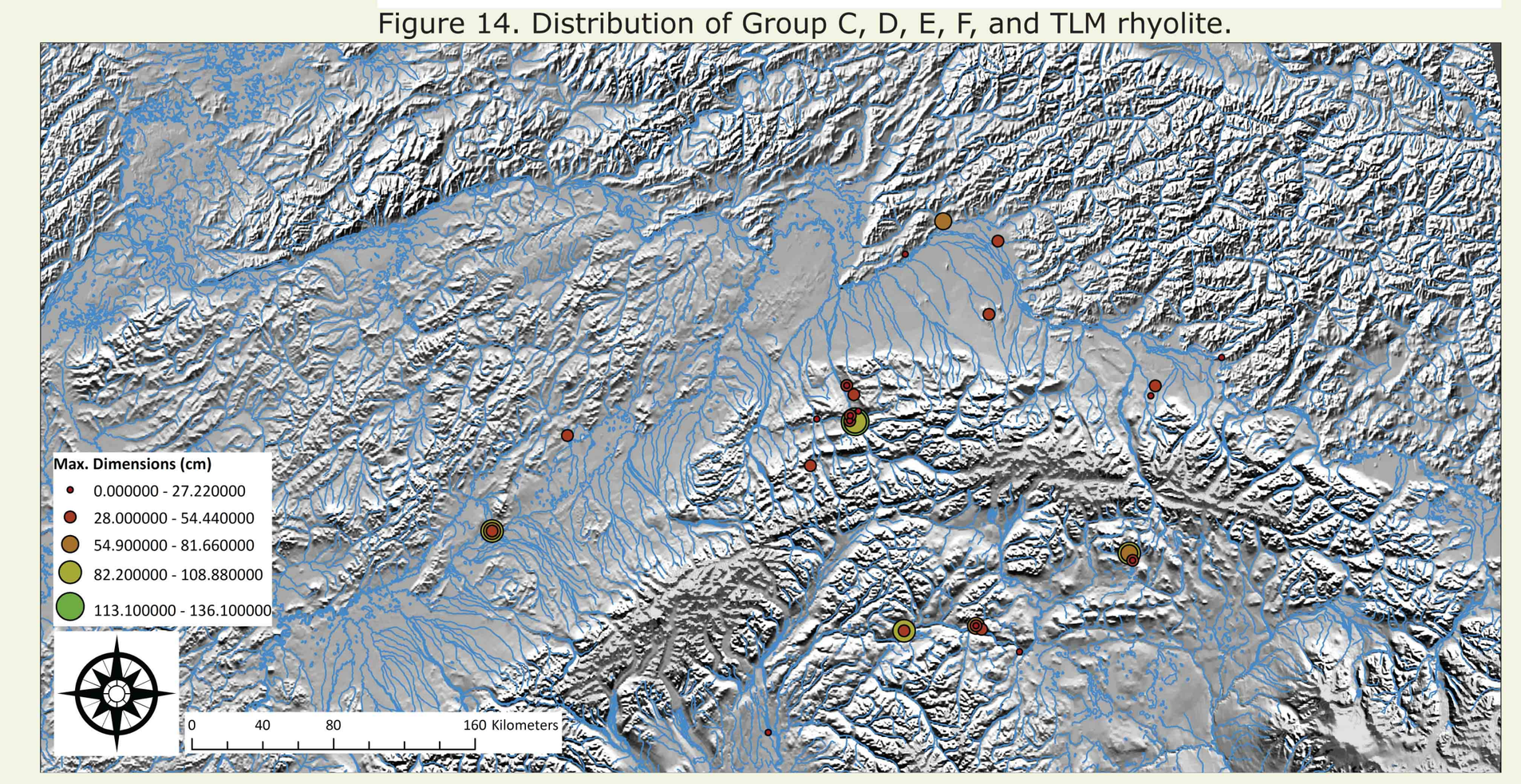


Figure 16. Group C, D, E, F, TLM. samples mapped by max. size (cm).

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