IAOS

International Association for Obsidian Studies

Bulletin

Number 50 **Winter 2014**

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NEWS AND INFORMATION

IAOS Annual Meeting

The International Association for Obsidian Studies will hold its annual meeting during the Society for American Archaeology conference in Austin, Texas. Join us Friday, April 25, 2014 from 12-1:30pm. Please see your SAA program for location information.

CONSIDER PUBLISHING IN THE IAOS *BULLETIN*

The *Bulletin* is a twice-yearly publication that reaches a wide audience in the obsidian community. Please review your research notes and consider submitting an article, research update, news, or lab report for publication in the *IAOS Bulletin*. Articles and inquiries can be sent to IAOS.Editor@gmail.com Thank you for your help and support!

PUBLISH ANNOUNCEMENTS, NEWS, AND EVENTS IN THE *BULLETIN*

Do you have a new obsidian-related publication that you wish to announce? Or an upcoming conference that you would like to advertise? Want to notify our members of new lab services?

Please send news and announcements to IAOS.Editor@gmail.com for inclusion in the next issue of the *IAOS Bulletin*.

NOTES FROM THE PRESIDENT

Happy New Year to you all! Soon my tenure as IAOS President will conclude, so this is my last note to you in that role. Next time you will be hearing from Jeff Ferguson, who takes over this position in April at SAA. This also means that I must vacate the President's official residence in Sheffield, established here in England's third largest city when Lord Renfrew was a lecturer in the University's Department of Ancient History. My family is preparing for a trans-Atlantic move back to Minneapolis in January, generally considered the best time of the year to move to Minnesota (or as I describe it here, "Almost Canada"). Good luck to Jeff on his preparations to leave the Colonies and take over the official residence. I am sure that he and his family will enjoy South Yorkshire as much as we have these last two years. Jeff, we'll leave the keys under the doormat.

In all seriousness, my two-year position at the University of Sheffield, working on the EU-funded Marie Curie network *New Archaeological Research Network for Integrating Approaches to Ancient Material Studies in the Eastern Mediterranean*, comes to an end in January. I am returning to the University of Minnesota with a joint appointment in Earth Sciences and Anthropology, and I will be continuing my research on geochemical and magnetic sourcing of obsidian artifacts with a focus on Armenia. So it is an exciting time of change for us. All that we've sent back to the U.S. so far is 50 kg of well-travelled obsidian specimens on their third trans-Atlantic trip -- an incredulous DHL employee asked, "What use could you possibly have for all these rocks?" Anyway, my role as IAOS President and my position at Sheffield coincided simply out of serendipity, and I have hugely enjoyed both of them and feel fortunate to have been afforded these opportunities. Due to the chaos of this impeding move (with a three-year-old son who insists that he is actually British and a four-month-old daughter), this edition of "Notes from the President" will be somewhat brief.

January -- or rather the January issue of *Journal of Archaeological Science* -- marks another transition for me, if might I be allowed to briefly report on my own work. One of my articles in the *JAS* January issue reflects the last of my research in Syria before the ongoing and tragic conflict in the country. And, if I may be allowed an indulgence within an indulgence, can I please

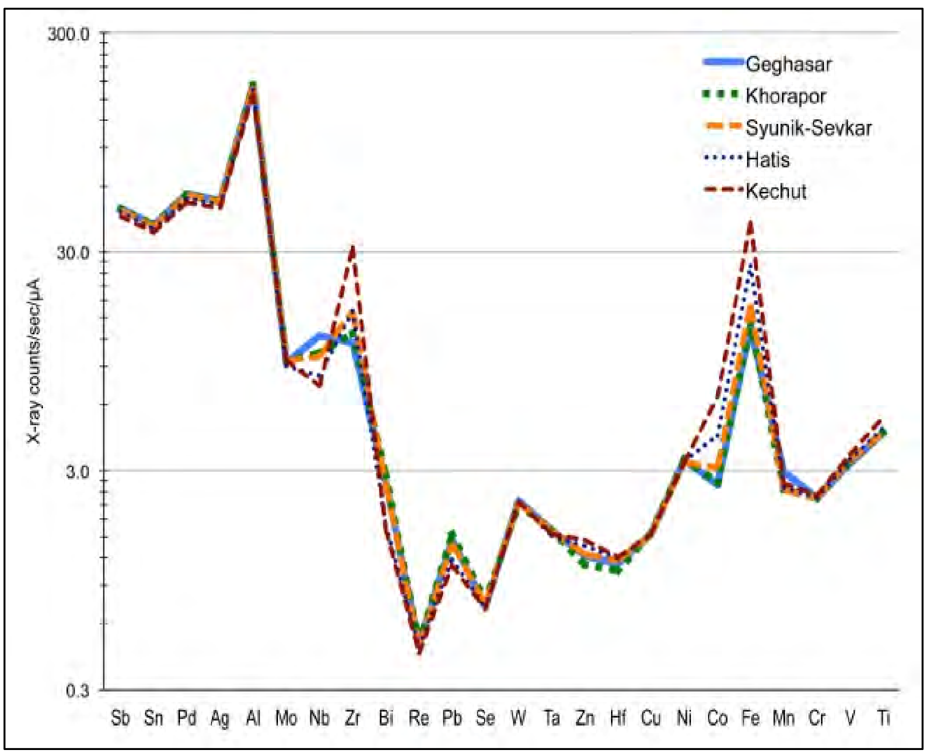

Figure 1. Comparison of the "spectral fingerprints" for different obsidian sources. Only five are shown for clarity. The vertical axis is the X-ray intensity for each element.

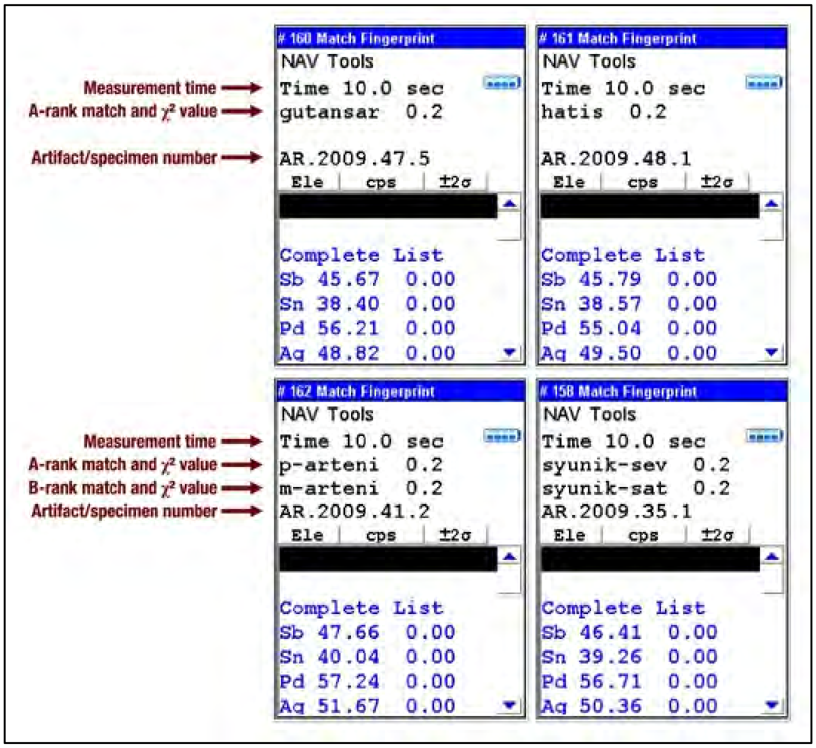

Figure 2. Screen captures of the pXRF instrument's screen demonstrate how the best matching sources (and their "goodness of fit" based on χ^2 values) are displayed to a user after 10 seconds using the Spectral Fingerprints method.

encourage people to consider contributing to the refugee relief efforts this winter? My relief organization of choice is Oxfam; however, the International Red Cross and the United Nations' Relief Agency are other excellent choices. So the publication of this work is quite bittersweet -- it is always exciting to publicize new findings, but my thoughts are with my Syrian friends and their families.

On the other hand, my second article in the January issue -- Ten Seconds in the Field: Rapid Armenian Obsidian Sourcing with Portable XRF to Inform Excavations and Surveys -- represents the first publication from my work in Armenia and a methodological development about which I am very excited. It was a challenge to keep quiet about it in the "Improving XRF Methods" session at SAA last April! You can read the article for yourself, but in short, I developed ways to get a pXRF instrument's built-in LCD to display the volcanic origin of Armenian obsidian artifacts after just 10 seconds. There are two ways to do this. First, one can use "spectral fingerprints" like those used in positive material identification (PMI) for metal alloys (Figure 1), and the pXRF screen will display, in real time, the closest statistical match to obsidian sources in a custom library (Figure 2). Second, one can use well-measured "mid-Z" elements, which can be accurately and precisely quantified in only 10 seconds (Figure 3), with thresholds commonly used to test for toxic elements in consumer products (Figure 4). In contrast, most recent studies using pXRF to source obsidian have analyzed artifacts for 3-5 minutes -- the mode is 300 seconds. Taking pXRF measurements 30 times faster makes it practical to use the instrument on-site during an excavation or on a survey, and one has the source identification in just 10 seconds. I'm really excited about the attention this methodological development has received, from *The Economist*'s Babbage Blog to *Archaeology Magazine* and even a brief mention in NBC News' five leading science themes of 2013.

I look forward to seeing many of you in April at SAA, which returns to Austin this year and will be an exciting meeting for several reasons. For starters, for the first time (to my knowledge), IAOS will have a booth in the exhibit hall. Specifically, Booth #106. Let's check the SAA website and see who is next to us. Booth #107 is... Aww, dammit, University of Leicester... I can't take any more of the "king in the car park." No word yet on who will be in Booth #105. The booth is a way to celebrate and publicize that this is the 25th anniversary of IAOS's founding. I don't

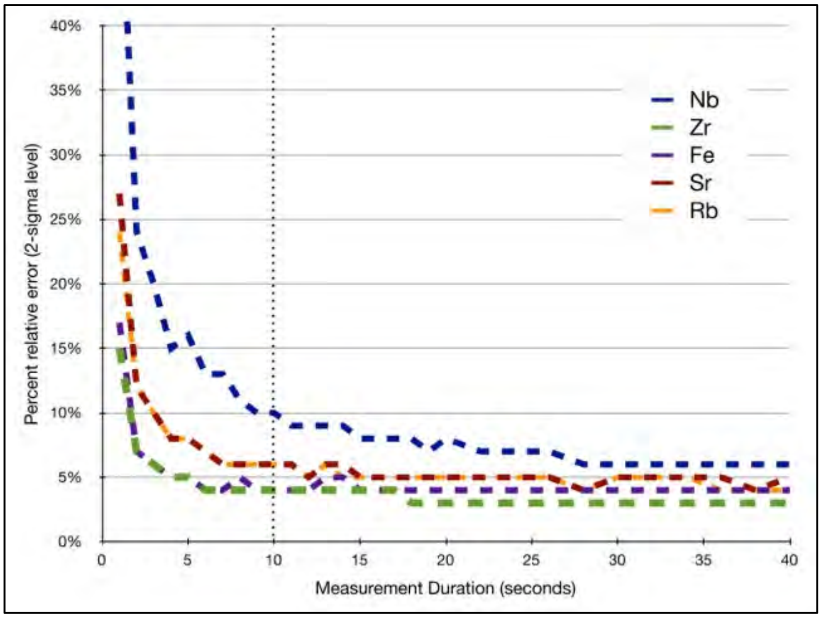

Figure 3. Empirical tests show the inverse square relationship between measurement uncertainty and time for Zr, Sr, Rb, Nb, and Fe for an obsidian specimen from Gutansar volcano. The specimen was measured multiple times for a series of durations between 1 and 40 seconds. After 10 seconds, these elements have uncertainties of only 4-10%, which do not improve much with additional time.

expect that the booth will be staffed at all hours, but feel free to take even a short shift there.

Second, the booth will have our "best-of" *IAOS Bulletin* volume for sale. Carolyn Dillian has been working on assembling the articles from our archives, sorting the logistics of printing and shipping, and extending her editorial powers from bulletin to book. Of course, she's already edited the book *Trade and Exchange: Archaeological Studies from History and Prehistory*, so she has experience in this realm. She has found a local press, and the book will be about 180 pages on 6 x 9" paper with a four-color cover -- it looks very professional, and the price will be about $10. I am excited by (and deeply appreciative of) Carolyn's hard work to bring this idea to fruition in time.

Last but not least, Rob Tykot has organized a fantastic two-part session to celebrate the 50th anniversary of the publication of *The Characterisation of Obsidian and its Application to the Mediterranean Region* by Cann and Renfrew. *Both Cann and Renfrew will be participating in this session!* Both parts of the session will be held on Saturday the 26th. Part 1 in

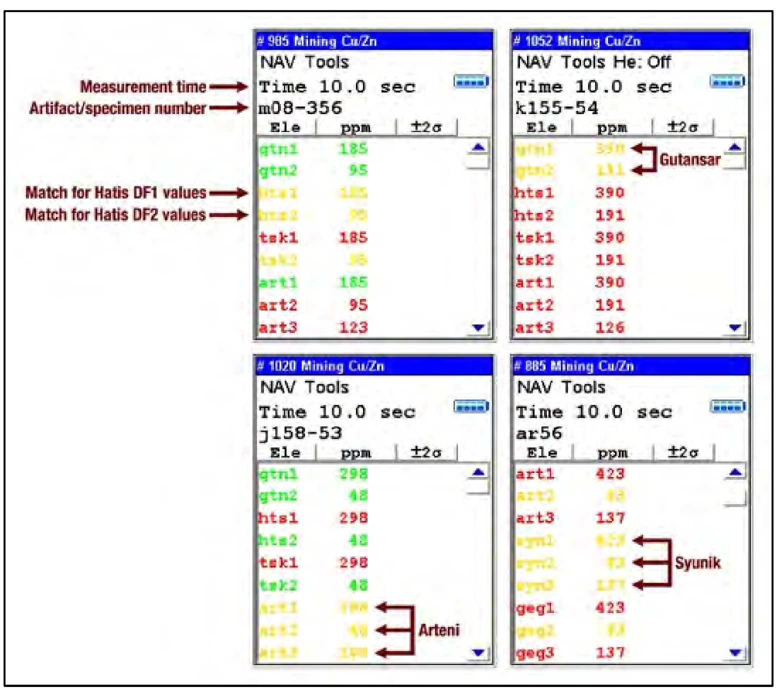

Figure 4. These screen captures of the pXRF instrument's screen demonstrate how a matching source is displayed to a user after 10 seconds using the discriminant analysis method. Gutansar and Hatis are each defined by two discriminant functions, and when both of their respective functions display yellow values, it is a match. Arteni and Syunik are defined by three functions, and a match occurs when all three display yellow values.

the morning will include presentations from Johnson Cann and Colin Renfrew; François-Xavier Le Bourdonnec, Gérard Poupeau, Ludovic Bellot-Gurlet and Marie Orange; Marie Orange, François-Xavier Le Bourdonnec, Anja Scheffers and Renaud Joannes-Boyau; Anna Maria De Francesco, Marco Bocci and Gino Crisci; Robert Tykot; Kyle Freund; Laurence Astruc; Korhan Erturaç, Laurence Astruc, Bernard Gratuze, Sébastien Nomade and Nur Balkan-Atli; Damase Mouralis, Ebru Akköprü, Laurence Astruc, Korhan Erturaç and Catherine Kuzucuoglu; Tristan Carter; me (Ellery Frahm); Elizabeth Healey and Stuart Campbell; Steven Brandt, Jeffrey Ferguson and Lucas Martindale Johnson; and Carolyn Dillian, Emmanuel Ndiema, Purity Kiura and David Braun. Renfrew will be the discussant. Part 2 in the afternoon will include presentations from Yoshimitsu Suda, Jeffrey Ferguson, Michael Glascock, Vladimir Popov and Sergei Rasskazov; Jeffrey Ferguson and Masami Izuho; Richard Hughes; Jeanne Binning, Alan P. Garfinkel, Jennifer J. Thatcher, Craig E. Skinner and Brian Wickstrom; Sean Dolan; Meredith Anderson; Michael Glascock; Martin Giesso, Valeria Cortegoso, Victor Duran, Gustavo Neme and Ramiro Barberena; Elizabeth Pintar and Jorge G. Martínez; Christopher Stevenson; and Alexander Rogers and Christopher Stevenson. Tristan Carter, Robert Speakman, and Robert Tykot will be the discussants for Part 2. I'm looking forward to what will be a fantastic session and to seeing/meeting old friends and new ones.

Please also mark your calendar (or set your iPhone reminder) for the IAOS business meeting at SAA at lunchtime (12:00-1:30) on Friday. Bring your best ideas and a friend!

I have been honored to serve as IAOS President. It has been an enjoyable two years, and I thank you once again for electing me to this position. I look forward to seeing many of you in Austin, and I wish you all the very best for 2014!

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NEWS AND NOTES: Have announcements or research updates to share? Send news or notes to the *Bulletin* Editor at IAOS.Editor@gmail.com with the subject line "IAOS news."

IAOS Bulletin "Best Of" edited volume available in 2014!

As part of our celebration of the 25th anniversary of the IAOS, we will be publishing an edited volume highlighting important contributions from the *IAOS Bulletin.* Articles will be selected that trace the history of the IAOS, present new or innovative methods of analysis, and cover a range of geographic areas and topics. We are working with a press that has assured us that we will have delivery of the books in time for the 2014 Society for American Archaeology conference, where they will be offered for sale at a bargain price of $10. Please stop by the IAOS booth in the book room and purchase your copy!

THE PALIZA CANYON SOURCE OF ARCHAEOLOGICAL OBSIDIAN IN THE SOUTHERN JEMEZ MOUNTAINS, NORTHERN NEW MEXICO

M. Steven Shackley

Geoarchaeological XRF Laboratory, Albuquerque, New Mexico
www.swxrflab.net

Introduction

All the known sources of archaeological obsidian in the Jemez Mountains of northern New Mexico have been well dated and chemically, stratigraphically, and isotopically studied for a number or years, mainly due to geologically recent, extraordinary caldera collapse events - all except one, traditionally called Paliza Canyon (Baugh and Nelson 1987; Gardner et al. 1986; Glascock et al. 1999; Goff et al. 1996; Kues et al. 2007; Nelson 1984; Self et al. 1986; Shackley 2005; Spell and Harrison 1993; Wolfman 1994).

Paliza Canyon was originally reported as a source of archaeological obsidian by Nelson in 1984 and Tim Baugh and Fred Nelson in 1987 as a small nodule source; they analyzed four samples from Paliza Canyon proper (Baugh, personal communication 2013; Baugh and Nelson 1987: 317; also Nelson 1984: 52). Church (2000) and Shackley (2012a) have both reported the presence of Paliza Canyon obsidian in the Rio Grande Quaternary alluvium at least as far south as Las Cruces, New Mexico, and it occurs in Pueblo Revolt period sites in the Jemez Springs region in the southern Jemez Mountains, many of the sites near Paliza Canyon (Liebmann 2012; Shackley 2009, 2012b; Figure 1 here).

Origin

Baugh and Nelson's collection was apparently from the southwestern portion of the Redondo Peak 7.5' USGS Quad in Paliza Canyon (Nelson 1984; Figure 1 here). The collection reported here from September 2013 was in the northwest corner of the adjacent Bear Springs Peak 7.5' USGS Quad just south of Paliza Canyon in what is mapped as part of the El Cajete tephra deposit adjacent to Tertiary volcanoclastic gravels (Kempter et al. 2003; Figure 1 here). At both collection localities, the tephra is very similar to El Cajete sediments seen at various points in the Jemez Mountains. The largest marekanite recovered was only about 4 mm in largest dimension, but most were 1- 2 mm. Given that Paliza Canyon secondary deposit samples at Tijeras Wash south of Albuquerque over 150 stream km south of the southern Jemez Mountains are up to 3 mm in largest dimension, obsidian from the primary source, wherever that is, must be larger than the marekanites recovered in September 2013. As a media for tool production this smoky gray to nearly transparent obsidian is equal to other Jemez Mountains sources.

No obsidian marekanites have been recorded in association with the El Cajete deposits elsewhere, the most recent eruptive event in the Jemez Mountains dating to about 50-60 ka (Ellisor et al. 1996; Kempter et al. 2003). Bearhead Rhyolite is located just to the north of these collection areas, but the elemental chemistry is quite different from the Paliza Canyon obsidian with much lower Sr and Ba values (Ellisor et al. 1996:240; see Table 1 here). The elemental chemistry of the Paliza Canyon obsidian with relatively high Sr and Ba values is distinct from all the other rhyolite in the Jemez Mountains (Table 1). Except for the Sr and Ba composition, Paliza Canyon is compositionally similar to Canovas Canyon Rhyolite and the obsidian

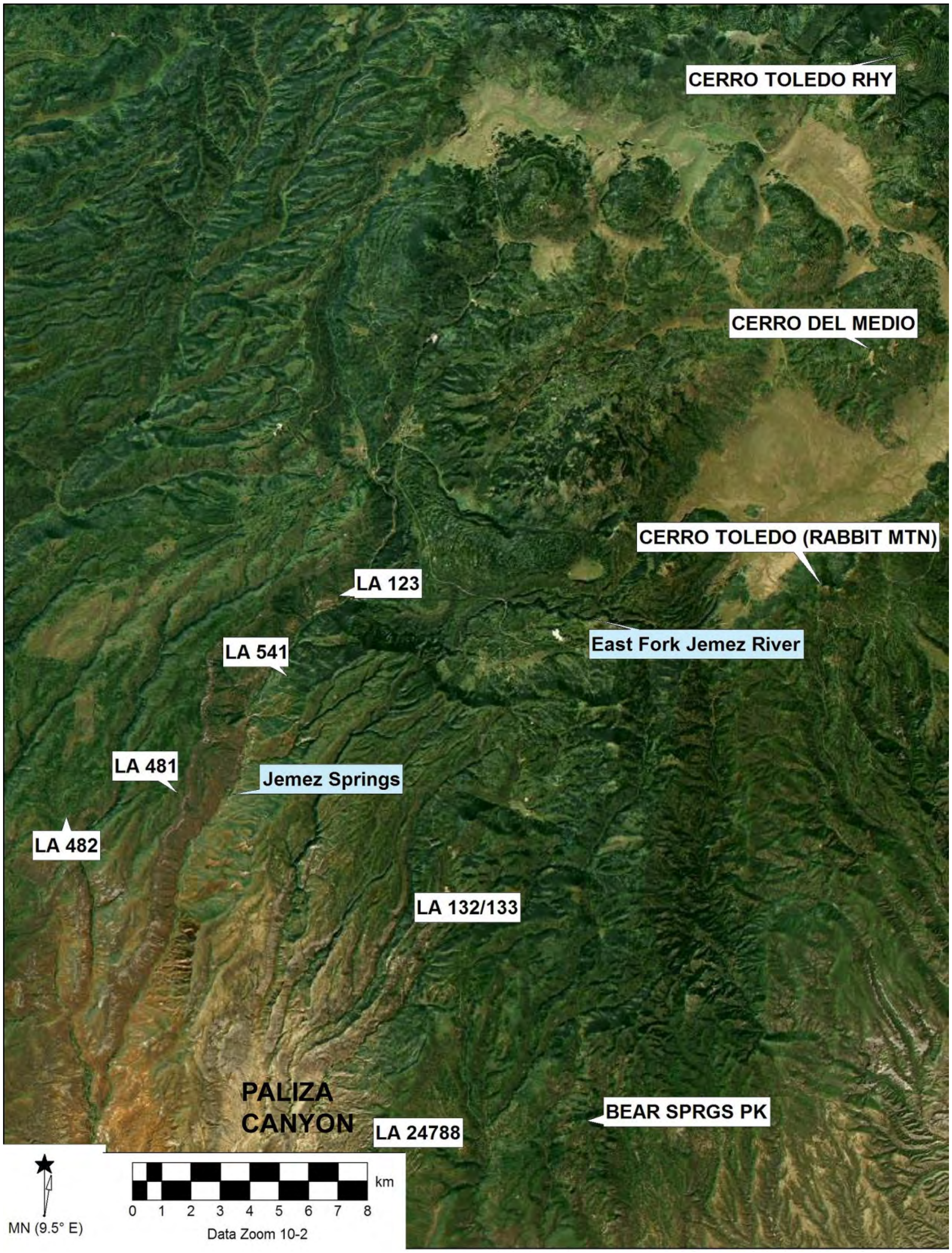

Figure 1. Digital elevation model of the Paliza Canyon locality, relevant sources in the Jemez Mountains, and Liebmann's Pueblo Revolt sites (Liebmann 2012).

from the domes at Bear Springs Peak southeast of Paliza Canyon, and like the other obsidian in the Jemez, is a high silica rhyolite (Tables 1 and 2). The volcanics in the Paliza Canyon Formation are all intermediate to mafic composition (Kempter et al. 2003). It could be unfortunate that this obsidian was originally named Paliza Canyon since it is likely not related to the rocks in the Paliza Canyon formation. At this point, the origin of the Paliza Canyon obsidian remains a mystery at least as far as this data reveals, but the first approximation is that it is likely a member of the Keres Group, which includes Canovas Canyon Rhyolite and Bearhead Rhyolite (see Ellisor et al. 1996). Further field collections and mapping may illuminate the origin of this source of archaeological obsidian.

Paliza Canyon					
	N	Minimum	Maximum	Mean	1 Std. Deviation
Zn	26	46	145	75	27
Rb	26	87	109	100	5
Sr	26	72	94	85	5
Y	26	20	28	23	2
Zr	26	112	138	124	7
Nb	26	27	43	33	4
Ba	26	960	1741	1613	146
Pb	26	15	24	20	2
Th	26	7	22	14	4

Table 1. Mean and central tendency for Paliza Canyon elemental data. Raw data available at http://swxrflab.net/jemez.htm. EDXRF instrumental conditions discussed at http://www.swxrflab.net//anlysis.htm.

Sample	SiO_2	Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	MnO	Na_2O	TiO_2	Σ
090413-3-2	74.668	13.104	0.892	1.483	5.416	0.209	0.132	3.369	0.278	99.55
RGM1-S4	75.680	12.477	1.3024	1.806	4.550	<.001	0.0379	3.77	0.196	99.82

Table 2. Oxide values for one sample of Paliza Canyon obsidian and USGS RGM-1 rhyolite standard. EDXRF instrumental conditions discussed at http://www.swxrflab.net//anlysis.htm.

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THE NCH'KAY (MOUNT GARIBALDI) OBSIDIAN SOURCE AND ITS LOCAL TO REGIONAL ARCHAEOLOGICAL DISTRIBUTION

Rudy Reimer

Simon Fraser University

Introduction

Obsidian along the Northwest Coast of North America occurs at a number of volcanic centers, all at high elevations in the Coast Mountains, the Cascade Range to the adjacent interior Plateau Mountains and Foothills. They are a result of plate tectonic and hot spot volcanism (Wood and Kienle 1990). While most of the large sources in this region have a long history of archaeological research (Carlson 1994; James et al. 1996; Nelson 1975), many of the sources located in Canada remain systematically under reported, especially in terms of their exact location, size and extent, number of identified flows, and standardized elemental values reported in parts per million (ppm). The main exception of this is the research conducted on Mount Edziza, where extensive survey, test excavation, and XRF obsidian characterization is well documented (Fladmark 1984, 1985; Godfrey-Smith 1986; Reimer n.d.). However, the elemental signatures of this and other sources in Alaska are currently under further investigation (Moss et al. 20 13; Reimer n.d.).

Figure 1. Source locations in British Columbia, Canada.

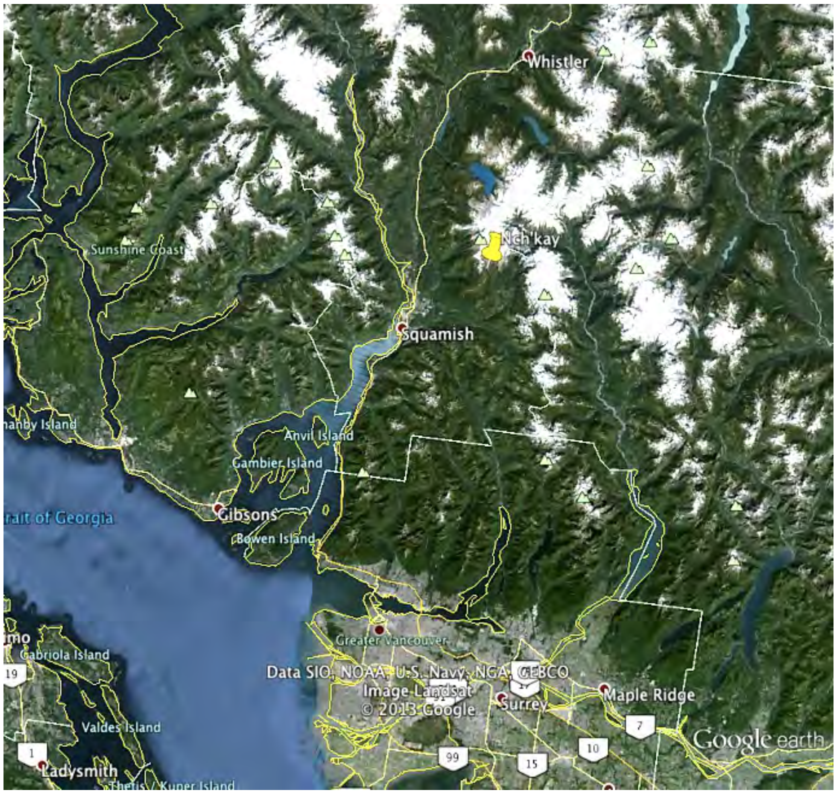

Figure 2. The location of the Nch'kay/Mount Garibaldi obsidian source.

The major hindrance to researchers investigating obsidian sources in Canada is their difficult access and remote location (Figure 1). The mountainous terrain of the region is a challenge for focused archaeological exploration as peaks rise from sea level to 2000 meters above sea level in 1-1.5 kilometers horizontal distance. This makes for a steep landscape, passing through fast flowing rivers and dense rainforest, up to dramatic sub-alpine and alpine landscapes, considerably different to the easy experiences like those documented by Frahm (2012). The Nch'kay or Mount Garibaldi obsidian source is no exception to this pattern, despite its close proximity to the large city center of Vancouver and the town of Squamish, British Columbia, Canada (Figure 2).

The Nch'kay/Mount Garibaldi Obsidian Source

Historically, the obsidian source discussed here was known as Mount Garibaldi, but is changed here to Nch'kay (pronounced inch-kiey), a Squamish First Nation place name that reflects its long-term history and meaning (Reimer 2000, 2003, 2012). Initially, its chemical fingerprint was defined using X-ray Fluorescence in the archaeological literature by Erle Nelson of the Department of Archaeology, Simon Fraser University (Nelson 1975). However, these samples were submitted by members of the Archaeological Society of British Columbia (ASBC), who collected them from along the edge of a hiking trail near Elfin Lakes in Garibaldi Provincial Park. They do not represent a source location. Nevertheless, these samples matched the elemental "finger prints" of artifacts found across the southern Northwest Coast culture area. Regional researchers inferred that a lithic scatter site near Mount Garibaldi was the source of these materials, without actual documentation of a source area or outcrop.

Later in 1979, the ASBC returned to this locale and documented a sub-alpine site, DkRr 1, at 1500m above sea level. This site was not revisited until the early 1990's when ARCAS

Figure 3. Descending into the reaches of upper Ring Creek, with Nch'kay or Mount Garibaldi in the background.

Archaeological Consultants Ltd, undertook research for the Squamish First Nation as part of documenting evidence for Aboriginal land claims. Part of their research surveyed sub-alpine and alpine areas for lithic sources, but did not find the Nch'kay obsidian source. In the late 1990's and throughout the 2000's Reimer (2000, 2003) conducted additional surveys to find the elusive source, without success. However, this research did systematically apply visual and XRF analyses of materials occurring in the region. A spatial and temporal pattern recognized by Reimer (2000, 2003) found that the distribution of Mount Garibaldi obsidian was restricted mostly to the Coast Salish/lower mainland region of British Columbia and did not occur at archaeological sites dating to periods of alpine neo-glaciation. Neo-glacial episodes in the Coast Mountain region, where the Mount Garibaldi source was believed to occur, date to three distinct times: 6000-5000BP (Garibaldi advance), 3300-1900BP (Tiedeman advance) and 1100-500 BP (Little Ice Age).

Discovery of the Nch'kay Source

In the summer of 2009, I found the actual location of the Nch'kay obsidian source. Survey in other seasons than summer is impossible due to over 2 meters of snow cover, making examination of the surface of the landscape impossible. Previous surveys focused on examination of the high elevation slopes of the Mount Garibaldi volcanic complex but did not completely consider early geologic maps and the possibility of the source occurring at lower elevation. William Mathews, of the University of British Columbia Department of Geography and Geology, initially documented a small geological "intrusive glassy rhyodacite" along the upper reaches of Ring Creek, flowing off the southeastern flank of Mount Garibaldi (Mathews 1952). Extrapolating latitude and longitude coordinates from his map, relocation of the obsidian outcrop was possible with the use of GPS. The source occurred exactly where he originally mapped it.

The source, now recorded as archaeological site DkRr 6, is a small outcrop in comparison to other obsidian sources in the Pacific Northwest. It measures 20m North to South and an unknown extent East to West as it occurs as a high, steep and difficult to quarry glacial cut bank along the upper reaches of Ring Creek (Figures 3 and 4). A range of samples collected along the vertical

Figure 4. Alternating lava flow bands of the Nch'kay obsidian source

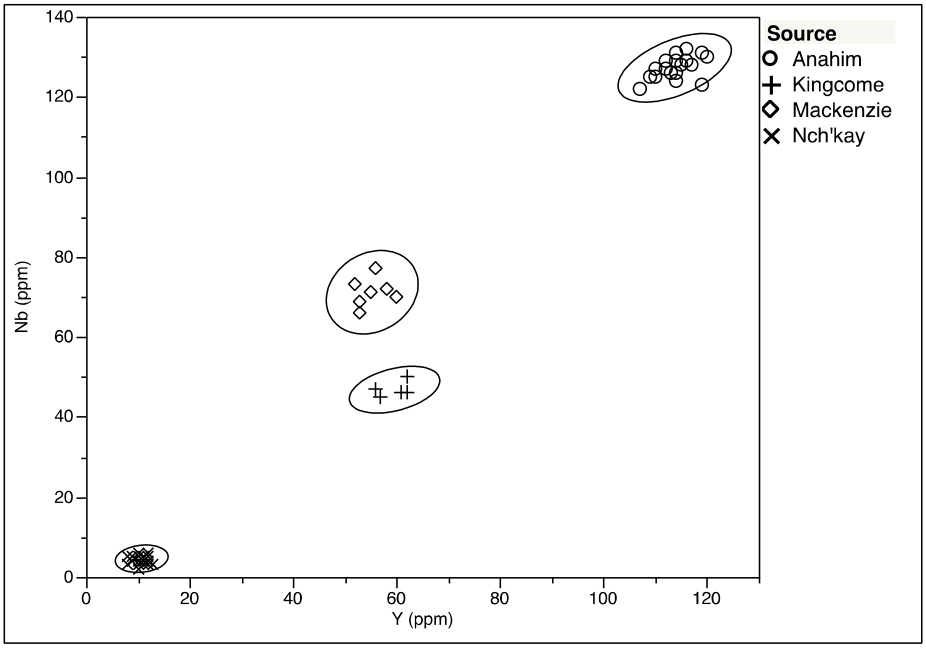

Figure 5. Bi-plot of Nb and Y obsidian source data.

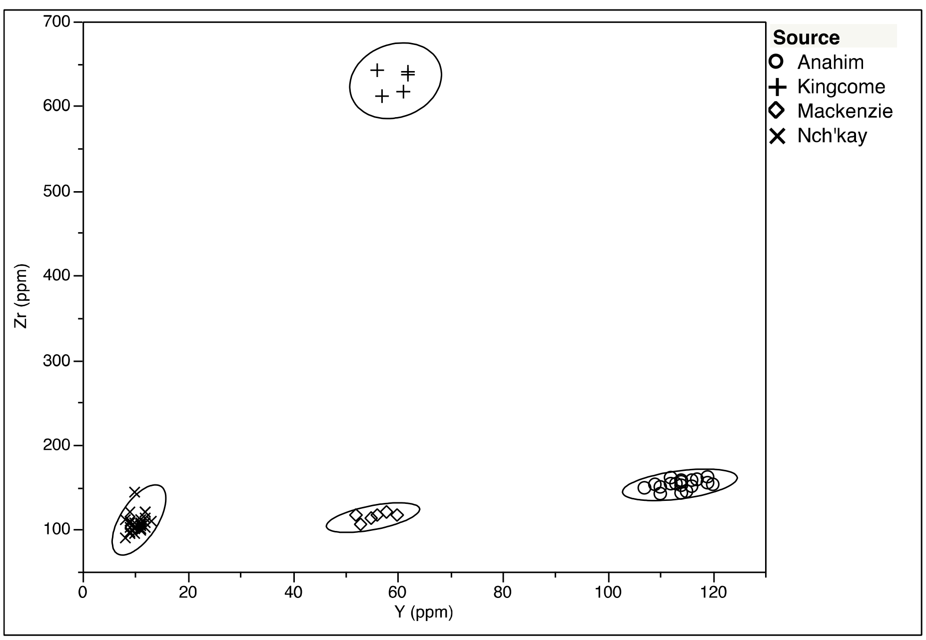

Figure 6. Bi-plot of Zr and Y obsidian source data.

and horizontal occurrence of the outcrop and brought back to the Department of Archaeology, at Simon Fraser University for XRF analysis.

Analytical Method

The instrument used in this analysis is a Bruker AXS Tracer III-V+ portable energy dispersive X-Ray Fluorescence (EDXRF) spectrometer. In the lab, the instrument mounted in a stable stand, allows for easy maintenance of a fixed position. It is equipped with a rhodium tube that emits X-Rays, a peltier cooled silicon PIN diode detector, operating at 40 kV (kilovolts) and 15uA (microamps) from an external power source. Samples ran for 180 live seconds with a filter comprised of 6mm Cu (copper), 1mm Ti (titanium), and 12mm Al (Aluminum). This arrangement allows for the analysis of the mid Z range of the periodic table of elements, specifically where Fe (iron), Rb (rubidium), Sr (strontium), Y (yttrium), Zr (zirconium) and Nb (niobium) occur. This suite of elements is well suited to archaeological obsidian characterization (Ferguson 2012). The Tracer produces an X-ray beam at a 45-degree angle from the center of the analyzer window that measures 4mm across. Careful placement of each sample, with a clean and flat surface ensures maximum exposure to X-rays. This allows for an optimal count rate and minimizes X-ray scatter.

X-ray counts, processed through the S1PXRF computer program developed by Bruker allow the user to examine spectra, live time during analysis or review afterwards. Results were converted to parts per million (ppm) through another Bruker program S1CalProcess using the rhodium Compton backscatter and a database of forty five previously known and established values for obsidian sources around the world, as determined by the University of Missouri Research Reactor (Speakman 2012). This database empirically calibrates the instrument by comparing expected values with those produced by the instrument for the following elements: manganese (Mn), iron (Fe), zinc (Zn), gallium (Ga), thorium (Th), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr) and niobium (Nb).

Results

Thirty source samples from the outcrop of DkRr 6, subjected to XRF show distinctive chemical fingerprints of high but variable Fe and Sr values, low Rb, Y, and Nb values, and average Zr values when compared to other obsidian sources in the region surrounding Nch'kay, including Anahim Peak, Kingcome and MacKenzie Pass (Carlson 1994; James et al. 1996; Nelson 1975). Elemental ppm data, inserted to the statistics program JMP 10, allowed for the formation of a scatter plot matrix of elements known to be useful for obsidian source statistical discrimination, using Fe, Rb, Sr, Y, Zr, and Nb (Ferguson 2012). In comparison to three other known and previously (but equally under-documented) obsidian sources, Nch'kay is easily discernable by the use of bi-plots of Zr, Nb and Y elements (Figures 5 and 6), but all other elements can differentiate Nch'kay from these and other sources when compared to additional data in the modernized and growing obsidian reference library at the Department of Archaeology, XRF laboratory at Simon Fraser University. Nch'kay is a single small flow obsidian source, which was and still is hard to access. Useful pieces require the scaling of steep slopes to get to the source, but also significant physical ability to acquire nodules useful for tool manufacture.

Local to Regional Significance

Nch'kay obsidian is considered easy to identify by regional researchers, as it contains white phenocrysts (likely quartz), possesses greyish to green and black bands of color in appearance under light, and is assumed to have poor flaking qualities in comparison to other sources across the region (Reimer 2012). However, the other sources considered in this study also share this list of visual and subjective attributes. Visually, both Kingcome and MacKenzie Pass obsidians contain similar phenocrysts and color attributes, while Anahim Peak obsidian only occurs as small nodules suitable for microlithic tool manufacture.

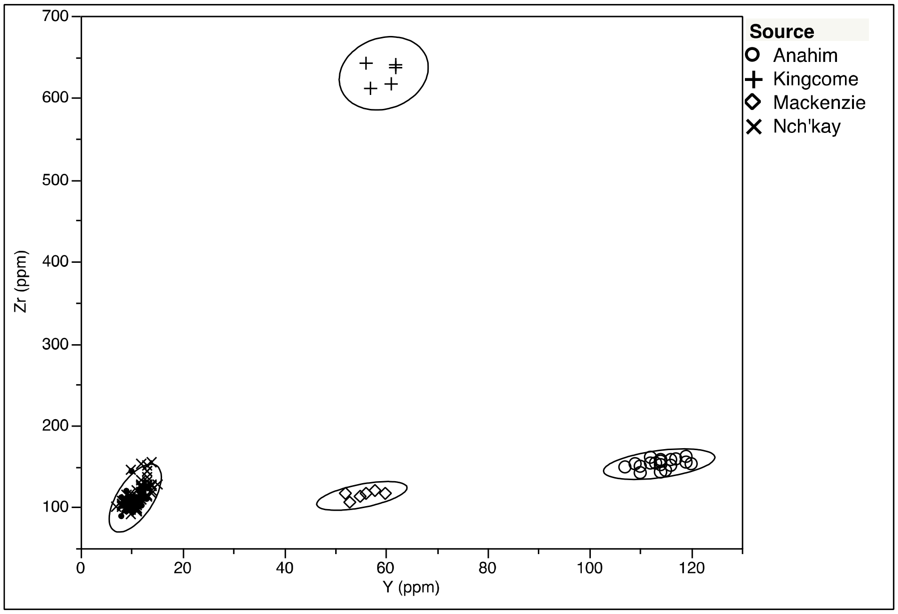

Figure 7. Bi-plot of Zr and Y for all samples in this study with 99% confidence, with Nch'kay source samples represented as a small dot.

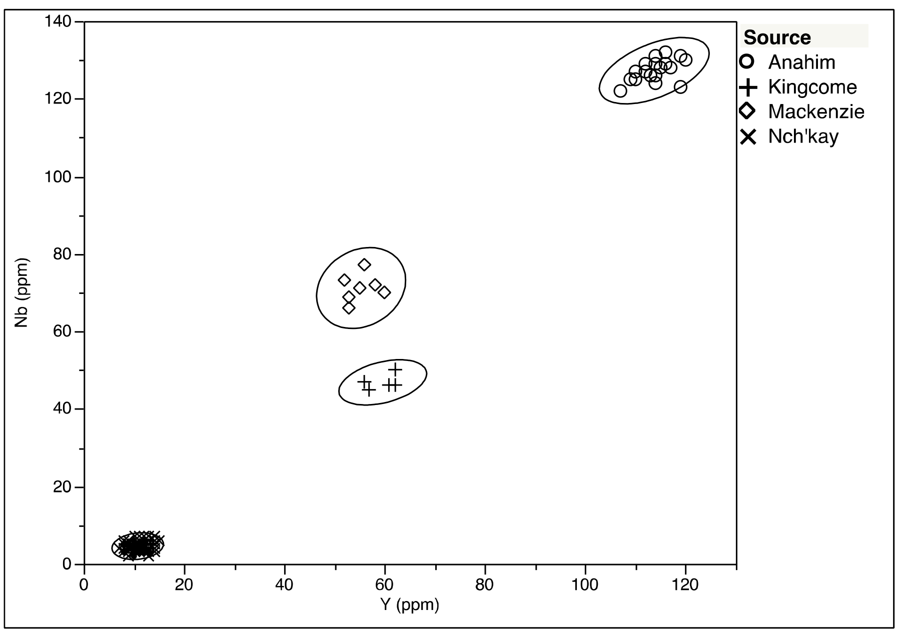

Figure 8. Bi-plot of Nb and Y for all samples in this study with 99% confidence, with Nch'kay source samples represented as a small dot.

Therefore, the long held assumptions of Nch'kay and other regional source materials, as being easy to identify solely through visual means is wrong. Archaeologists working across this vast region need to conduct additional XRF analyses of these materials. As a starting point, I sampled previously excavated collections from Squamish Nation territory to discern the local to regional pattern of use of Nch'kay obsidian (ARCAS

Site	C14 Age	Number of Pieces	Number Tested
DkRr 1	2850±40 BP	2642	15
DkRr 2	none	32	5
DkRr 3	None	5	1
DkRr 4	7130±40 BP	26	14
DkRr 5	None	6	1
DkRr 6	None	0*	30
DkRr 7	None	2	1
DkRs 6	4000±60 BP to 2270±60 BP	14	11
DiRt 11	1190±120 BP	1	1
DiRu 15	2690±70 BP	2	2
DiRu 19	2050±90 BP	3	2
EaRu 5	1210±35 BP to 75±35 BP	13	6
DlRt 9	1390±40 BP to 30±40 BP	52	14
DhRt 6		42	13
DhRr 18		2	1
DhRr 20		1	1
Totals		2843 (100%)	118 (4%)

Table 1. Occurrence of Nch'kay/Mount Garibaldi Obsidian in the Study Area. Note DkRr 6 is assigned a value of 0* at its source as it is impossible to estimate its true value.

1999, Reimer 2000, 2003, 2012). While the sample is preliminary and small (Table 1), it does consider the entire temporal length of habitation in Squamish Nation territory (Reimer 2012). Sites selected for this analysis include those in close proximity to the Nch'kay source (DkRr 1-5 and 7), to mid elevation and low elevation seasonal camps (DiRt 11, EaRu 5, DlRt 9, DhRt 6, DhRr 18 and DhRr 20) and low elevation village sites (DkRs 6, DiRu 15 and DiRu 19). Results of this preliminary analysis are in Figures 7 and 8.

Conclusions

Archaeologists working in almost any region need to consider the local to regional use of obsidian. Multiple factors need to be considered in the the interpretation of elemental and statistical plots for source discrimination, including instrument reliability, accuracy, and precision. However, these debates miss important long-term historical meanings of why people in the ancient past actually used these culturally important places. We must augment our scientific research with the research and application of Indigenous place names. Nch'kay means "dirty place" but has multiple cultural histories in terms of its use and deeper cultural meaning. It is associated with ancient great flood histories, the Thunderbird, and many other place names that link it to a broader cultural landscape.

Considering the perspective of the peoples who actually used these materials is integral to understanding nuances of their use and distribution. The names of places carry meaning, including obsidian sources' names. For those of us who find this incredible material so fascinating to analyze, and to argue and debate over, we may be losing the point of why people went to get this material in the first place.

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FROM PAEKTUSAN VOLCANO TO CAMBRIDGE: DECIPHERING THE ANCIENT TRADE ROUTES

British volcanologists were able to obtain new data on the origin of obsidian exchange in prehistoric East Asia.

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A large portion of this article previously published in *Science in Siberia* 44(2929), 7 Nov. 2013. Reprinted with permission of the author.

What could there be in common between the Paektusan Volcano (on the border of North Korea and China) and the University of Cambridge? The thing is that scientists from Cambridge in the Summer of 2013 were able to do something that was impossible for decades – they received access to the North Korean side of this huge (up to 2750 metres high) mountain massif for volcanological research.

The importance of this study lies primarily in the fact that about one thousand years ago (according to the latest study, around AD 938) there was a gigantic eruption of the Paektusan Volcano; about 100 km3 of volcanic material was ejected to the atmosphere (for comparison: during the famous eruption of the Krakatoa Volcano in 1883, the volume of ejecta is estimated to about 18–20 km3). The ash cloud rose from the volcano's crater to a height of 25 km, flew across the Sea of Japan, and finally reached the northern part of Honshu Island (Japan). The parts of Korea and Manchuria adjacent to the volcano were covered with a thick layer of ash and pumice. Of course, all life at and around Paektusan Volcano was either immediately destroyed by hot ash and gases, or died shortly after the eruption. The volcano continues to "live" today, and every visitor will find here hot springs and emissions of sulphur gases. In 2003, increased seismic activity was detected around Paektusan Volcano. By knowing about the catastrophic nature of the Paektusan eruption one thousand years ago, the governments of China and North Korea became seriously concerned about any possible volcanic event.

The need to examine the current state of Paektusan Volcano and to predict its activity led North Korean scientists contacting British colleagues in 2011, with a proposal to conduct joint research. Preparations for the expedition continued for two years, and at the last minute the whole enterprise almost collapsed because the North Koreans were not ready to sign a lease agreement for seismological equipment with the Richard Lounsbery Foundation based in the USA. The situation was rescued by the world's oldest scientific organisation, founded in 1660, The Royal Society of London (better known as "The Royal Society"), which acted as the foreign counterpart. A week-long visit of the British–US group of volcanologists to Paektusan Volcano took place in August 2013; details about this trip can be found in a review article by R. Stone "Sizing up a slumbering giant" in the journal "Science" (6 September 2013).

Work on the previously inaccessible active volcanic area is, of course, very important for the scientific community, but what does it have to do with the Siberian Branch of the Russian Academy of Sciences? The fact is that the Paektusan Volcano is also a research area of our informal Russian–US group, and I am part of it.

Figure 1. C. Oppenheimer (left) and Y. Kuzmin near the Tudor gateway of Trinity College, Cambridge.

In the summer of 2002, we examined the Chinese side of the slopes of Paektusan's caldera. The main objective was to find the source of *obsidian* – a high quality volcanic glass from which ancient humans made very sharp artefacts. By knowing where in prehsitory this highly-valued commodity was obtained, it is possible to establish exactly when and how far from the source the ancient exchange (and, perhaps, trade?) in the raw material occurred. Prehistoric people could make tools only from certain rocks, and obsidian with the sharpest fracture in nature was a kind of "black gold" for ancient humans. It is known that the distance between the source of stone and the settlements to where it was transported is often in the range of several hundred kilometres. For example, Paektusan obsidian is found at a distance of 800 km from the volcano, and this was in the Palaeolithic when there were no roads, boats, or horse-drawn transportation. Apparently, there was a great need for the ancient inhabitants of Korea, Manchuria, and Primorye [Maritime] Region of Russia for obsidian, beginning at 25,000 years ago!

When we enquired about the opportunity to visit the Chinese side of Paektusan in the early 2000s, it turned out that there is no problem to travel as individual tourists. In the course of the 2002 fieldtrip, we collected several samples (although pure obsidian was not among them). After that, we also obtained obsidian from a Palaeolithic site in South Korea, which is located relatively close to Paektusan (around 300–400 km away). After analysis of the chemical composition of these two collections, we were able to arrive at a reliable conclusion – one of the most important source stone raw material for the entire region of Northeast Asia source is located in Paektusan Volcano area. Our paper with the results of these studies was published in the "Proceedings of the Academy of Sciences" ("*Doklady Earth Sciences*") in 2005. Later on, in July 2007 there was another trip to Paektusan Volcano, this time with our South Korean colleagues, but again good quality obsidian was not found ... I have already published the report on our research in "Science in Siberia" (see the issue of 27.01.2011).

An article in the journal "Science" about the work of the British–US group at Paektusan Volcano was detected by me almost immediately after its release. I quickly decided to contact the principal "Western" participant of the expedition, Professor Clive Oppenheimer from Cambridge University, in order to learn more about the primary source – is there any obsidian on the North Korean side of Paektusan? This mineral was initially described on the Korean side of the volcano by Russian geologists, first by E.E. Anert in

1897, and afterwards by E.P. Denisov in 1958. However, for our group it is extremely important to have 'geological' reference samples of obsidian, because we already collected and analysed more than 50 artefacts but still don't have comparative source material.

Without much hope to get a response, I wrote a short email to Prof. C. Oppenheimer. My pessimistic mood was explained by the fact that a previous attempt to find out anything from the world-famous German volcanologist Hans-Ulrich Schmincke, who worked on the Korean side of Paektusan in 1993, came to nothing – I didn't get any reply. Subsequently, a Muscovite colleague–volcanologist explained it this way: "People like H.-U. Schmincke never respond to such requests ..." But C. Oppenheimer is a figure in the world of volcanology of no smaller calibre than H.-U. Schmincke; it is suffice to say that in 2006 he was given the R. Murchison's Award from the Royal Geographical Society "for publications enhancing the understanding of volcanic processes and impacts." Besides numerous articles in high-ranked scientific journals (including "Nature" and "Science") based on studies in Europe, Asia, Africa, America, and the Antarctic, C. Oppenheimer is the author of a series of textbooks and also well-received popular scientific book "Eruptions that shook the world", published by Cambridge University Press in 2011. Well, let's try one more time to get information on Paektusan ...

Sending an email message to C. Oppenheimer on 8 September (a Sunday), to which some of our articles in English about the source of Paektusan obsidian were attached, I (to my great surprise) received a very encouraging response on the same evening! The essence of it was: yes, we observed volcanic glass on the Korean side of Paektusan; I have a sample which I can give for analysis; and I am ready to meet in person in Cambridge and talk in detail about the work on Paektusan. It looked to me like as a kind of fiction: having searched for more than ten years for at least some clues, and then so easy to find them. I decided at once to go to Cambridge; before that I took a business trip to Germany (not too far from England), and I already had a British visa. We quickly agreed on the time of a visit, and I got a very friendly written letter of invitation.

There was also another reason to visit Cambridge – to meet the world-known archaeologist Professor Colin Renfrew (also known as The Lord Renfrew of Kaimsthorn), Fellow of the British Academy. Together with Japanese and American colleagues, we had just completed work on an edited volume about the geology and archeology of obsidian in Northeast Asia, which include presentations given at a symposium in Japan two years ago (see my report in "Science in Siberia", 24.11.2011: "Obsidian brings together scientists"). Prof. C. Renfrew has kindly agreed to write a short Foreword to this volume, and not just because he is a very broad-minded scholar. The fact is that in 1964 (almost 50 years ago!) archaeologist C. Renfrew and geologist Johnson Cann published a paper in the "Proceedings of the Prehistoric Society" in which they demonstrated for the first time the ability to accurately identify the sources of obsidian used for manufacture of tools by means of geochemical analysis, with the Mediterranean and the Near East as a case study. They also laid the foundation for studies of prehistoric exchange and trade. C. Renfrew created the concept of "long-distance exchange/trade": in his view, when the distance between the source of a raw material an ancient settlement where it is found is more than about 300 km, the way of raw material acquisition suggests the existence of intermediaries. Apparently, at this time - in the Neolithic - prehistoric trade originated in the Near East.

Figure 2. C. Renfrew (right) and Y. Kuzmin.

Although my visit was disturbed by the storm on St. Jude's Day, 28 October 2013 (airplanes arrived at Heathrow Airport with long delays, and all the trains from London to Cambridge were cancelled), my visit to Cambridge University was very productive. It appeared that Clive Oppenheimer is a sociable and friendly colleague, and he gave a sample of volcanic glass from the North Korean side of Paektusan for analysis. However, as it turned out this is not a pure obsidian but perlite (volcanic glass with a high water content, and because of this it lack the sharp edge which was so valuable in ancient times). Nevertheless, it is much better than the semi-mythical stories of obsidian in the volcano's caldera! During my visit, we decided to cooperate, and this happened just in time – in 2014, a group led by C. Oppenheimer is planning the second trip to North Korea, and he will be able to focus on obsidian in the crater of Paektusan. Perhaps, after that the mystery of the ancient origin of exchange and trade in the Far East will be finally solved.

Meeting with Prof. Colin Renfrew has also been effective. I handed him the manuscript of our book for his preparation of the Foreword, and noted that we decided to dedicate this "jubilee" volume (published 50 years after the date of the beginning of research) to the pioneers of the field of obsidian source studies, including C. Renfrew and J. Cann. In a personal conversation, C. Renfrew told us how this work began in the 1960s: "I and Joe [Johnson] Cann were sitting together at the Geology Department and thinking – which characteristics of obsidian can be used to determine its source? We decided to use spectrographic analysis, in order to measure the concentration of trace elements – even though they are present in volcanic glasses in very small quantities, their contents are almost unique for each source; that was what we needed." It should be noted that both researchers at that time were quite young; C. Renfrew, for example, was only 26 years old.

At the Annual Meeting of the Society for American Archeology in April 2014 a special Session, dedicated to the Golden Anniversary of the publication of the first article on obsidian source study of prehistoric tools, will be held, with the participation of 30 speakers from all over the world. But we are now thinking about a bigger international conference on various aspects (geological, archaeological, and social) of obsidian research. The idea is to hold it in 2016 somewhere in the Mediterranean; for example, on the volcanic island of Lipari near Sicily where there is also an Archaeological Museum and an obsidian source; a perfect place for such a meeting!

Observing the set of issues which are now studied using the provenance of obsidian, one can understand how universal this mineral is which half a century ago attracted the attention of British scientists! We can hope that the international scientific community will continue its in-depth study of ancient trade routes and migrations based on the identification of volcanic glass sources. My meetings in Cambridge in Autumn 2013 will assist in the clarification of when and where the ancient people obtained their "black gold."

For more information on this collaborative work and the Paektusan volcano, click the link to see an article in *The Economist* (Oct. 26, 2013).

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The site has some great resources available to the public, and our webmaster, Craig Skinner, continues to update the list of publications and must-have volumes.

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Other items on our website include:

- World obsidian source catalog
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- An obsidian bibliography
- An obsidian laboratory directory
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Thanks to Craig Skinner for maintaining the website. Please check it out!

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ABOUT THE IAOS

The International Association for Obsidian Studies (IAOS) was formed in 1989 to provide a forum for obsidian researchers throughout the world. Major interest areas include: obsidian hydration dating, obsidian and materials characterization ("sourcing"), geoarchaeological obsidian studies, obsidian and lithic technology, and the prehistoric procurement and utilization of obsidian. In addition to disseminating information about advances in obsidian research to archaeologists and other interested parties, the IAOS was also established to:

1. Develop standards for analytic procedures and ensure inter-laboratory comparability.
2. Develop standards for recording and reporting obsidian hydration and characterization results
3. Provide technical support in the form of training and workshops for those wanting to develop their expertise in the field
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