Source Identification of Obsidian Projectile Points from Kaman-Kalehöyük

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1. INTRODUCTION

The archaeological study of obsidian, especially source identification of artefacts, has been one of the most successful archaeological science approaches, providing important information on obsidian procurement in ancient times (Williams-Thorpe 1995). Several researchers including present authors, have carried out research on source identification of archaeological obsidians in the Central Anatolian region (Bigazzi *et al*. 1998; Blackman 1984; Carter *et al*. 2006; Kobayashi 2003; Kobayashi and Mochizuki 2001; Kobayashi and Mochizuki 2002; Mochizuki 1997). These studies shed light on important aspects of human activities, such as trading or interaction. However most studies have mainly addressed analyses of lithics, the so-called debitage, whereas little analysis has been done on formal tools, including arrowheads, projectile points or blades. Such valuable tools might have been treated in different a way from non-valuable goods. Hence, source identification of formal tools should also be conducted.

In this study, six projectile points excavated from Kaman-Kalehöyük were non-destructively analysed using X-Ray fluorescence analysis (XRF).

2. SAMPLES

2-1. Source materials

Source samples were collected from outcrops existing in Central and Eastern Turkey. Table 1 shows the list of obsidian sources analysed in this study. Locations of each source were reported at somewhere by present authors (ibid. 2003).

2-2. Artefacts

All projectile points were excavated from Kaman-Kalehöyük (see Fig.1 and Table 2). All artefacts were

Table 1 Obsidian sources in Central and Eastern Turkey

No		Name	Abbr.	Location name	latitude (N) ° ’	longitude (E) ° ’	SN*
1	Central Anatolia	Kömürcü (Göllü Dağı East)	KMR	Kaletepe, Kömürcü			20
2		Kayırlı	KYR	Kalebatışı, Gösterli Köyü	38° 19.42’	34° 29.07’	25
3		Nenezi Dağı	NNZ	Nenezi Dağı, Bekarlar			19
4		Tulece Tepe	TLC	Tulece Tepe, Boğazköy	38° 31.60’	34° 38.78’	20
5		Acıgöl	ACG	Göbekli, Karapınar	38° 30.87’	34° 34.40’	19
6	Eastern Anatolia	Erzincan	EZC	Boztepe, Karakaya	39° 41.161’	39° 43. 753’	7
7		Ömertepe	OMT	Ömertepe, Erzurum	39° 53.527’	41° 06. 167’	10
8		Pasinler	PSL	B dere, Pasinler	40° 04.134’	41° 37.313’	26
9		İkizdere	IKZ	İkizdere, Rize	40° 48.438’	40° 39.729’	21
10		Sarıkamış1	SRK1	Mescitli, Sarıkamış	40° 12.816’	42° 39.076’	15
11		Sarıkamış1	SRK2	Hamamlı, Sarıkamış	40° 17.999’	42° 41.699’	15
12		Meydan Dağı	MYD				22
13		Süphan Dağı	SPH	Çanakyayla,Ahlat,Bitlis			19
14		Nemrut Dağı	NMR	Nemrut Dağı,Tatvan,Bitlis	38° 36.609’	42° 16.856’	22
15		Muş	MUS	Konukbekler,Yaygın,Muş			11
16		Bingöl	BGL	Karan,Solhan,Bingöl			25

* :Sample Number

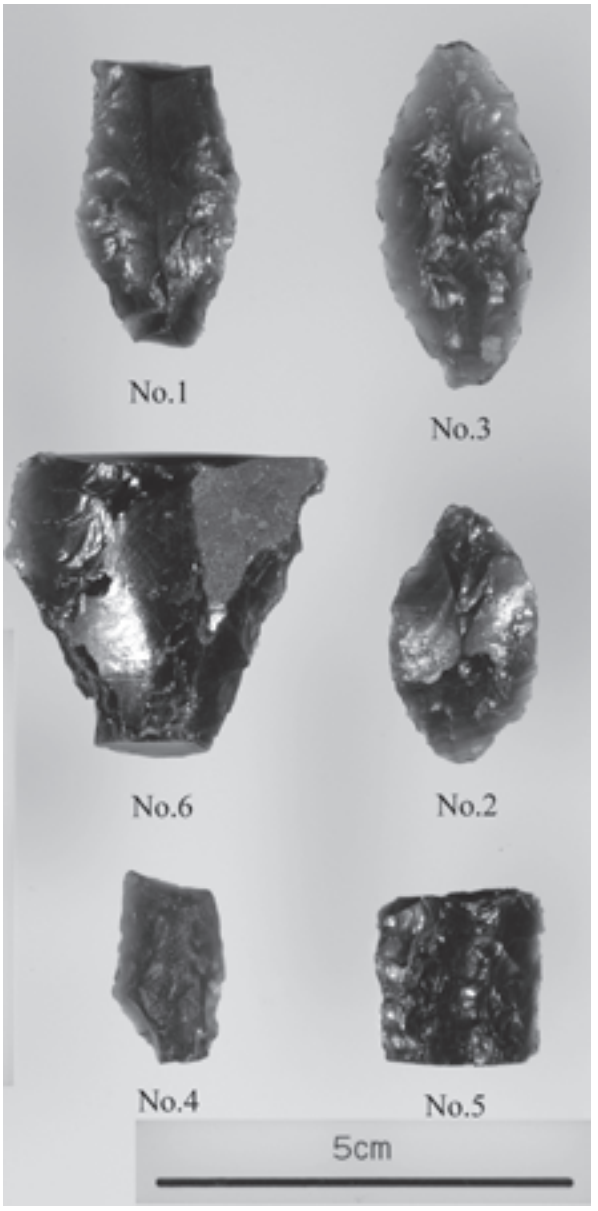

Fig.1 Obsidian projectile points found at Kaman-Kalehöyük

recovered from stratum II or III which belong to the first or second millennium BC. Although the context of each artefact was not examined in detail, these tools were probably originated from older layers because it is unlikely that this type of tool was used after the Middle Bronze Age (Rosen 1984). One of the authors has discussed projectile points excavated from this site in another paper (Kobayashi 2004), and according to that, the tools might belong to the Neolithic Age, though the oldest stratum that has been confirmed so far is the Early Bronze Age at Kaman-Kalehöyük.

3. EXPERIMENTAL PROCEDURE

All source samples were struck to create a fresh and flat surface. Artefacts were washed in water and were non-destructively analysed.

Analysis was carried out at the Japanese Institute of Anatolian Archaeology in Kaman, Turkey using an EDXRF spectrometer, SEA-2010 manufactured by Seiko Instruments Inc. with an Rh X-ray tube and Si (Li) detector. Applied voltage and current were 50 kV and 6 to 11μA. Each sample was analysed for 300 seconds in an air atmosphere. Nine elements, Mn, Ca, K, Ti, Fe, Rb, Sr, Y and Zr were identified and their XRF intensities were obtained. Quantitative data were calculated from the intensities using the fundamental parameter method with a geological standard, JG-1. For Mn, Ca, K, Ti and Fe, the concentration of each element was calculated as an oxide. Table 3 shows the result of quantitative analysis of the geological standard (JG-1).

4. CLASSIFICATION METHOD

Using by Mochizuki's method (ibid. 2003; ibid. 1997), Central and Eastern Anatolian obsidian sources can be clearly distinguished into groups. The method utilises unique indices that relate to the concentration of

Table 2 Obsidian projectile points found at Kaman-Kalehöyük

No	Year	Sector	Grid	PL [1]	Source	L [2]/mm	W [3]/mm	T[4]/mm	We [5]/g	Retouch	Shape	Section	Stem	etc
1	2004	XXXIV	XXXII-56	①	NNZ	35.46	20.28	6.08	3.9	Edge	?	Triangle	Yes	
2	2004	XXVII	XLVI-53	⑱	NNZ	31.61	18.26	7.04	2.7	Semi-bifac ial	Oval	Semi-Ova l	No	
3	2006	XXXIV	XXXIII-57	③	KMR	42.12	20.27	6.99	4.8	Semi-bifaci al	Oval	Semi-Ov al	No	
4	1997	XXX	XLVIII-51	⑲-ⓑ	TLC	22.25	13.78	6.8	2.4	Semi-bifacia l	?	Semi-Oval	No	
5	1995	XXI	XLVII-57	⑩	NNZ	20.32	21.01	8.78	4.5	Bifacial	?	Oval	No	
6	2006	XIII	XL-52		KMR	37.31	39.24	12.64	18	Edge	?	Triangle	Yes	Surface cleaning

1:Provisinal Layer 2: Length 3: Width 4:Thickness 5:Weight

Table 3. Results of XRF analysis for geological and source samples

	JG-1(N=6)		JG-1 Pref. Value		KMR (N=20)		KYR (N=25)		NNZ (N=19)		TLC (N=20)		ACG (N=19)		EZC (N=7)		OMT (N=10)	
	Mean	SD			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
MnO /%	0.06	0.00	0.06		0.05	0.00	0.05	0.00	0.05	0.00	0.04	0.00	0.06	0.00	0.04	0.00	0.06	0.00
CaO /%	2.23	0.02	2.20		0.40	0.02	0.76	0.02	0.90	0.05	0.66	0.02	0.37	0.01	0.85	0.05	0.40	0.03
K_2O /%	4.03	0.02	3.98		3.72	0.10	4.28	0.35	4.06	0.32	3.78	0.11	3.56	0.10	3.78	0.15	4.36	0.17
TiO_2 /%	0.28	0.01	0.26		0.04	0.01	0.05	0.01	0.06	0.01	0.04	0.01	0.01	0.01	0.04	0.01	0.14	0.02
Fe_2O_3 /%	2.17	0.01	2.18		0.68	0.02	0.93	0.03	1.02	0.04	0.92	0.03	0.71	0.02	1.48	0.09	2.28	0.07
Rb /ppm	188	3	182		184	6	169	5	162	5	177	6	269	9	127	4	187	14
Sr /ppm	180	3	184		9	2	65	3	87	4	53	3	0	1	97	4	2	4
Y /ppm	25	3	30.6		20	3	17	2	16	4	22	3	36	4	8	2	59	3
Zr /ppm	95	2	111		71	3	118	3	130	4	109	4	76	7	159	5	591	30
Rb%[1]	38.54		35.86		64.86		45.82		40.99		49.06		70.50		32.47		22.28	
Sr%[2]	36.96		36.25		3.01		17.57		22.14		14.65		0.13		24.82		0.18	
	PSL (N=26)		IKZ (N=21)		SRK1 (N=15)		SRK2 (N=15)		MYD (N=22)		SPH (N=19)		NMR (N=22)		MUS (N=11)		BGL (N=25)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
MnO /%	0.04	0.00	0.04	0.00	0.03	0.00	0.06	0.00	0.06	0.00	0.03	0.00	0.11	0.04	0.04	0.00	0.08	0.00
CaO /%	0.34	0.03	0.70	0.04	0.40	0.02	0.29	0.02	0.38	0.02	0.47	0.02	0.37	0.05	0.37	0.02	0.22	0.03
K_2O /%	3.95	0.20	4.18	0.21	3.70	0.15	3.67	0.12	3.67	0.15	4.01	0.12	4.41	0.23	3.63	0.12	4.13	0.12
TiO_2 /%	0.07	0.01	0.06	0.01	0.03	0.01	0.05	0.00	0.05	0.00	0.02	0.01	0.24	0.08	0.03	0.01	0.17	0.03
Fe_2O_3 /%	0.96	0.07	0.76	0.05	0.65	0.03	0.85	0.02	1.21	0.05	1.09	0.04	4.69	1.65	1.16	0.04	4.25	0.12
Rb /ppm	178	9	132	7	126	5	147	4	203	9	144	5	249	12	186	5	253	16
Sr /ppm	1	2	126	13	18	3	1	1	13	2	12	3	0	0	0	1	0	0
Y /ppm	32	4	9	4	24	3	48	4	54	4	29	4	146	18	67	5	158	10
Zr /ppm	182	24	136	7	93	6	180	7	284	7	110	11	1359	115	235	19	1408	82
Rb%[1]	45.45		32.74		48.31		39.09		36.59		48.71		14.21		37.99		13.90	
Sr%[2]	0.24		31.22		6.92		0.33		2.41		4.13		0.00		0.09		0.01	

JG-1 Pref. Value (Preferable Value) is cited from http://www.aist.go.jp/RIODB/geostand/igneous.html

Table 4 Result of XRF analysis for artefacts

No	1	2	3	4	5	6
Source	NNZ	NNZ	KMR	TLC	NNZ	KMR
MnO /%	0.05	0.05	0.05	0.05	0.05	0.05
CaO /%	0.91	0.89	0.52	1.12	0.99	0.45
K_2O /%	3.69	3.65	3.81	4.04	3.88	3.99
TiO_2 /%	0.08	0.07	0.05	0.03	0.06	0.04
Fe_2O_3 /%	1.05	1.04	0.72	1.00	1.08	0.74
Rb /ppm	164	161	185	177	161	192
Sr /ppm	83	85	8	56	88	6
Y /ppm	19	17	19	16	21	24
Zr /ppm	128	127	69	108	136	73
Mn*100/Fe	5.05	5.12	6.32	4.99	5.08	6.73
Rb%[1]	41.70	41.38	66.02	49.64	39.75	65.01
Sr%[2]	21.09	21.68	2.71	15.68	21.63	2.10

1: Rb% = Rb*100/(Rb+Sr+Y+Zr) 2: Sr% = Sr*100/(Rb+Sr+Y+Zr)

trace elements in the obsidian. Groups are delineated by plotting two indices against each other in scattergrams. The two most effective combinations of indices for discriminating the sources of tools in this study are:

Rb×100/(Rb+Sr+Y+Zr) and Mn×100/Fe
Rb×100/(Rb+Sr+Y+Zr) and Sr×100/(Rb+Sr+Y+Zr)

(where each element symbol indicates the compositional data of the element).

5. RESULTS AND DISCUSSION

Figures 2 and 3 show the results of source discrimination. All obsidian sources in Central and Eastern Turkey can be distinguished by these diagrams. Artefacts analysed in this study also can be assigned to particular sources. Three of them are identified as the Nenezi Dağı obsidian source (NNZ) and two of them are identical to the Kömürcü (Göllü Dağı East) obsidian source (KMR). Although one artefact cannot be distinguished between the Sarıkamış source (SRK1) and Tulece Tepe (TLC) in Figure 2, it is possible to differentiate these two outcrops by Figure 3, and this sample should be identified as TLC.

Though the number of artefacts is relatively small, the majority of utilised obsidian sources for projectile point production seems to be Nenezi Dağı and Göllü Dağı East sources. This tendency is congruent with results obtained from the XRF analysis of debitage from Kaman-Kalehöyük (ibid. 2002; ibid. 1997). This might mean that there is no substantial difference between material acquisition for stone tool manufacturing of formal tools and that of expedient ones. However, we may need to analyse more formal tools because some lithic industries in Central Anatolia are known to be linked with a particular source (ibid. 2006).

In addition, it is worth emphasising the regional importance of Nenezi Dağı and Göllü Dağı East sources. Not only in Kaman-Kalehöyük, but also in adjacent areas and other distant regions, such as Levant or Cyro-Mesopotamia, these two sources had been widely utilised

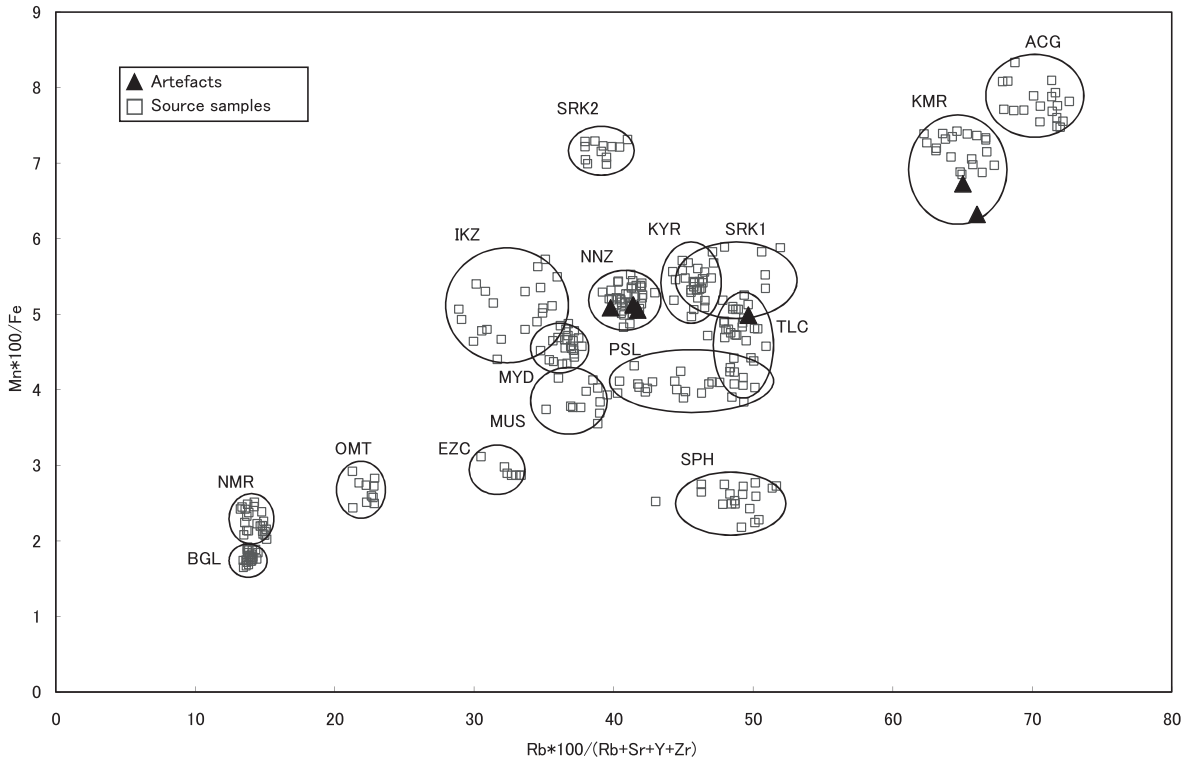

Fig.2 Result of XRF analysis (1)

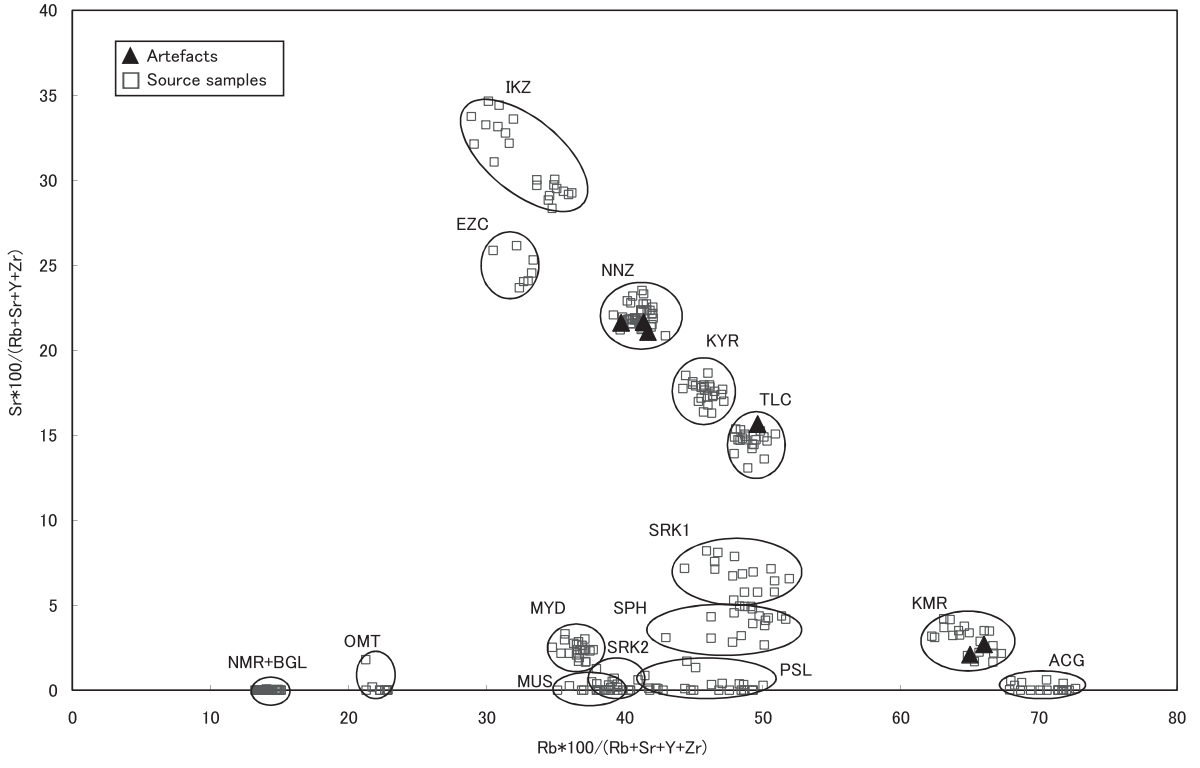

Fig.3 Result of XRF analysis (2)

sources since the Neolithic Age (ibid. 2006; Chataigner, Poidevin and Arnaud 1998; Gratuze 1999; ibid. 2001b; Maeda 2000). At both outcrops, stone tool workshops have been confirmed (Balkan-Atlı 1998; Balkan-Atlı and Aprahamian 1998; Balkan-Atlı *et al*. 2001). Existence of such a workshop should have been a driving force to distribute obsidian to wider areas.

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