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The source of obsidian artefacts found at East Chia Sabz, Western Iran

Hojjat Darabi [a], Michael D. Glascock [b,*]

[a] Department of Archaeology, Razi University, Kermanshah, Iran
[b] Research Reactor Center, University of Missouri, 1513 Research Park Drive, Columbia, MO 65211, USA

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ABSTRACT

Excavations at the site of East Chia Sabz in western Iran uncovered deposits dating from the 9th through 7th millennium BC showing evidence of obsidian use. A total of twenty obsidian artefacts was found at the site and they were analyzed by X-ray fluorescence and neutron activation analysis. The results show all of the obsidian found at East Chia Sabz came from the Nemrut Dağ source in southeastern Turkey located a distance of almost 750 km from East Chia Sabz. The results and their archaeological implications are discussed.

1. Introduction

The site of East Chia Sabz is a settlement in western Iran containing deposits from the Transitional Neolithic period (ca. 9500–8000 BC). The site was discovered during an archaeological survey inside the reservoir of Seimareh dam in 2007 (Brojeni, 2007) and excavated by an Iranian team under the leadership of H. Darabi in 2009. Evidence shows that East Chia Sabz was occupied from the early 9th–early 7th millennium BC (Darabi et al., 2011). The first season of salvage excavation resulted in identification of seven phases indicating cultural changes through time, mostly attested by lithic industry. Table 1 lists the proportions of chipped stone recovered from the stratigraphic levels of trench #2 (the only trench with complete information) for all seven phases. As the result of analysis of lithic artefacts, a change from flake to blade-bladelet production was observed. The change is accompanied by a transition from use of local chert to flint and then to small amount of obsidian. The latter, thus, was only used in the late (I–III) phases. Twenty obsidian samples from all excavated trenches at East Chia Sabz were submitted to the Archaeometry Lab at the University of Missouri Research Reactor (MURR) for chemical analyses. Analysis of the artefacts by X-ray fluorescence (XRF) indicated that all were chemically similar. However, because the two possible sources – Bingöl A and Nemrut Dağ – have similar chemical fingerprints that are difficult to separate by XRF [although see Orange et al., in press], it was necessary to further analyze the samples by neutron activation analysis (NAA) which gives a more definite result. This article presents the chemical results and discusses them archaeologically.

2. Background

Since the early 1960s, considerable research has been devoted to locating Anatolian obsidian sources and determining chemical fingerprints for them (Rapp and Hill, 1998: 137). Early research was undertaken by Renfrew (1969) who attributed the Anatolian sources for obsidian tools found at Ali Kosh to southeastern Turkey. Subsequently, other researchers using a variety of chemical analytical methods have identified more than 30 possible obsidian sources in Armenia, Azerbaijan, Georgia, and eastern Turkey (Blackman, 1984; Chataigner et al., 1998; Gratuze et al., 1993; Keller et al., 1996; Poupeau et al., 2010). For most of the obsidian sources in this region, the chemical differences between sources are so obvious that artefacts can be easily assigned to their proper sources.

On the other hand, two varieties of obsidian have been identified at Bingöl known as Bingöl A (peralkaline) and Bingöl B (calcalkaline), and at least six different types of peralkaline obsidian have been discovered at Nemrut Dağ. The peralkaline obsidians from Bingöl A and Nemrut Dağ are a distinctive green color and are unlike the obsidian from any other sources in the region. Although

* Corresponding author. Tel.: +1 573 882 5270.
E-mail address: glascockm@missouri.edu (M.D. Glascock).

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Table 1
The proportions of chipped stone recovered from stratigraphic levels of trench #2 at East Chia Sabz.

Phase	Chert	Flint	Obsidian*	Dolomite	Quartzite	Total
1	22	26	4	1	0	53
2	36	62	7	3	0	108
3	107	153	3	0	1	264
4	15	19	0	0	0	34
5	3	3	0	0	0	6
6	17	12	0	0	0	29
7	21	15	0	0	0	36
Total	221	290	14	4	1	530

Note that the only trench for which the proportions of chipped stone are available for all of the phases is trench #2. The 20 obsidian artefacts analyzed in this study came from all trenches at the excavation, were not limited to those from trench #2.

the two source areas are more than 120 km apart as shown in Fig. 1, differentiating between the peralkaline obsidians from Bingöl and Nemrut Dağ has been challenging. Various schemes for separating the sources have been proposed (Chataigner, 1994; Pernicka, 1992; Poidevin, 1998). But, none of the schemes are completely satisfactory. Recently, Frahm (2012) demonstrated that these sources could be successfully differentiated by Electron Microprobe (EMPA) measurements of Al_2O_3, FeO, TiO_2, and Zr; and Orange et al. (in press) used a combination of XRF and SEM-EDS to identify differences between the sources. A study by Coleman (2010) and continued work by M.D. Glascock have demonstrated that high-precision measurements of the trace elements Br, Cs, and Mn by neutron activation analysis (NAA) can be used to differentiate between the sources with more certainty than the other analytical methods employed, thus far.

3. Analytical procedures

The samples were analyzed initially by energy-dispersive XRF with a Bruker III–V+ portable spectrometer at MURR. The spectrometer is equipped with an air-cooled rhodium anode with 140 micron Be window and a thermoelectrically cooled Si–PIN diode detector. The detector has a resolution of 180 eV for the 5.9 keV peak from iron. Beam dimensions are approximately 2×3 mm. The X-ray tube was operated at 40 kV using a tube current of about 17 μA and produced a count rate of about 1200 counts per second. Measurement times were 180 s per sample. Instrument calibration was established using data obtained from a series of well-characterized source samples previously analyzed by NAA, XRF, and ICP-MS at MURR (Glascock and Ferguson, 2012). The best measured elements in obsidian by XRF are Rb, Sr, Y, Zr, and Nb.

Because the results from XRF identified the artefacts as having a composition similar to both Bingöl A and Nemrut Dağ, the artefacts were also analyzed by NAA (Glascock et al., 1998) which offers greater precision and accuracy than XRF. Although NAA measurements can determine up to 30 elements, the most useful elements in this study were found to be Br, Cs, and Mn. Information for the additional elements measured by NAA in the sources and artefacts in this study will be presented in a more detailed article being prepared by M.D. Glascock describing the procedures used on obsidian from the Anatolian sources and the artifacts from multiple sites in western Iran.

4. Results

The compositional data for Fe, Rb, Sr, Y, Zr, and Nb measured in the artefacts by XRF are listed in Table 2. Table 3 presents the means

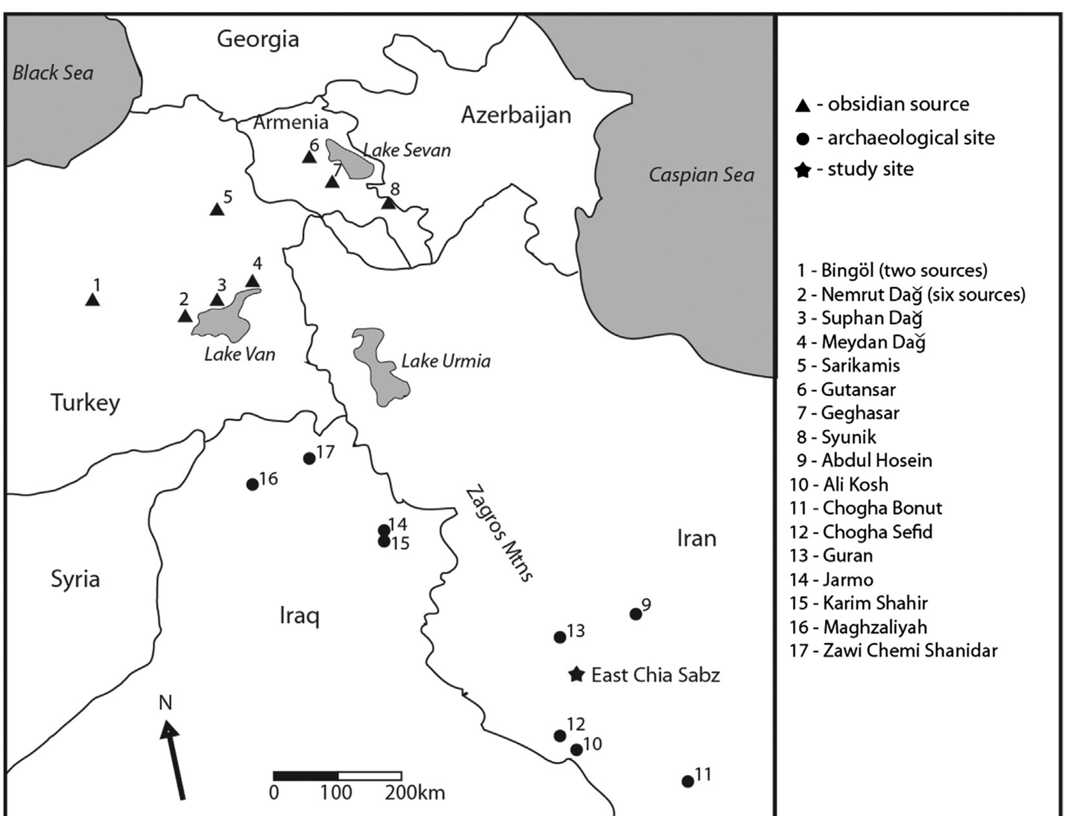

Fig. 1. Map showing locations of major obsidian sources, East Chia Sabz, and other archaeological sites in the Zagros region. Several of the less important obsidian sources are not shown to reduce clutter.