Journal of Archaeological Science: Reports 16 (2017) 248–257

Contents lists available at ScienceDirect

Journal of Archaeological Science: Reports

journal homepage: www.elsevier.com/locate/jasrep

Bronze Age Caucasian metalwork: Alloy choice and combination

Marianne Mödlinger[a,*], Benjamin Sabatini[b]

[a] IRAMAT-CRP2A - UMR 5060 CNRS, Université Bordeaux Montaigne, Maison de l'archéologie, Esplanade des Antilles, 33607 Pessac, France
[b] Department of Materials Science & Engineering, Massachusetts Institute of Technology, 13-5065, 77 Massachusetts Avenue, Cambridge, MA 02139-4307, USA

ARTICLE INFO

Keywords:
Bronze Age
Greater Caucasus
Metallurgy
Daggers
Lead isotope analyses
Chemical composition

ABSTRACT

The chemical composition and microstructure of eleven Bronze Age Caucasian daggers from North Ossetia-Alana, Russia were studied in order to establish a baseline for metallurgy and alloy production in the region. They have been housed in the Natural History Museum, Vienna since the 1880's. The assemblage comprises arsenical bronzes characterized by high concentrations of arsenic (2–10 wt%), tin bronzes with high tin (10–17 wt%), and several ternary Cu-As-Sn dagger blades. The chemical composition of the dagger blades was analysed with EDXS and XRF. Furthermore, metallographic analyses and lead isotope analyses were carried out. Two of the arsenical bronze blades showed extreme γ-phase segregation along their surfaces and grain boundaries. Two tin-bronze dagger blades, containing high amounts of eutectoid, prevented the measurements of the hardness of the eutectoid. One dagger combined a tin bronze blade and arsenical bronze hilt. Lead isotope analyses of selected daggers indicate a close relation to copper ore sources in the Greater Caucasus and Armenia.

1. Introduction

The aim of this study is to document the microstructure, chemical composition, and lead isotopic signatures of several copper-based daggers from North Ossetia Alana, Russia. These artefacts are listed as having belonged to the Koban culture (phase I) by the Stuttgart-based *Studien zu den Anfängen der Metallurgie* (SAM) project (Junghans et al. 1968–1974; Krause, 2003), but have no other extant information. Until now, no detailed characterisation of metal objects from the eponymous find spot of Koban has been produced. Those chosen for study were reported by the SAM project as having high As content, ranging between 2 and 5 wt% As.

Presented at the 5th *Allrussian Congress of Archaeology*, September 8–11, 1881 in Tbilisi, Georgia, these daggers and other bronzes from Koban (Fig. 1) were sold to the *Naturhistorisches Hofmuseum* in Vienna, and other museums, including the Berlin museum and MAN in St. Germain-en-Laye. The daggers studied originated from the Natural History Museum, Vienna, Austria, where they have been housed since the late 19th century, having been purchased by F. Heger, the director of the anthropological and ethnographic department between 1881 and 1893 (Fig. 2).

Although purchased, the daggers are known to have been plundered by landowner C. D. Kanukov beginning in 1869 from the Verchni Koban and Chmi cemeteries, both located in the Republic of North Ossetia-Alania, Russia. Of the more than 1000 graves (see Heinrich 2006/7, 126), most of the metal artefacts were sold to various museums throughout Europe devoid of context and detailed description. The grave goods associated with the daggers, and gender of the interred, are, however, listed in Table 1 as they appeared on the parcel listing that accompanied the daggers to the museum. Record of the parcel listing comes from the museum inventory book.

As a result of their uncertain procurement, much archaeological evidence of the grave sites has been lost, however, several excavations were undertaken by G. D. Filimonov in 1869, V. B. Antonovič in 1871, E. Chantre in 1881, and F. Heger himself during his last visit to the site in 1891. Artefacts sent to the Natural History Museum, Vienna, including those studied in this work, arrived in several parcels between 1883 and 1888 with the following information (after Heinrich 2006/7, 139):

1) Parcel XVIII, 1883: prehistoric finds from Koban and Chmi, 'excavated' by C. D. Kanukov; the acquisition of the finds was paid by the consul general of Peru, L. Schiffmann (inv.no.s 41.226–41.441).
2) Parcel XIX, 1883: prehistoric finds from Koban and Chmi, 'excavated' by C. D. Kanukov; the acquisition of the finds was paid by the consul general of Peru, L. Schiffmann (inv.no.s 41.442–42.154).
3) Parcel I, 1884: prehistoric finds from Koban (inv.no.s 42.155–42.361).
4) Parcel VI, 1884: prehistoric finds from Koban (inv.no.s 42.362–42.465).
5) Parcel XVIII, 1884: finds from Chmi, excavated by I. Dolbežev in Wladikawkas in 1883. The content of seven graves is a donation

* *Corresponding author.
E-mail addresses: marianne.modlinger@u-bordeaux-montaigne.fr (M. Mödlinger), bsabatin@mit.edu (B. Sabatini).

http://dx.doi.org/10.1016/j.jasrep.2017.10.018
Received 21 March 2017; Received in revised form 21 September 2017; Accepted 7 October 2017

Fig. 1. – Verchni Koban and Chmi cemeteries located in the Republic of North Ossetia-Alania, Russia.

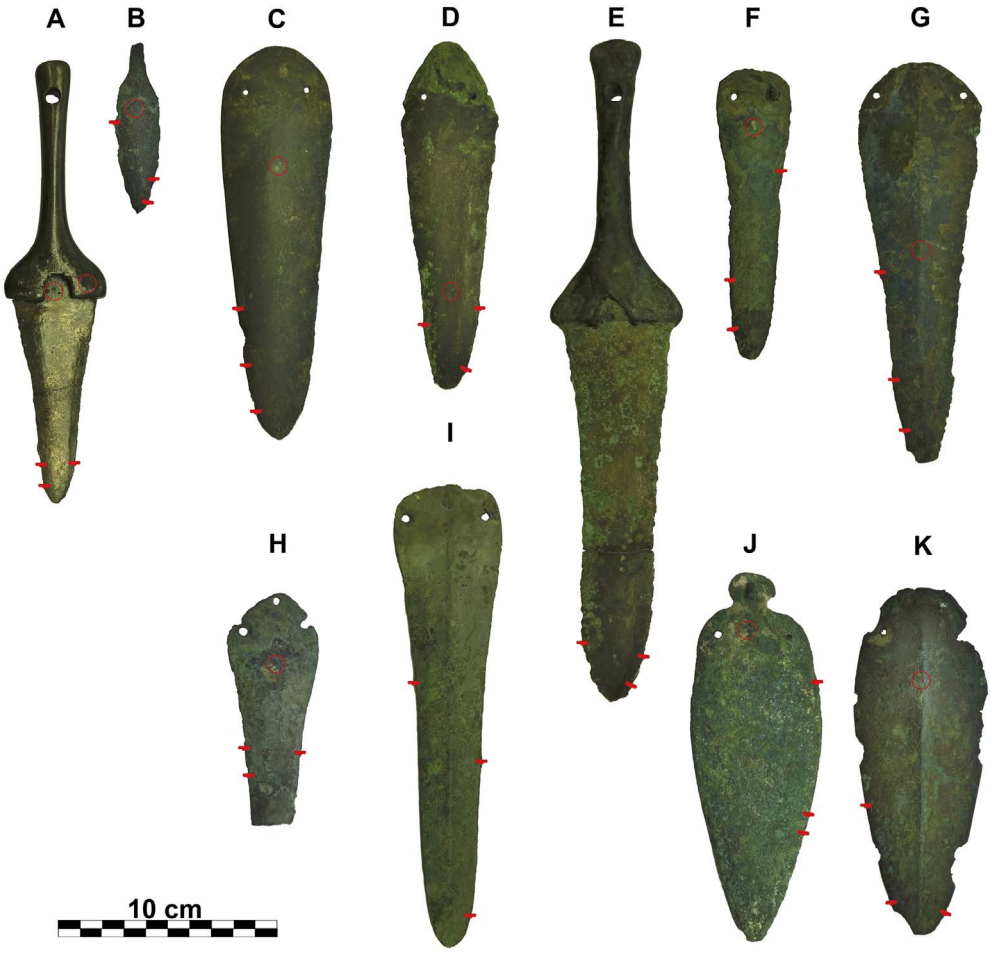

Fig. 2. – Studied Bronze Age daggers. Daggers A – I likely originated from the Koban cemetery, and J and K from Chmi. Samples were taken from the locations indicated with an arrow. The OES analyses from the SAM database are indicated by circles. However, the sampling location of the OES analyses could not be identified on daggers E and I. The samples taken from the blade of dagger J for OES analyses were not published in the SAM database.

from the *Anthropologische Gesellschaft* (F. Zwicklitz) (inv.no.s 42.466–42.553).

6) Parcel I, 1888: old finds from the Caucasus, which were bought from S. Kulov in Wladikawkas, February 1888 (inv.no.s 42.554–42.637).

Despite their insecure find associations, the daggers can be approximately dated. Dagger B is dated to the Early Bronze Age, while dagger J is associated with the Meskhetian Culture of southwestern Georgia. Dagger J and K are dated to the beginning of the Late Bronze