# METEORITIC ORIGIN OF A DAGGER AMONG THE IRON OBJECTS OF TUTANCHAMUN

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**Introduction:** Meteoritic iron is of great interest in the archeological context [e.g., 1]. The production of iron metal from ore only started in the middle of the second millennium BC, but a number of earlier iron artefacts are known to exist. These probably are made from accidental by-products of copper smelting, or may represent meteoritic iron, or be younger iron intruded into older archaeological contexts [2]. Recent studies revealed a meteoritic origin of beads excavated from grave pits at the prehistoric Gerzeh cemetery (near Cairo), dating to 3300 BC [3, 4]. For archeological samples it is often difficult to obtain the necessary analyses, as most analyses in such a context need to be non-destructive (see, e.g., Brandstätter et al., this meeting). Since 1922, the year Howard Carter discovered the tomb of King Tutanchamun (18th Dynasty), this unique archaeological complex was the topic of numerous publications of egyptologists and other scholars. Although some material identifications were already noted or have been suggested in the excavation and restoration reports by H. Carter and A. Lucas [5], only few scientific analyses were performed on these objects since that time. Among the iron objects from the tomb of Tutanchamun, only a dagger (Carter No. 226) is widely known and has previously been suggested to be of meteoritic origin [see discussion in 1,2, 6]. So far, only two studies are known to the authors that published analytical results of the blade. The first study gives a value of 2.8 wt% Ni and concludes that the blade is not made from meteorite iron [7]. This study is not well documented and no analytical details are presented. A second study that is just in press found 10.8 wt% Ni and 0.58 wt% of Co [8]. The latter study concludes the blade is made from meteorite iron.

**Methods and material:** All analyses were done in 2014 and 2016 at the Egyptian Museum, Cairo, using a Tracer IV-SD handheld x-ray fluorescence XRF device (Bruker). Repeated spectral measurements were taken at six different spots on the dagger blade. Measurement conditions were identical in all cases (40 kV, 10 μA, 300 s counting time, spot size of 4 mm in diameter). For quantitative analyses calibration curves for major and minor elements, Fe, Ni, Co, and Cr, were determined using well characterized iron meteorites (analyzed separately by electron microprobe and energy dispersive spectrometry and by XRF), mostly hexaedrites and ataxites (Boguslavka, Braunau, Calico Rock, Chinga, Hoba, Lombard, Prambanan, Tlacotepec, Santa Clara, and Skookum). In addition, a qualitative analysis of some trace element contents (such as Ge) was done by evaluating the spectra.

**Results:** *XRF:* The blade composition appears to be homogenuous on a cm scale. The dagger has a mean composition of Ni content of 12.8 +/- 0.1 wt%, and a Co content of 0.58 +/- 0.02 wt% and 0.03 +/- 0.01 wt% of Cr. A Ge peak was not detectable in the spectra. *Microstructure:* Due to curatorial restrictions, no preparation was allowed to see if the material shows any microstructure that could possibly be linked to meteorites.

**Conclusion:** Our results show that the blade of the dagger is made from meteoritic iron. The high concentrations of Ni and Co fall in the compositional fields of IAB-IIICD or IIF irons as well as some ungrouped irons [9, 10]. However, none of the these groups has similarly high Cr. The unknown way of production may have altered the bulk composition. Our results clearly confirm the meteoritic origin of the famous King Tut dagger. Differences between our data and previously published data exist and may at least in the case of the recent data [8] be explained by differences in the calibration, but this will be subject of further investigations.

**Acknowledgments:** We are grateful to the Egyptian ministry of antiquities for the authorisation to work and publish on the material from the Egyptian Museum in Cairo.

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