INTRODUCTION

A large limestone relief fragment depicting the over life-size head of Amenhotep I (c. 1525-1504 B.C.E.) was acquired by the Metropolitan Museum of Art (MMA) in 1945. Although subsequent doubts about the relief’s authenticity led to its removal from the galleries, it has been recently proposed that this fragment belongs to a monument built by Amenhotep I at Karnak [1]. In an effort to confirm this proposed context, the relief was brought to the Sherman Fairchild Center for Objects Conservation in September 2009 for technical examination and analysis.

One aspect of this study included the investigation of the unusual gray and pinkish-gray spots observed on much of the carved surface of the relief; many of these spots are also associated with dendritic black spots similar in appearance to manganese dioxide accretions, as described by O’Grady [2]. Similar gray and black spots were observed on the surface of two other relief fragments purported to be from the same monument; one in the Museum of the Rhode Island School of Design (RISD) and the other in the open air magazine at Karnak Temple. Although the presence of these unusual spots on all three reliefs seemed to suggest a single context, analysis was carried out on the spots on the MMA relief in order to determine whether or not they were the result of natural or artificial patination. It was hoped that this characterization of these spots, in combination with other technical and art historical evidence, might provide clues about the origin and history of the MMA relief.

METHODOLOGY

1) Areas of the surface exhibiting gray (A), pinkish-gray (B) and black spots (C) were analyzed with X-Ray Fluorescence Spectroscopy (XRF) using a Bruker Axiatar XRF Spectrometer.
2) Surface scrappings from A, B and C were analyzed with Fourier Transform Infrared Spectroscopy (FTIR) and Raman Microscopy. Preparation and analysis of scrappings were carried out by Adriana Rizzo and Jane Woo in the Department of Scientific Research.
3) The surface of the relief was examined under long-wave UV radiation.
4) A flake was sampled from the surface where the gray spots are present, embedded in epoxy resin and dry polished as a cross section for Scanning Electron Microscopy and Energy Dispersive Spectroscopy (SEM/EDS). Preparation and analysis of the sample was carried out by Federico Carò in the Department of Scientific Research.

PREVIOUS ANALYSIS: STONE IDENTIFICATION

In 1997, a sample of the stone from the MMA relief was sent to the Faculté Polytechnique de Mons, Belgium for thin section analysis. The sample was identified as limestone quarried at El-Banat in the region of Gebelein, on the East Bank of the Nile; stone from this quarry has been described as fine-grained, fossiliferous dolomitic limestone [3]. Limestone from the Gebelein region was widely used in the first half of the 18th Dynasty to construct monuments at Karnak [5].

CONCLUSIONS

No evidence of a discrete deposition layer or patina was observed on the surface of the sample so it is unlikely that the intimately integrated gypsum crystals are the result of artificial patination. The microcrystalline gypsum visible in the pores of the cross-section is likely inherent to the stone itself and has leached to the surface over time; the Thebes Formation (to which Gebelein limestone belongs) has been found to have particularly high salinity within the sample area. The gray and pinkish-gray spots on the surface of the MMA relief, however, do not appear to be the result of this outward migration of gypsum. Rather, they were likely produced by the selective dissolution of the gypsum and calcite components, possibly by biological activity, although no evidence for biological colonization was observed. It is suspected that many of the relief fragments at Karnak were partially submerged in standing water during the annual flooding of the Nile [8], possibly creating a favorable environment for the growth of microorganisms. The color of the spots might be imparted either by the presence of less soluble material left behind, or by new material deposited in the surface cavities. The relatively high manganese content of the black spots, in addition to their observed dendritic morphology, make it likely that these spots are manganese dioxide accretions as described by O’Grady [2].

Discussion of Results

SEM/EDS confirms that the sample is a fine-grained, fossiliferous limestone. Back-Scattered Electron imaging of the cross-section (Figure 1) shows a gradual decrease in the porosity of the stone toward the surface of the sample caused by an increasing abundance of microcrystalline gypsum, at least 100 µm beneath the surface. Distribution of calcium sulphate is shown in the X-ray map in Figure 2, while Figure 3 shows a detail of the intimate growth of sulphate and calcite close to the surface. However, the areas of the sample actually containing the grey spots (indicated by the red box in Figure 3) are characterised by the selective dissolution of carbonate and sulfates up to a depth of 10 µm.

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REFERENCES


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