

MONITORING OF CORROSION IN FAIRY CHIMNEY BY CLOSE RANGE PHOTOGRAMMETRY

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ABSTRACT:

A Fairy Chimney is a conical rock formation and typically found in the Cappadocia region of Turkey. It consists of a cap of hard rock resting on a cone-shaped pinnacle of softer rock. The geology of areas where Fairy Chimneys form typically comprises a thick layer of tuff (consolidated volcanic ash), covered by a thin layer of basalt or other volcanic rocks that are more resistant to erosion than the underlying tuff. Over time, cracks in the basalt allow the much softer tuff to be eroded and washed away. Fairy Chimneys are formed where a small cap or boulder of the original basalt remains, and protects a cone of tuff beneath it from erosion. Eventually, the tuff will be undercut to the extent that the cap falls off, and the remaining cone is then quickly eroded. In this study, corrosion on the surface of fairy chimney, which is located in Selime district of Aksaray in Turkey, has been examined by digital close range photogrammetry. The fairy chimney has been evaluated by photogrammetric in two period. Its three dimensional (3D) model has been obtained. Its volume has been calculated from known heights. Corrosion in Fairy Chimney has been investigated.

1. INTRODUCTION

Cappadocia is a magical and breathtaking region with its unique mix of natural geography, Anatolian history and vibrant traditional Turkish culture. The rocky fairy chimneys attest to ancient volcanic eruptions and the ravages of sun, frost, wind, and rain; the history embodies the consequences of its unique Central Anatolian situation which offered both protection from and vulnerability to the various armies that swept across the region; but more importantly, the living culture encapsulates a tolerance of religious and cultural differences which is deeply rooted in a past where Muslims, Christians and Jews lived alongside each other in harmony for centuries.

The Cappadocian tuff contains unique erosion features, the so-called fairy chimneys, some of which in the past were dwelled in and contain valuable wall paintings. These historical heritages, however, are undergoing chemical and physical deterioration due to atmospheric effects. For the conservation studies, understanding of the deterioration phenomenon of the tuff is essential (Topal, 1998)

The corrosion of the tuff structure of the valley by the waters of the floods and winds had formed strange and interesting formations named 'peribacasi'. As the floodwaters find their way through the steep slopes, the hard rocks cracked and break off. As the easily abrading material found at the lower parts of the valley was carved deeply the slope was moved backwards, therefore forming a hat like formation on the top and a conical shaped body part preserved without corroding. The peribacalari with hat like formations are mostly encountered at the vicinity of Urgup district and are with conical bodies carrying a block of rock at the top section. The body is a variety of rock composed of tuff, tuffite and

volcanic ash; and the hat like formation is formed from hard rocks like lahar and ignimbrite. Namely, the rock type forming the hat like formation is more resistant than the rock type forming the body part. This is the first condition for the formation of a peribacasi. According to the resistance of the rock at the hat like formation, the life span of the peribacalari varies between long or short periods. (URL-1; URL-3; URL-4).

In this study, corrosion on the Fairy Chimney in Selime has been investigated by close range photogrammetry.

2. STUDY AREA

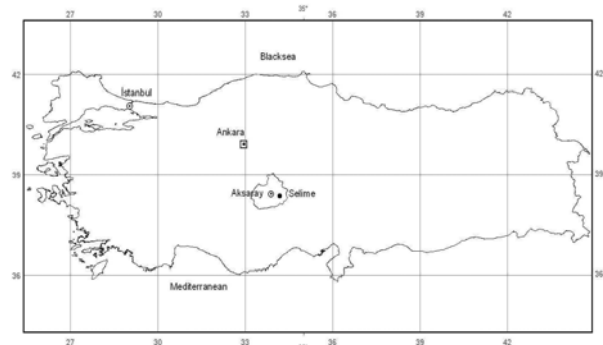


Figure 1, Location of Selime Town in Turkey

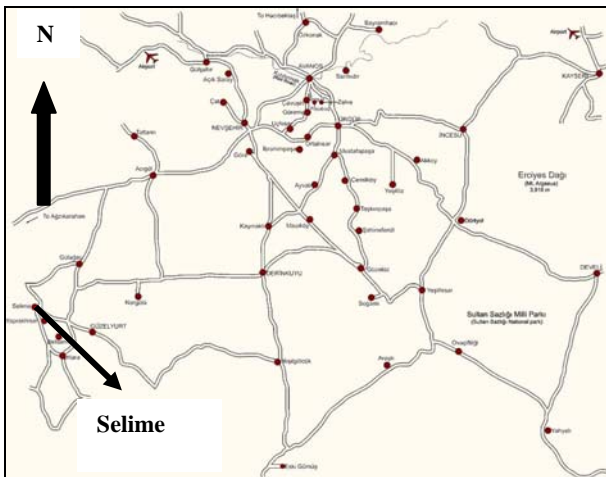


Figure 2, Cappadocia Region



Figure 3, A Fairy Chimney in Selime

The study area is inside of Selime Town in cappadocia region. (Figure 1). This town is west entrance door of cappadocia region (Figure 2), (URL-2). There are fairy chimneys and Selime Cathedral in this town. For this study, it was selected a fairy chimney which is located on the east direction of this town (Figure 3).

The fairy chimney has approximately 9 m. heights, 4.5 m. diameter and a hat. The east and north sides of fairy chimney is covered with bigger fairy chimneys. On the other hand, the south and west sides of fairy chimney is open.

3. METHODOLOGY

Close range photogrammetry was used in this study. A local net was constituted around the fairy chimney. Sheet remark plates were settled on the fairy chimney. These plates were used as control points in photogrammetric evaluation. The coordinates of control points were measured by geodetic total station instrument. RMSEs in control points are 9 mm, 8 mm and 7 mm in X,Y and Z axes respectively. The fairy chimney was evaluated by photogrammetric method in February 2007. 3386 points on the fairy chimney were measured by photogrammetric

method. 3 dimensional model of fairy chimney was obtained by means of these points (Figure 4).



Figure 4, 3D model of Fair Chimney at February 2007



Figure 5, 3D model of Fair Chimney at February 2008

The fairy chimney was re-evaluated by photogrammetric method within the same coordinate system in February 2008. 3406 points on the fairy chimney were measured by photogrammetric method. 3 dimensional model of fairy chimney was obtained by means of these points (Figure 5).

Canon ixus zoom 7.1 MP digital camera was used for take pictures of fairy chimney. Photomodeler 5.0 photogrammetric software was used for photogrammetric evaluation. 3D models of fairy chimney and volume computing were accomplished in Surfer 8.0 software.

Corrosion on fairy chimney was calculated from difference of volume in certain cross sections. Hat of fairy chimney could not be well modelling by reason of the fact that volume computing were done on the without hat models of fairy chimney (Figure 6).

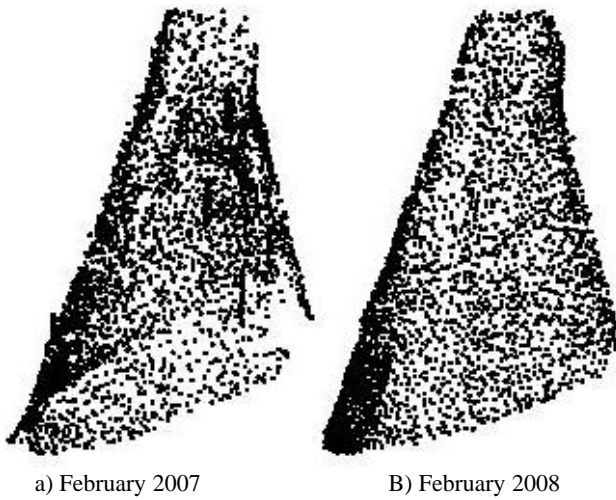


Figure 6, Fair Chimney without hat

9 natural points were selected on the fairy chimney. Differences between coordinates of these points in both periods were calculated as $\Delta x=12$ mm, $\Delta y=11$ mm and $\Delta z=10$ mm. Geometrical structure of fairy chimney, which has no hat, was assumed as frustum cone. If dimensions of frustum of cone have changed approximately 1 cm, volume of frustum of cone has changed as well as 0.369815 m³.

Volumes of fairy chimney were calculated from two different references in both periods. These volumes are seen in Table 1.

Reference Height (m)	Volumes (m ³)		Difference (m ³)
	February 2007	February 2008	
105	9.4143	9.8303	0.4120
107	1.3624	1.7407	0.3783

Table 1, Corrosion amount in Fairy Chimney
When it take into account of changes in volume of frustum of cone, differences of volume in Table 1 are shown that no corrosion on the fairy chimney.

4. CONCLUSIONS

The geology of areas where fairy chimneys form typically comprises a thick layer of tuff (consolidated volcanic ash), covered by a thin layer of basalt or other volcanic rocks that are more resistant to erosion than the underlying tuff. Over time, cracks in the basalt allow the much softer tuff to be eroded and washed away. Fairy chimneys are important in terms of historical and touristy. In this study, corrosion on fairy chimney which is located in cappadocia region of Turkey was investigated. Fairy chimney was evaluated by close range photogrammetry in two different periods. 3D models of fairy chimney were obtained. Volumes of fairy chimney were calculated from the same references surfaces. Volumes were compared. Finally, it is seen that no corrosion on the fairy chimney.

ACKNOWLEDGEMENT

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