# DIGITIZING AND DOCUMENTING HERITAGE FOR CONSERVATION, A CASE STUDY: CHIRIBIQUETE NATIONAL PARK ARCHAEOLOGICAL SITE

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**ABSTRACT:**

This paper presents the documentation carried out by the Carleton Immersive Media Studio (CIMS) in collaboration with the Colombian Institute of Anthropology and History (ICANH) to support the conservation of the archaeological pictographs in the UNESCO World Heritage Site of Chiribiquete National Park, Colombia; listed in 2018. This project entitled Preserving the past: preventive conservation on World Heritage Site Chiribiquete National Park and its buffer zone (Colombia) is funded by the U.S. Ambassadors Fund for Cultural Preservation (AFCP) and managed by the Fundación Erigaie. The dense rainforest landscape includes a mountain range with Tepuis inscribed with Paleoindian pictographs, painted and layered over time. The area was the site of the Colombian armed conflict that ended in 2016 and now remains remote and highly inaccessible. High-resolution 3D dense clouds and meshes of the painted Tepuis were created to record the pictographs with a high level of detail. This method of non-destructive investigation results in minimal impact on the biological environment of the site and on the uncontacted Indigenous communities who continue to inhabit the area, and the results will enable further remote investigation of the pictographs. Such tools demonstrated effectiveness while communicating the mass, scale of the site, colour, and texture of the pictographs at a high level of detail. The non-invasive nature of the immersive documentation is a powerful tool in the ongoing conservation and management of the site by mitigating the impact of tourism, by providing a remote method of sharing and experiencing the archaeological site.

## 1. INTRODUCTION

Sites with heritage value are constantly subject to change due to environmental and anthropogenic factors such as changing climatic conditions, deterioration of materials, lack of maintenance, poor conservation practices, tourism, and natural disasters. The ongoing influence of these factors on heritage sites triggers the need to document their current state for posterity. In order to document the site, digital tools are used, including aerial and terrestrial photogrammetry and traditional surveying tools including a Total Station. The gathered data is processed to develop digital records of the site at a high level of detail, which communicate the site's scale, massing, experience, and history.

Documentation starts as a preliminary measure for heritage conservation, mainly because it is necessary to record the current state and subsequently generate conservation strategies. This global process that mixes the documentation and safeguarding of heritage is supported by UNESCO (United Nations Educational, Scientific and Cultural Organization)'s World Heritage Convention (1972), which supports the protection of the world's heritage, first declaring it as such and then making it part of a suitable program for its preservation.

This paper summarizes the documentation of archaeological sites in Chiribiquete National Park "The Maloca of the Jaguar" (UNESCO, 2018), the first site declared mixed heritage in Colombia, which is under the category because of its natural and cultural significance. The documentation was conducted by a team of emerging and senior professionals from the Colombian Institute of Anthropology and History (ICANH) and the Carleton Immersive Media Studio (CIMS).

Moreover, this contribution covers the implementation work of Phase 1 of a two-phase project entitled Preserving the past: preventive conservation on World Heritage Site Chiribiquete National Park and its buffer zone (Colombia). The project is funded by the U.S. Ambassadors Fund for Cultural Preservation (AFCP) and administered by the Fundación Erigaie. Phase 1 of this project focus on the documentation of sites located in the buffer zone of Chiribiquete as a pilot case study to develop protocols to document rock art shelters located within the boundaries of the site in Phase 2.

The project objective is to document and digitize the pre-historic pictographs found on this site, prior to impacts from the ongoing threats of invasive tourism, deforestation, and fires. These pictographs represent a cultural legacy in an archaeological category, which reflects the idiosyncrasies of Chiribiquete, emphasizing their need to be digitized for their analysis, understanding, and preservation.

## 2. CHIRIBIQUETE NATIONAL NATURAL PARK

Chiribiquete is a protected natural zone located in the Amazon region of Colombia, specifically in the departments of Caquetá and Guaviare. Within its biodiversity exist rocky plateaus, tepuis, high-density jungles, waterfalls, rivers, deep canyons, endemic species, and endangered species. More than 700 species of fauna and 3000 species of plants coexist in the area, which inhabits

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surprising geography, for which the place classifies as one of the richest regions of biodiversity in the world (Carrillo and Castro, 2009).

The Chiribiquete National Natural Park had two expansions throughout its history. The first was in 1989, with the addition of 1.3 million hectares, and the second in 2013, in which it was extended into a park with 1.5 million hectares, making it one of the largest in the world with 4.3 million declared hectares. The Chiribiquete mountain range is a testimony of the history of Paleoindian groups, who created pictographs in rocky shelters that were places of worship or temporary refuge (Melo, 2017); as a result, there are approximately 75,000 rock paintings in the area.

According to history, the area's populations were Indigenous peoples and colonial settlers. The first legal measures for its conservation occurred in 1959 with the second forest reserve law and the declaration of protected areas. During this period, the guerrilla of the revolutionary armed forces of Colombia FARC formed, generating an armed conflict of more than 50 years and appropriating the area. That conflict ceased in 2016 with the signing of a peace agreement, and as a consequence, later in 2018, the Chiribiquete mountain range was opened to the public (ICANH et al., 2021); and on June 23 of that same year, it was also declared a site of natural and cultural heritage of humanity (UNESCO, 2018).

The rock art (Figure 1.) makes this park an area with high cultural value through its materials, colours, and shapes demonstrating characteristic elements of antiquity. The surface used to paint was the rock, which for ancient cultures was sacred, represented memory, and was used to capture the thought and serve as an offering (Castaño-Uribe, 2019). The colour used in the pictographs of Chiribiquete is mainly red, which symbolizes struggle, suffering, the desire to live, and resistance during the life cycle (Matapi, 2017).

**Figure 1**. Chiribiquete rock art.

The red and terracotta colours originate from mixtures of ocher, iron oxide, and titanium minerals. The pictographs contain zoomorphic, phytomorphic, and anthropomorphic forms and figures with geometric motifs which denote movement, expressiveness, and temporal sequences (Castaño Uribe and Gonzalo, 2017). Most forms of the Chiribiquete rock paintings depict groups of hunters and gatherers in a warlike interaction, together with plant and fauna species from the Amazon environment (Castaño-Uribe, 2017).

Based on the importance of the rock paintings, their conservation is necessary for reasons of cultural significance. Studying this art contributes to understanding Colombian culture and its safeguarding (Urbina and Peña, 2020). However, despite the relevance of this topic in Colombia, the care of rock art is developed experimentally because of unfortunate results obtained, so their care is focused on preventing damage (Martínez, 2015). Taking into account the effect of tourism and the truth that the current measures focus on preventive conservation, the documentation of pictographs in the Chiribiquete mountain range makes sense to establish security measures according to the problematic context surrounding the area.

## 3. DATA ACQUISITION

The process began with the site visit, which allowed planning of data collection and determining the scope of activities. The archaeological sites were recorded separately according to geographic separation. Five of the recorded sites are presented here, and each rock panel is given a distinct name: Principal, Largo, Dantas, Mirador, and Demoledores. Survey points, and aerial and terrestrial photographs were collected at each of these panels.

### 3.1 Acquisition of geo-referenced data

Two types of control points were measured. The first type is the natural points; a geometric point that can be recognized repeatedly without additional identification. For the facility of their recognition, these were selected distinct points of the rock paintings easy to distinguish. The second type is the checkpoints, which are artificial elements added to the environment. Checkpoints drawn on tape and printed checkerboard targets were adhered to surfaces around the rock paintings, where their centre cross-points could be measured by the Total Station.

After establishing the control points, the Total Station is set up and configured (Figure 2). The Total Station is used to measure the x, y, z coordinates of each control point, establishing a local geographic system at each panel. The local system of control points is recorded according to a systematic naming convention and each location is recorded for further processing. A photograph is taken to record the location and nomenclature at each control point for identification during the digitization processing.

**Figure 2**. Acquisition of geo-referenced data with a total station.

### 3.2 Acquisition of photographs

The acquisition phase began with capturing one photograph using a professional camera and a colour checker inside the photo frame. This image is necessary for the digitization process to capture and then calibrate the acquired data to the true colours of the environment.

To capture aerial photographs, a DJI Mavic 3 and a DJI Mini 1 drones (Figure 3) were used to capture each panel and their immediate natural context. Aerial photographs were captured in a systemic plan from multiple distances and elevations around each panel, providing high overlapping data between the photographs. Terrestrial photography was done with a Sony Mirrorless Camera Alpha A7RIV, equipped with a Sony 24 – 105 mm lens. This camera offers a high-quality 61 MP resolution full-frame sensor. The photographs according to the CIPA's 3x3 rules to guarantee sufficient overlap and quality of data acquisition for photogrammetric processing (CIPA, 1988).

**Figure 3**. Drone image.

## 4. DATA PROCESSING

The data processing workflow required two main phases. The first phase consisted of performing a colour correction of the captured images and applying a format change. During the second phase, 3D models are generated based on Structure from Motion technology from all data collected. Through this methodology, it was possible to obtain the final digital results.

### 4.1 Correcting and updating image format

The colour correction is relevant so photographs can be calibrated to the colours of the subject without the influence of lighting and atmospheric conditions., Adobe Photoshop version 21.2.1 software (Adobe Photoshop Development Team, 2020) was used to perform colour correction, with the Camera Raw processing tools. The colour correction is carried out using the white balancing tool, which configures the colours of the selected images according to the white square of the colour checker (Figure 4). In this way, the result was the correct colour configuration of all the photographs.

**Figure 4**. Images in Photoshop Camera Raw.

Following the colour correction, it is pertinent to change the format of the images to the .DNG (Digital Negative) format to preserve the high quality of the files. This is an essential step for the photogrammetric processing phase because it enables the final digital products to represent the true colour and quality of the original data.

### 4.2 Digitization

Within the digitization process and unification of the information, a series of parameters were evaluated to determine the scope and form of the final digital models. As a result, different versions per panel originate, taking into account differences such as:

- Amount of vegetation left on the model
- File quality
- Terrestrial, aerial, or combined images
- True colour correction
- Presence or absence of control points

The first step was to upload all the images to the Agisoft Metashape 2.0.1 software (Agisoft Metashape Development Team, 2022). Then, the image quality is determined, and images with a quality metric of less than 0.5 are removed. If surveying data is available for the panel, the GPS data of the imported images is removed, in order to rely solely on the captured survey data.

The next step is the masking process, which excludes the unwanted parts of the vegetation or the panels. The alignment of the images is carried out based on Structure from Motion technology. The process calculates the relative orientation and distance between pairs of images based on common pixel data, until all of the images in the dataset are globally aligned. The result is a sparse cloud of points representative of the 3D form created from the aligned images. Next, markers are used to identify the location of each control point in each image, which scales and orients the aligned sparse cloud according to the local system created with the survey points. The information is imported in .TXT format specifying the name and location to geo-reference these markers.

From the sparse cloud, a dense point cloud is built based on the high confidence level of aligned data between the images, resulting in a detailed point cloud representing the 3D form and colour of the captured data. From the dense cloud, a 3D mesh is generated by generating a surface of polygons triangulated between the points of the dense cloud. A texture is generated from the colour data of the aligned images, overlaid onto the 3D mesh. The results of the textured meshes from the documented sites are shown for each of the five panels: Principal (Figure 5,

Figure 6), Largo (Figure 7, Figure 8), Dantas (Figure 9, Figure 10), Demoledores (Figure 11, Figure 12), and Mirador (Figure 13).

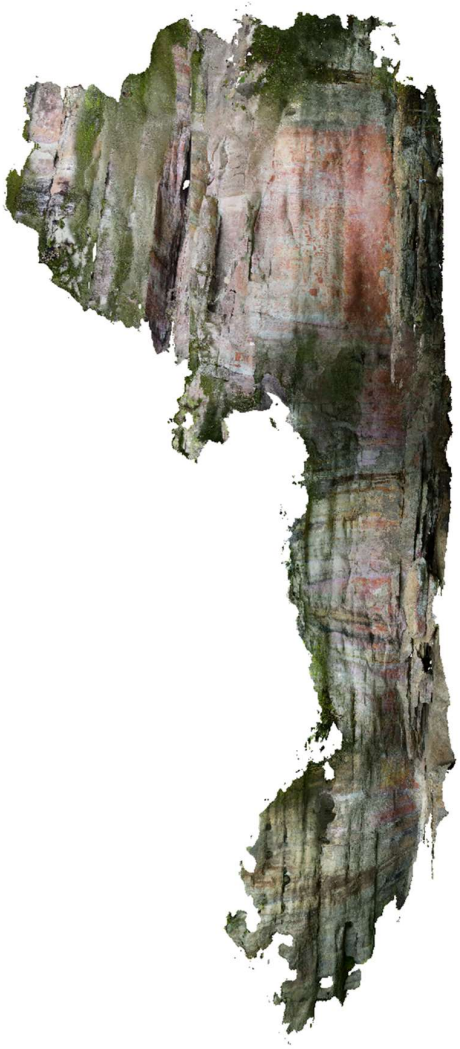

**Figure 5**. 3D Model of Panel Principal.

**Figure 6**. 3D Model texture of Panel Principal.

**Figure 7**. 3D Model of Panel Largo.

**Figure 8**. 3D Model texture of Panel Largo.

**Figure 9**. 3D Model of Panel Dantas.

**Figure 10**. 3D Model texture of Panel Dantas.

**Figure 11**. 3D Model of Panel Demoledores.

**Figure 12**. 3D Model texture of Panel Demoledores.

**Figure 13**. 3D Model of Panel Mirador.

The results of this research is a digital representation of each rock panel at a high level of detail, capturing the true geometric form of each panel and the true colour of the painted rock surfaces. From these digitisations, the details and layers of the rock paintings can be understood and further investigated remotely, without extended periods of working in the challenging conditions of the unique biological area and without imposing invasive investigation methods on the area, which could impose threats on the natural environment and uncontacted Indigenous communities.

## 5. RESULTS AND CONCLUSIONS

The Chiribiquete mountain range is a place of high cultural and natural importance due to its unique biological environment and the continued habitation by uncontacted Indigenous groups, to whom the subject archaeological sites are of great cultural importance. Consequently, there are national and international laws aiming at its protection and conservation, aimed at mitigating the current threats due to tourism, deforestation, and fires. Therefore, there is a need to document the most outstanding elements of the area, the pictographs, without affecting the environment.

This project shows that non-invasive documentation techniques applied to mixed heritage contribute to conservation and are effective in terms of information quality. It also highlights the importance of the planning process, which shows that in a large area, it is necessary to adequately divide the place and be careful in data collection to avoid errors in its processing.

The final result provides detailed and concise quality information for the panels, evidenced in each of the 3D models. The resulting models are digitisations of the painted rock surfaces in Chiribiquete National Natural Park, in which their scale, colours, and surrounding vegetation is represented. These models are also converted to images to appreciate the result through different formats. In this way, digitization helps to know and understand the place, supporting future research in analysing the forms, meaning, and artistic composition of the pictographs.

The digitisations of the rock art offer a potential solution that may enable public access to the sites by remote means, without the invasive effect of tourism. In this way, the population is made aware of the importance of the management and conservation of the Chiribiquete mountain range, based on the declaration of heritage made by UNESCO.

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