

THE PHOTOGRAMMETRIC SURVEY OF THE CITADEL OF AMMAN AND OTHER ARCHAEOLOGICAL SITES IN JORDAN

by
Antonio Almagro

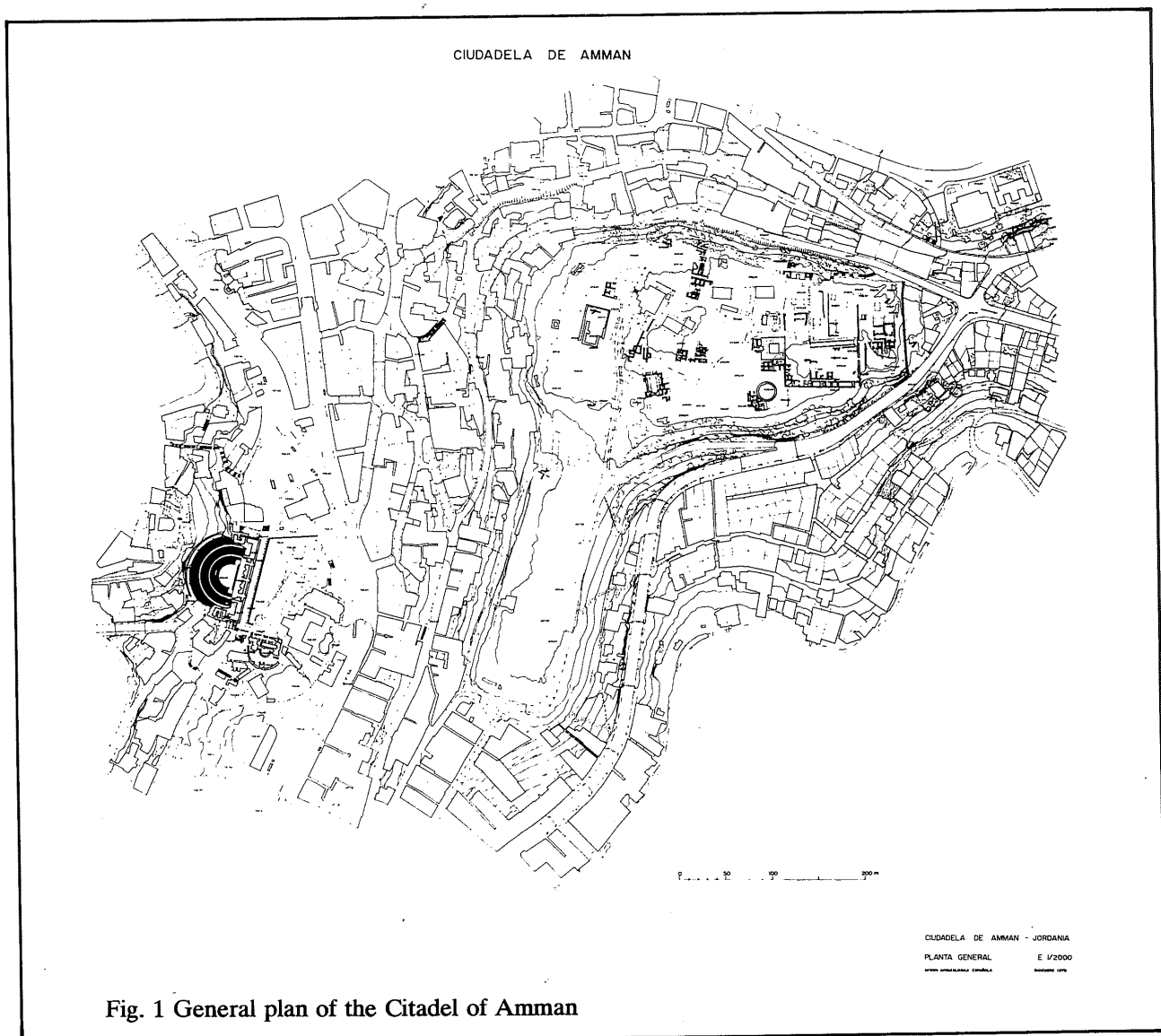
(Pl. L XIV - L XXVIII)

At the end of our work at the Umayyad monument of Qusayr 'Amra, the Spanish Archaeological Mission, with the cooperation of the Spanish Embassy in Amman, proposed to the Jordanian Government the initiation of an archaeological survey of the monuments preserved on the Citadel of Amman, beginning with the so-called Umayyad Palace, also known as "The Tomb of Uriah."

When the Spanish Archaeological Mission began its work on the Amman Citadel, an initial requirement was to have at our disposal comprehensive topographic maps of the entire Citadel region and in particular of the area in which the Mission anticipated developing its activities.

This need was difficult to satisfy primarily because of the almost complete absence of pre-existing relief maps. The largest plan at our disposal was of a scale of 1/5000; this was clearly insufficient except for determining general locations within the region.

Consequently it became necessary to create a cartographic plan. The documentation



which we considered essential as a point of departure for the Mission's project included: A) A general plan of the Citadel at a minimum scale of 1/1000 with contours recorded at one meter intervals. Such a plan was to include, if possible, the area of the theater and nymphaeum, and would thus provide a general archaeological map of the city of Amman. B) A plan of the area in which the Mission planned to pursue its studies and excavations, at a scale of 1/200 with contours drawn at 0,50 meter intervals. C) The recording of the different structures and archaeological remains through plans, elevations and sections at a scale varying from between 1/20 and 1/100.

The topographic plans referred to under (A) and (B) represented the greatest obstacle because of the large area which would have to be surveyed. From the outset it was not considered possible to conduct a survey through conventional topographic methods because it would require dispatching to Amman a team of at least two topographers - for several months duration thus presenting the difficulties of contacting capable personnel and meeting the high costs of the project.

For these reasons we sought to employ photogrammetric techniques which permit (with quality and precision of results superior to conventional methods) a notable reduction both in the time used for surveying and in the accommodation of technical personnel in Amman.

On the other hand, plotting and drafting, the slowest and most expensive aspects of the operation, could be done in Spain without haste and at a rate corresponding to the fluctuations of the Mission's budget.

Thus, the remaining problem was to obtain metric photographs and the few previously known measurements upon them.

In order to compile plan (A) it was necessary to have at our disposal aerial photographs taken at a minimum scale of 1/4500. An initial search was undertaken to determine if such aerial photographs of Amman existed at that scale. From the beginning we received maximum co-operation from the Jordan National Geographic Center, and in particular from its director, Lieutenant Colonel Ra'fat Majali. However the highest scale aerial photographs available were 1/8000 and thus impractical for our purposes.

It then became necessary, in order to obtain photographs at the correct scale, to commission them "ex professo".

To acquire such pictures we needed metrical cameras of high precision mounted upon a specially equipped airplane. These could be provided only at a very high cost.

We investigated as to whether the Jordanian Armed Forces or any private corporation located within Jordan or near by possessed this type of equipment. The results of our inquiry led us to conclude that it would be necessary to bring an airplane from Europe.

Thus, at the very beginning of the Mission's project certain aspects had to be delayed.

For plan (B) we considered two possibilities: either the utilization of aerial photographs at a minimum scale of 1/2000 (which were very difficult to obtain) or the employment of surface photographs, taken with cameras from the ground, with the latter offering even greater difficulties and inconveniences. Progress on this plan was therefore dependent upon the resolution of the obstacles to plan (A).

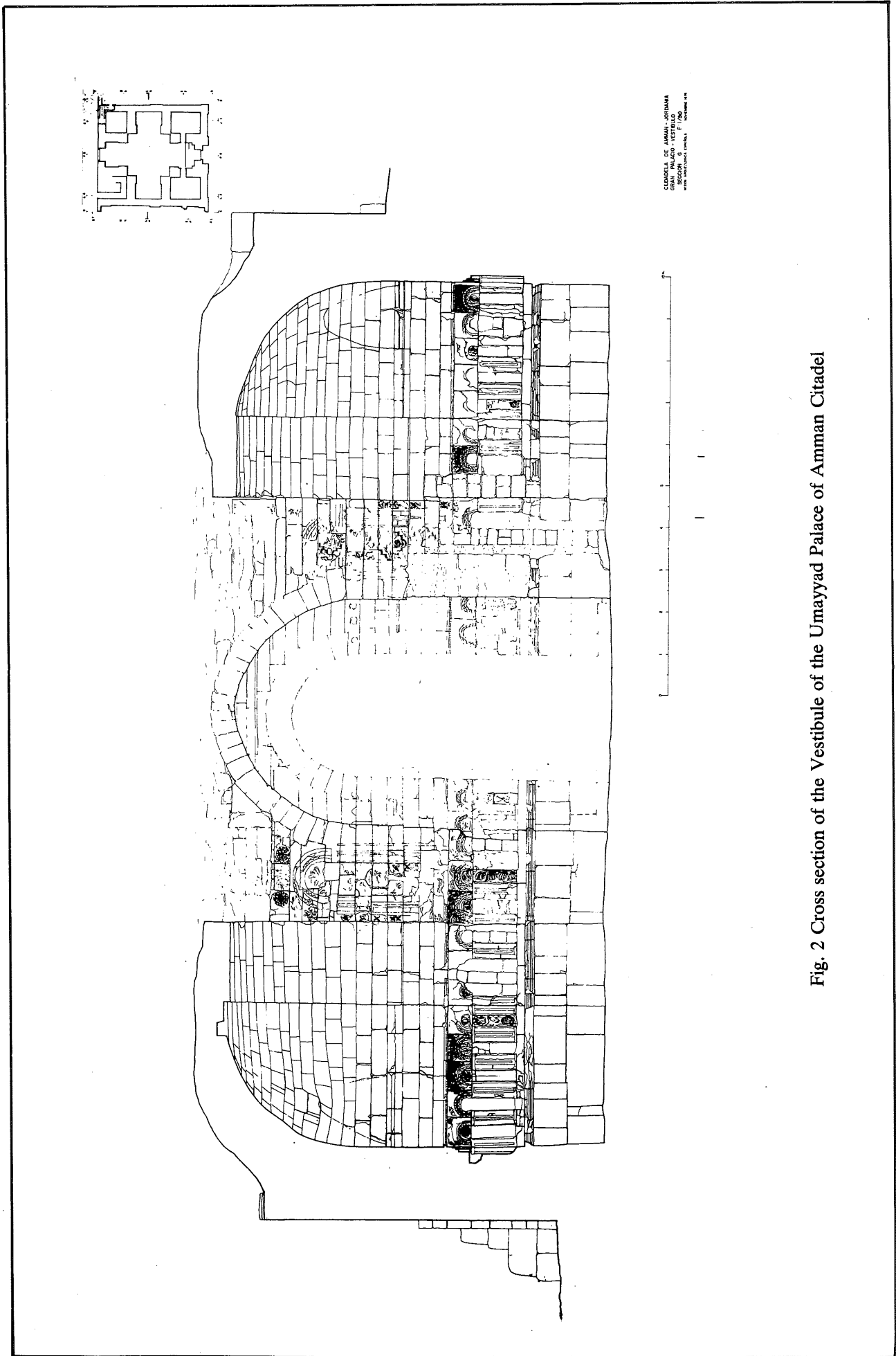
As to the scheme of documentation presented in (C), we had at our disposal all the necessary equipment.

When the necessary work of mapping the Citadel of Amman had been scheduled, we contacted the *Servicio de Fotogrametría y Fotointerpretación* at the *Universidad Politécnica de Madrid*, whose director, Mr. Fernando López de Sagredo, offered, with great enthusiasm, all his technical equipment for this project.

To all and in particular to the Excmo. y Magnífico Señor Rector de la Universidad Politécnica Mr. José Luis Ramos Figueras, who granted authorization and supported this collaboration we express our thanks and appreciation for the success of our work.

The *Servicio de Fotogrametría* had plotting equipment at its disposal for both aerial and terrestrial photogrammetry as well as terrestrial cameras for recording, at the required scale, the monuments and architectural elements on the Amman Citadel.

In the month of November, 1974, in agreement with the Director of the Mission, Professor Martin Almagro, the first mapping campaign was scheduled with the purpose of obtaining the necessary data for drawing plans of the so-called "Umayyad Palace".



ESQUEMA DE AMMAN - CITADELA
GRAN PALACIO - VESTIBULO
SECCION G - F/100
ARQUITECTO: ANTONIO GONZALEZ

Fig. 2 Cross section of the Vestibule of the Umayyad Palace of Amman Citadel

Working together in this campaign were: the author, Director of the Mission, and technicians from the Servicio de Fotogrametría, Mr. Germán Roibas Pérez and Mr. José Iganacio Merino Sepúlveda.

For this objective the equipment which was shipped by air included the following apparatus:

- Bicamera: Galileo BMG 3 "VEROPLAST" with bases of 200 and 56 cms. Focal 150 mms. Photograph size: 13 x 18 cms.
- Theodolite: Wild T2 with *estadia de Imbar* and range rod.
- Level: Kern GK 1.
- Auxiliary photographic supplies and darkroom laboratory equipment.

In the course of this three week campaign we obtained all the data (photographs and measurements) necessary for 1/20 scale drawings and all the plans, elevations and sections of the monument, enabling all the wall faces, both interior and exterior, to be recorded.

The general plan was surveyed with the theodolite, but the exterior elevations, all of the interior faces of the central room and the vaults were recorded with stereophotogrammetry. The undecorated walls of the adjacent rooms were recorded with metrical photographs alone. Finally, measurements of the staircases, corridors and straight passages in which it was not possible to use normal photographic techniques were taken with a conventional meter tape.

Before the pictures were taken, the reference points were arranged with signs fixed upon the face of the wall at a minimum of at least 4 per photogram. Due to the strong limitations of the bicamera Galileo, including its short, reduced visual field which could not allow for wide angle perspective, it was necessary to fit the bicamera to a scaffold and take several pictures from above. This delay significantly impeded the progress of our project.

During the year 1975 and under the direction of the author, the compilation of the plans as scheduled was accomplished by using the documentation obtained in the first campaign. For this work we used the plotter Topocart B from Carl Zeiss (Jena) at the *Servicio de Fotogrametría y Fotointerpretación* of the *Universidad Politécnica de Madrid*.

The four external elevations were plotted at a scale of 1/20, as well as the four central sections of the monument (Fig. 2,3). A plan was also drawn at the level of the decorations, and a plan of the vaults with contour lines and a record of the stones which shape the vaulting. (Fig. 4) From this basic outline of the general plan, and with the photographs of the side room walls, two additional eight-sided sections were drawn, so that each wall of the monument was now fully recorded. The task of drafting and lay-out assembly was efficiently accomplished by Mr. José Sandoval, chief draftsman in the Servicios Técnicos de la Subdirección General del Patrimonio Artístico.

Although the work of the Spanish archaeologists was interrupted for two years, we sought to renew the Mission's project early in 1978 beginning with the restoration of the monument and the excavation of the surrounding outside area. At this time the unavoidable problem which still presented itself was the general mapping of the entire area and of the Citadel. Promises and agreements established with the Department of Antiquities of Jordan were contingent upon the accomplishment of these objectives which had furthermore drawn the attention of the Spanish Ambassador in Amman and the Ministry of Antiquities and Tourism of the Jordanian government.

In a last attempt, we exhausted all possibilities to obtain aerial photographs locally and began to look for a solution in Spain.

When we discovered, through the *Servicio de Fotogrametría* that the Spanish Air Force possessed equipment and airplanes suited to our needs, we decided to request the collaboration of the Ministry of Defense.

In his request to the Excmo. Sr. Minister of Foreign Affairs, Mr. Marcelino Oreja, the Director of the Mission, Professor Martin Almagro solicited the necessary assistance from the Excmo. Mr. Lieutenant General Manuel Gutierrez Mellado, Vicepresident of the Government and Minister of Defense.

With his immediate consent an airplane of national origin and sufficiently equipped, CASA C 212 from Squadron 403 based in Cuatro Vientos, was dispatched to assist the Mission. In this paper we wish to thank Lieutenant Colonel Mr. Francisco Javier Anadon and all of the team from Squadron 403 who assisted the Mission for their help and enthusiasm.

Having access to the plane and its equipment we desired to use the facilities to maximum

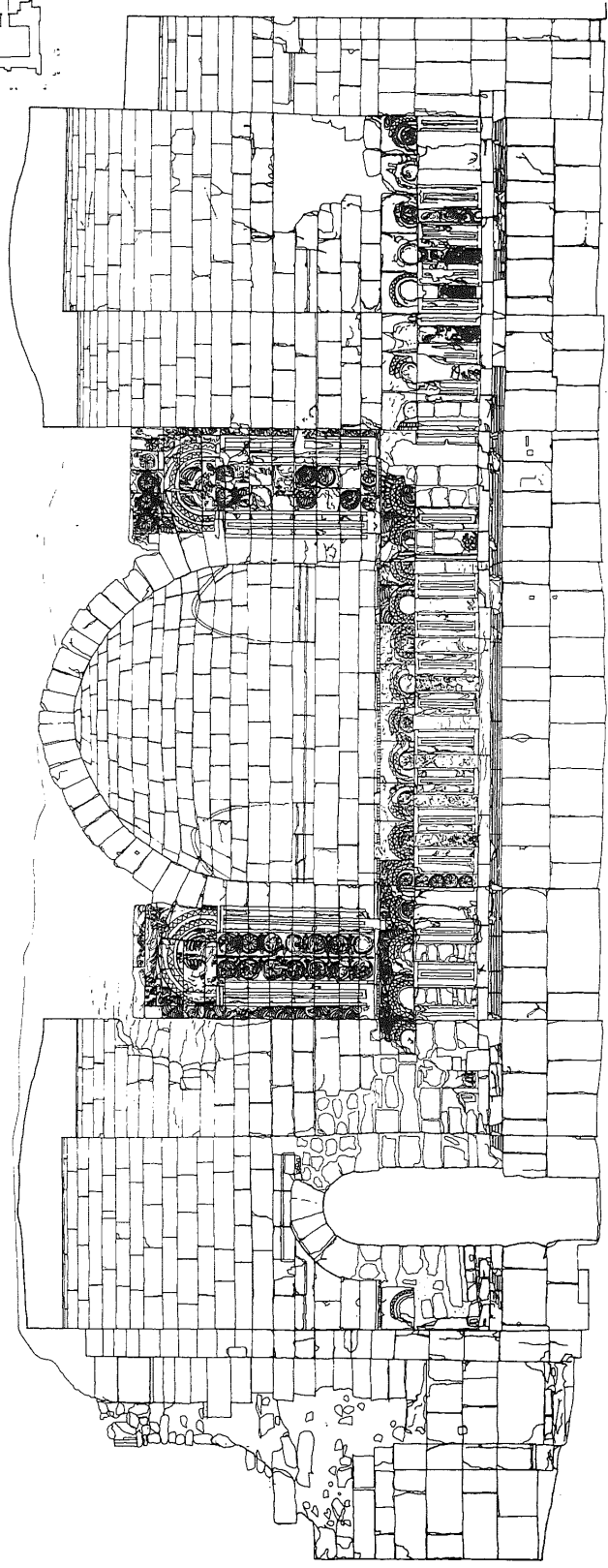
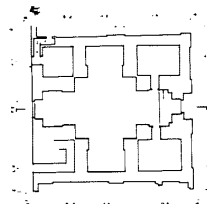


FIG 3
CAPITOLA DE AMAMA - JORDANIA
GRAN PALACIO - VESTIBULO
1:100



Fig. 3 Axial section of the Vestibule

benefit and offered the Department of Antiquities of Jordan the possibility of documenting with aerial photogrammetry other sites in the country.

At the same time we decided to make further use of the plane's trip by transporting the terrestrial photogrammetric and topographical supplies with which we could complete the recording of that part of the Citadel under study by the Spanish Archaeological Mission. The presence of the airplane also enabled us to obtain reference points for the serial photographs.

Thus, in September of 1978 the new campaign of photogrammetric documentation was successfully launched with the assistance of airplane C 212 from Squadron 403 of the Spanish Air Force and its crew, Majors Jacinto Valor and Cándido Alvarez Paredes, Captain Diego Alonso and Corporals Julián Olalla and Carlos Alonso.

The airplane was equipped with two Wild RC 10 cameras of 152 mm. focal and 24 x 24 cms. negative size.

Travelling in the same plane were two technicians from the *Servicio de Fotogrametría*, from the *Universidad Politécnica de Madrid* who had participated in the initial campaign and were equipped with the following:

- Bicamera: SMK 120 of Karl Zeiss (Jena). Base 120 mm. Focal 60mm. Plate size 9 x 12 cms.
- Phototheodolite: Wild P 30. Focal 290 mms. Plate size 10 x 15 cms.
- Wild Distancemeter. Distomat A with Theodolite T 2.
- Laboratory supplies.

The airplane's journey lasted three days with stops in Palma de Mallorca, Palermo, Athens and Larnaca (Cyprus), and on the return trip stops were made at Larnaca, Athens, Rome and Palma de Mallorca. The airplane was in Amman for 10 days. The Mission team spent 5 days on photogrammetric flights, the remaining time being taken up with the unloading of equipment, flight preparation, developing of photographs, and finishing the remaining terrestrial photogrammetric work.

On the first day of flight, pictures were taken of sites in the Amman region including the Citadel. On the same day working contact prints were developed.

The second day concentrated on the Irbid region, the third day around Kerak, the fourth day in the area of Petra and Aqaba and on the last day photographs were taken of some of the Desert Castles and of sites in the Mafraq district.

In the appendix we refer to all of the areas photographed and the approximated scales of those pictures.

The plane made two flights over the Citadel, the first at an altitude of 1100 metres above sea level (250 metres over the surface of the ground) which resulted in photographs at an approximate scale of 1/1660 and the second at 1500 metres above sea level (650 metres over the surface of the ground) producing photographs at an approximate scale of 1/4500 (Pl. V)

In addition to the stereoscopic photographs to be used for reconstruction, we took color pictures of other sites at an oblique angle with a Hasselblad camera equipped with an 80 mm. lens and 6x6 cm. negative plates.

While the aerial documentation of the Citadel and other sites was being carried out, the team from the *Servicio de Fotogrametría* used surface cameras to record all the buildings and architectural remains in the area under study by the Mission and in particular the Roman enclosure wall encircling the "Temenos", or court, and the north fortification wall of the Citadel.

As soon as we obtained the first copies of the aerial photographs of the Citadel we began the task of establishing the photographic reference points necessary for later reconstruction.

In the autumn of 1978, having obtained all this data, we began the *restitution* of the aerial photographs with the purpose of making plans (A) and (B), which from the out set had been considered imperative for the logical development of the Mission's project.

The first finished plan was that of the area studied by the Spanish Mission and this was drawn at a scale of 1/200 with topographic contours at 0,25 metre intervals. At this scale we were able to show not only the overall plan, but also each individual stone of the walls, and pavements as well. Such detail was possible only because of the high quality of the aerial photographs.

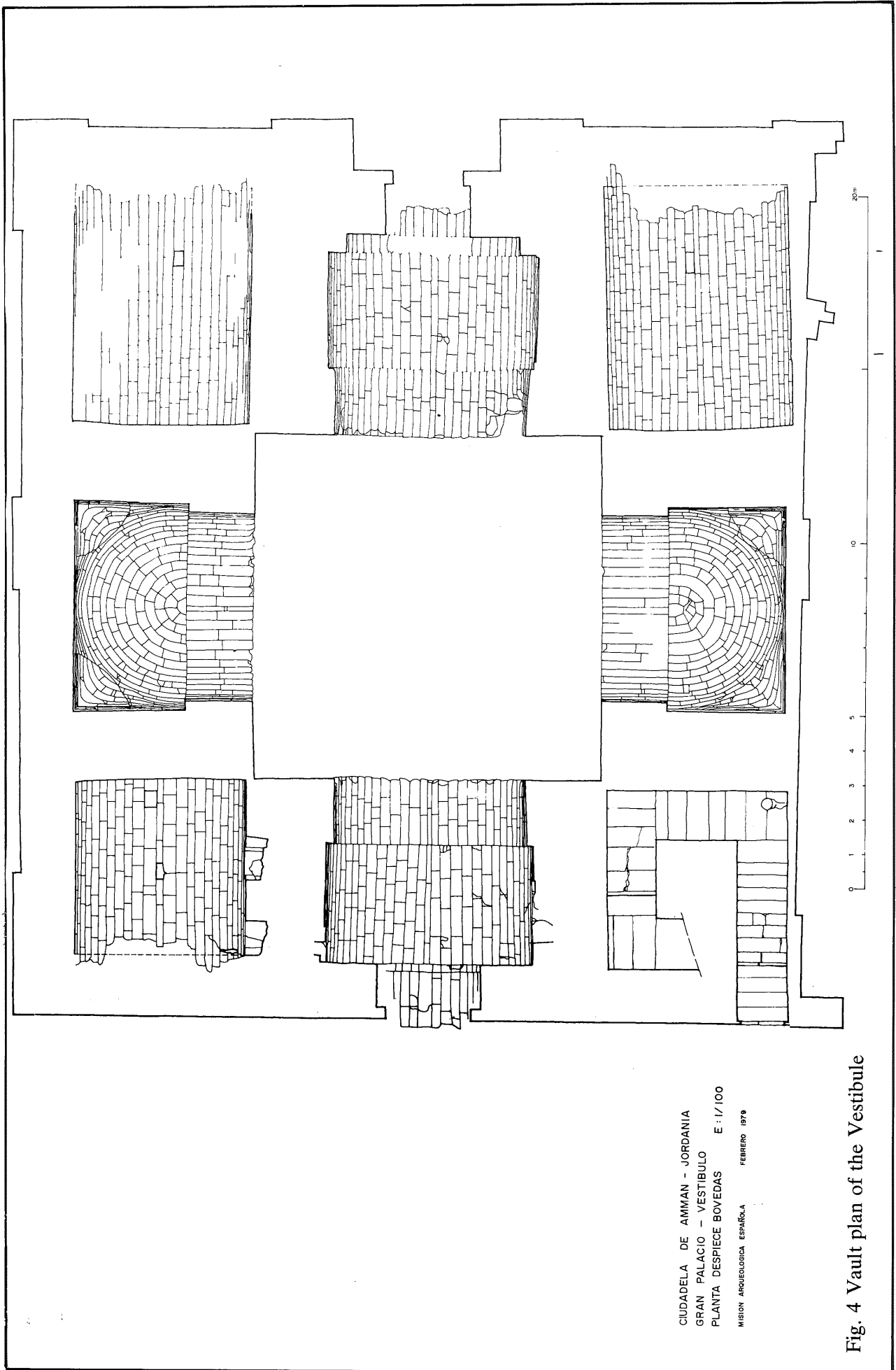


Fig. 4 Vault plan of the Vestibule

We were especially interested in obtaining a horizontal plan of the roof of the "Umayyad Palace", which previously had not been possible to survey.

Until now only the area of the Spanish Mission's study has been plotted at this scale, but in the future it will be possible to plot the remaining zones of excavation on the Citadel.

Using the plotting and the negative of the aerial photograph, a photo-plan was made of the great court, or "Temenos". This photo-plan has been of great benefit for the study of the area in that it permits observations with photographic detail of all the different elements at a pre-determined scale.

Finally, we finished the plotting of the general plan of the Citadel which includes the Theatre and Nymphaeum at a scale of 1/1000 with contour lines at 1.000 metre intervals. (Fig. 1)

This plan, which will be useful for general locations within the area, also has intrinsic value for use in developing an urban plan of the entire archaeological area of Amman.

Such topographic documentation is indispensable for any study which aims at the evaluation and preservation of the monuments which at present are standing on the Citadel. This documentation is also vital to any future arrangements for an archaeological park which could serve not only as a place for study and research but also as a place of leisure for the resident and tourist alike.

Antonio Almagro,
Architect, Spanish
Archaeological Mission

Monuments and Sites Documented by the Spanish Archaeological Mission in Jordan in September 1978.

Site	Approx. Scale	Negative No.
<i>Amman Area</i>		
RAJIB	1/5 000	5384
USAHAB	1/5 000	5404
EL MUWWAQQAR	1/5 000	5415
MUSHATTA	1/5 000- 1/1 600	5423 5430
HISBAN	1/5 000	5477
SIYAGHAH	1/5 000	5455
Mt. NEBO	1/5 000	5470
IRAK EL AMIR	1/5 000	5483
AMMAN CITADEL	1/5 000- 1/1 650	5490 5500-5501
<i>Irbid Area</i>		
JERASH	1/5 000	7977-7978-7988
BEIT RAS	1/5 000	7997-7998
SAMA	1/5 000	8012
AJLUN	1/5 000	5553
<i>Kerak Area</i>		
DHIBAN	1/5 000	8018
RAJIB	1/5 000	8012
WADI MUJIB AREA	1/5 000	8023
MEDEINEH S.	1/5 000	8030
MEDEINEH N.	1/5 000- 1/1 600	8036 8048
LAJJUN	1/5 000	8054
RABBA	1/5 000	8062
KERAK	1/5 000	8083
KHIRBET TANNUR	1/5 000	8092
BUSEIRA	1/5 000	8107
<i>Petra and Aqaba Area</i>		
SHOBAK	1/5 000	8119
PETRA	1/5 000	8131-38-58-60-67
TAWILAN	1/5 000	8174
BEIDA	1/5 000	8179
UDRUH	1/5 000	8185
AQABA	1/5 000	8190
<i>Mafraq and Desert Area</i>		
HALLABAT	1/5 000	8206
QUSAYR AMRA	1/1 600	8212-8215-8216
AZRAK	1/5 000	8221
UM EL JIMAL	1/5 000	5534
UM EL SURAB	1/5 000	5541
SAMA EL SARHAN	1/5 000	5547