THE COLOUR PALETTE IN THE ARCHITECTURE OF LA BLANCA (PETÉN, GUATEMALA). COMPARISON BETWEEN THAT OF THE MAYAN LOWLANDS AND THAT USED IN OTHER CIVILIZATIONS OF THE ANCIENT WORLD

Mª Luisa Vázquez de Ágredos Pascual[1]; Mª Teresa Doménech Carbó[1] and Antonio Doménech Carbó[2]
Instituto Universitario de Restauración del Patrimonio de la Universidad Politécnica de Valencia
[1]Laboratorio de Análisis Físico-Químico y Control Medioambiental de Obras de Arte
[2]Departamento de Química Analítica. Universitat de València.

CONTACT AUTHOR: Mª Luisa Vázquez de Ágredos Pascual, m.luisa.vazquez@uv.es

ABSTRACT: *The chemical characterization of the remains of mural painting conserved on the palace architecture in the Mayan city of La Blanca (Department of Petén, Guatemala) and the interpretation thereof, in light of current knowledge about the arts of this ancient American culture, constituted one of the lines of research promoted by the La Blanca Project since 2004. The importance of the data obtained during this time has led to the extension of this line of research, over the last year, to other settlements in the Mayan lowlands in order to analyse the possible relations between the materials, techniques and painters working at these settlements. This study provides a fairly representative panorama of the materials used in mural painting by this millenary prehispanic civilization and ultimately enables a very precise comparison to be made between these works and those carried out in other cultures of the ancient world.*

KEYWORDS: La Blanca, Petén, Guatemala, Maya culture, pre-Columbian art, mural painting, pigments, architecture

1. INTRODUCTION

Colour was a highly important form of expression in the art of ancient American civilizations, including the Mayan culture, which was established and developed between the early Preclassic period (c. 1800 to 900 BC) and the Late Postclassic era (c. 1300 to 1530 AD) in the vast territory spanning the present-day nations of Guatemala, Honduras, Belize, El Salvador and the southern Mexican states of Chiapas and Tabasco. One of the most widely used backdrops for this artistic resource were the buildings themselves and this application extended continuously over a period going from the end of the Mid-Preclassic period (c. 400 BC) to the end of the Late Postclassic period (c. 1530 AD). The propensity of the Mayan culture, from very early times, to paint monumental architecture and particularly temples, royal tombs and the palatial residences of the nobility was shared by other civilizations of the ancient world where colour was also employed as a decorative and distinguishing feature of the areas pertaining to the social elite, and this subsequently enables highly interesting comparisons to be made regarding the materials and artistic techniques used in ancient mural painting.

The attention given to the study of these works and their vestiges by a number of archaeological projects currently underway in the Mayan lowlands has largely contributed to the fact that this research is now done with an increasingly interdisciplinary approach more suited to gathering complete and precise knowledge on these artistic manifestations. In this regard, the study of the small traces of polychromy that still remain at the residential palaces of the Acropolis at the ancient Mayan settlement of La Blanca has been one of the lines of research on which the *La Blanca Project (Department of Petén, Guatemala)*[1] has been working ever since it began in 2004 (Muñoz y Vidal, 2005; Munoz y Vidal, 2006). As a result, the on-site study of colour traces has been combined with chemical analysis of these traces, using very diverse microscopic, electroscopic, chromatographic and electrochemical techniques capable of characterizing the materials and techniques used by painters working at the site between the end of the Late Classic Period (c. 750/800 AD) and the beginning of the Postclassic period (c. 950 to 1050 AD). The analysis and interpretation of these results and comparison with those obtained from wall paintings at other prehispanic settlements in the Mayan lowlands by other investigators since the 1930s[2] shows that there were no significant differences between the materials used by the painters working on these murals throughout this vast territory in antiquity.[3] This makes it possible to conclude that wall painting in the Mayan lowlands was governed by a single technical tradition that experienced few modifications between the Preclassic and Postclassic periods, that is to say, over more than one and a half millennia of history, and following the pattern occurring in other civilizations of the ancient world.

2. OBJECTIVES AND METHODOLOGY

The main objective of this article is to describe the colour palette employed by the mural painters working in the prehispanic settlement of La Blanca between the end of the Late Classic and the Early Postclassic periods, and to compare this information to the characteristic range of colours used in other areas of the Mayan lowlands and in mural paintings by other ancient Western and Eastern cultures.

As indicated in the introduction, the study of the pigments used in the painted architecture of La Blanca began with the *in-situ* analysis of the traces of colour that still remained on the surfaces of the buildings and continued with the selected removal of micro-specimens of colour in order to characterize them.[4] The process concluded at the physics-chemistry and environmental control of works of art laboratory at the Universitat Politécnica de València and the Department of Analytical Chemistry of the Universitat Politécnica de València, where the micro-specimens were analysed for identification using the techniques indicated below:

Figure 1. Ancient Maya settlement of La Blanca (Department of Petén, Guatemala)

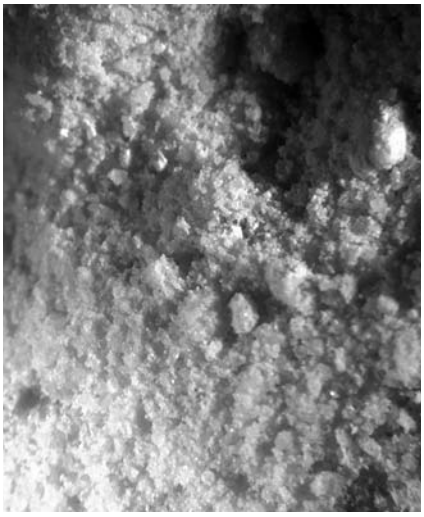

Figure 2. Silica sand or hí (Cerro of Camalote; Petén, Guatemala)

Figure 3. Atapulgite (Cerro of Camalote; Petén, Guatemala)

Optical microscopy (LM). The analysis of the specimens with this technique required that they be set in polyester mounting resin, which hardened after approximately 24 hours and provided a small mount that was then polished to form an appropriate cross-section of the embedded paint sample. This required the use of a Struers Knuth-Rotor 2 lapper/polisher and decreasing grain size silicon carbide abrasive discs. Then the prepared cross-sections were examined by means of a Leica DMR optical microscope with an incident polarized light system. This examination revealed the stratification of the paint layers and grounds and, subsequently, that of the wall paintings decorating the palatial buildings at this prehispanic settlement.

Scanning Electronic Microscopy combined with energy dispersive X-ray (SEM/EDX). The cross-sections were also examined by means of a scanning electronic microscope, though in this case the specimens required a carbon coating. The combination of this microscopic technique with energy dispersive X-ray microanalysis was conclusive in the identification of materials of mineral origin employed in the different strata found in the painted walls of the La Blanca Acropolis. A Jeol JSM 6300 scanning electron microscope operating with a Link-Oxford-Isis X-ray microanalysis system was used. The analytical conditions were: 20 kV accelerating voltage, a $2x10^{-9}$A beam current and 15 mm working distance. Qualitative analysis was performed in punctual mode. Quantitative microanalysis was carried out using the ZAF method for correcting interelemental effects. The counting time was 100 s for major and minor elements.

X-Ray Diffraction (XRD). The composition of the pictorial mortars and renders at the La Blanca Acropolis was ascertained through this analysis technique, which required grinding a small portion of the specimens in an agate mortar.

The X-Ray diffractometer employed was a Philips PW 1830, DMP 2000 operating with a copper anticathode at 40 kV and 20 mA.

Transmission Electronic Microscopy (TEM). The use of this microscopic technique played an essential role in establishing the morphology of the clays and pigments used by the La Blanca painters to prepare the colours used to decorate the residential buildings of the Acropolis. Pigments and clays were prepared by grinding a few micrograms of the samples in an agate mortar and then dispersing them with the help of an ultrasons bath in dichloroethane. A drop of the dispersions was poured on TEM grids pre-treated with a polymer film layer with holes in order to improve the images obtained. A Philips CM10 transmission electron microscope with Keen view camera soft imaging system was used, operating at 100 kV.

Fourier Transform Infrared spectroscopy (FT-IR). The analysis of the La Blanca samples with this spectroscopic technique was made using Vertex 70 equipment operating in attenuated total reflection mode and using a coated FR-DTGS detector for temperature stabilization. The use of this method, among the other techniques employed in this research, was particularly useful for the characterization of both organic and inorganic compounds present in the wall painting samples.

Voltammetry of Microparticles. The use of this electrochemical technique was fundamental for the identification of the materials used by the La Blanca painters to prepare the range of Mayan blue pigments.

This analysis was performed with CH I420 equipment using sample-modified paraffin-impregnated graphite electrodes as working electrodes, immersed into a 0.50 M acetate buffer under argon atmosphere. A AgCl (3M NaCl)/Ag reference electrode and a platinum wire auxiliary electrode completed the three electrode arrangement.

3. THE COLOUR PALETTE AT THE PALACE RESIDENCES OF LA BLANCA. THE RELATION BETWEEN THIS SCALE AND THE COLOUR RANGE USED IN THE ARCHITECTURE OF THE MAYAN LOWLANDS.

The La Blanca area was rich in deposits which provided the painters at the settlement with the minerals needed to prepare the majority of the pigments used in their paintings, with the exception of green and blue. One of these deposits was located just 800 m from the site, in the area now known as the Cerro of Camalote, which continues to be quarried to this day by the surrounding population. The materials that formed in the floors and walls of this cavity included calcium carbonate ($CaCO_3$), lime ($CaCO_3$) and silica sand (SiO_2) which in the Mayan language was known as *sascab* and *hí* respectively, goethite (FeOOH), limonite or brown iron ore ($Fe_2O_3.nH_2O$), hematite (Fe_2O_3) and different types of clays such as kaolin, attapulgite (palygorskite), sepiolite or montmorillonite.

These minerals were used in Mayan architecture and art for various purposes and La Blanca painters were, therefore, not the only specialists working at the settlement to make use of this rich deposit. The vast amounts of calcium carbonate found in the quarry served as the base material for the cement mixes used in the construction of the monumental architecture of the settlement and the white renders of lime and *sascab*, or lime and silica sand, which would then be decorated with graffiti and wall painting. Two types of render were used at the palace residences of the Acropolis: a thick mortar lining the wall and a thin outer layer in which the lime was enriched by the addition of montmorillonite type sand to obtain a more resistant layer and one more appropriate for burnishing (Fig. 4). The use of this clay and kaolin must have been common among the ceramists working at La Blanca and other

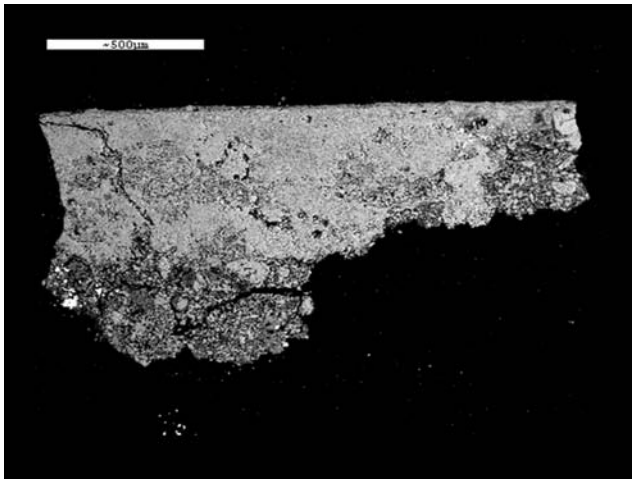

Figure 4. Substrates of the mural statigraphy (SEM/EDX). Palace residences of La Blanca Acropolis

Figure 5. Goethite (SEM/EDX) (Cerro of Camalote; Petén, Guatemala)

neighbouring settlements in the prehispanic era, as its rough structure, as opposed to the fibrous and porous structure characteristic of attapulgite and sepiolite clays, gave it a less absorbent texture and, subsequently, one better suited to the high temperatures at which these ceramic pieces were baked. However, the fibrous texture of the attapulgite and sepiolite clays made these aluminium and magnesium silicates more appropriate for the preparation of Mayan blue pigments used by the mural painters at the settlements of the Department of Petén, who appeared to restrict the use of green and blue, as neither the Cerro of Camalote nor the other deposits in the surrounding area contained copper and lazulite (sodium feldspar) minerals which yielded these colours, and particularly the azurites and malachites in the case of the former,[5] and lapis lazuli in terms of the latter colour.

However, these deposits were rich in the formation of ferric minerals of diverse compositions with which the La Blanca painters prepared all the warm colours of their colour wheel, ranging from the strongest reds to the deepest yellows and running through all manner of oranges, pinks and ochres (Fig. 5). This must then have been the location of the goethite, limonite and hematite mentioned earlier, which were also found in the soils of the dense jungles of the southern Mayan lowlands (Morley, 1982: 348; Sharer, 1998: 609). Their respective iron-based compositions gave all of these materials different tones when fired and for this reason, from very early times, the Mayan painters, in parallel to most of the painters of the ancient world, would bake these pigments in order to obtain wide ranges of reds, oranges, pinks, ochres and yellows. This was the case of the artists painting the interior of the palatial residences of the La Blanca Acropolis between the end of the Late Classic and the start of the Early Postclassic periods, given the varied hues obtained from the same pigment used in these areas, as is the case of the earthy reds and ochres represented by goethite and limonite respectively (Fig. 6). These partially hydrated iron oxides were used in the decoration of the buildings of upper classes together with other pigments which, in general, were identical to those employed throughout the Mayan lowlands and not just by the mural painters but also by those dedicated to other artistic specialities such as painting ceramics and codices, or the decoration of household items carved from bone, obsidian, serpentine or jadeite, among other precious stones, and decorated with engraved coloured figures. The pigments used in the buildings at La Blanca were as follows:

White from calcium carbonate ($CaCO_3$) mixed with white clay or silica in the same manner as that employed in the wall paintings at other settlements in the Mayan lowlands.

Carbon black from vegetable origin (C), proceeding from the calcination of various woods (Fig. 7). The murals in the Mayan lowlands rarely employed carbon blacks of animal origin. Some calcium phosphate was identified in the bellicose mural painted during the Late Classic period at Structure A of Mulchic, to the north of Yucatán in Mexico (Vázquez de Ágredos, 2006: 307) but it could be ascribed to some accessory mineral rather than carbon black of animal origin. These murals also made little use of the blacks obtained from manganese minerals such as manganese oxide (MnO) or pyrolusite (MnO_2), which were more commonly employed in the painting of ceramics.

While no traces of grey have been found in the architecture of the La Blanca Acropolis, it would have been sufficient to mix the carbon blacks of vegetable origin described above with some white clay or with the characteristic white of calcium carbonate in order to obtain this colour.

Reds and yellows of ferric nature (Hematite. Fe_2O_3; goethite. FeOOH; limonite. $Fe_2O_3.nH_2O$), which were similarly employed to prepare the oranges, pinks and ochres that formed part of the mural polychromy of the La Blanca residential palaces, either by means of calcination or by suitable mixes of colours. These were the most widely employed pigments at both the La Blanca buildings and in the rest of the Mayan lowlands, this selection being largely influenced by the abundant iron formations throughout the Mesoamerican region and how easy it was for the painters to prepare them, as opposed to the complex procedure required by the other two red pigments, which have also been identified in these works in the area: specular hematite (Fe_2O_3) and particularly cinnabar (HgS). The volcanic origin of the former gave it a bright purple surface which was highly appreciated by the ancient Maya but there was a risk that it would disappear if the painter did not take care when grinding it. The use of cinnabar was even more complicated as the sublimation required of the mercury sulphate (HgS) prior to its use as a pigment meant that the painter had to have very precise knowledge that sometimes was difficult to put into practice. However, the highly symbolic value that the Maya attributed to these latter two sources ensured that they were used in their architecture and art, though the small number of deposits providing them meant that their respective use was considerably restricted and, in the case of cinnabar, almost entirely limited to royal and noble funerary contexts (Magaloni *et al.,* 1996: 159-168; Vázquez de Ágredos, 2005; Vázquez de Ágredos, 2006: 604-607; Vázquez de Ágredos, 2004: 145-151)[6] and this coincides with the use of this pigment among the majority of ancient American cultures.

It is interesting to note that ilmenite ($FeTiO_3$), frequently found as an accessory mineral accompanying other clayey pigments, has not been identified to date in the painted architecture at La Blanca in spite of its use by painters working at other settlements in the Department of Petén relatively close to La Blanca, as was the case of the mural decoration of one of the four interiors of Structure II-18 at Yaxhá (Vázquez de Ágredos, 2006: 947, 957, 963, 967 y 973).

Yellows and ochres of goethite (FeOOH) and limonite ($Fe_2O_3.nH_2O$), which change their initial colour on being baked or mixed. With the exception of the yellow pigment rich in phosphorus which has recently been detected for the first time in the murals of the Mayan lowlands (Vázquez de

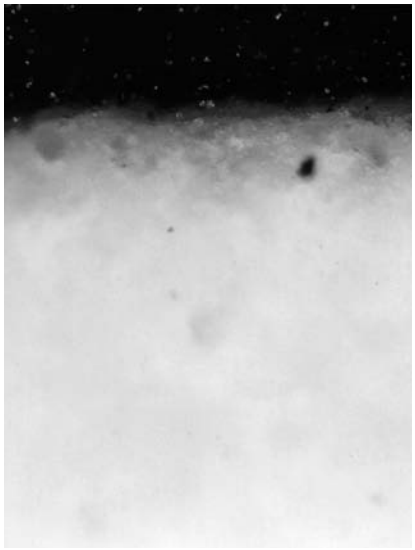

Figure 6. Red (LM). Palace residences of La Blanca Acropolis

Figure 7. Carbon black. Palace residences of La Blanca Acropolis.

Figure 8. Indigo (Indigofera Suffruticosa Mill.)

Ágredos, 2006: 955 y 967-969), these were the minerals generally employed in the manufacture of the yellows and ochres in Mayan painting.

Blues and greens of organic origin, which were prepared by precipitating and calcinating the indigo colouring (*Indigofera Suffruticosa Mill.*) in inert substrates of white colour and clayey nature (Fig. 8). The texture of these matrices had to be sufficiently porous to allow the penetration of the dye during the baking of the pigment and this explains why Mayan painters almost exclusively used attapulgite and sepiolite clays, particularly the former of the two (Fig. 9). The perfect tubular structure of this clay allowed penetration of the indigo into its interior, where it was firmly anchored with the aid of the high temperatures in the ovens in which these pigments were prepared (Doménech *et al.*, 2007a; Doménech *et al.*, 2007b; Doménech *et al.,* 2007c; Doménech *et al.*, 2006). These were most probably the *cum* referred to in the dictionaries of the Mayan language published in Yucatan in colonial times (Álvarez, 1984: 201).

Using this same manufacturing technique, painters of the Mayan lowlands prepared reds, yellows and ochres, which varied from their equivalents of mineral origin on account of their greater intensity. The wood of the *chucum* (*Havardia Albicans*) tree, the *kikche´* (*Apoplanesia Paniculada Presl.*), the *chacte´* (*Caesalpinia Mollis*), the *chaká* (*Bursera Simaruba*), the *piich* (*Caesalpinia Violaceae– Miller–Standley*), and the *Chacmolche´* (*Erythrina Sepium H.B & K.*), as well as the seeds of the *k´uxub* (*Bixa Orellana L.*), whose colouring was known by the Spanish as the 'saffron of the West Indies', provided a rich variety of red dyes that, when precipitated and baked in inert substrates of white clay, or occasionally lime and silica, were converted into stable pigments suitable for artistic use. This was also the case of the yellow dye contained in the root of the 'Palo Mora' (*Clorophora Tinctoria*) or the stronger ochre of the bark of the 'Palo Amarillo' (*Gliciridia Sepium H.B & K*). However, none of these organic (dye) – inorganic (inert substrate) pigments formed part of the polychromy of the residential palaces of the Acropolis of La Blanca, where the standard practice was to prepare the warmer range of colours from the red, pink, yellow and ochre minerals prevailing in the area around the site and the vicinity and to reserve the complex process of manufacture implied in the transformation of colouring into a stable pigment purely for the indigo greens and blues, following the general tendency among the painters working in the Mayan lowlands between the Preclassic and Postclassic periods.

4. THE COLOUR PALETTE OF THE MAYAN LOWLANDS IN COMPARISON WITH THAT USED IN OTHER ANCIENT CIVILIZATIONS.

The architecture of the Mayan lowlands was painted with a far more sparing or restricted colour palette than that used in other ancient cultures as, in all of these, it is possible to identify the same pigments characteristic of mural painting from this ancient pre-Columbian culture, but accompanied by others which considerably enrich the polychromy of their architecture and their art. Lead whites, smoke or ivory black, lead oxide red, realgar orange, orpiment yellows, lapis lazuli or azurite blue and malachite green were just some of the lead, arsenic, lazurite or copper pigments incorporated into the mural painting of these other ancient civilizations to the palette of calcium carbonate whites, carbon blacks, reds, pinks, oranges, yellows and ochres of ferric base (hematite, goethite and limonite) and cinnabar reds characteristic of the mural paintings of the Mayan lowlands which, to this extent, did not differ very much from those used in prehistoric rupestrian painting (Pomiès et al., 2000: 22-27). Only the indigo blues and greens prepared by precipitating and baking this colouring in attapulgite substrates serve to separate Mayan wall painting from paintings done from the Lower Palaeolithic onwards, as the colourings extracted at this time, manipulated and used in funeral type contexts and practices, were not created by combining them with any type of inert matrix, but were purely applied in their natural state (Regert *et al.*, 1998: 191-192).

These two pigments of indigo and attapulgite were the most sophisticated pigments in Mayan mural painting on account of their complex manufacturing process and also represented the most exceptional or unique aspect of this art, much in the same way as the Egyptian blue or frit blue used in Egyptian painting (Nicholson and Shaw, 2000: 109; Colinart, 1996: 29-45; Bianchetti, 2000: 179-188; Mazzochin, 2004: 129-133),[7] the Pompey Red in Roman painting (Bearat, 1997: 11-34; Andreotti, 2003: 171-179), the lapis lazuli in Mesopotamian painting and that of the majority of the ancient cultures of the Far East, particularly India (Agrawal, 1989; Agrawal and Wickramasinghe, 2002), Tibet (Twilley, 1998: 129-130) and China (Illouz, 1985), the lead black in Japan (Sa Dug, 1999: 48-58), the azurite and malachite in Teotihuacan painting (Magaloni, 1998: 88-109) or the orpiment and realgar in various of those arising in ancient Peru (Bonavia, 1985: 180), among other examples. These pigments were not only known among the cultures where they were first prepared and used, but were also exported from their place of origin to other civilizations either due to geographical proximity, trade or conquest, among other possibilities, this being the case of the Mayan blue in Mesoamerica or the Egyptian blue in Rome and its provinces.

5. CONCLUSIONS

The colour palette used by the La Blanca mural painters to decorate the palatial residences of the Acropolis between the Late Classic and Early Postclassic periods was based on the use of calcium carbonate whites mixed with white clays or silica sand, carbon blacks of vegetable

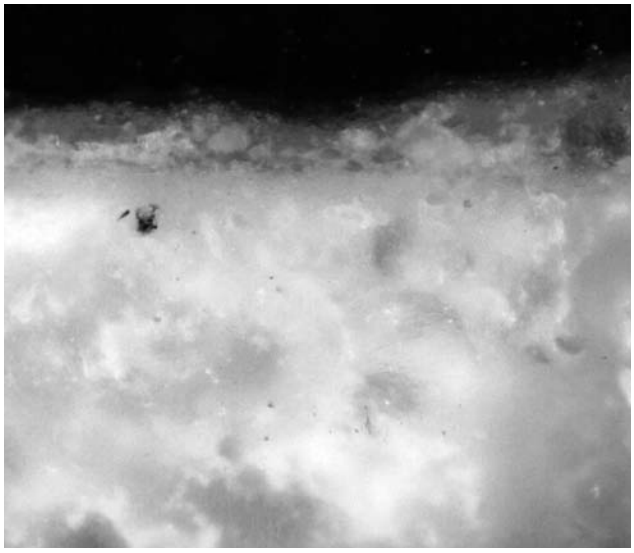

Figure 9. Maya blue (LM). Palace residences of La Blanca Acropolis.

origin, ferric-based reds, pinks, oranges, yellows and ochres (hematite, goethite and limonite), and indigo blues and greens established with inert substrates of white clay and, generally, attapulgite clay. This colour palette was identical to that used for the same purposes in other settlements within the Mayan lowlands between the Preclassic and Postclassic periods, though it lacks some of the pigments used at these other sites, such as cinnabar or specular hematite for the reds, ilmenite for the oranges or calcium apatite for the yellows and ochres. While the pigments employed to decorate the palaces, temples and tombs of the Mayan lowlands were also used for the same purpose in Mesopotamia, Egypt, Crete, Greece, Etruria, Rome, India, Tibet, Japan or China, among other civilizations of the ancient world, these other cultures incorporated other pigments into their colour palette that could not be included in the wall painting of the Mayan lowlands due to the absence of the minerals required for their preparation, which then meant an ensuing parsimony with regards to these other cultures.

ACKNOWLEDGEMENTS

Financial support is gratefully acknowledged from the Generalitat Valenciana GVAE06/131 and ACOMP/2007/138 Projects and the MEC Projects CTQ2005-09339-C03-01 and 02, which are also supported with FEDER funds as well as the project ascribed to the program of postdoctoral stages of novel researchers at Spanish universities and research centres from the Generalitat Valenciana. The authors would also like to acknowledge Dr. Cristina Vidal and Gaspar Muñoz, the leaders of the intervention project at the La Blanca site. The authors wish to thank Mr. Manuel Planes Insausti and Dr. José Luis Moya López for technical assistance.

NOTES

[1] The *La Blanca Project* is financed by the Spanish Ministry of Culture. The following organizations are also collaborating with the Project: The Ministry of Foreign Affairs through the Spanish International Cooperation Agency; the Universidad Politécnica de Valencia; UNESCO Forum; the Universidad de Valencia; the Universidad San Carlos de Guatemala and the Guatemala Natural and Cultural Heritage Department.

[2] The chemical-analytical characterization of mural painting in the Mayan lowlands began at the laboratories of the Carnegie Institution in Washington in 1931. The mural of the Temple of the Warriors at Chichén Itza was the first work to be studied with H. Merwin as the scientist in charge of this pioneering research.

[3] The chemical-analytical study of wall painting in the Mayan lowlands was established in a definitive manner in the 1990s by the *La Pintura Mural Prehispánica en México* project, founded by Dr. Beatriz de La Fuente at the Institute of Aesthetic Research of the National Autonomous University of Mexico. The multi-disciplinary approach characterizing this project since its conception ensured that one of its lines of research was the chemical identification of the materials and painting techniques used in these works. This was an aspect that, with the exceptions of those studies carried out in the 1930s on the Postclassic mural painting of Chichén Itzá and those conducted in the forties at Bonampak and in the early eighties in Palenque, had not been given prior consideration.

[4] The removal and transfer of painting specimens from La Blanca and the surroundings was conducted at all times with approval from the Guatemala Natural and Cultural Heritage Department.

[5] The only Mayan wall paintings that have been identified as containing these copper pigments are those used at Structure I at Bonampak, Structure I at Ichmac, Structure I at Xuelén, room 22 of the Nun's Quadrangle at Chichén Itzá, the Jaguar House at Xelhá and Structure 86 in Group B at this same settlement.

[6] Cinnabar has been detected in various mural paintings in the Mayan lowlands from the Classic and Postclassic periods. The earliest known example of the use of cinnabar may be seen in the wall paintings at Bonampak. At approximately the same time, trail No. 1 at Kajtún on the Rio Bec, was also painted with cinnabar. Some time later, in 695 AD, cinnabar was used in the wall decoration of the tomb of the King of Calakmul, *Yuknom Yich'ak K'ak*, also known as Garra de Jaguar. Finally, the polychromy of certain Postclassic architecture on Isla Uayamil in Campeche (Mexico) also included cinnabar among the pigments forming their colour palette.

[7] Pigment prepared with malachite or one of its copper, silica, calcium carbonate and natron variations. The earliest use of this pigment dates back to the IV Dynasty (c. 2300 BC), Old Kingdom.

BIBLIOGRAPHY

Agrawal, O. (ed.): *Wall paintings of India: A Historical perspective*, INTACH Conservation Centre, Lucknow, India.

Agrawal O., y Wickramasinghe N. (2002): *Materials & Techniques of Ancient Wall Paintings of Sri Lanka*, INTACH (Advanced Centre for Conservation, Research & Training), New Delhi, India.

Álvarez, C. (1984): *Diccionario etnolingüístico del idioma maya yucateco colonial*: Aprovechamiento de los Recursos Naturales, Vol. II, Universidad Nacional Autónoma de México, México D.F.

Andreotti, A., *et al.*, (2003): "Caracterizzazione di pigmenti pompeiani rosa": *Scienze e Archeologia. Giornate di Studio*, Pompei, 171-179.

Bearat, H. (1997): "Quelle est la gamme exacte des pigments romains? Confrontation des resultats d´analyse et des textes de Vitruve et de Pline", en *Roman Wall Painting. Materials, Techniques, Analysis and Conservation*, *Proceedings of the International Workshop Fribourg 7-9 March 1996*, ed. H. Béarat, M. Fuchs, M. Maggetti and D. Paunier, Fribourg, 11-34.

Bianchetti P. *et al.*, (2000): "Production and characterization of Egyptian blue and Egyptian green frit", *Journal of Culture Heritage* **1** 179-188.

Bonavia, D. (1985): *Mural Painting in Ancient Peru*, Indiana University Press, Bloomington.

Colinart S. *et al.*, (1996): "Couleurs et pigments de la peinture de l´Egypte Ancienne, *Techné* **4** 29-45.

Doménech A. *et al.*, (2007a): "Electrochemical monitoring of indigo preparation using Maya's ancient procedures", *Journal of Solid State Electrochemistry* **11** 1335-1346.

Doménech A. *et al.*, (2007b): "Chemometric Study of Maya Blue from the Voltammetry of Microparticles Approach", *Analytical Chemistry* **17** 2812-2821.

Doménech A. *et al.*, (2007c): "Indigo/Dehydroindigo/Palygorskite Complex in Maya Blue: An Electrochemical Approach", *Journal of Physical Chemistry* **111** 4585-4595.

Doménech A. *et al.*, (2006b): "Dehydroindigo: A New Piece into the Maya Blue Puzzle from the Voltammetry of Microparticles Approach", *Journal of Physical Chemistry* **110** 6027-6039.

Illouz C. (1985): *Les sept trésors du lettré. Les matériaux de la peinture Chinoise et Japonaise*, EREC, Puteaux, France.

Magaloni D. (1996): *Materiales y técnicas de la pintura mural maya*, tesis de maestría, Facultad de Filosofía y Letras, Universidad Nacional Autónoma de México, México D.F.

Magaloni D. (1998): "El arte en el hacer: técnicas de pintura mural", en: *Fragmentos del pasado: Murales Prehispánicos*, ed. M.T. Uriarte, Instituto de Investigaciones Estéticas-Universidad Nacional Autónoma de México, México D.F., 88-109.

Magaloni D., *et al.*, (1993): "Los pintores de Bonampak": *Eight Palenque Round Table*, ed. M.G. Robertson, Pre-Columbian Art Research Institute, San Francisco Vol. X 159-168.

Mazzochin, G.A., *et al.*, (2004) "A short note on Egyptian blue", *Journal of Cultural Heritage* **1** (5) 129-133

Merwin, H. (1931): "Chemical Analysis of Pigments", en *The Temple of Warriors at Chichen Itza, Yucatan*, eds. E. Morris, A. Morris y J. Charlot, Carnegie Institution of Washington, Publication 406, Washington D.C., 395.

Morley S. (1982): *La civilización maya*, Fondo de Cultura Económica (4ª ed.), México D.F.

Muñoz, G., y Vidal C. (eds.) (2005): *La Blanca. Arqueología y Desarrollo*, Universidad Politécnica de Valencia, Valencia.

Muñoz, G., y Vidal C. (eds.) (2006): *La Blanca. Arquitectura y Clasicismo*, Universidad Politécnica de Valencia, Valencia.

Nicholson, P., y Shaw, I. (eds.) (2000): *Ancient Egyptian Materials and Technology*, Cambridge University Press, Cambridge.

Pomiès M.P., et al., (2000): « Lascaux, pigments préhistoriques à base d´oxydes de fer: hématite naturelle collectée ou goethite chauffée ? »: *Art et Chimie. La Coleur. Actes du Congrès*, CNRS Editions, Paris, 22-27.

Regert M., *et al.*, (1998) : « Etude analytique de matières colorantes paléolithiques »: *Art & Chimie. La Coleur. Résumés*, Ministère de l´Education Nationale de la Recherche et de la Technologie, Paris, 191-192.

Sa Dug, K. (1999): "The present condition in the conservation traditional wall paintings in Korea": *Ninth Seminar on the Conservation of Asian Cultural Heritage: Conservation of Wall Paintings in Asia*, Tokyo, 48-58.

Sharer, R. (1998): *La civilización maya*, Fondo de Cultura Económica (3ª ed.), México D.F.

Twilley J. (1998): « Materials of the Monastic Wall Paintings of Western Tibet »: *Art & Chimie. La Coleur. Résumés*, Ministère de l´Education Nationale, de la Recherche et de la Technologie, 1998, Paris, 129-130.

Vázquez de Ágredos, M.L. (2006): *Recursos materiales y técnicas pictóricas en los murales de las tierras bajas mayas*, unpublished doctoral thesis (Cristina Vidal Lorenzo Dir.), Universidad de Valencia, Valencia.

Vázquez de Ágredos, M.L. (2005): "Caracterización químico-analítica de las bases de preparación y de la paleta cromática de las pinturas de Río Bec, Campeche, México", en: *Proyecto Río Bec. Informe de la temporada de campo 2005*, eds. D. Michelet, M.CH. Arnaud y P. Nondoneo, unpublished, France.

Vázquez de Ágredos, M.L. (2004): "Informe de los pigmentos de pinturas halladas en Isla Uaymil", en: *El Surgimiento de la civilización en el Occidente de Yucatán. Los orígenes de la complejidad social en Sihó. Informe de la temporada de campo 2004*, ed. R. Cobos, México D.F., 145–151.

AUTHORS

Mª Luisa Vázquez de Ágredos Pascual: Doctor in Geography and History by the Universitat de València, and "European" Doctor in Conservation of Cultural Heritage by the Universitat Politécnica de València.
Researcher at the Institut de Restauració del Patrimoni of the Universitat Politécnica de València.
Professor for the Official Master's Degree courses in Science and Restoration at the Department of Conservation and Restoration of Cultural Property of the Universitat Politécnica de València.

Mª Teresa Doménech Carbó: Doctor in Chemistry by the University of Valencia. Professor at the Universitat Politécnica de València.
Professor in the Department of Conservation and Restoration of Cultural Property, specialist in chemical and physical analysis of works of art.
Director of the Institut de Restauració del Patrimoni of the Universitat Politécnica de València.

Antonio Doménech Carbó: Doctor in Chemistry by the Universitat de València. Senior Lecturer in the Department of Analytical Chemistry of the University of Valencia, specialist in chemical analysis of materials with electrochemical techniques, particularly the analysis of works of art by solid state electrochemistry .

Versión española

TITULO: ***La paleta de colores in la arquitectura de La Blanca (Petén, Guatemala). Comparación entre la de las tierras bajas mayas y la que se empleó en otras civilizaciones del mundo antiguo***

RESUMEN: *La caracterización química de los restos de pintura mural que se han conservado en la arquitectura palaciega de la ciudad maya de La Blanca (Departamento de Petén, Guatemala) y su interpretación a la luz de los conocimientos que existen actualmente sobre las artes de esta antigua cultura de América es una de las líneas de investigación que ha potenciado El Proyecto La Blanca desde sus inicios en el año 2004. La importancia de los datos que han sido obtenidos desde entonces explica que en el último año esta línea de investigación se haya extendido hacia otros asentamientos de esta región de las tierras bajas mayas con la intención de analizar las relaciones que hubo entre los materiales, las técnicas y los pintores que trabajaron en ella. Así ha sido como se ha obtenido un panorama bastante representativo de los materiales con los que se ejecutó la pintura mural de esta milenaria civilización prehispánica, lo que en última instancia ha permitido iniciar comparaciones muy precisas entre estas obras y las que se realizaron en otras culturas del mundo antiguo*

PALABRAS CLAVES: *La Blanca, Petén, Guatemala, cultura maya, arte precolombino, pintura mural, pigmentos, arquitectura*